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Kajal Lahiri

Transportation Indicators and Business Cycles

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KAJAL LAHIRI
University at Albany, SUNY, Albany, NY, USA

United Kingdom – North America – Japan
India – Malaysia – China

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Introduction to the Series

This series consists of a number of hitherto unpublished studies, which are introduced by the editors in the belief that they represent fresh contributions to economic science.

The term "economic analysis" as used in the title of the series has been adopted because it covers both the activities of the theoretical economist and the research worker.

Although the analytical methods used by the various contributors are not the same, they are nevertheless conditioned by the common origin of their studies, namely, theoretical problems encountered in practical research.

Since, for this reason, business cycle research and national accounting, research work on behalf of economic policy, and problems of planning are the main sources of the subjects dealt with, they necessarily determine the manner of approach adopted by the authors. Their methods tend to be "practical" in the sense of not being too far remote from application to actual economic conditions. In addition, they are quantitative. The editors hope that the publication of these studies will help to stimulate the exchange of scientific information and to reinforce international cooperation in the field of economics.

The Editors

Introduction

During the 2001 International Symposium on Forecasting in Atlanta, Peg Young approached me to inquire whether I would be interested in developing an output measure of the transportation sector for the purpose of macroeconomic forecasting. At that time, the Bureau of Transportation Statistics (BTS) of the U.S. Department of Transportation (US DOT) was interested in developing such a project in order for it to join the company of other federal agencies that produce monthly U.S economic indicators. During next two years with a research grant from US DOT at the University of Albany, SUNY, entitled "The Theoretical Development, Selection, and Testing of Economic Indicators for the Transportation Industry," I developed the transportation services index (TSI) with the assistance of Herman Stekler as the consultant and graduate student Wenxiong Yao as the research assistant of the project. Needless to say, we had to make numerous visits to Washington to consult with DOT staff and for presentations. Identifying monthly indicators for different sectors of the transportation sector was difficult because transportation indicators had virtually disappeared from business cycle research since the early 1950s. The research project was completed in a year and during the summer of 2003. I went to US DOT headquarters in Washington DC with Wenxiong Yao to train its staff to produce the index on a monthly basis. On January 2, 2004, after ringing the opening bell of the New York Stock Exchange, the U.S. Transportation Secretary Norman Mineta announced the roll out of the TSI as a new economic indicator intended to measure the total freight and passenger activity in the U.S. economy. Six weeks later, the first monthly release of the TSI on March 10, 2004, marked the official beginning of the series that has been released and updated every month since then, and all reports are now available at http://www.bts.gov/xml/tsi/src/index.xml. The new indicator did not escape the media attention. On April 5, 2004, issue of *Business Week*, columnist James Mehring noted, "The index provides another sorely needed measure of the service sector. Services constitute about two-thirds of the economy, yet few government reports cover the ... [It] should become a new crystal ball for economists and investors to peer into." On March 15, 2010, the front page of *Wall Street Journal* reported the recent upward movement in the freight component of TSI, suggesting that the latest recession might have turned around.

In business cycle research, transportation has an intriguing history. Among the service-providing sectors, transportation-related sectors (viz., transportation services, transportation equipment, and transportation infrastructure) had been of great interest to the early National Bureau of Economic Research (NBER) scholars (Dixon, 1924; Burns and Mitchell, 1946, p. 373; Hultgren, 1948; Moore, 1961, volume I, pp. 48–50). Burns and Mitchell (1946, p. 373) and Hultgren (1948) found that the cyclical movements in railroads coincided with the prosperities and depressions of the economy at large. More interestingly, a number of transportation indicators were included as part of the 21 cyclical indicators in the original NBER lists refined by Mitchell and Burns (1938) and Moore (1950). The transportation indicators included by Mitchell and Burns were passenger car production, total railroad operating income, truck production, and ton-miles of freight hauled by railways. Moore (1961, volume I, pp. 48–50), based on updated data through 1958, found that railway freight car loading, while still being coincident at troughs, showed longer leads at peaks after the 1937–1938 recession. This observation, which Moore attributed to the declining trend of rail traffic, marked the failure of railway freight movements as a roughly coincident indicator of the aggregate economy. Further efforts to study the role of transportation in monitoring modern business cycles were hindered due to the discontinuation, in the 1950s, of many of the monthly transportation indicators used by early NBER scholars. Recently, Klus et al. (2002) used railroad shipments data to examine the forecastability of the 1929 depression. An interesting history of the cyclical fate of different cyclical indicators can be found in the NBER Macrohistory database available online (Feenberg and Miron, 1997). Today, as businesses face harder international competition and production, inventory control and sales get more integrated, both in-house and for-hire transportation have become more important to business operations.

