Measuring Transportation in the U.S. Economy

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ABSTRACT

This paper argues that the System of National Accounts (SNA) is the most appropriate framework for comparable economic measures of national transportation, and shows that within the SNA transportation can be represented as an industry, as a component of Gross Domestic Product (GDP) measured from the demand side and as a component of Gross Domestic Demand (GDD). Two measures of transportation comparable to GDP and one comparable to GDD are presented. Transportation-related final demand is the measure of transportation as a component of GDP, which includes the value of all goods and services delivered to final users for transportation purposes regardless of which industry produced them. In contrast, transportation industry GDP is the measure of transportation as an industry, which comprises value-added created in the provision of transportation services by the industry. Transportation domestic demand measures the U.S. domestic final demand for transportation regard-

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less of who supplies the demand, domestic producers or imports. It differs from transportation-related final demand in that it excludes the balance of trade in transportation goods and services.

INTRODUCTION

Transportation exists in every phase and facet of life today. For those living in an industrialized economy, transportation's importance should be too obvious to warrant lengthy elaboration. Measuring transportation's economic importance, however, is not as obvious, even for transportation experts.

Historically, the most widely used measure of transportation's role in the economy has been the "Transportation Bill" (Eno 1996). The Transportation Bill is constructed from statistics on revenues and expenditures, and attempts to measure the sum total of economic transactions for transportation services, equipment, and so forth. While this reflects how much is spent on transportation throughout the economy, it does not measure how much the transportation industry contributes to the total economy nor does it measure the final demand for transportation in a way that is consistent with other established economic measures, such as GDP. By using a framework that is consistent with the System of National Accounts one can measure transportation's share of the economy in a way that is directly comparable to GDP.

After a summary discussion of aggregate measures of the economy in the SNA, we discuss measuring transportation in the SNA from two perspectives, production and final demand. Following that, we present the three measures of transportation based on actual data from the U.S. National Income and Product Accounts (NIPA).

TRANSPORTATION IN THE SNA

The System of National Accounts consists of a coherent, consistent and integrated set of macroeconomic accounts, balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules. It provides a comprehensive accounting framework within which economic data can be compiled and presented in a format that is designed for purposes of economic analysis, decision-taking and policy-making. (UN et al 1993, 1, para. 1.1.)

One key statistic of the SNA is GDP, which is widely used as a summary indicator of the size of economic activity and the welfare of a nation. GDP is the sum of gross value-added by resident producer units (institutional sectors or industries). From the demand perspective, GDP is equal to the sum of the final uses of goods and services, measured in terms of purchasers' prices. The major components of GDP viewed from both the supply side and the demand side and their relationship to output are shown in figure 1.

From the demand perspective, the major components of GDP are consumer expenditures, government expenditures, capital investment, and net exports. These components are also often referred to as final demand, as distinguished from intermediate demand.[1] From the supply perspective, GDP consists of every industry's value-added, which includes labor compensation (wage and salary), business taxes, corporate profits, and depreciation of fixed capital. GDP measured as total value-added and as total final demand (or expenditures) are identical.[2] This identity can be easily derived from the following relations:

Intermediate demand + Final demand = Output
= Intermediate demand + Value-added

Final demand = GDP = Value-added

[1] While final demand consists of goods and services delivered to the consumers of economic output, intermediate demand, which is not counted in GDP consists of inputs into processes of production that are used up within the accounting period. A good deal of transportation is produced for intermediate consumption. Normally, households, governments, and foreign consumers and foreign producers are considered final users. In addition, capital formation (or private investment) is also considered as final demand.

[2] This identity between value-added and final demand exists only at the national level, however, and breaks down at the industry level. As an example, there is no final demand for pig iron, but the steel and iron industry generates value-added in producing pig iron. Through the input-output chain of production (e.g., pig iron is used as an input to produce steel, and steel is further used as an input to produce automobiles), the value-added generated by the steel and iron industry will eventually be embodied in the products delivered to final demand. Final expenditures on a product reflect the total value-added embodied in the product, which is the sum of the value-added generated in its production and all the value-added of the inputs used in the production.

