

U.S. Transportation Satellite Accounts for 1992

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THIS ARTICLE introduces the transportation satellite accounts (TSA's), which are an extension of the U.S. input-output (I-O) accounts.¹ Satellite accounts rearrange information from the basic economic accounts for the purpose of analyzing important economic activities more completely than is otherwise possible. They expand the analytical capacity of the basic accounts without overburdening them with details or interfering with their general-purpose orientation. The TSA's were jointly developed by the Bureau of Transportation Statistics (BTS) of the U.S. Department of Transportation and the Bureau of Economic Analysis (BEA).² In 1994, BEA introduced a set of prototype economic and environmental satellite accounts and a satellite account for research and development expenditures; BEA is also developing satellite accounts for travel and tourism that will be introduced in a few months.³

Like other satellite accounts, the TSA's provide a more comprehensive measure of an economic activity by bringing together components of that activity wherever they occur throughout the economy, including activities which are internal to the firm and for which there are no observable

prices. In this case, the activity is transportation, and the intrafirm transportation activities identified in the TSA's include, for example, the transportation activities that are conducted by a grocery company's truck fleet when it moves goods from warehouses to the retail outlets of the grocery store chain. The TSA's identify and aggregate such transportation activities whether they are purchased from other firms or performed by other units in the same firm and present the data on both an industry and a commodity basis.

The TSA's are based on and are an extension of the I-O accounts. They are the result of rearranging the 1992 I-O data using additional information from other sources of transportation data so as to provide a unified picture of the impact of transportation on the U.S. economy. The TSA's cover both the transportation activities conducted on a for-hire basis, which are identified as transportation within the published I-O accounts, and those conducted by businesses for their own use, which—though included—are not separately identified as transportation activities in the I-O accounts. The estimates from the TSA's, therefore, have several major advantages for transportation analyses.

First, the TSA estimates provide a more comprehensive measure of all transportation activities, both in terms of their contribution to the economy and their use of inputs from other industries in the economy. For example, the value added of transportation industries as defined in the TSA's represents 5.0 percent of gross domestic product (GDP) in 1992. In contrast, the total value added of all transportation industries identified in the I-O accounts is 3.1 percent of GDP for the same year.⁴ In addition, the TSA's show that transportation industries used \$33.2 billion of petroleum products in 1992, while the I-O accounts show that transportation industries used \$21.6 billion of these products in the same year.

1. For a description of the I-O accounts, see Ann M. Lawson, "Benchmark Input-Output Accounts for the U.S. Economy, 1992: Make, Use, and Supplementary Tables," *SURVEY OF CURRENT BUSINESS* 77 (November 1997): 36-82; and "Benchmark Input-Output Accounts for the U.S. Economy, 1992: Requirements Tables," *SURVEY* 77 (December 1997): 22-47.

2. The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) established BTS and charged it with carrying out various statistical functions, including "compiling, analyzing, and publishing a comprehensive set of transportation statistics to provide timely summaries and totals (including industry-wide aggregates and multi-year averages) of transportation-related information." ISTEA also mandated that "such statistics shall be suitable for conducting cost-benefit studies (including comparisons among individual transportation modes and intermodal transport systems) and shall include information on—(A) productivity in various parts of the transportation sector." See appendix A of *The Bureau of Transportation Statistics—Priorities for the Future* (National Academy Press, 1997) by the National Research Council. In its first annual report to the U.S. Congress, BTS recommended that special studies be undertaken to measure total transportation services in a way that is consistent with the national economic accounts. See pages 4-5 of the *Transportation Statistics Annual Report, 1994*, prepared by BTS.

3. For a description of the environmental satellite accounts, see "Integrated Economic and Environmental Satellite Accounts" and "Accounting for Mineral Resources: Issues and BEA's Initial Estimates," *SURVEY* 74 (April 1994): 33-72; for a description of the research and development account, see "A Satellite Account for Research and Development," *SURVEY* 74 (November 1994): 37-71. For the travel and tourism satellite accounts, BEA is proceeding with funding provided by the International Trade Administration of the Department of Commerce.

4. Industries in the I-O accounts that provide transportation commodities for hire as their primary products include the following: Railroads and related services and passenger ground transportation; motor freight transportation and warehousing; water transportation; air transportation; pipelines, freight forwarders, and related services; and State and local government passenger transit. These industries are described in table 2.

Second, the TSA estimates show more accurately the total use of transportation across industries, as shown in table 1. For example, in the I-O estimates, the largest user of transportation was manufacturing (\$80.2 billion, 21.0 percent), followed by motor freight and warehousing (\$35.0 billion, 9.2 percent), services (\$21.5 billion, 5.6 percent), and air transportation (\$14.4 billion, 3.8 percent). In the TSA estimates, the largest user was still manufacturing (\$102.0 billion, 18.7 percent), but the next largest user was services (\$63.5 billion, 11.6 percent), followed by construction (\$52.2 billion, 9.6 percent) and wholesale and retail trade (\$51.8 billion, 9.5 percent).

Third, the TSA estimates on transportation are not affected by changes in the way transportation is provided, and therefore they provide a more reliable representation of transportation in the economy. For example, when a grocery company contracts out its internal trucking operations to a common carrier trucking company, the I-O estimates show an increase in the output of transportation; when the company switches back to its internal operations for its trucking needs, the I-O estimates show a decrease in the output of transportation. In contrast, the TSA estimates remain unchanged in both cases.

The first section of this article explains why the TSA's were developed. The second section provides a conceptual overview of the TSA's, including their relationship to the I-O accounts. The third section describes the major components of the TSA's. The fourth section provides a methodological overview of the estimation

anx derivation of the TSA's. The final section summarizes the TSA estimates for 1992.

Background

Current statistics on transportation from the I-O accounts and other data sources do not provide a comprehensive and consistent view of transportation activities in the economy. Specifically, the I-O accounts separately identify only transportation that is provided on a for-hire basis—that is, services provided by common carriers of freight and passengers—but not those that are provided by a business for its own use—for example, delivery of furniture by a retailer using either an owned or leased truck.

