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Transportation Investment and GDP, Some Concepts, Data, and Analysis

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Executive Summary

Transportation investment consists of purchases of transportation fixed assets with a service life of more than one year and changes in inventories. Transportation fixed assets include transportation infrastructure, rolling stocks, and other equipment that are used in the provision of transportation services. Transportation investment, by implementing new technology, establishing continuity of routes and eliminating bottlenecks, and by improving the coverage and accessibility of the transportation network, helps augment the capacity and improve the efficiency of the transportation industry. Hence, statistics on transportation investment indicate the potential capacity and efficiency of transportation in future years. Transportation investment utilizes current economic resources. Transportation investment data show the quantity of economic resources allocated to transportation capital. Transportation investment data are also of great value to government for planning and budgeting purposes, to policy makers trying to understand the impacts of investment decisions, and to researchers interested in investigating the relationship between transportation investment and economic development or conducting other research in this area.

This report provides statistics on capital investment by sector (government, private business, and households), asset type (infrastructure, rolling stock, and other equipment used by transportation industries), and by mode of transportation (air, highway, water, mass transit, railroad, and pipelines). The investment dataset represents transportation investment before deducting depreciation of the existing capital; and this data is presented as a percentage of GDP, and wherever useful, as a percentage of total gross fixed capital formation. The report also provides a review of the literature that examines the linkage between transportation investment and economic performance, a survey of similar statistical works undertaken by other U.S. government agencies and agencies of foreign countries, a discussion of data sources and procedures used to develop the dataset, and a descriptive analysis of transportation investment in relation to GDP. The descriptive analysis is not intended to determine a causal relationship between transportation investment and economic development, which is beyond the scope of this report.

The following findings resulted from the descriptive analysis of transportation investment in relation to GDP:

- First, for the period running from 1987 to 2003, overall transportation investment (including household purchase of rolling stock) on average accounted for more than 6% of GDP. Of this overall transportation investment, investment in rolling stock accounted for an average of 80.5%, and that in transportation infrastructure and other transportation equipment averaged 14.7% and 4.8%, respectively.
- Second, while households are the primary purchasers of rolling stock, government is the dominant investor in transportation infrastructure with the exception of railroads and pipelines modes in which the business sector appears to be the major investor.

- Third, investment in highway infrastructure accounted for the largest share of the total transportation infrastructure investment (64%), followed by air (12.5%), and transit (7.5%) during 1987-2003.
- Fourth, investment in highway, water, and railroad infrastructure as a share of total infrastructure investment exhibited declining trends, while that for air, transit and pipeline increased between 1987 and 2003.
- Fifth, while overall transportation investment (of which 80.5% is in rolling stock) closely echoed the business cycle, investment in transportation infrastructure evidently lagged behind the business cycle. During 2001-2003, in particular, transportation infrastructure investment was declining, while GDP growth had already reached its lowest point in 2001 and begun recovering in 2002.
- Sixth, business sector's transportation investment has been more sensitive to the business cycle compared with its non-transportation investment.
- Finally, transportation investment made by non-transportation industries has been consistently greater than that of transportation industries. However, the intensity of use of transportation capital, particularly rolling stock, is much higher for transportation industries than for non-transportation industries.[1]

[1] Intensity of use of transportation capital is measured as the ratio of investment in transportation capital to value added (GDP) from transportation. GDP from transportation services is higher in the transportation industries relative to investment in transportation capital than it is for in-house transportation services in the non-transportation industries. This drives the above conclusion.

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1. Introduction

Transportation investment is defined as additions to transportation fixed assets. Transportation fixed assets refers to structures, motor vehicles, and other machinery and equipment, which are used in the provision of transportation services for more than one year. Due to data limitations, we exclude other machinery and equipment that are used in transportation by non-transportation-entities. Our definition thus reflects a combination of asset type and business characteristics of investors. Therefore, our list of transportation fixed assets includes all fixed assets within transportation industries and fixed assets that are transportation-specific and acquired by entities outside transportation industries. A fixed asset is transportation-specific when its only use is in transportation. For example, a pickup truck is transportation-specific whether or not it is used by a transportation entity, while a computer is not transportation-specific even if it is used by a trucking company. Therefore, our list includes all pickup trucks but only the computers used by transportation industries. Our extended definition of transportation assets and the related investment measures better serve transportation analysis purposes than measures of investment on a pure asset basis or industry basis.

Many public policy questions focus on infrastructure, and there is interest in the levels and patterns of investment in infrastructure. The data in this paper address infrastructure, but they also cover the transportation equipment (aircraft, railroad cars, trucks) that use the infrastructure. Many issues relating to the impact of transportation investment on the economy, such as impact on aggregate demand and employment, relate just as much to equipment as to infrastructure. Infrastructure investment can leverage equipment investment, by improving equipment turn times, and can impact directly on equipment maintenance costs. On the other hand inadequate equipment investment can constrain the transportation system even if infrastructure is adequate. By providing total investment data, but breaking out infrastructure investment, we provide data that can be used to address these issues. In this way we also provide data that is comparable to investment data in national account statistics and in the Government Transportation Financial Statistics reports.

Transportation investment or additions to transportation fixed assets can take two forms, purchase of new assets and change in inventories. Both purchases of new fixed assets and change in inventories are incorporated in our transportation investment estimates. Purchases are conducted by government, business, and households. Change in inventories consists of the current production of goods for transportation use that are not used or sold. Examples of change in inventories include motor vehicle inventories in the hands of manufacturers and dealers, work in progress on construction of transportation infrastructure, etc. Here is another innovation of our approach to measuring transportation investment, i.e., counting household purchase of transportation assets as investment. The national accounts classify household purchase of motor vehicles under current consumption to satisfy current national accounting principles, but household transportation activities are an integral component of overall transportation operations and should be so treated for transportation analysis purposes. Such treatment on the operations side requires similar treatment on the investment side.

The total value of investment, calculated before deducting depreciation or the portion of investment that is used to replace depreciation of the existing transportation capital stock, is referred to as gross investment. Deducting the depreciation from gross investment provides net investment, which represents the net addition to the stock of transportation capital for the period. Whether the transportation capital stock increases or decreases over a given period of time depends upon whether gross investment is greater or less than depreciation. Although the net investment is often more informative than gross investment, calculating it requires extensive measurement work in capital stock accounting.

Transportation investment relates to the economy on both the demand and supply sides. Data on transportation investment have many different uses in dissecting the inter-relationship between transportation and the economy. First, as additions to the stock of transportation capital, transportation investment helps augment the capacity and efficiency of transportation by implementing new technology, establishing continuity of routes, eliminating bottlenecks, improving the coverage and accessibility of the transportation network. Thus, the level of transportation investment indicates the potential capacity and efficiency of transportation, and its contribution to the overall economy for years to come.

Second, as a component of aggregate demand, transportation investment shows the amount of economic resources devoted to transportation capital. A time series of transportation investment and its percentage share in GDP provide an overview of changes in the resource allocation, and the relationship between transportation and GDP over time.

Third, data on transportation investment can be used to support policy analysis on the dynamics of transportation infrastructure, transportation technology, and the industrial structure in relation to the overall economy. Moreover, the relationship between public and private investment in transportation has been an ongoing research interest of academics. For example, the data can support research studies that attempt to investigate whether an increase in public investment displaces private investment or encourages private investors to invest more.

Fourth, transportation investment as a final demand (use) is affected not only by the total output but also by structural changes in the economy. For example, during a given period, a steady increase in transportation investment as a percentage of GDP could be accompanied by an increase or a decrease in overall capital investment as a percentage of GDP. Change in transportation investment in relation to overall capital investment might indicate a change in the future structure of the economy.

Fifth, there are two major types of fixed capital, namely, infrastructure and rolling stock, for transportation. While the private sector is the major investor in rolling stock, government is the major investor in infrastructure. This may, however, differ among transportation modes. For example, whereas highway infrastructure is almost entirely funded by the government, railroad and pipelines are mostly investments of the private

sector. Therefore, data on transportation investment by sector of investors, types of assets, and transportation mode provide a clearer picture of transportation investment patterns for each of the transportation modes.

Finally, transportation investment by mode of transportation can indicate possible structural changes *within* the transportation industry, which is important for transportation policy making. For example, a significant switch in capital investment between different modes (e.g., from air transportation to public transit) or unmatched growth for different types of assets within a single mode (e.g., a rising annual growth rate in the number of motor vehicles on the road compared with a much lower growth rate in highway investment) may signal a need to adjust future transportation investment plans.

It is apparent from the above discussion that statistics on transportation investment are of great value for transportation planning and budgeting purposes, policy makers interested in understanding the impacts of transportation investment, and for researchers interested in investigating the link between transportation investment and economic development. In order to serve these and other related purposes, the data compilation effort should go beyond producing aggregate statistics on transportation investment. The effort should produce comprehensive statistics, incorporating public and private investment, and also it should be as detailed as possible.

2. Objective, Scope and Organization

The main purpose of this report is to provide time series data on transportation investment in fixed assets, which include infrastructure, rolling stock, and other equipment used in transportation activities. The data are reported by sector (private, government, and households), type of fixed assets (infrastructure, rolling stock, and other equipment), and by mode (highways, air, transit, railroads, water, and pipelines). The investment figures are presented before deducting depreciation of the existing transportation capital. While it is of paramount importance to compile data on net investment and/or depreciation of capital in order to determine the net addition to the capital stock, they are not covered in this report because of data limitations. Data on transportation investment as a percentage of GDP and a descriptive analysis of the trends in transportation investment in relation to GDP are also provided. The descriptive analysis is not intended to determine the causal relationship between transportation investment and GDP, which requires more rigorous work. Rather, it is a simple analysis that provides a bird's eye view of the statistical trends of transportation investment in relation to GDP.

All investments made by private business engaged in transportation activities as well as transportation-related investments made by non-transportation industries (such as agriculture, manufacturing, mining, construction, etc.) are covered. As far as non-transportation industries are concerned, only rolling stock is accounted for. The infrastructure components of transportation investments made by non-transportation industries are not included because of lack of information. Government investment constitutes investments made by all levels of government, namely, federal, state and local government. Although the existing classification in the National Income and Product Accounts (NIPA) defines household purchases of rolling stock as consumption rather than capital investment, household purchases of rolling stock are treated as transportation investment in this report. Since household-owned automobiles account for about 60% of total investment and have a significant impact on the transportation network and the economy (Chen, Fang, Han, and Sloboda, 2002), it is appropriate, therefore, to classify household purchases of rolling stock as a component of transportation fixed capital.

