Case Study

Relationship between Economic and Transportation Infrastructure Indicators and Freight Productivity Growth

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Abstract: This study strives to examine the relationship between truck transportation productivity growth and economic indicators. The subjects for the case study were identified using the levels of economic activity for the years 2001 through 2007 and transportation indicators for 2002. On the basis of past works that have explored a similar theme, a truck transportation productivity measure is defined. First, the relationship between economic indicators—including employment and gross domestic product—and mobility, as a transportation indicator, are examined using descriptive statistics and maps. Then, three cases were selected for further qualitative examination on the basis of outlier measures. The factors that determine the metropolitan statistical areas (MSAs) with high rates of trucking productivity growth and those with low growth, or even decline, seem to be influenced by the overall economic conditions, and also the economic development incentives and ingenuity of the communities to attract businesses. Case studies suggest that the MSAs that have been successful in attracting various types of businesses have also been successful in growing the trucking sector. DOI: 10.1061/(ASCE)UP.1943-5444.0000111. © 2012 American Society of Civil Engineers.

CE Database subject heading: Freight transportation; Productivity; Economic factors; Transportation management; Infrastructure.

Author keywords: Freight productivity growth; Economic indicators; Transportation infrastructure indicators.

Introduction

Over the past few decades, several factors have contributed to the increase in freight transportation demand. Based on the historical economic growth rate in the Upper Midwest Region of the United States, intercity truck freight and rail freight demand for the region are expected to double over the next 20 years (Adams et al. 2006) if the economy in the Upper Midwest grows at even a modest rate. However, the transportation systems in the United States have not kept pace with the increased demand.

This study specifically examines some economic and infrastructure indicators that could potentially help to interpret the interrelationships between freight infrastructure development, economic growth, and specifically freight transportation productivity in the Upper Midwest Region that includes Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin. A productivity measure for freight transportation is defined using some publicly available economic indicators. Employment and gross domestic product (GDP) by figures for each industry for the years 2002–2007 are used for this purpose.

Specific research questions examined in this study are the following:

• Which metropolitan statistical areas (MSAs) have experienced significant improvements in trucking sector productivity?

• Is there a statistical correlation between highway infrastructure, economic indicators, and changes in trucking sector productivity at the MSA level?

The overarching objectives of this study are to: (1) advance the understanding of the relationship between the provision of highway infrastructure, its performance, and trucking productivity growth; and (2) examine whether more efficient trucking sectors are associated with efficiencies of other sectors that rely on trucking for their business activities.

Background

Productivity measures have been examined for different industry sectors as a useful quantitative tool to monitor the well being of the industry. The freight transportation industry, however, lacks such a measure because of several reasons, including data scarcity and associated complexities in defining clear input and output for this industry (Norwood and Casey 2002). It is a significant shortcoming, because freight productivity measures can be used to monitor the efficiency of the freight industry and also to identify factors influencing the efficiency of freight transportation systems. This study attempts to address this shortcoming by introducing a productivity measure for the freight transportation industry.

Because freight productivity has not attracted much interest from researchers in this area, looking at the definitions of productivity in other industry sectors is helpful for defining productivity in a similar fashion for freight transportation industry. At the most generic level, productivity is a technical concept that refers to the ratio of output to input, and is a measure to estimate the efficiency of the production cycle (Kusum Das 2003). However, different studies have used various output and input factors to estimate productivity for various industry sectors, based on the purpose of the study and data availability (Smith et al. 1982; Shah 1992; Pilat 1996; Kusum Das 2003).