Current measures of transportation activities

The current statistics on transportation from various public and private sources are presented in different ways, reflecting the multifaceted nature of transportation and the variety of uses for the statistics. The major methods of presentation include the following:

- *By what is transported:* The transportation statistics are divided into two broad groups—the conveyance of goods (freight transportation) and the conveyance of people (passenger transportation).
- *By mode of transportation:* The statistics are organized according to the means of transportation, such as rail, urban transit, highway, air, water, and pipeline.
- *By industry provider of transportation:* The statistics focus on those businesses or estab-

Table 1.—Total Use of Transportation Across Industries

Industry	Commodity					
	Millions of dollars at producers' prices			Percent		
	For-hire transportation	Own-account transportation	Total transportation	Share of total for-hire transportation	Share of total own-account transportation	Share of total transportation
Agriculture, forestry, and fisheries	5,720	13,177	18,897	1.5	8.0	3.5
Mining	2,810	3,870	6,680	.7	2.3	1.2
Construction	13,286	38,950	52,235	3.5	23.5	9.6
Manufacturing	80,248	21,806	102,054	21.0	13.2	18.7
Railroads and related services; passenger ground transportation	3,470	.....	3,470	.9	.....	.6
Motor freight transportation and warehousing	35,049	.....	35,049	9.2	.....	6.4
Water transportation	5,889	.....	5,889	1.5	.....	1.1
Air transportation	14,409	.....	14,409	3.8	.....	2.6
Pipelines, freight forwarders, and related services	1,294	.....	1,294	.3	.....	.2
State and local government passenger transit	173	.....	173	(*)	.....	(*)
Own-account transportation	1,306	.....	1,306	.3	.....	.2
Communications and utilities	8,803	1,187	9,990	2.3	.7	1.8
Wholesale and retail trade	8,963	42,819	51,783	2.4	25.9	9.5
Finance, insurance, and real estate	10,523	899	11,422	2.8	.5	2.1
Services	21,482	42,035	63,517	5.6	25.4	11.6
Other ¹	4,500	718	5,218	1.2	.4	1.0
Total commodity output	381,300	165,461	546,761	100.0	100.0	100.0

* Less than 0.1 percent.

1. "Other" consists of government enterprises (except state and local government passenger transit) and other input-output special industries. See Ann M. Lawson, "Benchmark Input-Output

Accounts for the U.S. Economy, 1992: Make, Use, and Supplementary Tables," SURVEY OF CURRENT BUSINESS 77 (November 1997): 58-62.

lishments that sell transportation in the marketplace. These establishments as a group are referred to as an industry, such as the air transportation industry, water transportation industry, and motor freight transportation industry.

Though useful for certain analytical purposes, the existing transportation data do not provide a comprehensive and comparable measure of the contribution of all transportation activities to an economy for two reasons.

First, they do not identify those transportation activities for which there are no corresponding, identifiable market transactions. Second, the data are often presented in a way that does not provide a common basis for comparison.

In the first case, the I-O accounts identify only for-hire transportation activities. Most of the estimates on transportation in the I-O accounts are based on data from the Census Bureau⁵ that are collected at the establishment level of detail and are classified on the basis of the 1987 Standard Industrial Classification (SIC) system.⁶ Two types of establishments are distinguished in the SIC: *Operating* establishments primarily produce goods or provide services for personal or household use or for use by other enterprises; *auxiliary* establishments primarily perform management or support services within the same enterprise.⁷ If transportation activities are conducted by an operating establishment, the activities are referred to as “for-hire” transportation, and the establishment is classified as transportation in the SIC system. If transportation activities are conducted as a support activity by an operating establishment within a

nontransportation enterprise, they are referred to as “own-account” transportation. Data on these own-account transportation activities are not identified separately from the primary activity of the establishment; hence they are not classified as transportation in the SIC system. In the SIC system, an exception is made for auxiliary establishments primarily engaged in long-distance trucking, stevedoring, water and pipeline transportation within nontransportation enterprises; these establishments are classified as for-hire transportation operating units in the SIC system, but auxiliary establishments performing other types of transportation activities are not.⁸

In the second case, there are different forms of limitations in the transportation statistics. Data from many sources, including various government transportation agencies and trade organizations, provide information on the physical characteristics of the transportation system—such as number of trips taken, number of people and tonnage of goods transported, and number of firms providing specific types of transportation. Though they usually cover all the activities for specific modes of transportation, two characteristics limit their usefulness. First, they are often measured in physical units, such as ton-miles and passenger-miles, rather than in dollar

8. Under the newly developed North American Industrial Classification System (NAICS), an auxiliary establishment is classified according to the nature of its own activity. Therefore, auxiliary establishments primarily engaged in transportation activities are classified as transportation.

5. The Census Bureau collects information—such as revenues, payroll, and employment—for all for-hire transportation industries except railroads and air transportation in the quinquennial Census of Transportation, Communications, and Utilities (TCU). In addition, the Census publishes in the quinquennial TCU data collected by other sources on railroads and air transportation. Data on railroad transportation were collected by the Association of American Railroads. Data on air transportation were collected by the Office of Airline Statistics, U.S. Department of Transportation.

Data on revenues and expenses for the trucking and warehousing industries are from the annual Motor Freight Transportation and Warehousing Survey. Data on flows of commodities are from the Commodity Flow Survey, and those on flows of passengers are from the American Travel Survey, both of which are collected every 5 years. Data on the physical and operational characteristics of trucks are collected from the Truck Inventory and Use Survey, which is conducted at the same time as the quinquennial census.

6. The SIC system defines an establishment as an economic unit that is typically at a single location where business is conducted or where services or industrial operations are performed. An establishment is classified into an industry on the basis of the primary activity of the establishment, which is the activity that makes up the largest proportion of the establishment's output. All other activities of the establishment are secondary. See Office of Management and Budget, *Standard Industrial Classification Manual, 1987* (Springfield, Virginia: National Technical Information Service): 11–18 and 265.