The rest of this report is structured in four sections. Section III reviews literature that examines the linkage between transportation investment and economic performance. A survey of major statistical undertakings by other government agencies that contain datasets on transportation investment is provided in Section IV. Both the literature review and the survey of statistical works are aimed at gaining insights into the type and level of detail of transportation investment data that can better meet multifaceted research agendas and facilitate policy making. Section V discusses data sources and procedures used to develop the dataset, and a list of data sources is provided in Table 1. The final section presents the data tables and a descriptive analysis of transportation investment in relation to GDP.

3. Review of Literature

The literature review covers the various research studies on the link between transportation investment and economic development. This literature review is intended to draw implications regarding the type, structure, and level of detail of transportation investment data that are needed to support transportation investment decisions. The objective here is not to critique the literature or provide an exhaustive review of all research on the subject; rather its purpose is to find out the data needs of current research efforts in order to narrow our data compilation effort towards meeting these and other related data needs.

Largely because of the work by Aschauer (1989), academics have undertaken numerous studies that explore the relationship between transportation investment and economic performance. Economic performance can be measured by output, value-added (GDP), productivity and employment (e.g., Demetriades and Mamuneas, 2000). Some studies have explored the impact of infrastructure investment on technical efficiency that enters the production function (e.g., Delorme, Thompson, and Warren, 1999). Similar studies have also been undertaken based on foreign data (e.g., Kim, Koo, and Lee for South Korea, Rioja for seven Latin American countries, Everaert and Heylen for Belgium, and Sturm, Jacobs, and Groote for the Netherlands). Three major literature reviews, which were conducted in the late 1990s, cover major literature and most research projects on this subject in the U.S. up to early 2000.[2] As pointed out above, by summarizing these literature reviews and some recent academic studies, we will draw observations that shed some light for our data work.

According to Bell and McGuire (1997), a major finding from studies up to early 1994 is that "a positive statistically significant but small effect of public capital on output has been confirmed by many." As pointed out in the report, however, *structural* changes in relation to infrastructure investment have received insufficient attention in the literature. These changes include "*differentiated economic linkage* between specific industry and specific type of infrastructure," the role of investment flows in examining "the *derived* demand for public infrastructure by private sector," and "the relationship between infrastructure types (e.g., complementary vs. substitutable)" (Bell and McGuire 1997, p. 9-10). The review indicates that research on the question of the relative productivity of different types of public infrastructure, which have been constrained by data limitations, requires data by infrastructure type or mode of transportation.

The subsequent literature review by Apogee Research and Greenhorne & O'Mara (1998) focused on evaluating the merits and limitations of techniques used in studies linking transportation investment and economic performance. This review divides the existing studies into macro- and microanalysis, with the former employing mainly production function and cost function methods and the latter cost-benefit analysis and case studies. In an attempt to find the impact of investment on productivity, the macroanalysis

[2] See Bell and McGuire (1997), Apogee Research, Inc. and Greenhorne & O'Mara (1998), and Weisbrod (2000).

methods compare national trends in economic activity with levels of total public infrastructure investment. According to the authors' view, these methods fail to address the causal relationship; instead they simply show how various data series are related to each other. The microanalysis methods, by focusing on the economic effects of a particular project, provide insights into how the private sector reacts to changes in transportation. The review points out that both methods lack "a solid understanding of the mechanisms by which transportation investment influence *structural* changes in a developed economy" (Apogee Research and Greenhorne & O'Mara 1998, p. 26).

A recent synthesis of practices for assessing economic development impacts from transportation investments (Weisbrod, 2000) covers studies by both academia and practitioners up to early 2000. The synthesis, aimed at providing sub-national (local, regional, and state) planners with analytical tools, defines the economic impact by using regional rather than national indicators (e.g., using gross regional product rather than gross domestic product). In addition to a literature review, the synthesis is primarily based on a survey of 75 transportation planning agencies (in the U.S., Canada and the United Kingdom) on their current research and practice in evaluating the relationship between transportation and economic development. It pointed out that the evaluation of economic impact of public investment in transportation infrastructure has to date "focused primarily on highway spending," implying the need to broaden the study to cover more transportation modes.

Among all the studies of the economic impact of transportation investment, Nadiri and Mamunees (1996) appeared to be the most influential.[3] The study used data on public highway capital, which was developed by Apogee Research, Inc., based on Federal Highway Administration capital outlay data. One of the findings that are most relevant to the design of our data work is that the economic impact of highway capital at the national level *differs* from that at the industry level and *varies by industry.* Furthermore, highway capital seems to have a *substitution effect* on private capital for most industries and is *complementary* for the rest. One comment on this ongoing study is that it overlooked the welfare benefits of highway capital to consumers that are "likely to be significant." (Eno, 1999, Appendix A).

Among other recent studies, Chandra and Thompson (2000) found that highways not only have "a differential impact across industries" but also "affect the *spatial allocation* of economic activity." Demetriades and Mamuneas (2000), using an inter-temporal optimization framework, found that in all 12 OECD countries, the magnitude of positive economic effect of public capital changes over time depending on the under-investment gap in infrastructure, which was wider during the 1970s and 1980s but narrowed down significantly by the early 1990s. Everaert and Heylen (2001), using single-equation co-integration analysis based on annual data, found a strong positive relationship with causality running from public capital (including roads, buildings, educational facilities, etc.) to multifactor productivity in Belgium for the period of 1953 to1996.

[3] Refer to Eno (1996, 1999).

In summary, the above literature review tells us that past studies were mostly focused on the economic impact of government transportation investment. Most of the studies were concentrated on impacts of highway capital. Little attention has been paid to business transportation investment, its economic impact, and its interaction with government investment; and other modes. Furthermore, as pointed out by the aforementioned literature reviewers, more work needs to be done to explore the *structural* impact of characteristically different transportation investments on the economy. Structural impacts refer to those impacts that may be classified by industrial, geographical, and even demographic changes within an economy. As for characteristically different transportation investments, one may include a broad range of characteristics that can differentiate one type of investment from the other in terms of transportation mode, asset type, sector of investors, funding source, technology embedded, and the nature of investment (i.e., public goods, club goods, or private goods). Finally, few studies raise the issue of how economic development impacts transportation investment. That is, how economic development (e.g., economic growth and industrial restructuring) stimulates transportation investment in terms of both growing demand and increased funding sources for transportation services.

Ideally, new data development initiatives should be broader and more detailed to support a wide variety of future research undertakings. This report, which provides transportation investment by sector of investors, types of assets, and transportation modes, will fill some of the data gaps mentioned above, thus providing the basic data that will support policy decisions, and researches on transportation investment and economic development. Using the dataset developed by this report, researchers will be able to conduct those studies that they could not conduct in the past due to lack of data. For example, this report provides the infrastructure investment data by mode called for by Bell and McGuire. This is the first step towards the breakdown of infrastructure by type that they also suggest. Similarly, by providing comparable data across all modes, this report emphasizes the need to move beyond the primary focus on highway spending that was pointed out by Wiesbrod. By bringing together data for infrastructure and equipment, and for government, industry and household sectors, this report provides information to support the kind of investigation of substitution and complentarity effects performed by Nadiri and Mamunees. Not only will this data begin to address some of the specific gaps mentioned above, but it may also stimulate further related research.

4. Survey of Existing Statistical Work

This survey is focused on existing statistical works that are similar to this one. It covers only undertakings by other domestic and foreign government agencies that are comparable to either the Department of Transportation or the Bureau of Transportation Statistics. For broader coverage of works on a smaller scale and by lower-level government agencies, one may refer to Lakshmanan (Eno, 1996, Appendix C) and Weisbrod (2000).

Congressional Budget Office

The Congressional Budget Office (CBO) has in recent years (1992, 1993, 1995, and 1999) published its analysis on *Trends in Public Infrastructure Outlays and the President's Proposals for Infrastructure Spending*. The analysis is based on data supplied by the Office of Management and Budget, the U.S. Census Bureau, and CBO's Budget Analysis Division. As identified in its 1999 paper (Appendix), all the government capital outlays for transportation infrastructure are included in the public infrastructure outlays. They are highways, mass transit, rail, aviation, and water transportation (the other three types of public infrastructure are water resources, water supply, and wastewater treatment). Based on its analysis, the published CBO paper on this subject divides spending into capital outlays (primarily the purchase, construction, or rehabilitation of physical assets) and non-capital outlays (primarily the operation and maintenance of physical assets) for each type of public infrastructure. All the amounts are presented in both current dollars and constant dollars. The analysis covers the period of 1956 up to the latest year for which the budget estimates are available. Through 1994, based on the U.S. Census Bureau's Government Finances series (available only through 1994), CBO calculated government spending, in both amount and percentage share, by the level of government, the total including all levels of government, federal, and state and local. Federal spending is further divided into direct and indirect outlays, with the latter comprising grants and loans to state or local government entities; state and local outlays are categorized as total and net outlays, with the former including grants and loans from the federal government. As a result of this detailed calculation, the analysis shows trends in relative contributions of federal, state, and local governments split between capital and non-capital outlays and priorities for infrastructure programs. Since 1995, the CBO analysis of trends in public infrastructure spending has covered only federal government outlays.

Office of Management and Budget

The Office of Management and Budget (OMB) publishes historical tables that contain several time series on federal government capital outlays that are somewhat related to our work. The latest version of Historical Tables (OMB, 2003) covers the period of 1940 to 2003 for the federal government outlays on major public physical capital. In particular, Table 9.6 in Section 9 contains information on "grants for major public physical capital

investment" in transportation by mode (highways, urban mass transportation, airports, and other). However, the publication does not provide further breakdown by asset type (i.e., infrastructure vs. other capital outlays) since most of these grants are spent by state and local governments, over which OMB does not necessarily have control. Furthermore, the OMB publication is based on the federal government fiscal year, which is not directly comparable to statistics on transportation investment made by state and local governments and the private sector including both business and households.