FIGURE 1   Major Components of an Economy
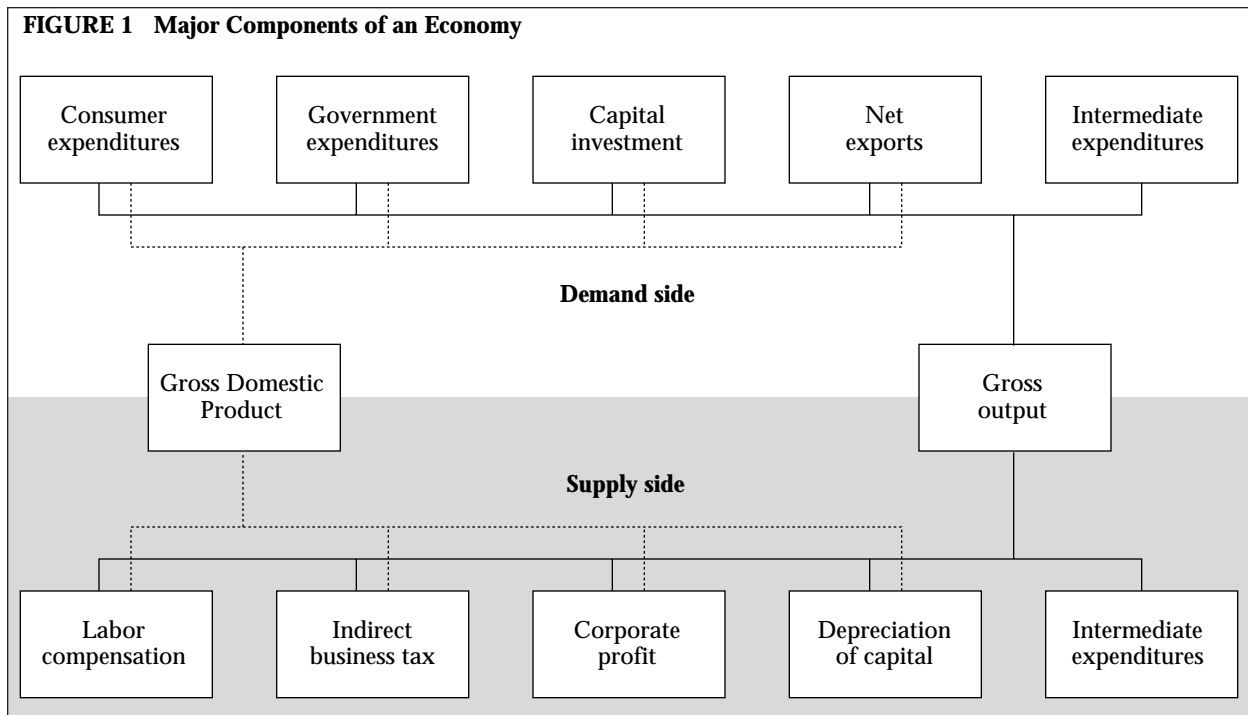
These identities give a comprehensive picture of the magnitude of an economy that remains the same when looked at from any angle.

Transportation appears on both the demand and supply sides of GDP. On the supply side, the output of transportation as an industry is measured. In both the Standard Industrial Classification system and the newly developed North American Industrial Classification System, transportation is identified as a separate industry group.

On the demand side, transportation appears as one of many distinct purposes for which households, governments, and others purchase goods and services. Within each broad expenditure category on the demand side in the SNA (see figure 1), expenditure items can be identified as transportation-related. Some obvious components include purchases of automobiles and gasoline, government expenditures on highways, and business expenditures on railway construction.

Because GDP measures the total amount of goods and services for final uses, as opposed to intermediate uses in production, transportation-related final demand measures how much of those goods and services were used for transportation purposes. But GDP also measures total value-added.