7. Auxiliaries that primarily produce goods and services for other establishments of the same enterprise are generally classified as establishments in the industry where the goods or services are primary.

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values. Second, they are generally presented by mode of transportation, and detailed information on industry distributions of their use are not available. As a result, it is very difficult to use these data with data from the national economic accounts for industry analysis.

Satellite accounts

In general, satellite accounts are frameworks designed to expand the analytical capacity of the "basic" economic accounts without overburdening them with details or interfering with their general-purpose orientation. Satellite accounts, which are meant to supplement rather than to replace the existing accounts, organize information in an internally consistent way that suits their particular analytical focus, while maintaining links to the existing accounts. They typically expand a particular segment of the existing accounts with more details and additional dimensions of information, including nonmonetary information; in addition, they may use definitions and classifications that differ from those in the existing accounts. Depending on the analytical focus, the production boundary of the national accounts can be maintained or modified.⁹

In the United States, satellite accounts have been used to extend the analytical capacity of the national economic accounts in two ways. In 1994, BEA released the Integrated Economic and Environmental Satellite Accounts (IEESA's) and a satellite account for research and development expenditures. BEA also has produced supplementary balance of payments accounts that record U.S. trade and capital flows on an ownership basis rather than a residence basis. Currently, BEA is working with the International Trade Administration to develop satellite accounts for travel and tourism.

The 1993 manual of the System of National Accounts (SNA) recommends using satellite accounts to handle such situations as measuring own-account transportation.¹⁰ Own-account transportation in the TSA's is what is referred to as an "auxiliary" activity in the SIC and as an "ancillary" activity in the SNA manual. According to the SNA manual, an ancillary unit is one whose sole function is to produce one or more common types of services for intermediate consumption within the same enterprise. In the SNA,

ancillary units are not treated as separate units. However, it is suggested that for some types of analysis it may be useful and necessary to estimate and record the activities of ancillary units separately—preferably by using satellite accounts. In addition, the UN handbook of input-output accounts suggests the satellite account approach to estimating own-account transportation and including it in the output of the transportation industry.¹¹ The satellite account approach has also been used for own-account transportation in other countries. For example, France's Department of Transportation and Tourism developed national transportation satellite accounts in 1992.¹²

Conceptual Overview

As a satellite to the 1992 benchmark I-O accounts, the TSA's focus on transportation-related activities by industries. Its primary purpose is to provide a systematic and consistent framework and data set for conducting analytical studies of the role of transportation in the economy on both an industry and commodity basis.

Boundary of transportation

Transportation in the TSA's includes all activities related to the use of vehicles (such as trucks, aircraft, and boats) and of related structures (such as highways, airports, and port facilities) for the movement of goods and passengers. Specifically, transportation in the TSA's consists of six groups of for-hire transportation industries from the I-O accounts and a single group for own-account transportation. Table 2 lists all the for-hire transportation industries and one own-account transportation industry in the TSA's. The table also shows the major output components of these industries.

Relationship to the I-O accounts

The TSA's are a satellite to the I-O accounts. This relationship facilitates the construction and application of the TSA's in two ways. First, the I-O accounts provide detailed estimates of the intermediate purchases by industries, including the for-hire transportation industries; this detailed information can be used to prepare

11. United Nations, Statistics Division, *Handbook of National Accounting—Input-Output Table Compilation and Analysis*, Manuscript (November 1997): 149–50.

12. France's satellite account provides estimates of transportation expenditures by transportation modes in a framework similar to BEA's national income and product accounts. See Commission Des Comites Des Transports de la Nation, *Le Compte Satellite Des Transports En 1992*.

9. For a discussion of the purposes and characteristics of satellite accounts, see Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, World Bank, *System of National Accounts 1993*, pages 489–518.

10. See SNA 1993, page 490.

the TSA estimates. Second, the I-O accounts provide an analytical framework with detailed linkages among industries and between industries and final demand; this framework facilitates the estimates of the interdependencies between transportation and the rest of the economy.

What is the same.—The TSA's maintain the following I-O account treatments:

- The measurement of the value of own-account transportation activities is similar to that of own-account construction activities in the I-O accounts; that is, the intermediate inputs and the value-added inputs associated with the own-account construction, such as capital consumption allowance and labor costs, are moved—or, using I-O terminology, “redefined”—to the other industries in which the activities are primary. In the TSA's, these inputs are similarly redefined, but to a new industry—own-account transportation.

• The overall industry and commodity classification system and the special definitions and conventions in the I-O accounts are used in the TSA's except for the single new industry and commodity (own-account transportation).

- The total value added for all industries, or GDP, is the same in the TSA's as in the I-O accounts.¹³
- The general valuation conventions used in the TSA's are consistent with those in the I-O accounts. In particular, all transactions are valued in producers' prices, and

13. Though total value added for the total economy remains unchanged, the value-added estimate for transportation industries is increased by the amount of the value added of the own-account transportation that is subtracted from other industries' value added. In addition, though the output for each industry remains unchanged, the total output for all industries is increased by the amount of output identified for the own-account transportation industry; this is because the total of all purchases of intermediate inputs—including own-account transportation commodities—by industries is increased by the same amount as the sum of the own-account transportation industry output.