A summary of the workshop on transportation indicators, conducted by the National Research Council’s Committee on...
National Statistics and Transportation Research Board (Norwood and Casey 2002) includes a chapter on transportation productivity. They identified seven types of indicators, each having distinct characteristics with regard to policy relevance, simplicity, reliability, and timeliness. Russo and Comi (2011) recently proposed a general classification of freight transport performance measures at the urban level and discussed each measure along with the empirical results in different European cities. Bhatia and Drennan (2003) offered a comprehensive overview of research that studied the benefits of transportation infrastructure investments. Recent work by Rodrigue et al. (2009) provides a thorough review of the measures of freight productivity, and also transportation in general. Understanding the factors that affect freight transportation productivity is of considerable importance, as it should lead to policies that improve the efficiency of the transportation industry and thereby reduces total production costs in many freight-dependent industries. A few recent studies have specifically focused on the productivity improvement in the truck, rail, and water transportation industries (Pilat 1996; Mohammed and Williamson 2003; Boyer and Burks 2003; Hilmola 2007; Boyer and Burks 2007). In a study of the railway sector, Pilat (1996) used average technical efficiency, in which output was defined as a combination of gross hauled ton-kilometers by freight trains and gross hauled ton-kilometers by passenger trains, and the inputs were engines and railcars, employment, and electrified and non-electrified lines (Pilat 1996). Furthermore, Hilmola (2007) analyzed two data envelopment analysis models, in European countries, with two separate outputs—namely freight ton-kilometers and freight tons. The models included multiple inputs such as number of freight wagons, total distance in kilometers, and total numbers of locomotives and staff. Bitzan and Keeler (2003) addressed a similar topic of railway productivity in the U.S., and analyzed the effect of elimination of cabooses (i.e., freight trains for use of the crew) and freight train crew members on rail freight productivity. Among studies that focused on truck freight productivity, Boyer and Burks (2003) reported that miles per truck, pounds per loaded truck, miles per gallon, and reduction in empty movements are the primary indicators of trucking productivity. They showed that the decline of trucking prices is not necessarily because of an increase in ton-mile per truck, but occurs instead because of a drop in input prices (e.g., labor and equipment costs) and fuel economy improvements. Effects of fuel cost fluctuations on truck and rail sectors, however, were specifically investigated in a recent study by Samimi et al. (2011). In another study by Boyer and Burks (2007), they looked into the changes in traffic compositions and concluded that increased in speed limits is a cause of of increasing miles per truck, and increased lengths of trucks leads to an increase in the average volume and loaded weight of trucks. Smadi and Maze (1996) adopted the ratio of ton per employee to calculate the productivity rates for nine commodity groups. Table 1 provides a summary of different inputs and outputs that are commonly used in the literature to define productivity indicators in the transportation sector.

According to Table 1, among the few studies that have focused on transportation productivity, ton-mile is a widely used measure of output. There are, however, several other outputs that can be potentially used such as GDP, which is commonly used in productivity assessments of other industries. Output measure in the productivity ratio has a significant importance, as it can change the interpretation and use of productivity measures substantially. For instance, if a policymaker aims at boosting the trucking industry in a region to obtain greater financial benefits, indicators of total turnover within this industry sector, such as GDP or income, would provide a more informative measure of output as compared to ton-mile. Conversely, if a policymaker is interested in focusing on environmental aspects of trucking productivity or analysis of trucking as an input to manufacturing processes, the ton-mile could be more appealing, as it gives a measure for the efficiency of truck usage. As stated, GDP has not been used as an output indicator for the freight industry, and this study aims at introducing a productivity measure using trucking GDP to address this shortcoming to some extent.

The freight industry plays an important role in the productivity of many other industrial sectors that have close relations with the freight transportation industry. For instance, manufacturers, wholesalers, and retailers depend on the trucking industry to a large extent (Boyer and Burks 2003). Agriculture is also a freight-related industry whose products are mostly carried by railroads, especially in long-hauls, because of the low values of these types of commodities (Kawamura and Rashidi 2010). Construction and mining are two other types of industries that are highly dependent on truck

### Table 1. Summary of Input and Output Definitions in Transportation Productivity Indicators

<table>
<thead>
<tr>
<th>Researcher(s)</th>
<th>Year</th>
<th>Input</th>
<th>Output</th>
<th>Modes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilat</td>
<td>1996</td>
<td>Engines and railcars, Employment, Electrified and non-electrified lines</td>
<td>Gross hauled ton-kilometers</td>
<td>Rail</td>
</tr>
<tr>
<td>Smadi and Maze</td>
<td>1996</td>
<td>Freight tonnage</td>
<td>Number of employees</td>
<td>Road/Rail</td>
</tr>
<tr>
<td>Norwood and Casey</td>
<td>2002</td>
<td>Transportation and inventory costs, Full supply chain and distribution cost, Growth in transportation infrastructure, Labor productivity</td>
<td>Gross Domestic Product</td>
<td>Road/Rail</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Growth in the economy</td>
<td></td>
</tr>
<tr>
<td>Mohammed and Williamson</td>
<td>2003</td>
<td>Ship size and capacity, Coal consumption, Crew sizes</td>
<td>Port turnaround time</td>
<td>Water</td>
</tr>
<tr>
<td>Boyer and Burks</td>
<td>2003</td>
<td>Labor cost, Equipment costs</td>
<td>Miles per truck, Pounds per loaded truck, Miles per gallon, Empty movements</td>
<td>Road</td>
</tr>
<tr>
<td>Hilmola</td>
<td>2007</td>
<td>Number of freight wagons, Total distance, Total number of locomotives and staff</td>
<td>Freight ton-miles, Freight tons</td>
<td>Rail</td>
</tr>
<tr>
<td>Rodrigue et al.</td>
<td>2009</td>
<td>Level of motor vehicle ownership</td>
<td>GDP per capita</td>
<td>Road</td>
</tr>
</tbody>
</table>

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freight transportation. We use economic indicators for the manufacturing and construction sectors to examine the relationship between trucking sector productivity and the economic activities of those sectors.