Transportation as an industry on the supply side measures how much of the total value-added was created in transportation industries. These two measures are qualitatively and quantitatively different. The measure of transportation as final demand includes the value of gasoline produced by the petroleum refinery industry and cement produced by the cement industry to the extent that they are part of final demand and used for transportation purposes. The measure of transportation as an industry would include value-added generated in transporting food from producer to consumer, although the food is not part of transportation final demand.

MEASURING TRANSPORTATION AS FINAL DEMAND

In the NIPA, GDP calculated from the final demand perspective is the sum of four components: personal (household) consumption expenditures, gross private domestic investment, net exports of goods and services, and government consumption expenditures and gross investment. (Various detailed breakdowns of these four components are presented in the NIPA tables. USDOC 1993–96)

PERSONAL CONSUMPTION EXPENDITURES

Personal consumption expenditures are broken down into 12 functional categories of which transportation is one. Expenditures included in the transportation function are:

1. User-operated transportation
    a. New autos
    b. Net purchases of used autos
    c. Other motor vehicles
    d. Tires, tubes, accessories, and other parts
    e. Repair, greasing, washing, parking, storage, rental, and leasing
    f. Gasoline and oil
    g. Bridge, tunnel, ferry, and road tolls
    h. Insurance
2. Purchased local transportation
    a. Mass transit systems
    b. Taxicabs
3. Purchased intercity transportation
    a. Railway
    b. Bus
    c. Airline
    d. Other

Gross Private Domestic Investment

Gross private domestic investment is the sum of fixed investment and the change in business inventories. Change in business inventories is typically very small relative to fixed investment and may be positive in one year and negative in the next. In the NIPA, fixed investment is divided into two broad categories: structures and producers' durable equipment. Private purchases of producers' durable equipment comprise five subcategories, one of which is transportation and related equipment. Transportation and related equipment is further broken into:

1. Trucks, buses, and truck trailers
2. Autos
3. Aircraft
4. Ships and boats
5. Railroad equipment

Net Exports of Goods and Services

Net exports of goods and services in the NIPA are calculated as exports of goods and services less imports of goods and services. "Exports and Imports of Merchandise by End-use Category" comprises six categories, one of which is automotive vehicles, engines, and parts.

U.S. exports and imports of transportation services are found in the NIPA tables on "U.S. International Transactions" and "Private Service Transactions" under four categories:

1. Passenger fares
2. Freight transportation services
3. Port services
4. Other transportation services

Government Consumption Expenditures and Gross Investment

The NIPA records information about federal government consumption and state and local government consumption separately, but transportation is a category in both tables. Within transportation, there are five subcategories: highways, water, air, railroads, and transit. Government investment in transportation concentrates primarily on infrastructure, more specifically, on highways and streets. (Expenditures on highways and streets are also listed in the NIPA table on "Purchases of Structures by Type," and should not be counted twice.) Expenditures under transportation in the two tables exclude defense transportation demand. Statistics on defense transportation expenditures are contained in the NIPA table "National Defense Purchases of Goods and Services" under "transportation of materials" and "travel of military persons."

Transportation-Related Final Demand

The summation of all the transportation-related components in each of the four categories gives the measure of *transportation-related final demand*. Transportation-related final demand is directly comparable to GDP, and its ratio to GDP can be used as an indicator of transportation's importance as a component of GDP. Table 1 presents the components of transportation-related final demand and its relationship to GDP.

In current dollars, transportation-related final demand totaled $847 billion in 1996, equivalent to 11% of GDP. Personal consumption is the dominant component of transportation-related final demand. Its share in the total was 71% in 1996. Gross private domestic investment and govern-

TABLE 1 U.S. Gross Domestic Product Attributed to Transportation-Related Final Demand
(Billions of current dollars)