Table 2.—Components of Transportation Industry and Industry Output

Industry	Industry components	Industry output
For-hire transportation industries		
Railroads and related services; passenger ground transportation.	Railroads, including AMTRAK Switching and terminal companies Freight car rental Private local and suburban passenger transportation Intercity, rural, and other bus services, including charter and school buses Bus terminal and service facilities Taxicabs	Total operating revenues Less: Rental receipts
Motor freight transportation and warehousing.	Trucking and courier services, except air Public warehousing and storage Trucking terminal facilities	Total operating revenues Plus: Trucking receipts of construction firms Warehousing revenues of wholesalers Delivery and storage charges of retailers Less: Merchandise sales Rental receipts
Water transportation	Deep sea and other water transportation of freight Water transportation of passengers Services incidental to water transportation, including marinas and other services	Total operating revenues Plus: Docking and boat cleaning and maintenance at retailers Federal excise tax on cruise ship receipts Less: Merchandise sales Boat repair at marinas
Air transportation	Domestic and international passenger and freight air transportation ... Airport terminal services	Total operating revenues Plus: Federal taxes on air fares, air freight, and air facilities Aircraft storage and services by wholesalers and retailers Less: Rental receipts Flight training and instruction
Pipelines, freight forwarders, and related services.	Refined petroleum pipelines Other pipelines, including crude petroleum and natural gas Arrangement of freight and passenger transportation, including freight forwarding Miscellaneous services incidental to transportation	Total operating revenues Plus: Pipeline receipts by wholesalers Less: Rental receipts
State and local government passenger transit.	State and local government passenger transit	Total operating revenues Less: Operating subsidies
Own-account transportation industries		
Own-account transportation	Private trucking and bus operations in all nontransportation industries	Total operating expenses of highway motor vehicles and overhead expenses Less: Expenses on advertising, depository institutions, security and commodity brokers, and other services unrelated to own-account transportation operations

the valuations of purchases for final use are unchanged.

What is different.—The TSA's differ from the I-O accounts in the following ways:

- They introduce a new industry called “own-account transportation” whose output is a new commodity called “own-account transportation.” The own-account transportation commodity is only produced by the own-account transportation industry, and the own-account transportation industry only produces the own-account transportation commodity.
- The treatment of own-account transportation provided by an industry for its own use in the TSA's is different from the treatment of for-hire transportation used by an industry in the I-O accounts. In the TSA's, the use of own-account transportation by an industry includes the costs of operating the industry's own trucks and buses, whether those trucks are used to move the industry's intermediate inputs or its output. In the I-O accounts, the use of for-hire transportation by an industry includes only those transportation expenses associated with moving intermediate inputs to the industry plus the expenses for certain direct use of transportation commodities. For example, if a for-hire truck carries wheat from a farm to a mill, the I-O use table shows this activity as the mill using the trucking services, whether the services are purchased by the farm or the mill. If an own-account truck of the mill is used, the TSA use table shows this activity as the mill using the services; however, if an own-account truck of the farm provides the same services, the TSA use table shows this activity as the farm using the services.

Future work

The TSA's now provide a comprehensive picture of all for-hire and most own-account transportation activities. Future work could proceed in several directions to improve and extend the accounts. These include the following:

- The TSA's omit own-account transportation activities through modes other than truck and bus—such as the business use of automobiles and water transportation. These omissions can be addressed as additional information becomes available. For example, when the capital flow table for the

1992 benchmark I-O accounts is published by BEA later this year, additional information on the business use of automobiles will be available upon which to base estimates of related operating expenses for own-account transportation activities in the TSA's.¹⁴

- The accounts may be expanded to include the service values of government-owned transportation capital, such as highway infrastructure, and to include transportation provided by households for their own use, such as commuting to and from work in a privately owned automobile. Inclusion of these services in the TSA's would result in the expansion of the production boundary beyond that of the I-O accounts.
- Because the value of own-account transportation output cannot be measured directly, its output in the current TSA's is valued by summing the costs of all the intermediate inputs and the value-added inputs of compensation, indirect business taxes, and capital consumption allowances that are used for its production. Though this approach is frequently used to measure the value of own-account types of production, the resulting estimates of output are understated because they do not include profits. As a result, such estimates have limited value for productivity analyses and similar types of studies. An alternative approach would be to value own-account transportation output as the product of a quantity measure of output and the market price for a similar service. This approach requires the development of quantity and price estimates of for-hire transportation. Before this approach can be implemented, however, quantity measures for transportation activities at the detailed industry-level must be developed. For the TSA's, consistent measures of the related inputs would also have to be estimated.
- The treatment of own-account transportation used by industries in the TSA's may also be improved. Ideally, the TSA's should treat the use of own-account transportation as the I-O accounts treat the use of for-hire transportation, but doing so requires detailed information on the type of commodities carried by own-account trucks and on the

14. The capital flow table (CFT) shows how much each industry used of each type of new structures and equipment contained in gross private fixed investment (GPI) in the I-O use table. In other words, the CFT disaggregates GPI to show the flows of structures and equipment to using industries.

origin and destination of the transported commodities.

Components of the Transportation Satellite Accounts

The TSA's consist of four tables. The TSA make table (table 3) and the TSA use table (table 4) present for-hire and own-account transportation in a complete I-O framework. The TSA direct requirements table (table 5) presents the industry use of intermediate and value added inputs as a percentage of the industry output. The TSA total requirements table (table 6) presents industry-by-commodity output multipliers.¹⁵ This section presents the four TSA tables and their descriptions.

TSA make table

The TSA make table is an I-O make table with an additional column for own-account transportation as a commodity and an additional row for an aggregation of all redefined industry own-account transportation activities as an industry. An I-O make table shows the value in producers' prices of each commodity produced by each industry. In each row, the cell on the main diagonal shows the value of the production of the commodity for which the industry has been designated the primary producer. The other cells in the row show the value of the production of commodities for which the industry is a secondary

producer. The sum of all the entries in a row is the total output of that industry.

In the TSA make table, the own-account transportation industry produces only the own-account transportation commodity, and the own-account transportation commodity is produced only by the own-account transportation industry. Therefore, the cell value at the intersection of the additional column and row equals the total output of own-account transportation; all other cell entries in the own-account transportation column and row are zero. The data shown in the other parts of the TSA make table are the same as those provided in the 1992 I-O make table.