The economic importance of the service-providing sectors relative to the goods-producing sectors has steadily increased since the early 1950s in most countries. For instance, in the United States during 1953–2002, whereas the share of goods-producing sectors in the total non-farm employment has declined from 39% to 17%, the share of private service-providing sectors has increased from 47% to 66%. In the current NBER indicators system, information from services sectors is significantly underrepresented. Among the current four coincident and ten leading indicators, there is not a single series specifically measuring services sectors, and most of the attention in business cycle studies has remained focused on manufacturing sectors since the beginning of NBER.

Transportation represents a significant part of the U.S. service economy. Using different concepts about the scope of the transportation industry would yield different measures of its importance, varying anywhere from 3.09% (transportation GDP) to 16.50% (transportation-driven GDP). More importantly, transportation plays a vital role in facilitating economic activity between sectors and across regions. Ghosh and Wolf (1997), in examining the importance of geographical and sectoral shocks in the U.S. business cycles, find that transport (and/or motor vehicles) is one of sectors highly correlated with intra-state and intra-sector shocks, thus crucial in the propagation of business cycles. Thus, a measure of transportation activities could be very useful in monitoring the current state of general economic activity.

We developed a monthly index to measure the aggregate output of the transportation sector. This TSI output utilizes eight monthly series on freight and passenger movements from the airlines, rail, waterborne, trucking, transit, and pipelines (NAICS codes 481–486), covering around 90% of total for-hire transportation during 1980–2000. TSI is a chained Fisher-ideal index and is methodologically similar to the industrial production (IP) index, which is one of the four coincident indicators for the aggregate economy. Gordon (1992) and Bosworth (2001) have provided valuable insights into the different methodologies and data that Bureau of Economic Analysis (BEA) and Bureau of Labor Statistics (BLS) use to construct alternative annual transportation output series. We used TSI together with other monthly coincident indicators from transportation to study business cycles characteristics of this sector and its relationship to the aggregate economy. We find strong cyclical movements in TSI that is well synchronized with the NBER-defined recessions and growth slowdowns of the U.S. economy and thus can be an effective additional coincident indicator to date business cycle peaks and troughs.

Following the traditional NBER methodology and modern time series analysis, we also explore the classical and growth cycle properties for this sector. In addition to TSI, we identify three other coincident indicators to construct a composite index of coincident indicators of the sector. Also, seven individual leading indicators are identified, and a composite index is developed for the transportation sector. This effort helps us to track the ups and downs in the transportation sector and to explore its relationship with the aggregate economy. The former can be used for planning and economic policies in transportation, whereas the latter would be useful in understanding the role of transportation in economic development and monetary policies. By examining the recessions and growth slowdowns in the U.S. economy since 1958, we found that the inclusion of the transportation indicators in a system of coincident and leading indicators will greatly help in identifying the current state and improve the forecasting capability of the existing indicators.

The book is organized as follows: In Chapter 1, we present the methodology of constructing the TSI and explore its relationship with the indicators of the over all economy. In Chapter 2, the composite coincident index (CCI) is developed, and its business cycle and growth cycle properties are studied in relation to the over all economy. In Chapter 3, we identify seven leading indicators for the transportation and study the power of the composite index of leading indicators to foreshadow transportation CCI. In Chapter 4, we examine the usefulness of TSI as an additional coincident indicator for determining the peaks and troughs of business cycles in real time. Adding TSI to the current set of four coincident indicators will enable the NBER Business Cycle Dating Committee to account for several important changes that have taken place in the economy since the mid-1980s such as reduced macroeconomic volatility, declining share of manufacturing, rise of the services sector, and the failure of employment indicator to co-move with existing coincident indicators. Finally, conclusions are summarized in Chapter 5 including suggestions for future research.