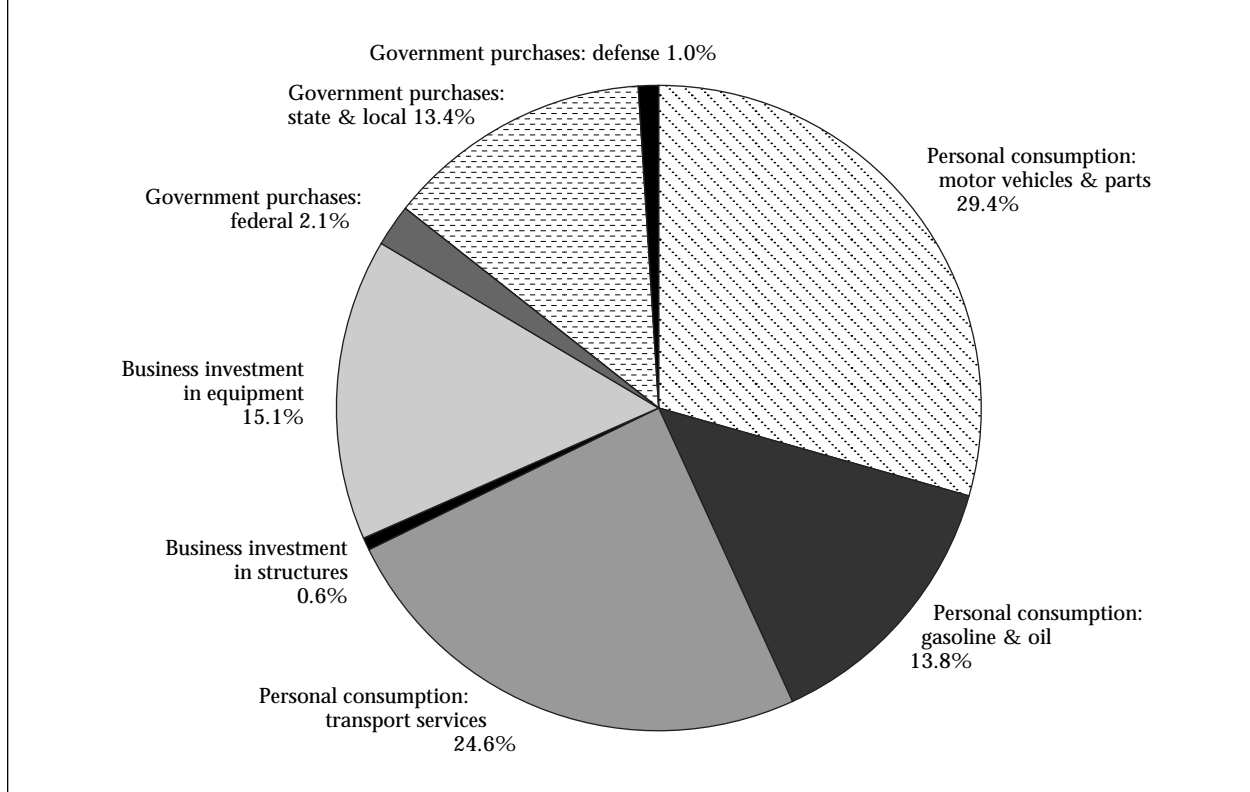|	1991	1992	1993	1994	1995	1996
Personal consumption of transportation	**436.8**	**471.6**	**504**	**542.2**	**572.3**	**602.3**
Motor vehicles and parts	187.6	206.9	226.2	246.6	254.8	261.3
Gasoline and oil	103.9	106.6	107.6	109.4	114.4	122.6
Transportation services	145.3	158.1	170.2	186.2	203.1	218.4
Gross private domestic investment	**82.7**	**89.9**	**104**	**122.9**	**130.1**	**140.1**
Transportation structures	3.2	3.7	4.1	4.3	4.4	5.6
Transportation equipment	79.5	86.2	99.9	118.6	125.7	134.5
Net trade of goods and services	**−16.8**	**−15.5**	**−25.8**	**−38.5**	**−42.8**	**−42.3**
Exports (+)	**115.8**	**125**	**124.9**	**131.3**	**134.4**	**143.6**
Civilian aircraft, engines, and parts	36.6	37.7	32.7	31.5	26.1	30.8
Automotive vehicles, engines, and parts	40	47	52.5	57.8	61.8	65
Passenger fares	15.9	16.6	16.6	17.1	19.1	20.6
Other transportation	23.3	23.7	23.1	24.9	27.4	27.2
Imports (−)	**132.6**	**140.5**	**150.7**	**169.8**	**177.2**	**185.9**
Civilian aircraft, engines, and parts	11.7	12.6	11.3	11.3	10.7	12.7
Automotive vehicles, engines, and parts	85.7	91.8	102.4	118.3	123.8	128.9
Passenger fares	10	10.6	11.3	12.9	14.4	15.8
Other transportation	25.2	25.5	25.7	27.3	28.3	28.5
Government transportation-related purchases	**121.2**	**123.4**	**126.9**	**133.6**	**139.1**	**146.5**
Federal purchases	16.2	16.8	17.6	18.8	17.9	18.7
State and local purchases	89.2	95.3	99.8	106.5	112.4	118.8
Defense-related purchases	15.8	11.3	9.5	8.2	8.8	9.0
Transportation-related final demand	**623.9**	**669.4**	**709.1**	**760.2**	**798.7**	**846.6**
Gross Domestic Product (GDP)	5,916.7	6,244.4	6,558.1	6,947	7,265.4	7,636
Transportation-related final demand in GDP	10.5%	10.7%	10.8%	10.9%	11.0%	11.1%
Transportation domestic demand	**640.7**	**684.9**	**734.9**	**798.7**	**841.5**	**888.9**
Gross Domestic Demand (GDD)	5,937.2	6,273.9	6,618.8	7,037.9	7,351.4	7,730.8
Transportation domestic demand in GDD	10.8%	10.9%	11.1%	11.3%	11.4%	11.5%