TSA use table

The TSA use table is an I-O use table with an additional row for the own-account transportation commodity and an additional column for the aggregation of all redefined industry own-account transportation activities as an industry. An I-O use table shows the values in producers' prices of own-account transportation and all other intermediate and value-added inputs used by industries or final users. The cell in each row of a given column shows the commodity that is used by the industry or final user in that column. The sum of all the entries in a row is the total output of the commodity in that row, and the sum of all the entries in a column is the total output of the industry in that column.

In the TSA use table, the use of the own-account transportation commodity is shown in the own-account transportation row. By assumption, the following cell values are equal to zero: The

15. This article presents these tables at a highly aggregated level of industry and commodity detail. For additional detail, see the box "Data Availability" on page 26.

Table 3.—The TSA Make of Commodities by Industries, 1992

(Millions of dollars at producers' prices)

Industry	Commodity														Total industry output		
	Agriculture, forestry, and fisheries	Mining	Construction	Manufacturing	Transportation						Communications and utilities	Wholesale and retail trade	Finance, insurance, and real estate	Services		Other ¹	
					Railroad and passenger ground	Motor freight and warehousing	Water	Air	Pipelines and freight forwarders	Own-account transportation							
Agriculture, forestry, and fisheries	235,591	0	0	1,022	0	11	0	0	0	0	0	0	0	0	1,038	0	237,682
Mining	0	147,001	0	9,716	0	0	0	0	0	0	0	0	0	0	0	0	156,717
Construction	0	0	679,330	0	0	0	0	0	0	0	0	0	0	0	0	0	679,330
Manufacturing	0	561	0	2,879,654	0	0	0	0	0	0	0	43	0	0	69,509	1,536	2,951,303
Railroads and related services; passenger ground transportation	0	0	0	0	55,576	174	0	0	0	0	0	0	0	0	0	4	55,754
Motor freight transportation and warehousing	0	0	0	0	0	155,590	0	0	0	0	11,363	0	0	0	0	0	166,953
Water transportation	0	0	0	0	0	0	32,440	0	0	0	0	0	0	0	0	0	32,440
Air transportation	0	0	0	0	0	0	0	94,141	0	0	0	0	0	0	0	0	94,141
Pipelines, freight forwarders, and related services	0	0	0	0	542	1,320	194	2,632	28,928	0	0	0	0	0	0	0	33,616
State and local government passenger transit	0	0	0	0	5,876	0	0	0	0	0	0	0	0	0	0	0	5,876
Own-account transportation	0	0	0	0	0	0	0	0	0	165,461	0	0	0	0	0	0	165,461
Communications and utilities	0	0	0	0	0	0	0	0	0	0	491,312	0	0	0	28,838	538	520,688
Wholesale and retail trade	0	0	0	0	0	0	0	0	0	0	0	1,091,489	0	0	0	0	1,091,489
Finance, insurance, and real estate	0	0	0	0	0	0	0	0	0	0	0	0	1,629,618	25,114	0	1,654,732	
Services	0	0	0	8	0	15	0	0	38	0	0	0	666	2,226,302	521	2,227,550	
Other ¹	0	0	0	37	64	0	1,713	2,046	0	0	48,012	3,659	9,132	3,301	846,432	914,396	
Total commodity output	235,591	147,562	679,330	2,890,437	62,058	157,110	34,347	98,819	28,966	165,461	550,730	1,095,148	1,639,416	2,354,102	849,031	10,988,108	

1. "Other" consists of government enterprises (except state and local government passenger transit) and other input-output special industries. See Ann M. Lawson, "Benchmark Input-Output Accounts for the U.S. Economy, 1992: Make, Use, and Supplementary Tables," SURVEY OF CURRENT BUSINESS 77 (November 1997): 58-62.

direct effects of changes in final uses on for-hire and own-account transportation industries and commodities can be derived. For example, this table can be used to analyze the relative effects on transportation and nontransportation industries of an increase in personal consumption expenditures or of a change in the composition of fixed investment that results from a change in business activity.¹⁶

16. When using the TSA industry-by-commodity total requirements coefficients to estimate the effects of changes in final uses on industries and commodities, the underlying I-O assumptions have to be kept in mind. For example, the table is based on a set of relationships that exist between producers and consumers in a given year; these relationships assume that technology and relative prices are constant. The interindustry relationships reflect the average input structure in each industry for that year, but these relationships do not necessarily reflect the input structure of an additional unit of production. Therefore, for analyses that require alternative assumptions, other

This table shows the total requirements coefficients for each industry group's output that is directly and indirectly required to deliver a dollar of a commodity to final users. Each column shows the commodity delivered to final users, and each row shows the total production that is required from an industry in response to a dollar change in the final demand for a commodity. The coefficients in the table are referred to as industry-by-commodity total requirements coefficients. The table is derived from both the TSA make and the TSA use tables.

The last row of the table shows the sum of all the changes in industry outputs that are required

economic tools may be required. See Lawson, "Benchmark Input-Output Accounts for the U.S. Economy, 1992: Requirements Tables," footnote 2.

Table 5.—The TSA Commodity-by-Industry Direct Requirements, 1992

[Direct requirements per dollar of industry output, at producers' prices]