In writing this book I have freely used many published and unpublished papers that I have completed with Herman Stekler, Peg Young, Wenxiong Yao, and more recently with Yongchen Zhao (see Lahiri et al., 2003, 2004; Lahiri and Yao, 2003, 2004, 2006). This study has benefited from the comments from BTS staff during our presentations and briefings. In particular, Peg Young of the BTS was instrumental at every stage of the project and was a very effective liaison. I also thank the following individuals for numerous insightful discussions and help in identifying relevant data sources: Mazhar Ali Awan, Terry Branson, David Chesser, Clyde Crimmel, Bob Costello, Christie Dawson, Stan Ellis, Robert Finkelstein, Robert Ganz, Bill Gullickson, Frank Hardesty, William Jeffers, Paul Kern, Brian Moyer, Sandia Porter, Paul Posey, Jeff Potter, Brian Sloboda, Miranda Stuart, Thea Thomas, Sharon Trench, and Jay Wieriman. All of them are true experts in their specific fields of transportation, environment and energy. Also, comments from Anirvan Banerji, Bill Bannister, Charlie Han, Rick Kowalewski, Ashish Sen, Jack Wells, and Victor Zarnowitz are deeply appreciated. Ullrich Heilemann and Victor Zarnowitz told me about some of the early efforts at NBER to incorporate transportation indicators in business cycle research. As is usually the case, contents of this book reflect my views, and not necessarily those of the BTS or the Research Foundation of the State University of New York. I have benefited from presentations of different parts of this work at many conferences including a CIRET-RWI conference in honor of Victor Zarnowitz in Essen (Germany), the 83rd annual meeting of the Transportation Research Board (TRB) in Washington D.C., and CIRET conference in Santiago de Chile.

This book was finally put together during the long Memorial Day weekend of 2010 – much to the dismay of my wife Nandini Lahiri. I am thankful to her for putting up with me on one more occasion.

Kajal Lahiri

Contents

CHAPTER 1

Transportation Services Index (TSI) and Its Characteristics

1.1. Introduction

In this chapter we develop a monthly output index of the U.S. transportation sector covering air, rail, water, truck, transit, and pipeline activities. We call it the transportation services index (TSI). Separate indexes for freight and passenger are also constructed. Before the development of TSI, there was no comprehensive monthly measure of the economic activity by all modes of transportation. Since policymakers are increasingly concerned about the critical role transportation plays in enabling economic growth, monitoring of TSI can provide them with insights about the current and future state of the economy. Fortunately we find that our monthly transportation services output index (TSI), which is based on a new measurement approach, matches very well with the annual transportation output figures produced by the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA). Some analysis reported in this chapter indicate that the cyclical movements in the transportation output appear to be more synchronized with the growth slowdowns rather than full-fledged recessions of the U.S. economy. The index has led the turning points of the 6 National Bureau of Economic Research (NBER)-defined growth cycles over the period with an average lead-time of 6 months at peaks and 5 months at troughs.

In contemporary business cycle analysis, industrial output is one of the four coincident economic indicators of the overall economy. Output refers to the physical quantity of items produced, as distinct from sales value, which combines quantity and price. In our context, transportation output measures freight movements and passenger travel by different transportation modes, i.e., subsectors of the transportation sector. There is, however, no unique indicator to measure the output of the transportation sector, on a monthly basis. The BEA and BLS of the federal government produce output measures for the transportation sector, but only on an annual basis. Unlike the manufacturing sector, the Federal Reserve Board (FRB) does not produce an index of production for service industries like the transportation sector.

Even though there has been considerable development of NBER-type indicator analysis for the whole economy, little work has been done in developing sectoral indicators. Although Layton and Moore (1989) have developed leading indicators for the service sector, there has been no monthly index of output for particular service industries.

In order to construct a monthly index of output for the transportation sector, it is, first, necessary to determine the constituent parts of the industry. We do that in Section 1.2. Then we discuss the output data that are available for each of these components of the transportation sector. We also explore possible use of the output index in business and growth cycle analysis. The newly developed output index will be compared against the annual transportation output figures produced by BEA and BLS.

1.2. Components of the transportation sector

Our definition of the industry is based on the North American Industrial Classification System (NAICS). This definition will also conform to the Transportation Satellite Accounts (TSAs) associated with the National Income and Product Account (NIPA). During 2000, however, TSAs are only available for the years 1992 and 1996.