5. Data Sources and Methodology

The Bureau of Economic Analysis (BEA), the U.S. Census Bureau (Census), and the Office of Management and Budget are the principal data sources. Not all data are directly taken from these sources. A number of adjustments are required due to differences in definitions, coverage, reporting periods, etc. We also fill in data gaps whenever necessary. The description of data sources and procedures used to produce the data tables are provided below.

5.1 Government Investment in Transportation

Gross government capital investment in transportation is classified as investment in infrastructure and rolling stock. The consensus is that equipment used for providing and maintaining the transportation infrastructure may be seen as a component of infrastructure despite the fact that the government invests in transportation equipment other than rolling stock (e.g., computers, communication equipment, software, office and accounting equipment, machinery, etc). It should be noted that there is no identifiable source of data that can be used for a reliable estimate of government investment in transportation equipment that is not blended with infrastructure. Besides, the available data from the Census Bureau show that government investment in transportation equipment is insignificant compared with the government investment in transportation infrastructure. Therefore, the report does not cover government investment in transportation equipment other than rolling stock.

5.1.1 Data Source and Method of Estimation for Government Investment in Rolling Stock

The government annual purchases of motor vehicles, including automobiles, trucks and buses, are estimated from BEA, National Accounts, Table for Auto Output (i.e., underlying table 7.2.5U). More specifically, government purchase of motor vehicles (excluding employee reimbursement and government investment in motor vehicles for defense) is counted as government capital outlays on rolling stock for the highway and mass transit modes.

Currently, no data are available on government purchases of other types of rolling stock like aircraft and ships. The government purchases aircrafts and ships, which are primarily used for defense purposes. These purchases are not treated as investment; instead they are counted as current consumption.

5.1.2 Data Source and Method of Estimation for Federal Government Investment in Infrastructure

New data sources and methods are used for assembling data on government investment in transportation infrastructure. The old data series of the government transportation infrastructure investments were gathered through personal communications with the

Bureau of Economic Analysis (BEA). The agency compiled government transportation investment by level of government and mode of transportation through special studies. These special studies were conducted on an *ad-hoc* basis and their results were not published. Consequently, this data source does not allow us to regularly update the government infrastructure investment data tables and figures. It was, therefore, necessary to look for alternative data sources in order to update the government infrastructure investment data tables and figures on a regular basis (Table 1).

Table 1 Comparison of Old versus New Data Sources

Government	Mode	Data Source	
		Old	**New**
Federal	Highway	U.S. Department of Commerce, Bureau of Economic Analysis (BEA), "Fixed Assets Tables," Washington D.C.	Same as old
	Air, Water, Transit and Railroad	Air, Water, and Transit: Personal communication with BEA, Government Division. Railroad was not included	Executive Office of the President of the United States, Office of Management and Budget, "Budget of the United States Government - Public Budget Database," and "Budget of the United States Government – Appendix," Washington, D.C.
	Water: U.S. Army Corps of Engineers	Personal communication with BEA, Government Division	U.S. Army Corps of Engineers (USACE), "Report on Status of Appropriations and Work Allowances – Civil Works Funds 3011a," Obtained through personal communication with USACE
	Saint Lawrence Seaway Development Corporation	Personal communication with BEA, Government Division	Saint Lawrence Seaway Development Corporation, "Annual Report," annual issues
	Rail: National Railroad Passenger Corporation	Personal communication with BEA, Government Division.	Amtrak for years 1988 - 2000, "Amtrak Annual Report," Washington D.C., annual issues Amtrak for years 1984-1987: estimated based on ratio of capital expenditure over total expenditure for 1988. Amtrak for years 2000 and after: estimated based on ratio of capital-total budget appropriations.
State and Local	Highway	U.S. Department of Commerce, Bureau of Economic Analysis	Same as old

Government	Mode	Data Source	
		Old	New
		(BEA), "Fixed Assets Tables," Washington D.C..	
	Air, Water, Transit, and Parking	Air, Water and Transit: Personal communication with BEA, Government Division. Parking was not included	U.S. Department of Commerce, Bureau of the Census, "State and Local Government Finance Estimates," Washington, D.C.
	Railroad	Not included	U.S. Department of Commerce, Bureau of the Census, "Value of Construction Put in Place," Construction Survey, Washington, D.C.

Federal investment in transportation infrastructure is compiled by mode, including highways, air, water, transit, and railroad. The investment data on highways and streets are directly obtained from the Bureau of Economic Analysis (BEA), Fixed Assets Table 7.5.

Federal infrastructure investment for air, water, transit and railroad is estimated based on data from the Office of Management and Budget (OMB). A number of adjustments to OMB's data are made in order to derive the final estimates of federal infrastructure investment, and make the coverage as complete as possible without double counting. The estimation process involves the following steps:

1. Identify transportation infrastructure investment related programs from the U.S. budget database.[4]

Table 2 provides the list of federal infrastructure related programs that are included in the estimates. The list includes those programs directly funded by federal government agencies. Note that the list in table 2 is not exhaustive. There are several federal infrastructure related programs that are not included in the list, because the federal government does not make any direct payments to these programs, instead transfers funds to state and local governments.[5]

[4] The entire fund for infrastructure programs may not be used for infrastructure purpose only. Instead, some of the money assigned for infrastructure programs can be used for current operational activities or for purchases of equipment. This limitation of the data should be taken into account in using the data.

[5] For example, several highway projects financed by funds from the Highway Trust Fund are not included in the list. Almost all of the Highway Trust Fund money (with the exception of funds used for administrative and other related purposes) is transferred to states. The highway investment amounts financed by money from the Trust Fund are captured in the data for states. Federal grants to the Washington Metro Area Transit Authority for the construction of the Washington Metro Rail System is not included. These funds were used for the construction of the Franconia/Springfield, Glenmont, Mid- City, and Branch Avenue lines, and for project management, real estate acquisition, and other expenses such as contingencies and insurance.

Table 2 Federal Infrastructure Investment Programs by Agency and Mode

Mode	Agency	Program	Purpose
Air	Federal Aviation Administration	Facilities, engineering and development	For acquisition and modernization of facilities and equipment and service testing in accordance with the provisions of the Federal Aviation Act (49 USC 1301-1542), including construction of experimental facilities and acquisition of necessary sites.
		Facilities and equipment (Airport and airway trust fund)	This program provides funds for the national airspace system equipment, facility, and related applied research activities.
		Metropolitan Washington Airports –Construction	This program provides funds for construction at National and Dulles International Airports.
	National Aeronautics and Space Administration	Construction of facilities	The goal of the Construction of Facilities program is to ensure that the facilities critical to achieving NASA's space and aeronautics program are constructed and continue to function effectively, efficiently, and safely, and that NASA installations conform with requirements and initiatives for the protection of the environment and human health. Transportation component of NASA outlays for construction of facilities are included in transportation investment.
Water	Maritime Administration	Ship construction	This program provides funds for acquisition of vessels.
	Saint Lawrence Seaway Development Corporation (SLSDC)	Saint Lawrence Seaway Development Corporation	Construction, acquisition of plant, property and equipment. Data are obtained form SLSDC annual report.
	U.S. Coast Guard	Acquisition, Construction and Improvement (Transportation outlays only)	This program provides funds for acquisition, construction, and improvement of the vessels, aircraft, information management resources, shore facilities, and aids to navigation required to execute the Coast Guard's missions and achieve its performance goals. The transportation portion was estimated on the basis of ratios developed from detailed federal obligations of the program.
		Alteration of Bridges	This program provides funds for altering or removing bridges determined to be obstructions to navigation.
	U.S. Army Corps of Engineers (USACE)	Construction of Locks and Dams	
		Construction of Channels and Harbors	

Mode	Agency	Program	Purpose
		Mississippi River and Tributaries	About 25 percent of this program's outlays are assumed to be for infrastructure purposes.
		Major Rehabilitation of Locks and Dams & Channels and Harbors	
Transit	Federal Transit Administration	Discretionary grants (Highway trust fund, mass transit account)	This program provides funds for fixed guide way modernization; for replacement, rehabilitation and purchase of buses; and the construction of bus related facilities.
	Washington Metropolitan Area Transit Authority	Interest payments	This program provided the annual Federal share (two-thirds) of interest payments on outstanding WMATA bonds sold in support of the rail construction program. The WMATA bonds, which totaled $997 million, were guaranteed by the Federal government and were to become due beginning in the year 2012.
Rail	Federal Railroad Administration	Freight line rehabilitation	Funds were provided through a grant to the Soo Line Railroad Company for track improvements to maintain Amtrak's rail passenger service in Wisconsin.
		Northeast corridor improvement program	Provides funds to upgrade passenger rail service in the corridor between Washington, D.C. and Boston, MA. Beginning in 2001, funding is available within the Amtrak appropriation.
		Capital grants to National Railroad Passenger Corporation	Grant funding, administered by the Federal Railroad Administration, is provided to support Amtrak's operating and capital requirements including Northeast Corridor improvements, railroad retirement, debt service interest and principal payments, operating assistance, preservation of capital and investments, and rolling stock maintenance. Only capital expenditure portion of these expenditure items is included. Data are directly obtained from Amtrak annual report.
		Next generation high-speed rail	The Next Generation High-Speed Rail Program provides funds for research, development, and technology demonstration programs and the planning and analysis required to evaluate technology proposals under the program.
		Pennsylvania station redevelopment project	Funds are used to redevelop the Pennsylvania Station in New York City, which involves renovating the James A. Farley Post Office building as a train station and commercial center, and basic upgrades to Pennsylvania Station. Funding for this project was included in the Grants to the National Railroad Passenger Corporation appropriation in 1995 through 1997, and the Northeast Corridor Improvement Program in 1998.
		Rhode Island rail development	Funds were provided for construction of a third rail line and related costs between Davisville and Central Falls, RI.