SOURCE: Calculated from data published in U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business,* various issues, 1996–97.

ment transportation-related purchases accounted respectively for another 16.5% and 17.3% of transportation-related final demand. The sum of the shares of personal consumption, gross private investment, and government purchases in transportation-related final demand was greater than 100%, because U.S. net exports of transportation-related goods and services were negative. International trade in transportation-related goods and services consistently ran a deficit over the six-year period from 1991 to 1996, primarily as a result of the automobile and parts trade deficit. In contrast, trade of civilian aircraft and parts ran a surplus, with exports consistently about three times imports.

If there were no international trade, the production of an economy would equal its consumption, and transportation-related final demand would be a good measure of the importance of transportation in the economy's final consumption. With international trade, what is produced by an economy and what is consumed by the economy may differ significantly. In the national accounts, a country's domestic final demand is called Gross Domestic Demand (GDD), to distinguish it from final demand for the products of the economy. In 1996, U.S. transportation-related final demand was $846.6 billion, while U.S. gross domestic demand for transportation was $888.9 billion, the difference being the net trade of transportation-related goods and services. Transportation GDD can be directly compared with total U.S. GDD to measure the importance of transportation in U.S. domestic

FIGURE 2   Components of Transportation Domestic Demand: 1996

Government purchases: defense 1.0%

Government purchases:
state & local 13.4%

Government purchases:
federal 2.1%

Business investment
in equipment
15.1%

Business investment
in structures
0.6%

Personal consumption:
transport services
24.6%

Personal consumption:
gasoline & oil
13.8%

Personal consumption:
motor vehicles & parts
29.4%

demand. Figure 2 presents the component structure of U.S. transportation GDD in 1996.

While transportation-related final demand is comparable to GDP, it is not a full and perfect indicator of the importance of transportation to society. First, a great deal of transportation is consumed as an intermediate demand and is not measured in transportation-related final demand. Second, transportation-related final demand covers only transportation services purchased in the market, and does not cover transportation services provided by consumers to themselves. For example, if a person rides a bus to work the fare he or she pays is counted as transportation-related final demand. But if he or she drives to work, the value of the driving service provided is not counted, because there is no market transaction. This kind of "household production" is not only important to measuring transportation, but is also a fundamental issue in the estimation of GDP in general. Although a full discussion of these issues is beyond the scope of this paper, they deserve our attention and demand future research.