Even though the transportation activities, in general, include House Production of Transportation Services (HPTS) through user-operated automobiles, and in-house as well as for-hire transportation by commercial establishments, in this study we only consider for-hire commercial activities for lack of available monthly data on the other two components. Official data on transportation services, defined in either Standard Industrial Classification (SIC) or NAICS, are confined only to establishments that provide passenger and/or freight transportation services for a fee. Neither in-house transportation nor HPTS are counted in. Although market activities by NAICS-defined establishments do not cover 100% of the transportation activities, it is nevertheless the most informative component of transportation sector. Han and Fang (2000) and Chen *et al.* (2003) have shown the importance of in-house and household components, respectively, but their estimates are currently annual. Arguably, these two components should be included as part of the transportation output as and when their monthly measures are developed.

For-hire transportation is defined to include the following subsectors: Air Transportation, Rail Transportation, Water Transportation, Truck Transportation, Transit and Ground Passenger Transportation, and Pipeline Transportation. Although these sectors are representative of economic activity in the transportation industry, and are closely associated with the sectors in the satellite NIPA, there is, nevertheless, a problem that has to be noted. These series do not include all of the subsectors that constitute the for-hire portion of the transportation sector of the economy. The subsectors that are included in NAICS for transportation sector but are excluded here are: Scenic and Sight-seeing Transportation, Support Activities for Transportation, Postal Service, and Couriers and Messengers. The industries that are included correspond to NAICS codes 481–486, which cover 89.7–93.9% of the total transportation during 1980–2000 according to "gross product by industry" published in *Survey of Current Business* (November, 2001). Nevertheless a monthly useful index of economic activity in the transportation sector can be derived from these series, because the subsectors that they represent constitute a significant portion of the entire industry. Moreover, the transportation subsectors that we are using to construct the index of transportation output account for a substantial portion of U.S. GDP (gross domestic product). The aggregate value of for-hire transportation accounted for 3.1% and 3.0% of GDP in 1992 and 1996, respectively (Fang *et al.*, 1998, 2000).[1] Given the critical role that transportation plays in facilitating economic activity between sectors and across regions, index of its output can potentially be an important indicator for either the current or future level of general economic activity (see Ghosh and Wolf, 1997).

1.3. Data

The total TSI was developed from eight series. Five of these series measure the level of activity in the freight component of the industry. The remaining three measure the level of passenger transportation services. The series used to measure the freight component of transportation services activity were: trucking tonnage, air revenue ton miles, rail revenue ton miles,[2] a waterway tonnage indicator, and pipeline movements of petroleum products and natural gas. Similarly, the passenger output index was constructed from three series: air revenue passenger miles, rail revenue

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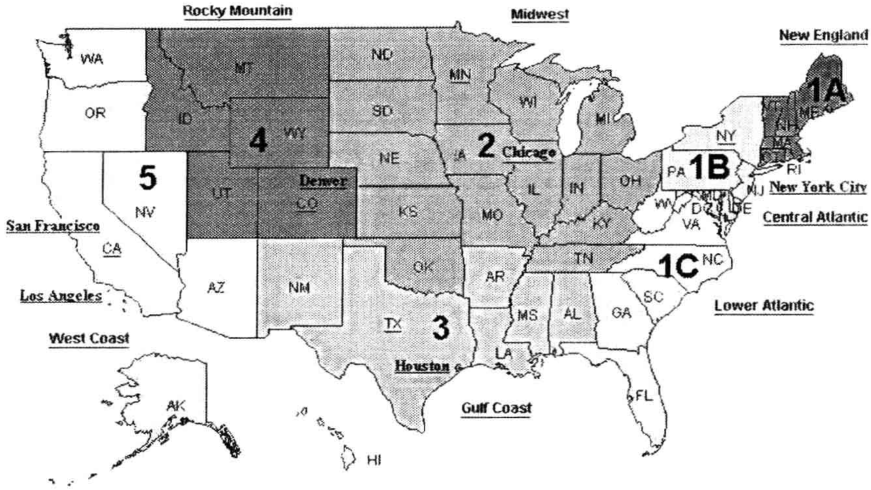
[1] These numbers and other measures on the importance of transportation were derived from the value added of the industry. Using different concepts about the scope of the transportation industry would yield different measures of its importance, varying anywhere from 3.09% (transportation GDP) to 16.50% (transportation-driven GDP) (see Han and Fang, 2000).