Mode	Agency	Program	Purpose
		High-speed rail train sets and facilities	Amtrak, the National Railroad Passenger Corporation, acquired train sets specially designed to offer enhanced high-speed (150 mph) service on the Northeast Corridor from Washington, DC, to Boston, Massachusetts. Funds provided by this appropriation will help finance the acquisition of the train sets and related maintenance facilities.
		West Virginia rail development	Funding for capital costs associated with track, signal and crossover rehabilitation and improvements on the MARC.
		Conrail commuter transition assistance	For necessary capital expenses of Conrail commuter transition assistance. Between 1986 and 1989 funds were appropriated to fund commuter rail and bridge improvements in Pennsylvania.

2. Calculate the non-grant portion of the outlays of those infrastructure related programs. The non-grant portion of these infrastructure programs represents the direct federal expenditures on infrastructure programs.

3. Make adjustments for offsetting collections whenever necessary.

Offsetting collections are federal receipts from the public resulting from business-type activities, or transfers from other federal accounts. Such receipts are deducted from gross outlays of a receiving program in the budget of the U.S. Government, instead of combining them with federal receipts to be counted as part of the federal revenue. Thus, outlays in the budget are reported net of offsetting collections. In order to provide the actual spending of a program in this report, it is necessary to adjust for any deduction of "offsetting receipts" from program outlays. This is accomplished by examining *grant and non-grant outlays* of each program from the Budget Database, and by analyzing detailed program appropriations from the Appendix of the U.S Budget.

4. Convert expenditures from fiscal year to calendar year.

The Office of Management and Budget (OMB) provides data on a fiscal year basis that starts on October 1 and ends on September 30. The estimates in this report are provided on a calendar year basis. Let $CY_{(t)}$ represent the expenditure of calendar year t, $CY_{(t-1)}$ the expenditure of calendar year t-1, $FY_{(t)}$ the expenditure of fiscal year t, which runs from October 1 of $CY_{(t-1)}$ to September 30 of $CY_{(t)}$. Assuming federal outlays are evenly distributed over the four quarters of a fiscal year, we can convert expenditures from fiscal year to calendar year using the following formula:

$$CY(t) = 0.75(FY(t) + 0.25FY(t+1)$$

5.1.3 Data source and Method of Estimation for State and Local Government Investment in Infrastructure

State and local government investment data for highways and streets are directly taken from BEA's Fixed Assets, Table 7.5.

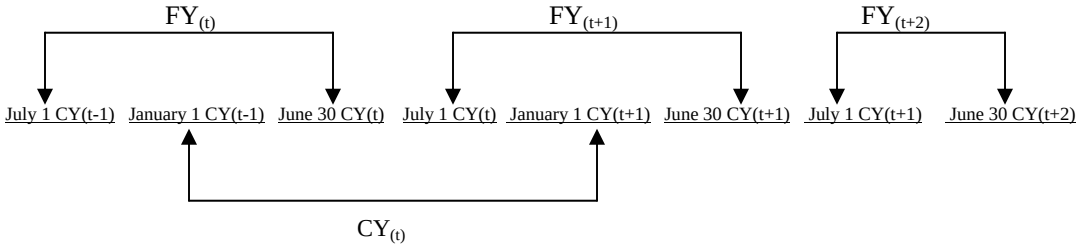
State and local government infrastructure investment for air, water, and transit are based primarily on Census Bureau's annual survey of government finances. The Census Bureau reports state and local government expenditures for the construction of air, water and transit infrastructure with a two year lag. For latest years, we use the trends of state and local spending, which are obtained from Census Bureau's Construction Survey.

The data from Census Bureau's survey of government finances are provided for fiscal years ending between July 1 and June 30. For example, the FY 2002 data represent the financial activities of state and local government for fiscal year that ended between calendar year July 1 2001 and calendar year June 30 2002.

Most state governments have fiscal years beginning on July 1 and ending on June 30. However, local governments have fiscal years ending at various dates during a year. Since data in our report are provided on a calendar year basis, we need to convert Census Bureau's state and local government expenditure data from fiscal year to calendar year. For this purpose, we applied BEA's method of conversion of state and local government finance from fiscal year to calendar year. BEA uses different methods for state governments, and local governments.

For state governments, the conversion of government finance data to a calendar year basis is accomplished by a 2-year average. For example, let $CY_{(t)}$ represent the expenditure of calendar year t, $FY_{(t)}$ the expenditure of fiscal year t, $FY_{(t+1)}$ the expenditure of fiscal year t+1, then BEA's two-year average method estimates $CY_{(t)}$ as: $CY(t) = \frac{FY(t) + FY(t+1)}{2}$.

For local governments, BEA uses weights established based on periodic Census Bureau tabulations by ending month of the fiscal year. For example, let $CY_{(t)}$ represent the expenditure of calendar year t, $CY_{(t-1)}$ the expenditure of calendar year t-1, $FY_{(t)}$ the expenditure of fiscal year t, which runs from July 1 of $CY_{(t-1)}$ to June 30 of $CY_{(t)}$, then BEA's formula for $CY_{(t)}$ is given by: $CY(t) = 0.33FY(t) + 0.65F(t+1) + 0.02FY(t+2)$. This formula extends over three fiscal years, because fiscal years of local governments start and end at various dates during a year (see the illustration below).



In the above diagram, calendar year $CY_{(t)}$ touches $FY_{(t)}$, $FY_{(t+1)}$, and the local governments' FY that start in August, September, October, November, December $FY_{(t+1)}$ and ends in $FY_{(t+2)}$. Consequently, the formula for converting fiscal year to calendar year incorporates three fiscal years.

5.1.4 Coverage of Government Investment

The coverage of government investment estimates is expanded to include investment in railroad infrastructure. This was not included in the old investment estimates.

In addition, local governments spend significant amount of money every year for providing parking lots and garages. Local government spending for the construction of these infrastructure facilities were not included in the earlier version of the report, but are included in the current report.

5.2. Business Investment in Transportation

Estimates for business investment in transportation are developed based on BEA data on capital investment by industry and by asset type. Our report classifies industries into two sectors for the purposes of measuring investment, the transportation industry, and all others, which we refer to as non-transportation industries. Six modes are specified within the transportation industry. They are: highways, air, water, mass transit, railroad, and pipelines. For the transportation sector, the following three types of assets are specified: infrastructure, rolling stock, and other. Non-transportation industries include agricultural, mining, utilities, construction, manufacturing, wholesale and retail trade, information, finance and insurance, real estate and rental and leasing, and services. For non-transportation industries, only investment in rolling stock (including motor vehicles, aircrafts, ships and boats, and railroad equipment) is identified as transportation investment.

The new private transportation infrastructure investment estimates are expanded to include private construction of parking lots and garages. This investment item was not included in the estimates of the previous report. Data on parking construction are obtained from Census Bureau's Survey of Construction for years 1993-2003. Data for years before 1993 are estimated using trends in the "other commercial construction," which has parking as a component. Investment in "other commercial construction" for years before 1993 is available from Census Bureau's Construction Survey old data series.

5.3. Household Purchase of Rolling Stock

Household purchase of rolling stock is classified into three modes: highways and streets (road), air, and water. For road transportation, household purchase of rolling stock includes automobiles, motorcycles, and bicycles. Household purchase of aircraft and boats are classified as air transportation and water transportation, respectively. The data are taken from the National Income and Product Accounts of BEA.

6. Trends in Transportation Investment

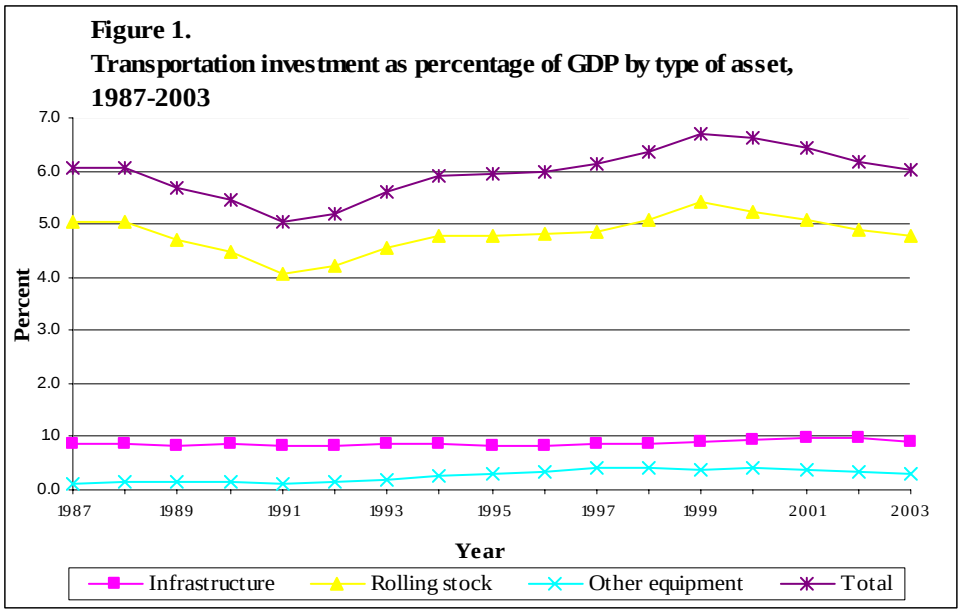
In this section, we discuss trends in transportation investment in the following sequence: *overall* transportation investment, transportation investment by sector, transportation investment *by asset type* (i.e., infrastructure and rolling stock) *and by sector* (i.e., government, business, and household sector), business investment by category (i.e., transportation and non-transportation investment), and business investment in transportation by industry (i.e., transportation vs. non-transportation industries).

6.1. Overall Transportation Investment

The overall transportation investment accounted for more than 6% of GDP for most of the years during the period of 1987 to 2003 (Figure 1). Investment (including household expenditure) in rolling stock accounted for 80.5% of the overall transportation investment, and that in transportation infrastructure and in other transportation equipment, 14.7% and 4.8%, respectively. Due to its largest share, the trend of investment in rolling stock dominates the trend in the total transportation investment (Figure 1).

It is also noteworthy that infrastructure investment fluctuated less than that of investment in rolling stock (net of government purchase for defense) in 1987-2003. As shown in Figure 2, investment in rolling stock exhibited significantly fluctuations along with the economic cycle. While the drops in overall investment in rolling stock echoed the repeated business downturns, the increases closely followed the upward performance of the economy. For example, expenditure in rolling stock dropped in 1991 and 2001 reflecting the downturn in the performance of the overall economy, while the increase during 1997-2000 reflects improvements in the performance of the economy.