Commodity	Industry														Communications and utilities	Wholesale and retail trade	Finance, insurance, and real estate	Services	Other ¹
	Agriculture, forestry, and fisheries	Mining	Construction	Manufacturing	Transportation						Own-account transportation								
					Railroad and passenger ground	Motor freight and warehousing	Water	Air	Pipelines and freight forwarders	State and local passenger transit									
Agriculture, forestry, and fisheries	0.23382	0.00027	0.00593	0.04171	0.00002	0.00002	0.00018	0.00001	0.00000	0.00034	0.00000	0.00012	0.00082	0.00406	0.00308	0.00034			
Mining .....	.00125	.16581	.00802	.03185	.00000	.00000	.00028	.00000	.00247	.00000	.00000	.10455	.00003	.00000	.00001	.00294		
Construction .....	.01210	.01694	.00081	.00612	.04421	.00441	.00092	.00254	.01708	.28319	.00411	.05778	.00664	.03203	.00866	.02131		
Manufacturing .....	.15566	.07304	.29433	.34464	.12867	.07678	.09889	.14023	.04388	.58884	.08921	.03952	.04037	.01020	.10220	.00953		
Railroads and related services; passenger ground transportation .....	.00637	.00663	.00191	.00500	.04247	.00265	.00059	.00136	.00098	.01174	.00127	.00948	.00081	.00059	.00120	.00122		
Motor freight transportation and warehousing .....	.01359	.00585	.01516	.01523	.00660	.17256	.00321	.00248	.00622	.00851	.00477	.00198	.00317	.00348	.00409	.00146		
Water transportation .....	.00183	.00273	.00106	.00144	.00140	.00125	.13200	.00174	.00167	.00494	.00111	.00161	.00016	.00003	.00021	.00043		
Air transportation .....	.00192	.00263	.00142	.00389	.00384	.00373	.00237	.06441	.00693	.00017	.00006	.00283	.00380	.00222	.00360	.00180		
Pipelines, freight forwarders, and related services .....	.00034	.00009	.00001	.00162	.00793	.02974	.04337	.08307	.02270	.00408	.00068	.00101	.00028	.00004	.00054	.00001		
Own-account transportation .....	.05544	.02470	.05734	.00739	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00228	.03923	.00054	.01887	.00079		
Communications and utilities .....	.01664	.04606	.00639	.02517	.01069	.03294	.00592	.01738	.04296	.10943	.02721	.10729	.03070	.01701	.02398	.00930		
Wholesale and retail trade .....	.04683	.01659	.07913	.05552	.03060	.03488	.01603	.01599	.00970	.05157	.04102	.00871	.01703	.00253	.01976	.00091		
Finance, insurance, and real estate .....	.06533	.12241	.01652	.01649	.03316	.03659	.06134	.03353	.05262	.01974	.00799	.02668	.06514	.13884	.06910	.00499		
Services .....	.02503	.03214	.09531	.06603	.06764	.09837	.14908	.09457	.19738	.03642	.08455	.09540	.11416	.07462	.13599	.00851		
Other ¹ .....	.00066	.00748	.00102	.00833	.00595	.00672	.09137	.09479	.01166	.00068	.00352	.01502	.01014	.01006	.00667	.00284		
Total value added .....	.36316	.47663	.41564	.37956	.61682	.49937	.39445	.44790	.58377	-.11964	.73450	.52575	.66754	.70374	.60003	.93363		
Total	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000			

1. "Other" consists of government enterprises (except state and local government passenger transit) and other input-output special industries. See Ann M. Lawson, "Benchmark Input-Output Accounts for the U.S. Economy, 1992: Make, Use, and Supplementary Tables," SURVEY OF CURRENT BUSINESS 77 (November 1997): 58-62.

Table 6.—TSA Industry-by-Commodity Total Requirements, 1992

[Total requirements, direct and indirect, per dollar of delivery to final demand, at producers' prices]

Industry	Commodity														Communications and utilities	Wholesale and retail trade	Finance, insurance, and real estate	Services	Other ¹
	Agriculture, forestry, and fisheries	Mining	Construction	Manufacturing	Transportation						Own-account transportation								
					Railroad and passenger ground	Motor freight and warehousing	Water	Air	Pipelines and freight forwarders	State and local government passenger transit									
Agriculture, forestry, and fisheries	1.32661	0.01332	0.03876	0.09211	0.02170	0.01294	0.01632	0.01771	0.00952	0.01085	0.01181	0.00901	0.01095	0.01863	0.00129				
Mining .....	.02486	1.21270	.03724	.07757	.02166	.01678	.01578	.01861	.01754	.01309	.14927	.01112	.00706	.01539	.00157			
Construction .....	.02990	.03596	1.01361	.02256	.08035	.01778	.02867	.02141	.03166	.01155	.08671	.01687	.04379	.02004	.01025			
Manufacturing .....	.38378	.20388	.53168	1.61763	.35810	.20657	.25097	.29130	.14239	.18043	.17479	.12020	.07032	.25783	.01666			
Railroads and related services; passenger ground transportation .....	.01081	.01005	.00567	.00971	.93508	.00645	.00290	.00385	.00283	.00286	.01312	.00228	.00163	.00332	.00070			
Motor freight transportation and warehousing .....	.03265	.01728	.03216	.03545	.01965	1.20178	.01339	.01314	.01311	.01172	.03892	.00947	.00863	.01320	.00230			
Water transportation .....	.00368	.00437	.00249	.00331	.00295	.00235	1.07995	.00299	.00207	.00171	.00326	.00066	.00038	.00091	.00030			
Air transportation .....	.00565	.00545	.00532	.00834	.00662	.00714	.00584	1.01853	.00835	.00180	.00535	.00554	.00364	.00600	.00208			
Pipelines, freight forwarders, and related services .....	.00360	.00232	.00322	.00563	.01990	.04849	.05630	.11725	1.02072	.00192	.00389	.00174	.00107	.00239	.00040			
State and local government passenger transit .....	.00114	.00106	.00060	.00102	.09886	.00054	.00031	.00041	.00030	.00030	.01349	.00024	.00017	.00035	.00007			
Own-account transportation .....	.08477	.03800	.07340	.02732	.01426	.00966	.01112	.01000	.00981	1.00758	.00169	.04612	.00716	.02783	.00197			
Communications and utilities .....	.04616	.07109	.03732	.05871	.04215	.05863	.03498	.04387	.06043	.04027	1.01879	.04493	.02836	.05502	.00589			
Wholesale and retail trade .....	.09563	.04149	.12252	.10595	.06712	.06200	.04238	.04242	.02704	.05725	.03537	1.02887	.01433	.04198	.00286			
Finance, insurance, and real estate .....	.13299	.19132	.06742	.07475	.07277	.08603	.11907	.08024	.09163	.03365	.07896	.09975	1.16842	.12299	.00558			
Services .....	.10472	.09420	.17678	.14030	.13189	.11707	.17807	.23439	.17358	.24863	.12187	.13360	.15692	.11124	1.13745			
Other ¹ .....	.01570	.02481	.01589	.02668	.01963	.02223	.16886	.13190	.02566	.01275	.12372	.02428	.02360	.02239	.99993			
Total industry output multiplier	2.30265	1.96730	2.16408	2.30704	1.91269	1.93744	2.08123	1.98721	1.71169	1.50960	1.89544	1.57800	1.50075	1.74572	1.06082				