[2] The monthly Rail revenue passenger miles data were obtained by interpolating the quarterly figures. We have also collected weekly railroad data on carloads and intermodal traffic to construct monthly series. These data have been used to update the index in subsequent analysis.

Figure 1.1. Petroleum administration for defense districts (PADDs)



passenger miles (RPMs),[3] and national transit Ridership. The sources and characteristics of all of these series are provided in Appendix A of this chapter.[4]

With the exception of the pipeline data, all of the data were available from 1980:1. The pipeline data were available from 1985:1 onward. The series that we use to measure pipeline transportation is constructed from data on movements of crude oil & petroleum products, consumption of natural gas, and the field production in Alaska. Crude oil & petroleum products are moved between different Petroleum Administration for Defense Districts (PADDs) as depicted in Figure 1.1, whereas natural gas is delivered to final users. The Alaska field production of crude oil & petroleum products is added because it almost never enters the PADD system. Alaskan petroleum used to be mostly consumed within Alaska or other PADD five regions due to an export ban. This ban was lifted in the early 1990s, and now most of it is exported to Japan. The addition of the Alaska field production accounts for the movement within Alaska along the Trans-Alaska Pipeline from the North Slope to the port of Valdez. Movements of crude oil & petroleum and natural gas are

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[3] Owing to a change in data collection procedure, RPM values during 1980:1–1985:12 were unusable. The RPM values for these months were backcasted based on regression of RPM on rail revenue passenger (RP), $Rail\_RPM = -27991243.120 + 51725.329*Rail\_RP - 0.485*Rail\_RP^2$, estimated over 1986:1–2002:4. Adjusted $R^2 = 0.562$.

[4] The transit data is monthly, but is available only on a quarterly basis.

measured in different units. The first is measured in millions of barrels per day while natural gas is measured in cubic feet. It is possible to combine them by converting both to tons (or Btu's) with physical conversion factors.[5] Then the converted tonnage of petroleum and natural gas are added together as the measure of total movements by the pipelines. Just as with the other series, these figures are converted to index number form with 1996 = 100.

In constructing the index, the weights were adjusted for the years in which the pipeline data were not available. The seasonal adjustment was done using the U.S. Census Bureau's X12-ARIMA program with adjustment for trading day and holiday effects.[6]

Since all of these series measure real quantities, no price deflation was required.

1.4. Index construction

1.4.1. Weights for the components series

The total output of this industry, like the index of industrial production (IP) of the manufacturing sector, is an aggregate of real output generated by each of the components. The data from the eight series were used to construct the TSI. Each of these series represents the output quantity of a subsector of the transportation sector. Therefore, each of these series was converted into index number form with 1996 = 100.

In order to construct the TSI, I_m^A (superscript, A, denotes "aggregate" and subscript, m, denotes the month), for the entire transportation sector, the indexes of these subsectors were combined by assigning weights to each of the components. The weights measure the relative importance of each transportation subsector to the entire sector. They are also interpreted as "price" of services provided by different transportation modes for quantity indexes. Although there are several different ways of measuring the relative importance of each subsector, we used value-added weights from NIPA. In our context, the value-added weights are more appropriate than gross output because transportation is an intermediate sector whose economic contribution is only the difference in values of goods in the process of transportation. This exactly conforms to the concept of GDP. These weights were obtained from the annually updated "gross product by industry" table published in *Survey of Current Business* (November 2001).

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[5] The conversion factors were obtained from the Department of Energy (DOE). They are presented in Appendix A. DOE actually has two types of conversion factors, one based on Btu's and one based on mass. Both yield similar estimates.

[6] The seasonal adjustment program was originally developed by Shiskin *et al.* (1967).