Comparison of Transportation with Other Functions

The 11% share of transportation-related final demand in GDP provides a useful measure of the role that transportation plays in the economy. In order to see the relative importance of transportation compared with other major socioeconomic activities, we break GDP into six major categories according to the purposes for which goods and services are produced: housing, health care, food, transportation, education, and "other." Their values and shares in GDP are presented in table 2. Housing is the largest component of U.S. final demand, health care is second, food is third, and transportation is fourth.

Between 1991 and 1996, as the economy grew, the expenditures for all six functions increased, with transportation leading the growth. Transportation, housing, health care, and education grew faster than GDP, while food and "other" grew more slowly. The increase in the shares of health care and transportation in GDP and the decrease in the share of food reflected a general trend of economic development: as incomes

TABLE 2   Gross Domestic Product by Major Social Function: 1991–96

	1991	1992	1993	1994	1995	1996
	Billions of current dollars					
Gross Domestic Product	**5,916.7**	**6,244.4**	**6,558.1**	**6,947.0**	**7,265.4**	**7,636.0**
Housing	1,375.1	1,470.3	1,568.4	1,695.9	1,768.0	1,870.6
Health	806.9	881.2	945.8	1,002.9	1,052.7	1,105.4
Food	781.4	804.0	834.9	872.5	901.8	931.7
Transport	607.9	658.7	701.8	758.6	793.2	840.3
Education	409.0	428.4	447.2	472.7	498.0	525.2
Other	1,936.4	2,001.7	2,060.0	2,144.3	2,251.8	2,362.6
	Share in GDP (%)					
Gross Domestic Product	100.0	100.0	100.0	100.0	100.0	100.0
Housing	23.2	23.5	23.9	24.4	24.3	24.5
Health	13.6	14.1	14.4	14.4	14.5	14.5
Food	13.2	12.9	12.7	12.6	12.4	12.2
Transport	10.3	10.5	10.7	10.9	10.9	11.0
Education	6.9	6.9	6.8	6.8	6.9	6.9
Other	32.7	32.1	31.4	30.9	31.0	30.9

SOURCE: Calculated from data published in U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, various issues, 1996–97.

increase, demands shift away from basic needs to services that improve the quality of life, such as health care and personalized transportation.

MEASURING TRANSPORTATION AS AN INDUSTRY

Transportation is considered a service industry, because its outputs cannot be traded separately from its production. In the NIPA, the value of the market output of the transportation industry is calculated as the sum of the values of the following items within a year:

1. The total value of transportation services sold (at economically significant prices[3]).
2. The total value of transportation services bartered.
3. The total value of transportation services used for payments in kind, including compensation in kind.

4. The total value of transportation services supplied by one transportation establishment to another belonging to the same transportation company to be used as intermediate inputs.

The difference between the value of intermediate inputs to the transportation industry (goods and services such as gasoline and vehicle repair services) and the value of transportation outputs is the gross value-added of the transportation industry. Since GDP is made up of the gross value-added of all industries in the economy, gross value-added of the transportation industry is the conceptually correct measure of the contribution of the transportation industry to GDP.[4]

Transportation Industry GDP

Table 3 presents the breakdown of U.S. GDP by major industries in the 1990 to 1994 period. The formal transportation industry, or for-hire transportation industry, contributed $223 billion to the U.S. GDP in 1994. Between 1990 and 1994, trans-

[3] "Market output is output that is sold at prices that are economically significant or otherwise disposed on the market, or intended for sale or disposal on the market. Prices are said to be economically significant when they have a significant influence on the amount the producers are willing to supply and the amounts purchasers wish to buy." (UN et al 1993, 128, para. 6.45)

[4] Statistics on the gross value-added of each industry in the U.S. economy are annually compiled by the Bureau of Economic Analysis and published in the "Gross Domestic Product by Industry" table in the *Survey of Current Business.*

(Current dollars)