1. "Other" consists of government enterprises (except state and local government passenger transit) and other input-output special industries. See Ann M. Lawson, "Benchmark Input-Output Accounts for the U.S. Economy, 1992: Make, Use, and Supplementary Tables," SURVEY OF CURRENT BUSINESS 77 (November 1997): 58-62.

to deliver a dollar of each commodity to final users. Because each of these sums is a dollar multiple of the initial dollar spent for a commodity group's output, the sum is often referred to as an "industry output multiplier." These multipliers can be used to estimate the impact of changes in the final uses of commodities on total industry output.¹⁷

Methodological Overview

The TSA's were estimated in two broad steps. First, the inputs used by each industry for its own-account transportation activities were estimated. Second, these estimates were used with the I-O make and use tables to derive the TSA tables. The following sections describe these two steps in more detail. The major sources of data are identified in table 7.

Estimating the transportation inputs

Transportation inputs include both intermediate inputs and value-added inputs. The value of these inputs for each industry in the I-O use table is for a combination of all uses. The TSA transportation estimates were separated from all other uses through the following steps.

- **Identifying the transportation-related inputs.**—A set of commodity inputs that are unique to or are mostly used for transportation were identified from the estimates underlying the I-O accounts. These inputs, which are called

"transportation-related inputs" (TRI's), consist of motor gasoline, light fuel oil, liquefied petroleum gases, tires, motor vehicle parts, and automotive repair services.

- **Developing industry distribution weights.**—Distribution weights were developed that can be used separately or in combination to distribute TRI commodities to using industries. Nine sets of weights were developed using industry-level information for the number of buses, the number of trucks, miles driven by trucks, and fuels used by trucks. These weights were based on several data sources, the most important of which are the Truck Inventory and Use Survey from the Census Bureau and the occupational employment data from the Bureau of Labor Statistics and the Census Bureau.
- **Distributing TRI's.**—For each TRI commodity, an estimate was made of its total usage for nontransportation purposes, such as gasoline used for heating or for operating machinery; this nontransportation use was subtracted from the total output of the commodity. The remaining amount of the commodity was then distributed to different transportation modes. Finally, for modes for which the current TSA's provide estimates of own-account transportation, the distribution weights were matched with and applied to the TRI's.
- **Estimating other inputs.**—Transportation activities require certain inputs that are not uniquely or mainly used for transportation. For example, office supplies and accounting services are shared by transportation and all other production activities. The transportation use of these commodities was estimated

¹⁷ For more information on the derivation of the industry-by-commodity total requirements table, see Appendix D in U.S. Department of Commerce, Bureau of Economic Analysis, *Benchmark Input-Output Accounts of the United States, 1987* (Washington, DC: U.S. Government Printing Office, November 1994).

Table 7.—Principal Data Sources

Data	Sources
Estimates of input-output accounts, 1992	U.S. Department of Commerce, Bureau of Economic Analysis, <i>Benchmark Input-Output Accounts for the U.S. Economy, 1992</i> (forthcoming) and detailed underlying data files for the I-O accounts.
Trucks, truck mileage, fuel use by industry, 1992	U.S. Department of Commerce, Census Bureau, 1992 Census of Transportation, <i>Truck Inventory and Use Survey—United States</i> , May 1995.
Statistics on occupation and industry, 1990	Census Bureau, 1990 Census of Population and Housing, <i>Occupation and Industry—National and State Totals</i> (CD-ROM), March 1995.
Employment of truck drivers by industry, 1992	U.S. Department of Labor, Bureau of Labor Statistics, Employment Projection Division, <i>Industry-Occupation Employment Matrix, 1983-1993</i> (Diskettes).
Energy use, 1992	U.S. Department of Energy, Energy Information Administration, <i>Annual Energy Review</i> , historical data for 1949-1996. EIA Website.
Energy use by transportation modes, 1992	U.S. Department of Energy, Oak Ridge National Laboratory, <i>Transportation Energy Data Book: Edition 14</i> , May 1994.
Vehicle miles of travel by type of vehicles, 1992	U.S. Department of Transportation, Federal Highway Administration, <i>Highway Statistics 1993</i> .

for each industry using the relationships from for-hire transportation industries.¹⁸

Two assumptions underlie these TSA procedures: First, that the distribution weights selected are reliable predictors of the use of TRI's for own-account transportation; second, that the distribution of commodity inputs (except for some value-added inputs) within a for-hire transportation industry is similar to the distribution of these inputs within a nontransportation industry for its transportation-related activities.

Deriving the TSA make and use tables

The TSA make and use tables are I-O make and use tables that have been modified using the estimates of transportation inputs. First, the estimates of transportation inputs for each industry are arranged in a transportation input matrix so that its rows and columns correspond to those in the intermediate industry portion of the I-O use table.¹⁹ Second, this input matrix is subtracted from the intermediate industry portion of the I-O use table; the result is a residual use table that shows the intermediate and value-added inputs to industries for nontransportation activities. Third, the TSA make table is derived by adding an additional column and an additional row—representing own-account transportation—to the I-O make table. Fourth, the TSA use table is derived by combining the residual use table derived above, an own-account transportation column with row totals from the transportation input matrix, an own-account transportation row with column totals from the transportation input matrix, and the final-demand portion of the I-O use table.

Estimates of Transportation for 1992

This section discusses how the results from the TSA's can be used to assess the size and impact of transportation in the U.S. economy.