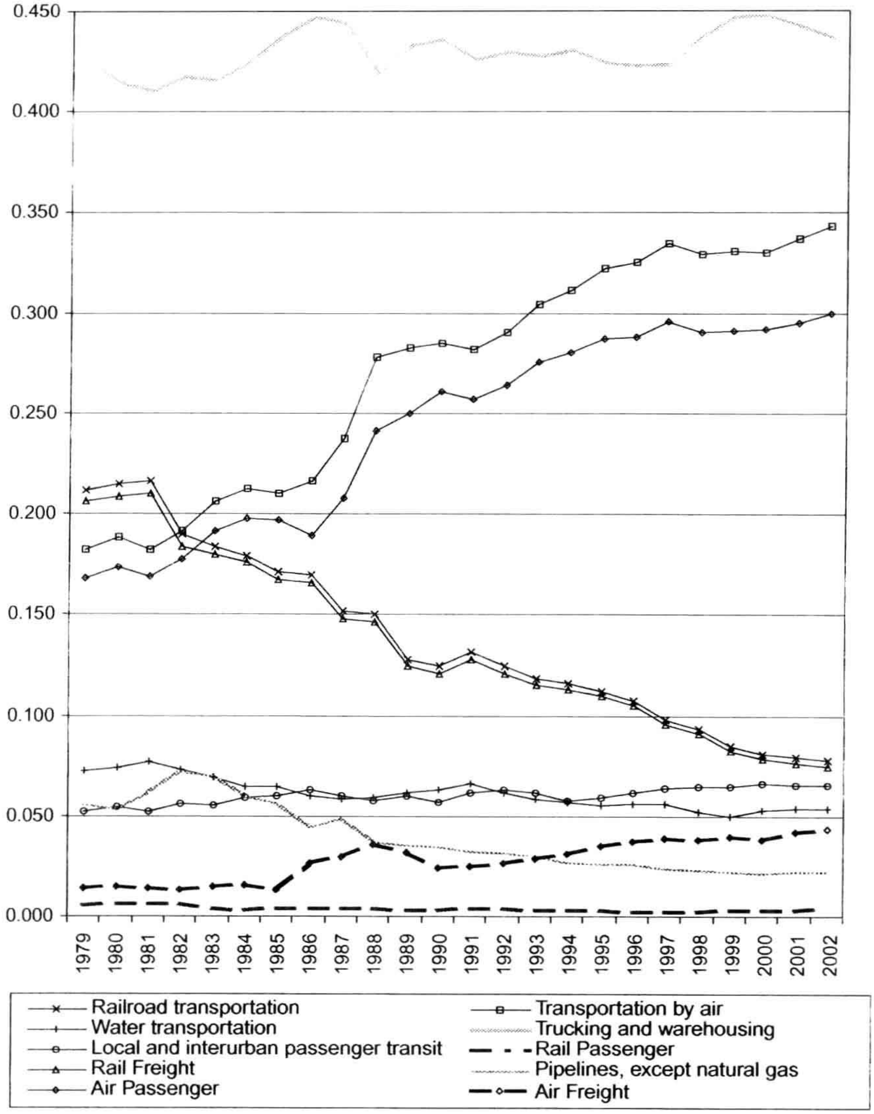
We disaggregated airline and railroad weights into their respective freight and passenger components by using the ratios of their operating revenues for the particular year. The historic annual weights are depicted in Figure 1.2 for each component of the TSI. From the graph, it is clearly seen that, since 1981, air passenger, which dominates the airline industry has an increasing weight relative to other subsectors, and railroad freight, which dominates rail transportation has a decreasing weight. From 1980 to 2000, the weights for airline industry and railroad transportation changed from 18.8% to 33.0%, and 21.5% to 8.1%, respectively. The trucking has the maximum weight among all subsectors throughout the period, always in excess of 40%. The weights for the others (i.e., rail passenger, air freight, pipelines, water transportation, and public transit) were always below 8% and changed little over this period. The graph also reflects the fact that economy has become less freight-intensive in that the total weight for freight movements relative to the total transportation activities has steadily shrunk from 72.3% to 61.1% in the past two decades. Hultgren (1948) discussed the causes and consequences of the decline in railroad transport in the United States since 1900.