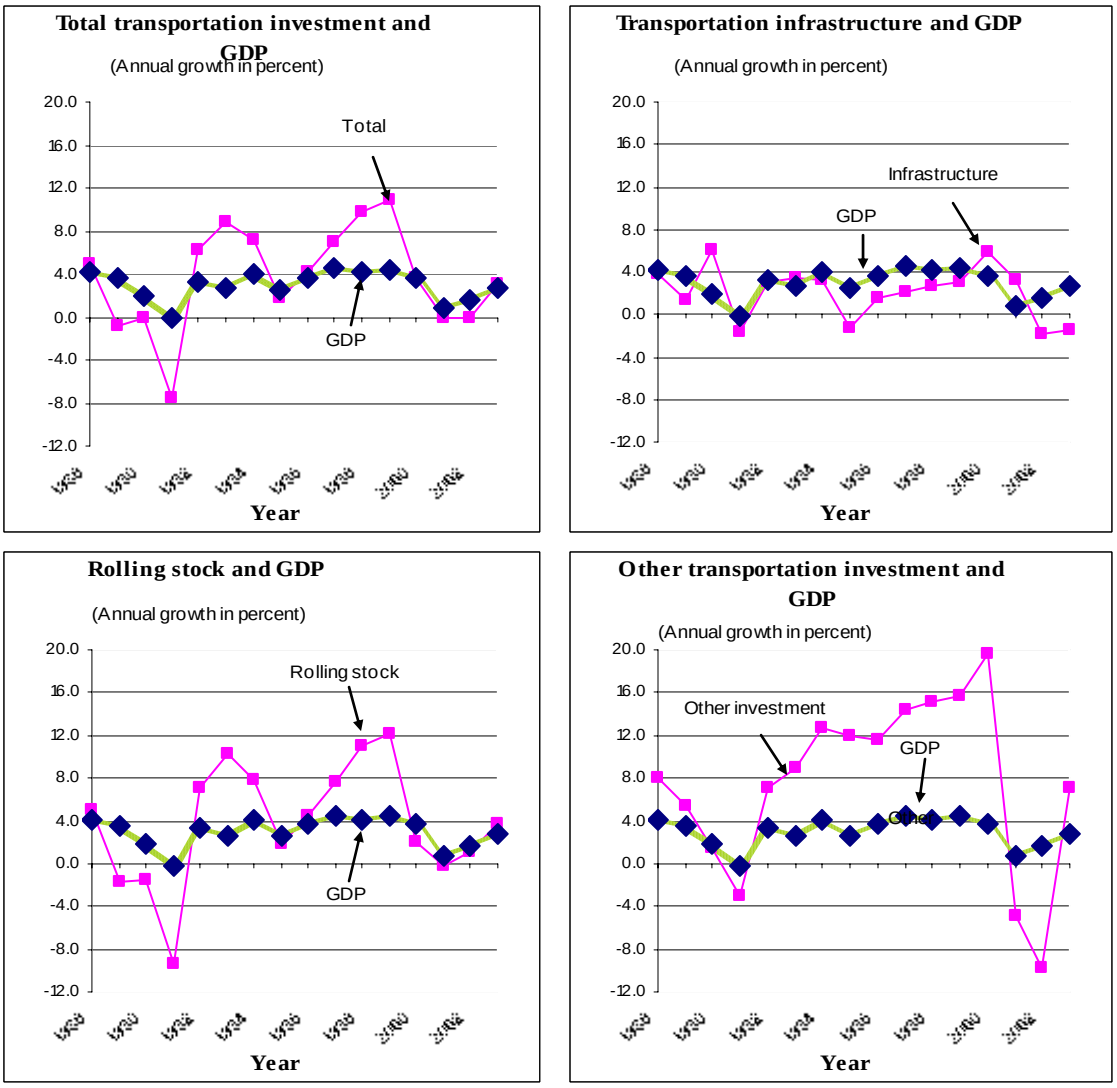
As shown in Figure 2, other transportation investment, which exclusively includes business sector's investment in equipment other than rolling stock, as a share of GDP, although insignificant, appeared to increase steadily for the second half of the 1990s. This may indicate technological advancement within the transportation industry during that period.



Note: Other equipment includes transportation industries' investment in different types of equipment, such as computers and peripheral equipment, software, communications, medical and non-medical equipment, photography and related equipment, engines, machinery, electric transmission and distribution, office furniture, agricultural machinery, etc.

Sources: BTS calculations based on data from the following sources:
U.S. Department of Commerce, Bureau of Economic Analysis (BEA), "Fixed Assets Tables," and "National Income and Product Accounts Tables," Washington, D.C.
Executive Office of the President of the United States, Office of Management and Budget, "Budget of the United States Government - Public Budget Database," and "Budget of the United States Government – Appendix," Washington, D.C.
U.S. Department of Commerce, U.S. Census Bureau, "State and Local Government Finance Estimates," and "Value of Construction Put in Place," Construction Survey, Washington, D.C.
Saint Lawrence Seaway Development Corporation, "Annual Report," annual issues.
Amtrak, "Amtrak Annual Report," Washington D.C.
Personal Communication with U.S. Army Corps of Engineers.

Figure 2.
Growth in transportation investment by type of asset compared with growth in GDP, 1988-2003



Note: All growth rates are calculated based on chained 2000 dollar values. Other transportation investment includes transportation industries' investment in different types of equipment, such as computers and peripheral equipment, software, communications, medical and non-medical equipment, photography and related equipment, engines, machinery, electric transmission and distribution, office furniture, agricultural machinery, etc.

Sources: BTS calculations based on data from the following sources:
U.S. Department of Commerce, Bureau of Economic Analysis (BEA), "Fixed Assets Tables," and "National Income and Product Accounts Tables," Washington, D.C.
Executive Office of the President of the United States, Office of Management and Budget, "Budget of the United States Government - Public Budget Database," and "Budget of the United States Government – Appendix," Washington, D.C.
U.S. Department of Commerce, U.S. Census Bureau, "State and Local Government Finance Estimates," and "Value of Construction Put in Place," Construction Survey, Washington, D.C.
Saint Lawrence Seaway Development Corporation, "Annual Report," annual issues.
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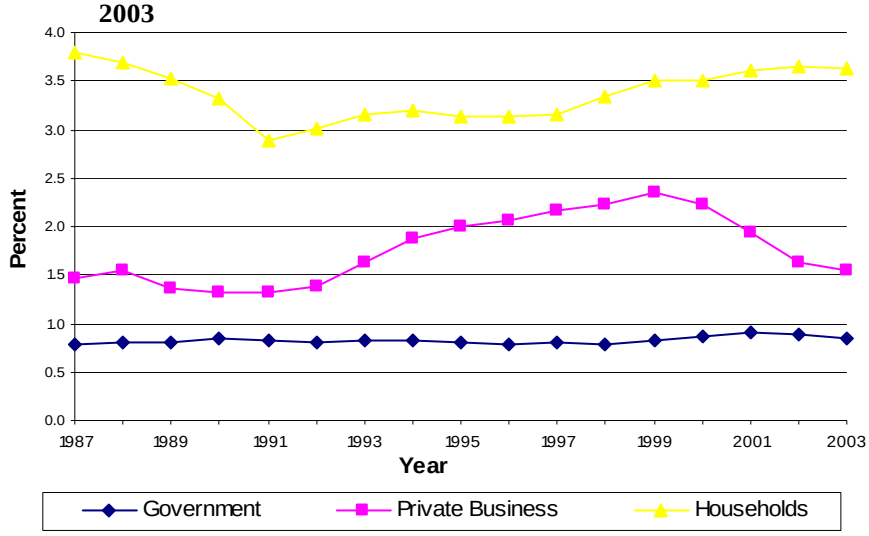
6.2. Transportation Investment by Sector

Figure 3 illustrates transportation investment by sector, namely, households, private business, and government. As a share of GDP, government investment, which consists of infrastructure and rolling stock, stayed almost the same, averaging 0.82% for the entire period, while private business investment, which includes infrastructure, rolling stock and other equipment, increased until 1999 and consistently declined since 2000. Transportation investment of the household sector has been consistently greater than that of the public and private business sectors combined during the period under consideration. As a share of GDP, transportation investment by the household sector averaged 3.4%, fluctuating between a low of 2.9% and a high of 3.8% during 1987-2003.

Figure 3.
Transportation investment as percentage of GDP by sector, 1987-2003



Sources: BTS calculations based on data from the following sources:
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Executive Office of the President of the United States, Office of Management and Budget, "Budget of the United States Government - Public Budget Database," and "Budget of the United States Government – Appendix," Washington, D.C.
U.S. Department of Commerce, U.S. Census Bureau, "State and Local Government Finance Estimates," and "Value of Construction Put in Place," Construction Survey, Washington, D.C.
Saint Lawrence Seaway Development Corporation, "Annual Report," annual issues.
Amtrak, "Amtrak Annual Report," Washington D.C.
Personal Communication with U.S. Army Corps of Engineers.