	1990		1991		1992		1993		1994	
	Billion $	%	Billion $	%	Billion $	%	Billion $	%	Billion $	%
Gross Domestic Product (GDP)	**5,744**	100.0	**5,917**	100.0	**6,244**	100.0	**6,550**	100.0	**6,913**	100.0
Agriculture, forestry, and fishing	109	1.9	103	1.7	112	1.8	105	1.6	118	1.7
Mining	112	2.0	101	1.7	92	1.5	89	1.4	90	1.3
Construction	245	4.3	229	3.9	230	3.7	244	3.7	269	3.9
Manufacturing	1,031	18.0	1,028	17.4	1064	17.0	1,117	17.0	1,197	17.3
Transportation	176	3.1	186	3.1	193	3.1	208	3.2	223	3.2
Communications	147	2.6	154	2.6	161	2.6	173	2.6	188	2.7
Electric, gas, and sanitary services	159	2.8	172	2.9	175	2.8	185	2.8	195	2.8
Wholesale trade	367	6.4	388	6.6	407	6.5	423	6.5	462	6.7
Retail trade	504	8.8	517	8.7	544	8.7	571	8.7	610	8.8
Finance, insurance, and real estate	1,025	17.8	1,083	18.3	1,149	18.4	1,214	18.5	1,274	18.4
Health services	308	5.4	338	5.7	369	5.9	385	5.9	408	5.9
Educational services	40	0.7	44	0.7	46	0.7	49	0.7	51	0.7
Other services	712	12.4	726	12.3	785	12.6	833	12.7	883	12.8
Government	793	13.8	840	14.2	874	14.0	900	13.7	931	13.5
Statistical discrepancy[1]	16	0.3	9	0.1	44	0.7	55	0.8	31	0.5

[1] Equals GDP measured as the sum of expenditures less gross domestic income.

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business,* August 1996, p. 150. 1994 is the most recent year for which GDP data by industry are available.

portation industry value-added grew 26%, with an average annual growth rate of 6%. During the same period, GDP increased 20%, with an average annual growth rate of 5%. As a result, the share of the transportation industry in GDP increased from 3.1% in 1991 to 3.2% in 1994. On a comparable level of classification and in terms of shares in GDP, the transportation industry is smaller than the health service and the construction industries, but larger than the communications, mining, and agriculture industries.

Based on the technology employed in providing transportation services, the transportation industry can be further broken down into seven sub-industries (see table 4). Among the seven transportation industries, trucking, including warehousing, is the largest. In 1994, the gross value-added of trucking was $95 billion, accounting for 43% of the overall transportation industry. Air transportation ranks second at 23% in 1994. During the past half century, the mode structure of the transportation industry changed drastically. These changes can be summarized as increasing shares of trucking and air transportation, and decreasing shares of rail (see figure 3).

## Future Improvement in Measuring Transportation

The transportation industry as covered in current national account statistics represents only a part, though the most important part, of all the commercial transportation activities in the U.S. economy. In addition to the transportation activities of the for-hire transportation industry, significant in-house transportation activities are produced by nontransportation industries. For example, a supermarket chain may own a truck fleet and use it to deliver groceries from central warehouses to individual stores. Such an in-house transportation activity is not counted as the output of the transportation industry in the NIPA, because the transportation industry is limited to only those establishments primarily providing for-hire transportation services according to the U.S. Standard Industrial Classification system. Even if all transportation produced by firms were accounted for, this would still fall short of the total value of transportation produced by society. Household-produced transportation is not a commercial activity and its value-added is not counted in GDP,

TABLE 4 Gross Domestic Product by Transportation Industries: 1990–94
(Current dollars)

	1990		1991		1992		1993		1994	
	Billion $	%	Billion $	%	Billion $	%	Billion $	%	Billion $	%
Transportation	**176.4**	100.0	**185.8**	100.0	**192.8**	100.0	**207.6**	100.0	**222.8**	100.0
Trucking	75.8	43.0	77.9	41.9	82.2	42.6	88.4	42.6	95.1	42.7
Air	39.4	22.3	40.8	22.0	43.0	22.3	48.6	23.4	51.1	22.9
Railroad	19.6	11.1	21.9	11.8	22.1	11.5	23.0	11.1	24.3	10.9
Transit	9.0	5.1	10.2	5.5	10.9	5.7	11.3	5.4	11.7	5.3
Water	9.7	5.5	10.7	5.8	10.3	5.3	10.3	5.0	10.6	4.8
Pipelines	5.0	2.8	5.0	2.7	4.9	2.5	5.2	2.5	5.7	2.6
Services	17.8	10.1	19.4	10.4	19.6	10.2	20.8	10.0	24.3	10.9

SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, August 1996, p. 150. 1994 is the most recent year for which GDP data by industry are available.