1.4.2. Fisher-ideal index

Given the weights, component series are aggregated into one single index using different index methods. Economic theory indicates that the preferred measure of quantity change is a geometric mean of the Laspeyres index and the Paasche index. This results in the so-called Fisher-ideal quantity index. Fisher-ideal index is one of the "superlative" aggregate indexes, which means current-weighted, whereas the other two are fixed-weighted using weights in a single period. The use of fixed-weighted measures of quantity index, such as those derived from Laspeyres quantity index may result in a "substitution bias" that causes an overstatement of output growth for periods after the base year and an understatement of growth for periods before the base year (see Landefeld and Parker, 1995, for further explanation). The tendency of "substitution bias" reflects the fact that those commodities for which output grows rapidly tend to be those for which prices change less proportionately. Although this bias may be small enough to be safely ignored for shorter sample periods, the output measures derived from a fixed-weighted index can become increasingly subject to "weighting effects" as the time between weighting period and the current period lengthens. A similar but opposite problem occurs with the other type of fixed-weighted index, the Paasche quantity index, which uses current period prices as weights.

The Fisher-ideal index registers changes that fall between those from Laspeyres and Paasche indexes, and is a chain index. Because of many advantages, BEA has been publishing NIPA with this new methodology since 1996 (Landefeld and Parker, 1995). The Board of Governors of

Figure 1.2. Annual weights for the aggregation of transportation



Source: "Gross Product by Industry" published in *Survey of Current Business* (November 2001)

Federal Reserve Board has also adopted the Fisher-ideal formula in constructing the industrial production index (Corrado *et al.*, 1997) since the mid-1990s. Conceptually our transportation output measure is very similar to FRB's industrial production index in the sense that both of them measure the physical production of a sector. The new formula for the growth of monthly transportation indexes is given by

$$\frac{I_m^A}{I_{m-1}^A} = \sqrt{\frac{\sum_j I_{jm} P_{jy(m-6)}}{\sum_j I_{jm-1} P_{jy(m-6)}} \times \frac{\sum_j I_{jm} P_{jy(m+6)}}{\sum_j I_{jm-1} P_{jy(m+6)}}} \tag{1.1}$$

where I_{jm} is output index in subsector j in month m and $P_{jy(m)}$ the value-added weight for subsector j in year y. The subscript, $y(m)$, denotes "year containing month m." The transportation output index (Fisher-ideal) uses annual outputs weighted by previous, current, and next year prices. To compute output quantity index as a chain-typed annually weighted Fisher index, we require unit value added for both current and the next year. Although the table for "gross product by industries" is published usually in the November issue of *Survey of Current Business* each year, the estimates for recent periods were obtained in two steps. First, industry producer prices (PPI) for each subsector of transportation (for transit, we used consumer price index (CPI) of intra-city transportation because PPI is not available for this subsector) that BLS produces on a monthly basis, were extrapolated to obtain the annual averages for the current year (i.e., 2002) and the next year (i.e., 2003). Second, the unit value-added measures were extrapolated based on these annual averages of PPIs. The TSI, as well as its freight and passenger components subtotals, is computed as the cumulative product of a monthly series of these growth estimates from 1980:1 onward. For $I_0^A = 100$ in the base year,

$$I_m^A = \frac{I_m^A}{I_{m-1}^A} \times \frac{I_{m-1}^A}{I_{m-2}^A} \times \cdots \times \frac{I_1^A}{I_0^A} \times 100 \tag{1.2}$$

Figure 1.3 compares the Fisher-ideal index of total transportation output with its alternative index computed from the linked-Laspeyres, are found to be almost identical. Note that the standard formula for linked-Laspeyres quantity index is $I_m^A = \sum I_m \cdot p_0 / \sum I_0 \cdot p_0$, where p_0 is the price in the base period (we set $I_0 = 100$). It shows changes in physical movements in the transportation sector with prices held fixed at base year values, which is 1996 here (Corrado *et al.*, 1997). Since the public transit subsector is often supported by public subsidies, its value-added figures are sometimes negative. As a result, we had to calculate the weight assigned to this sector as the average of the ratio of its output to the total transportation industry output for 1996. For airlines and railroads we determined the relative amount of operating revenue obtained from transporting passengers and freight to disaggregate the weight into passenger and freight. The weights for the Laspeyres index are obtained from 1996 TSA (Fang *et al.*, 2000) and presented in Table 1.1. Any difference between the two indices would arise from the different weights they are using. As seen from Figure 1.2, the weight on the largest component, trucking, has been pretty stable in the sample period, which