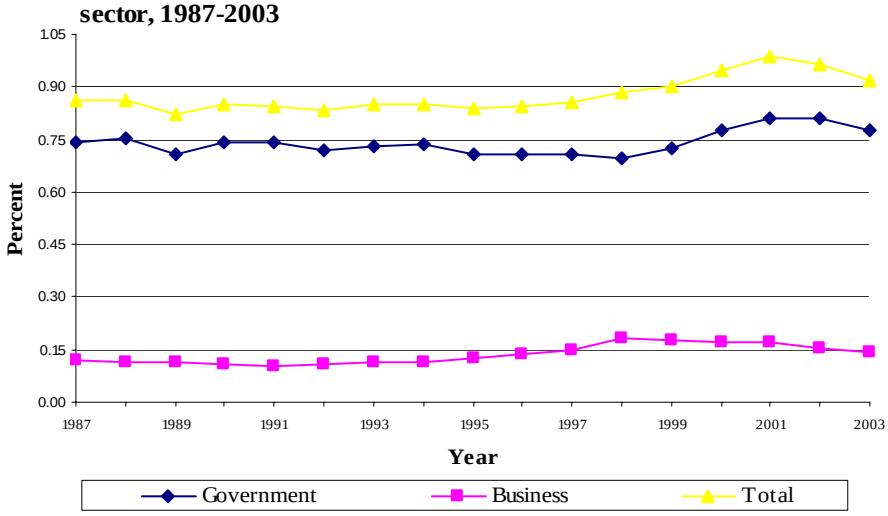
The role of government, private business, and households in transportation investment vary by asset type and mode of transportation (Figures 3 and 4). The public sector provides most of the nation's transportation infrastructure with the exception of railroads and pipelines. For example, infrastructure accounted for an average of 90% of the total government transportation investment for the period 1987-2003. The private business sector invests heavily in rolling stock and operates them on publicly provided infrastructure. Private business investment in rolling stock and other equipment used for

transportation activities accounted for about 92% of the total private sector transportation investment. The remaining 8% went to transportation infrastructure. A large proportion of the business sector's transportation infrastructure investment has been allocated to railroads, which accounted for about 36.1%, on average, during 1987-2003. The household sector doesn't invest in transportation infrastructure and hence its investment is entirely in rolling stocks (i.e., motor vehicles, trucks and vans, airplanes, boats, etc.).

6.3. Characteristics of Investment in Transportation Infrastructure

Figure 4 provides trends over time in transportation infrastructure investment by sector. Figures 5-7 further illustrates investment by transportation infrastructure by mode and by sector. Four observations can be drawn from analyzing these figures.

Figure 4.
Investment in transportation infrastructure as percentage of GDP by sector, 1987-2003



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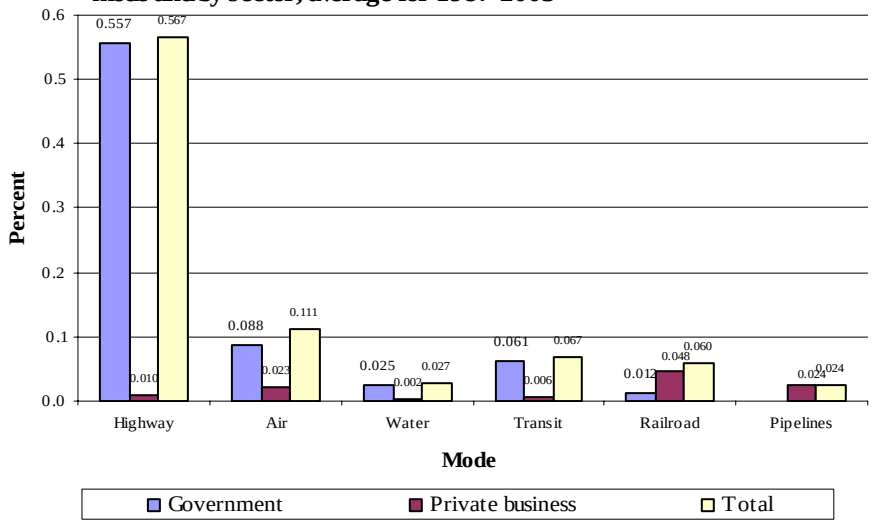
Executive Office of the President of the United States, Office of Management and Budget, "Budget of the United States Government - Public Budget Database," and "Budget of the United States Government – Appendix," Washington, D.C.
U.S. Department of Commerce, U.S. Census Bureau, "State and Local Government Finance Estimates," and "Value of Construction Put in Place," Construction Survey, Washington, D.C.
Saint Lawrence Seaway Development Corporation, "Annual Report," annual issues.
Amtrak, "Amtrak Annual Report," Washington D.C.
Personal Communication with U.S. Army Corps of Engineers.

First, government is the predominant investor in transport infrastructure (Figure 4). Therefore, government investment clearly dominates the trend of investment in transportation infrastructure for the period 1987-2003. During this period, the government's share in transportation infrastructure investment, on average, was 98% for highways, 91% for transit, 91% for water, and 81% for air transportation (Figure 5). As indicated earlier, the business sector is the primary investor in railroad infrastructure,

accounting for an average of 82% of the total during 1987-2003. In contrast, the government accounts for only 18% of the investment in railroad infrastructure during the same period (Figure 5).[6]

As a share of GDP, government investment in transportation infrastructure increased from 0.74% in 1987 to 0.81% in 2001, before declining to 0.78% in 2003. The business sector's investment in transportation infrastructure increased from 0.12% in 1987 to 0.18% in 1998, and then started declining after 1999 (Figure 4).

Figure 5.
Investment in transportation infrastructure as percentage of GDP by mode and by sector, average for 1987-2003



Note: Details do not add to the total investment, because the total includes parking and investments of establishments involved in transportation supporting activities.
Sources: BTS calculations based on data from the following sources:
U.S. Department of Commerce, Bureau of Economic Analysis (BEA), "Fixed Assets Tables," and "National Income and Product Accounts Tables," Washington, D.C.
Executive Office of the President of the United States, Office of Management and Budget, "Budget of the United States Government - Public Budget Database," and "Budget of the United States Government – Appendix," Washington, D.C.
U.S. Department of Commerce, U.S. Census Bureau, "State and Local Government Finance Estimates," and "Value of Construction Put in Place," Construction Survey, Washington, D.C.
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Personal Communication with U.S. Army Corps of Engineers.

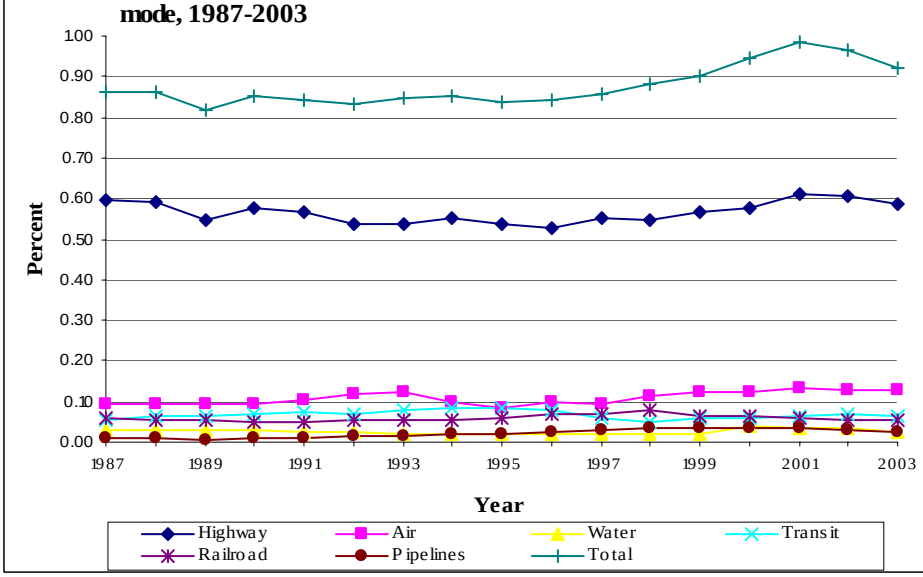
Second, investment in transportation infrastructure lagged behind the business cycle. For example, while overall transportation investment, of which about 80% is in rolling stock, began dropping in 1989 that bottomed out in 1991 when business contraction was well underway, investment in transportation infrastructure rose in 1989 and 1990 before receding in 1991 (Figures 2 and 4). The same is true during 2001-2003. During this period, transportation infrastructure investment was declining, while overall

[6] The government invests in railroad infrastructure. Most of the government investment is, however, allocated to commuter rail and subways, which are counted in transit mode.

transportation investment and GDP growth had already reached their lowest point in 2001 and started recovering in 2002. This implies that infrastructure investment, which is particularly funded by the government, is an induced variable of past economic performance. It is also affected by government budget decisions, which is often counter cyclical.

Third, highway investment accounted for the largest share of the total investment in transportation infrastructure, averaging for about 64% during the period 1987 to 2003 (Figures 5 and 6). Consequently, the trend in highway investment dominates the observed trend in the overall infrastructure investment. Air transportation infrastructure received the second largest share (10.7%), followed by transit transportation (7.5%) during the period under consideration.

Figure 6.
Investment in transportation infrastructure as percentage of GDP by mode, 1987-2003



Note: Details do not add to the total investment, because the total includes parking and investments of establishments involved in transportation supporting activities.
Sources: BTS calculations based on data from the following sources:
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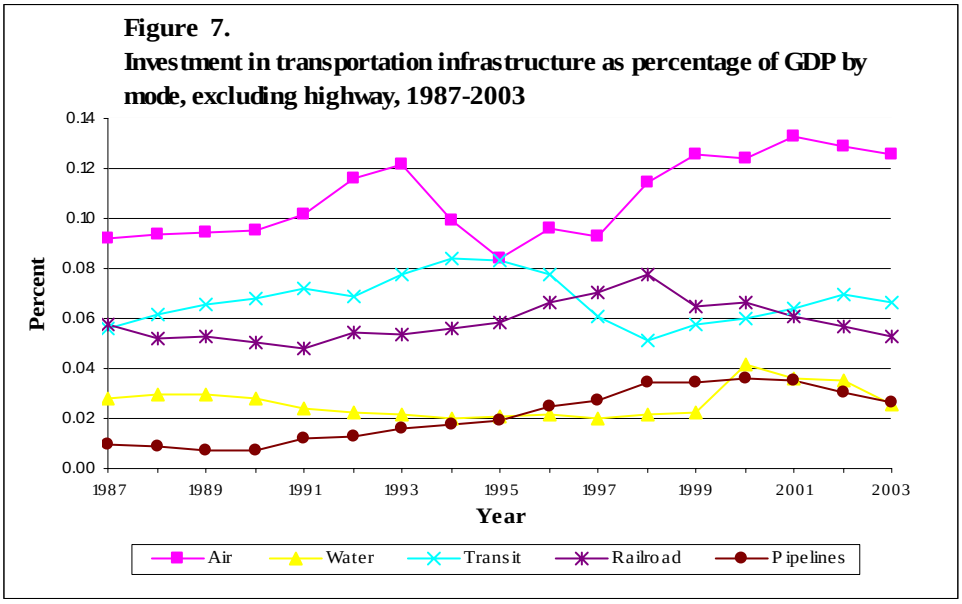
Finally, despite its fluctuations, infrastructure investment in non-highway transportation modes changed significantly in relative shares. As illustrated in Figure 7, as a percentage of GDP, investment in pipeline infrastructure grew the fastest from 0.01% in 1987 to 0.03% in 2003, with an average growth of 6.3% per year. Similarly, air transportation's