Transportation as a share of GDP

From the TSA's, a measure of transportation value added on an expanded industry basis provides a picture of transportation in comparison to the

18. Adjustments were made before and after applying the for-hire relationship. First, some commodities, such as advertising and brokerage services that are used by for-hire transportation industries but not by other industries for own-account transportation, were excluded. Second, estimates were made to reflect the total use in the I-O accounts. Third, the estimates of value-added inputs were adjusted to exclude profits.

19. Inputs for for-hire transportation industries in this matrix are all zeros because it is assumed that these industries do not have any own-account transportation activities.

economy as a whole that is more comprehensive than that provided by the corresponding industry-basis measure found in the I-O accounts. Comparisons of aggregate measures such as total value added between for-hire and own-account transportation indicate the importance of including own-account transportation in the analyses of transportation.

Own-account transportation activities generated \$121.5 billion of value added in 1992, and for-hire transportation generated \$191.6 billion. Together, these activities accounted for 5.0 percent of U.S. GDP in 1992—3.1 percent from for-hire and 1.9 percent from own-account.

Use of transportation by industry

The biggest industry user of own-account transportation services was the wholesale and retail industry group, which generated and used \$42.8 billion of the output of such services, accounting for 25.9 percent of total own-account transportation (table 1); in contrast, this industry group used only \$9.0 billion of for-hire transportation services output.²⁰ The next largest group was services, which used \$42.0 billion, accounting for 25.4 percent of the own-account total; this in-

20. See the section "Conceptual Overview" for an explanation of the different treatment of the uses of own-account and for-hire transportation in the TSA's.

Data Availability

This article presents the aggregated estimates of the 1992 transportation satellite accounts (TSA's). Summary estimates for 99 industries at the I-O summary level and detailed estimates for 499 industries at the I-O six-digit level are available on the following diskettes:

- The summary estimates for the make, use, direct requirements, and industry-by-commodity total requirements tables (one diskette)—product number NDN-0193, price \$20.00.
- The estimates at the I-O six-digit level of the make, use, and direct requirements tables (three diskettes)—product number NDN-0194, price \$60.00.
- The estimates at the I-O six-digit level of industry-by-commodity total requirements (one diskette)—product number NDN-0195, price \$20.00.

To order using Visa or MasterCard, contact the BEA Order Desk at 1-800-704-0415 (outside the United States, call 202-606-9666). To order by mail, send a check made payable to "Bureau of Economic Analysis, BE-53" to BEA Order Desk, BE-53, Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC 20230.

dustry group used only \$21.5 billion of for-hire services. The smallest user (excluding the group "other") was the finance, insurance, and real estate industry group.

Alternatively, measuring the use of own-account transportation as a share of an industry's total output (in I-O terminology, the direct requirements for own-account transportation) presents a different picture. According to this measure, the construction industry group was the largest user among all industry groups, at 5.7 percent. In contrast, the share for the wholesale and retail industry group, which was the largest user in absolute terms, was 3.9 percent, less than the share for agriculture (5.5 percent), which was only the fifth largest user in absolute terms. The finance, insurance, and real estate industry group had the smallest share.

The same measure for for-hire transportation shows the direct importance of for-hire transportation services in an industry's total output. Except for the transportation industries, manufacturing had the largest direct requirement of for-hire transportation services, at 2.7 percent. The industry groups of trade, of finance, insurance, and real estate, of services, and of "other" each had less than 1 percent.

Transportation cost by commodities


The use of transportation on an industry basis differs from that on a commodity basis because many industries produce more than one commodity and many commodities are produced by more than one industry. To analyze the importance of direct transportation costs in the producers' prices of commodities, both own-account transportation costs and for-hire transportation costs were distributed on a commodity-by-commodity basis.²¹

Among nontransportation commodity groups, agriculture, forestry, and fisheries had the highest

transportation content (8.0 percent), followed by construction (7.7 percent), reflecting the general pattern of the use of transportation by industry. For both commodity groups, own-account transportation costs had a larger share in the total transportation cost than for-hire. The services commodity group had a transportation content of 2.8 percent, of which 1.8 percentage points were own-account and 1.0 percentage point were for-hire. The commodities of finance, insurance, and real estate and "other" had the lowest transportation content, at less than 1 percent each.

Transportation and multipliers

The multipliers derived from the TSA's capture the total interdependence between transportation and the rest of the economy. Excluding changes in the final demand for transportation services itself, transportation as a combined group of industries, including both for-hire and own-account, was most affected by the changes in the final demand for agriculture, forestry, and fisheries commodities. For example, a 1-dollar increase in the demand for these commodities caused an increase of 14.2 cents in total transportation industry output, while a 1-dollar increase for services commodities caused only a 5.4-cent increase. For own-account transportation alone, the response pattern was similar, but for-hire transportation alone was more responsive to the changes in demand for communications and utilities and for manufacturing commodities.

The changes in demand for transportation services also induce changes in the output of transportation and of all other industries. This effect can be measured by the total industry output multiplier. The pipelines and freight forwarders group had the lowest total industry output multiplier, at 1.7. The multiplier for each of the other transportation groups was above 1.9. Overall, the economy's response to changes in demand for transportation was larger than that for communications and utilities, for trade, for finance, insurance, and real estate, and for services, but less than that for agricultural, construction, and manufacturing commodities. 

21. The total direct use of own-account transportation for an industry from the TSA use table is distributed to the commodities produced by the industry, using the industry's output mix from the I-O make table. Repeating this procedure for every industry results in a table that shows the contributions of own-account transportation within each industry to the output of various commodities, that is, the direct costs of own-account transportation in the producers' prices of commodities.

The direct costs of for-hire transportation are distributed to commodities in the same manner. If a commodity is produced in more than one industry, then the commodity will receive the distributed own-account and for-hire transportation costs from more than one industry; the sum of all these costs is the direct cost of transportation in the producers' prices of that commodity.