FIGURE 3 Mode Structure of Transportation GDP: 1959 and 1994
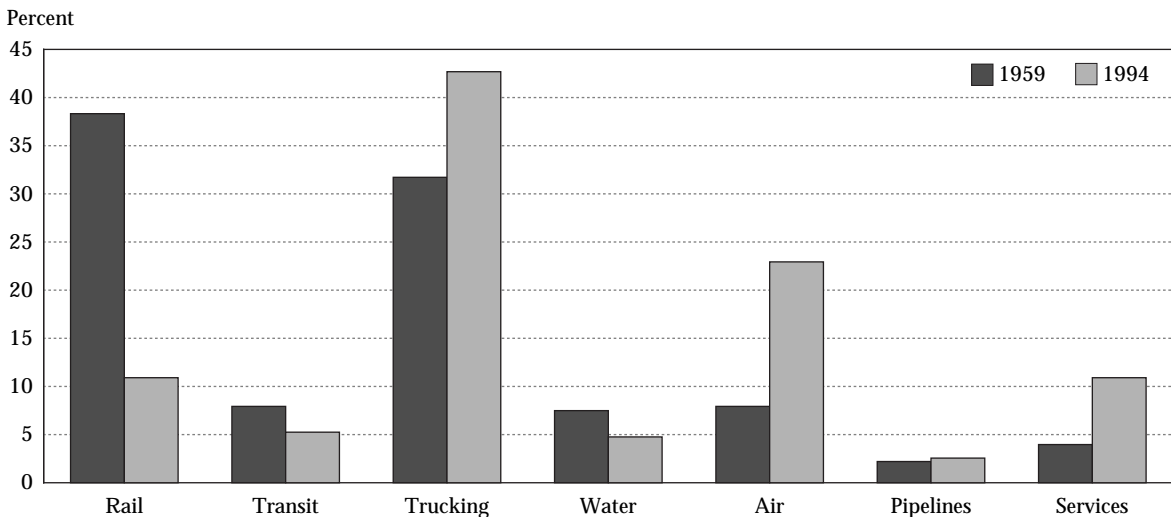
SOURCE: U.S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, August 1996.

although it is certainly a part of society's transportation activities.

To develop more comprehensive measures than can be obtained from the current national accounts system, the Bureau of Transportation Statistics (BTS) of the U.S. Department of Transportation and the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce are conducting research to estimate the size of in-house transportation activity in each industry of the economy. BEA's input-output account database provides the core of the data required for this project, and the resulting data from the project will be put into a format that is consistent with U.S. input-output accounts. Once this project is completed, BTS and BEA will be able to provide more accurate estimates of the contribution of productive transportation activities to U.S. GDP and conduct more comprehensive analyses of the role of transportation in the economy.

SUMMARY

Based on the SNA classification and accounting principles, this paper presents three alternative monetary measures of transportation: transportation-related final demand, transportation domestic

demand, and transportation industry GDP. Each measures transportation in a different way and is useful for different analytical purposes. An advantage all three measures share is their comparability with other economic measures available in the NIPA, most especially GDP. Transportation-related final demand and transportation industry GDP are both directly comparable to GDP. The former measures transportation from the demand side, the latter measures it from the supply side. Transportation domestic demand measures the importance of transportation in total U.S. domestic final demand. While none of the three is a perfect measure of the overall importance of transportation in the economy, each, properly understood, is a useful indicator of the significance of transportation in the economy.

ACKNOWLEDGMENTS

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