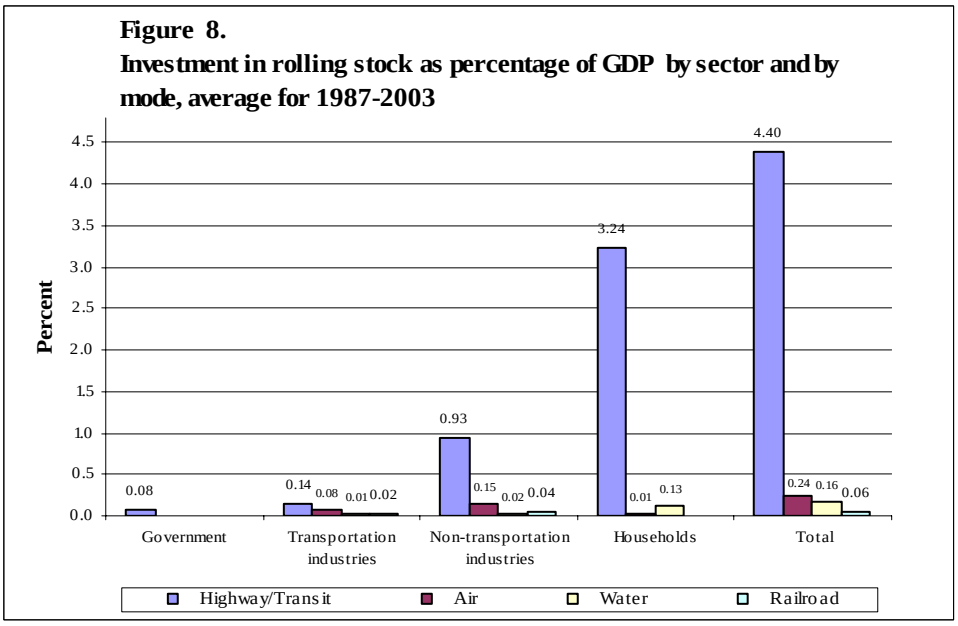
share in GDP grew from 0.09% in 1987 to 0.13% in 1999, and stayed the same thereafter. In contrast, water transportation infrastructure investment as a percentage of GDP decreased between 1987 and 1999, before recovering in 2000, and then declined during 2000-2003. As a percentage of GDP, transit and railroad infrastructure stayed constant over the period under consideration, with some fluctuations.



Sources: BTS calculations based on data from U.S. Department of Commerce, Bureau of Economic Analysis (BEA), "Fixed Assets and Consumer Durables," available at http://www.bea.gov, as of July 2002; and personal communication with BEA.

6.4. Characteristics of Investment in Rolling Stock

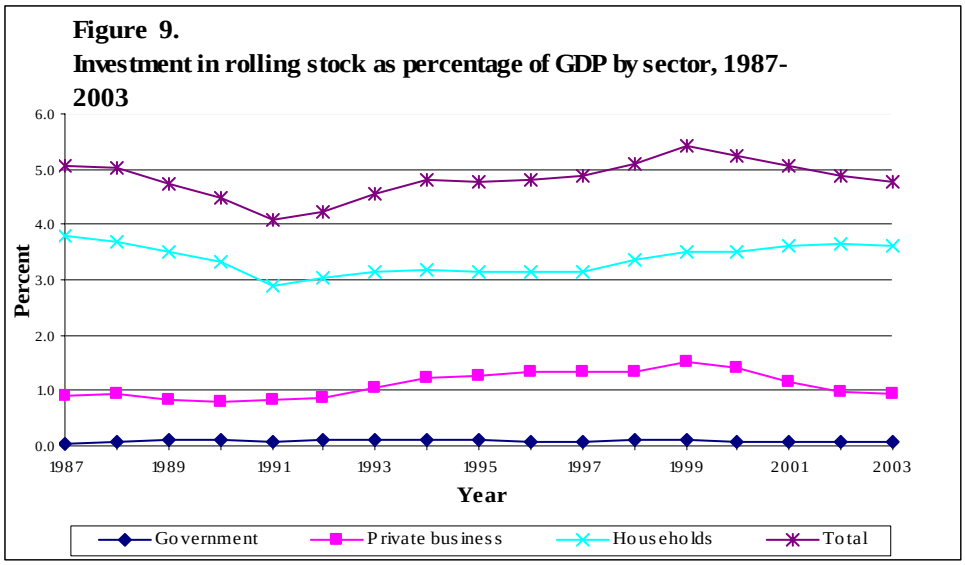
Figures 8-11 illustrate several characteristics of investment in rolling stock measured as a percentage of GDP. First, households are the primary investors in rolling stock, particularly motor vehicles (Figure 9). The annual changes in household-dominated investment in rolling stock appeared to be closely related to the annual changes in GDP (Figure 10). This is consistent with the close association between household spending and overall economic performance. In other words, as the growth in GDP speeds up, so does household purchase of rolling stock as a proportion of GDP (sometimes with a short time lag), and vice versa.



Notes: Transportation industries include establishments involved in providing railroad transportation, local and interurban passenger transit services, trucking and warehousing, water transportation, air transportation, pipelines, and transportation services. Non-transportation industries include agriculture, mining and construction, manufacturing, communications, utilities, trade, finance, insurance and real estate, and services industries.

Sources: BTS calculations based on data from the following sources:
U.S. Department of Commerce, Bureau of Economic Analysis (BEA), "Fixed Assets Tables," and "National Income and Product Accounts Tables," Washington, D.C.

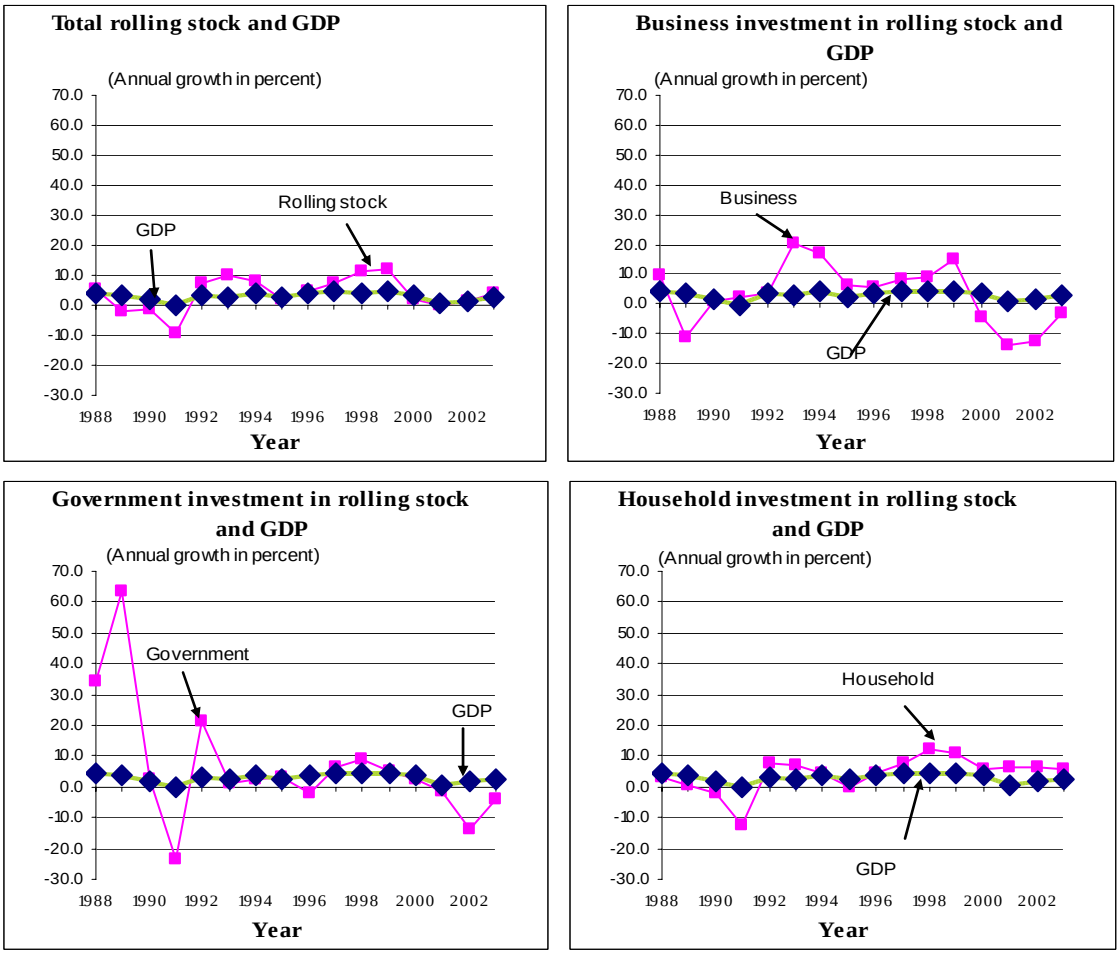
Second, household purchases of automobiles accounts for the largest share of the total investment in rolling stock. During 1987-2003, household purchases of automobiles (for the highway mode) on average accounted for about 70% of the gross investment in rolling stock (Figure 8). This is consistent with the findings of the study on household production of transportation services (Chen, Fang, Han and Sloboda, 2002). Moreover, household purchases of motor vehicles makes up the bulk of personal consumption expenditure (PCE), and closely follows the trend in GDP growth. This could be one of the reasons that PCE is an important component of several economic indicators, such as manufacturers' new orders for consumer goods and materials, personal consumption expenditure deflator for money supply, consumer installment credit to income ratio, etc.