Data

This study focuses on MSAs in the seven states of Illinois, Wisconsin, Indiana, Iowa, Michigan, Minnesota, and Ohio. Fig. 1 shows the locations of all 83 MSAs in the study area with the interstate highways that cross over the MSAs. As shown in this figure, minor sections of North Dakota, South Dakota, Nebraska, Kentucky, West Virginia, and Pennsylvania are also covered in this study, because some MSAs extend across borders between two states.

In this study, economic variables were originally obtained at the MSA level, while the transportation infrastructure indicators were compiled at the county level. Thus, MSA level data had to be calculated by aggregating values of transportation infrastructure indicators of counties in each MSA. Mobility is used as a transportation infrastructure indicator in this study. Other indicators, such as highway stock (Boarnet 1998), accessibility, impedance, or congestion (Norwood and Casey 2002) could have been used. Mobility is quantified using the ratio of vehicle mile traveled (VMT) over centerline road length. The VMT for each MSA was prepared at the data center at the Urban Transportation Center of the University of Illinois at Chicago in an extensive geographic information system (GIS) effort. The data was initially obtained from the Freight Analysis Framework (FAF) highway network (FHWA 2007) for use in the project. However, the transportation infrastructure variable is only available for the year 2002.

The economic indicators were compiled for two of the industries, the manufacturing and construction sectors, that are highly dependent on the trucking industry. As an independent variable, manufacturing productivity is defined as the ratio of manufacturing GDP over manufacturing employment. Construction productivity is also defined in a similar fashion. To derive the indicators, employment by industry and GDP were obtained from the regional economic data by the U.S. Bureau of Economic Analysis (2011). The economic indicators were obtained for each year from 2001–2007. The employment data are released only for the major industry classes. For instance, employment is given for the transportation and warehousing industry, which is a major industry, but not for truck, air, and rail transportation separately, as those are the minor industries. Table 2 provides an overview of economic and transportation infrastructure indicators and the number of valid cases for each variable.

![Fig. 1. MSAs and interstate system within study area (source of interstate corridor: FAF2.2)](image-url)
The productivity measure in this study was defined as the ratio of output over input, which is the standard framework used in many studies. This study focuses on the trucking industry and introduces a trucking industry productivity measure as the ratio of trucking GDP (output) to the total employment in all industries (input). This was to capture the size of the industry in each area and also because of the fact that the trucking industry is highly dependent on other industry sectors, because it does not produce a specific commodity. Also, the employment data for the trucking sector suffers from a high number of missing values and thus was deemed unreliable. Trucking industry productivity growth, which is the dependent variable in this study, is defined as 2007 productivity minus 2002 productivity, divided by the productivity in the year 2002. Table 3 shows basic statistics for trucking industry productivity and trucking industry productivity growth.

### Analysis

This study tries to identify the outlier MSAs in two ways: by statistical and visual methods. Filzmoser (2004) described outliers as “the abnormal data behavior,” meaning that “they are deviating from the natural data variability.” The purpose of finding outliers was not improving the results of the model, but instead was to identify the MSAs that are outliers and exhibited an unusual deviation from the typical relationship. The standard method for detecting multivariate outliers is estimation of a parameter, called Mahalanobis distance. Mahalanobis distance is a distance measure, on the basis of correlations between two or more variables (Filzmoser 2004).

Productivity growth is defined as the difference between 2002 and 2007 trucking productivities, divided by the productivity for the year 2002. This value has been calculated for all the MSAs in the study area, except for the 12 MSAs for which data were not available. The primary analysis is not performed considering the inflation. This is because the Consumer Price Index for all the goods in these Midwest Cities grew by only 13.2% between 2002 and 2007 according to the Bureau of Labor Statistics (2011).

Fig. 2(a) shows the MSAs with the highest productivity growth. Kankakee-Bradley had an 80% increase, followed by Anderson, Decatur, and Iowa City. Iowa City had the second highest productivity growth. By 2007, it became the most productive MSA after an improvement of around 73%. Even if the effect of inflation is taken into account, these are very high rates of growth in just 5 years. Fig. 2(b) provides a list of MSAs with the lowest productivity growth. Although GDP was not adjusted for inflation, it is surprising that many MSAs experienced considerable improvement in trucking sector productivity in a mere 5 years. Also, Fig. 3 shows the locations of the 10 MSAs with highest and lowest trucking industry productivity growth from 2002–2007. After adjusting for inflation, though the values slightly changed, the order of the 10 MSAs with the highest and lowest productivity growth did not change.