Notes: Private business includes transportation industries and non-transportation industries. Transportation industries consist of establishments involved in providing railroad transportation, local and interurban passenger transit services, trucking and warehousing, water transportation, air transportation, pipelines, and transportation services. Non-transportation industries include agriculture, mining and construction, manufacturing, communications, utilities, trade, finance, insurance and real estate, and services industries.

Sources: BTS calculations based on data from U.S. Department of Commerce, Bureau of Economic Analysis (BEA), "Fixed Assets and Consumer Durables," "National Income and Product Account (NIPA) Tables," available at http://www.bea.gov, as of July 2002.

Figure 10.
Growth of investment in rolling stock by sector compared with growth in GDP, 1988- 2003

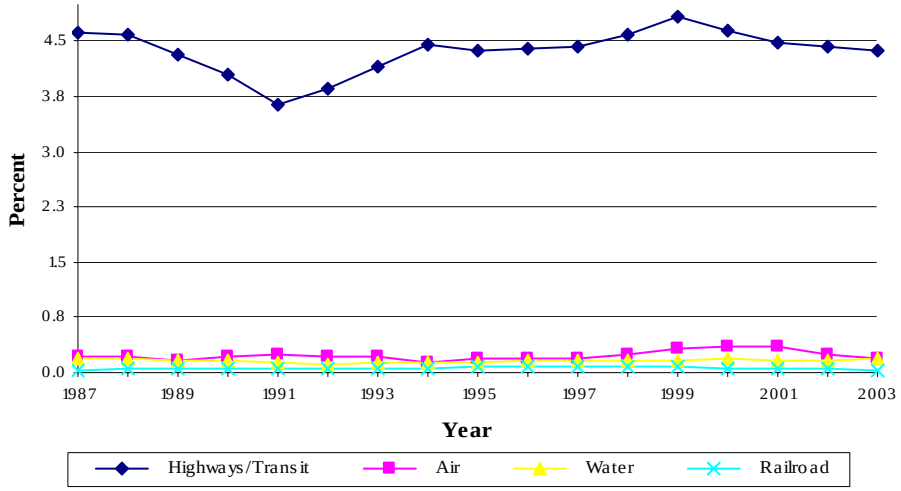


Note: All growth rates in this figure are calculated based on chained 2000 dollar values.

Sources: BTS calculations based on data from the following sources:
U.S. Department of Commerce, Bureau of Economic Analysis (BEA), "Fixed Assets Tables," and "National Income and Product Accounts Tables," Washington, D.C.

Finally, investment in motor vehicles makes up the bulk of the total investment in rolling stock. On the average, motor vehicles accounted for more than 88% of the total gross investment in rolling stock in 1987-2003. Since motor vehicles are operated in highway and transit transportation, the investments of these modes dominate the trends over time investment in rolling stock (Figure 11).

Figure 11.
Investment in rolling stock as percentage of GDP by mode, 1987-2003

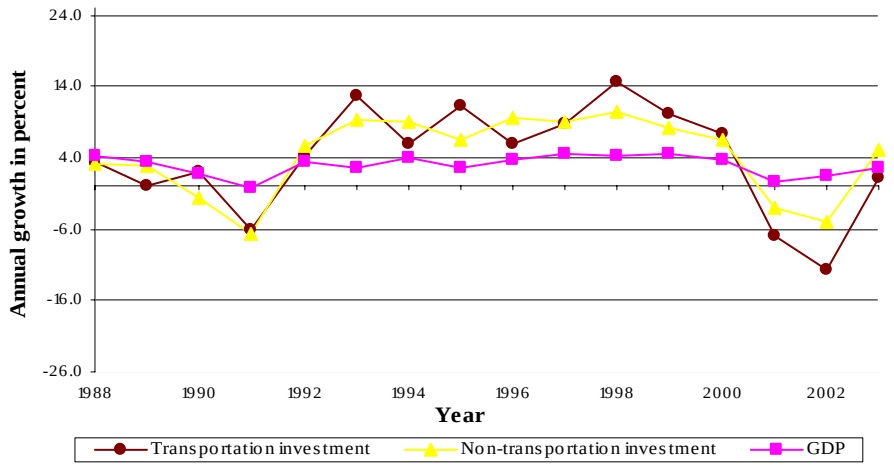


Sources: BTS calculations based on data from the following sources:
U.S. Department of Commerce, Bureau of Economic Analysis (BEA), "Fixed Assets Tables," and "National Income and Product Accounts Tables," Washington, D.C.

6.5. Business Investment in Transportation Assets Compared with that in Non-Transportation Assets

The term “business investment” in our report is equivalent to the term “gross private fixed investment” as used in the input-output (I-O) accounts. For our purposes, business investment or gross private fixed investment can be classified into transportation and non-transportation investment. As mentioned earlier, business transportation investment includes all the investments made by the transportation industries and investments in rolling stock made by non-transportation industries; non-transportation investment includes the rest. Compared with non-transportation investment, transportation investment is more sensitive to the business cycle as measured by the growth in GDP (Figure 12). In other words, transportation investment is more suppressed by economic contraction, and more buoyed by economic recovery (or economic boom) in contrast to non-transportation investment. A possible explanation of this is that transportation investment (largely rolling stock as indicated above) is more flexible in terms of its utilization and useful life, and hence its replacement cycle as compared with non-transportation investment.

Figure 12.
Growth of private business transportation and non-transportation investment: 1988-2000

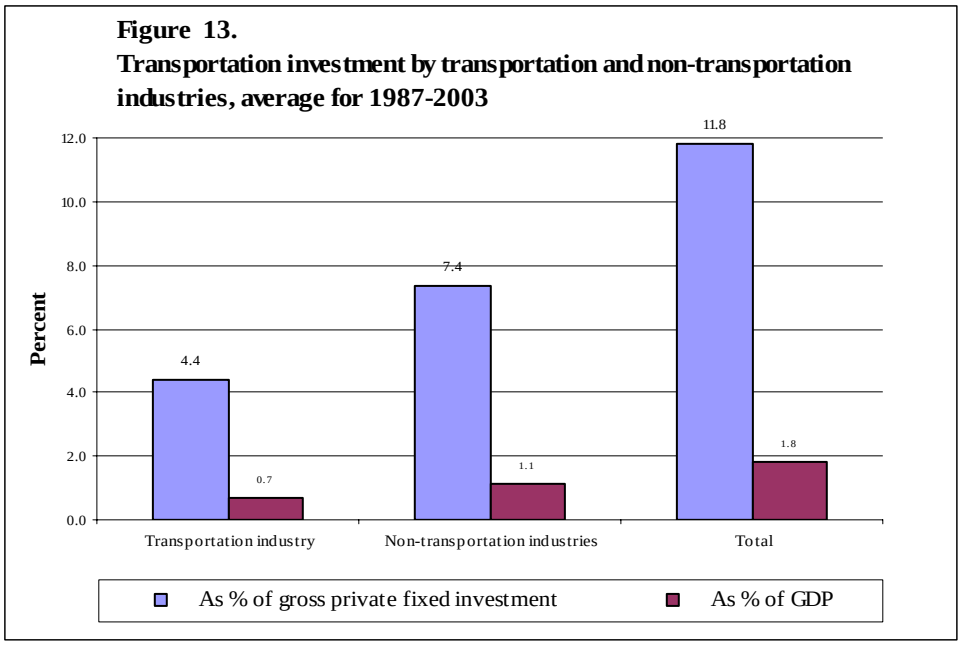


Note: All growth rates are calculated based on chained 2000 dollar values.

Sources: BTS calculations based on data from the following sources:
U.S. Department of Commerce, Bureau of Economic Analysis (BEA), "Fixed Assets Tables," and "National Income and Product Accounts Tables," Washington, D.C.

6.6. Investment in Transportation Assets by Transportation Industries vs. Non-Transportation Industries

Transportation investment made by non-transportation industries accounted for an average of 7.4% of the total gross private fixed investment and an average of 1.1% of GDP for the period between 1987 and 2003. Investments of transportation industries averaged 4.4% of the total gross private investment and 0.7% of GDP (Figure 13). In other words, transportation investment made by non-transportation industries (all in rolling stock) was about 68% more than that of transportation industries (including infrastructure, rolling stock and other equipment). It is interesting to look at these statistics in reference to the transportation satellite accounts (TSA). As indicated in the 1992 TSA (BTS, 1999), in-house transportation services provided by non-transportation industries were about 60% of the for-hire transportation services provided by transportation industries (i.e., in-house accounted for 1.9% of GDP; for-hire, 3.1%). This rough comparison indicates that the intensity of use of transportation capital (largely rolling stock) is higher for the transportation industries than that for non-transportation industries.



Sources: BTS calculations based on data from the following sources:
U.S. Department of Commerce, Bureau of Economic Analysis (BEA), "Fixed Assets Tables," and "National Income and Product Accounts Tables," Washington, D.C.

In summary, for the period running from 1987 to 2003, overall transportation investment (including household purchase of rolling stock) on average accounted for more than 6% of GDP. Of this overall transportation investment, investment in rolling stock accounted for 80.5%, and that in transportation infrastructure and in other transportation equipment, 14.7% and 4.8%, respectively. Second, while households are the primary purchaser of rolling stock, government is the dominant investor in transportation infrastructure, except for railroads and pipelines in which the business sector appears to be the major investor. Third, investment in highway infrastructure accounted for the largest share of the total transportation infrastructure investment (64%), followed by air (12.5%) and transit (7.5%) during 1987-2003. Fourth, investment in highway, water, and railroad infrastructure as a share of total transportation infrastructure investment exhibited declining trends, while that for air, transit and pipeline increased during the same period. Fifth, while the overall transportation investment (of which 80.5% is rolling stock) closely echoed the business cycle, investment in transportation infrastructure evidently lagged behind the business cycle. During 2001-2003, in particular, transportation infrastructure investment was declining, while GDP growth had already reached its lowest point and began recovering in 2002. Sixth, business sector's transportation investment is more sensitive to the business cycle compared with its non-transportation investment. Finally, transportation investment made by non-transportation industries is greater than that by transportation industries. However, the intensity of use of transportation capital, particularly rolling stock, is much higher in transportation industries than in non-transportation industries.

Readers should be aware that the above findings require further study on their economic and policy background to be used for planning, budgeting, or any other policy purposes.

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