The spatial pattern of the MSAs in Fig. 3 shows that all of the MSAs with the highest trucking industry productivity growth, with the possible exception of Ann Arbor, MI, are located within a wide band that roughly connects Pennsylvania and Iowa. Major roadways serving this corridor include I-80, I-70, and I-77. Also, they are not necessarily located near major urban areas. MSAs such as Iowa City, Decatur, and Parkersburg have achieved high rates of growth despite being located hundreds of miles from large urban areas in the Midwest.

In many cases, MSAs with highest trucking industry productivity growth are close neighbors with MSAs with the lowest growth. For example in Ohio, the Youngstown, Canton, and Parkersburg MSAs that experienced high growth in productivity are located in the same part of the state as the Akron and Wheeling MSAs that experienced some of the lowest rates of improvement. Although the Anderson, Muncie, and Columbus MSAs are all located near Indianapolis, only the Anderson MSA achieved a high rate of growth whereas the other two experienced very low or—in Muncie’s case—negative changes. This can be attributed to competition among the urban areas to attract trucking businesses. The factors that separate winners such as Anderson from losers such as Muncie cannot be determined from the maps, because in many cases they are served by the same interstate highways and are located similar distances from a major urban area.

### Transportation Infrastructure

Mahalanobis distance, which is a quantitative measure for detecting outliers, was used to identify MSAs that exhibited an unusual deviation from the typical relationship between trucking sector productivity indicators and transportation infrastructure indicators. An outlier can be either positive (e.g., a MSA exhibited an unusually high level of trucking sector productivity after accounting for the explanatory variables such as mobility or infrastructure indicators) or negative. Examination of outlier MSAs may reveal useful insights into factors that influence trucking sector productivity but are not being included in the analysis.

Mahalanobis distance is based on correlations between two or more variables that may have different patterns. Multivariate outliers can be defined as observations that have large squared Mahalanobis distances, with a quantile of approximately 97% (Filzmoser 2004). For two given vectors of random variables X and Y, Mahalanobis distance can be calculated as $d = \sqrt{(X - Y)^T S^{-1} (X - Y)}$ where $S$ is the covariance matrix between $X$ and $Y$. This study uses Mahalanobis distance as a quantitative statistical method, and scatter plots as a visual way of finding outliers. As Filzmoser (2004) indicated, there is not a specific

### Table 2. Economic Indicators for the Manufacturing and Construction Sectors at the MSA Level from 2001–2007

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Valid values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility (VMT/road length) in 2002</td>
<td>15206.35</td>
<td>7051.20</td>
<td>83</td>
</tr>
<tr>
<td>Total employment for all industries</td>
<td>353,444.80</td>
<td>730,644.58</td>
<td>581</td>
</tr>
<tr>
<td>Trucking GDP</td>
<td>253.22</td>
<td>577.504</td>
<td>517</td>
</tr>
<tr>
<td>Manufacturing employment</td>
<td>40,324.65</td>
<td>73,729.13</td>
<td>581</td>
</tr>
<tr>
<td>Manufacturing GDP</td>
<td>3799.75</td>
<td>7642.93</td>
<td>549</td>
</tr>
<tr>
<td>Manufacturing productivity</td>
<td>0.095</td>
<td>0.023</td>
<td>549</td>
</tr>
<tr>
<td>Construction employment</td>
<td>19561.36</td>
<td>40004.78</td>
<td>569</td>
</tr>
<tr>
<td>Construction GDP</td>
<td>956.79</td>
<td>2658.39</td>
<td>536</td>
</tr>
<tr>
<td>Construction productivity</td>
<td>0.046</td>
<td>0.008</td>
<td>536</td>
</tr>
</tbody>
</table>

### Table 3. Trucking Industry Productivity Data at the MSA Level

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Valid cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trucking industry productivity</td>
<td>$0.008 \times 10^{-14}$</td>
<td>$0.005 \times 10^{-14}$</td>
<td>517</td>
</tr>
<tr>
<td>Trucking industry productivity growth</td>
<td>0.286</td>
<td>0.247</td>
<td>71</td>
</tr>
</tbody>
</table>

*Average over 2001–2007.*
Fig. 2. Trucking sector productivity growth from 2002–2007 (source of data: BEA)

Fig. 3. 10 MSAs with the highest and lowest trucking industry productivity growth from 2002–2007 (source of data: BEA)
Among manufacturing GDP, manufacturing productivity, construction GDP, and construction productivity, the only indicator that showed a significant association with trucking sector productivity growth was manufacturing productivity. Scatter plots and Mahalanobis distance measures were utilized to identify outlier MSAs. Two classes of outliers could be arguably defined as: economically active and nonactive MSAs. Champaign-Urbana and Muncie are in the nonactive class and were identified as outliers in four scatter plots in Figs. 5 and 6. These two MSAs were also outliers according to Fig. 4, in which trucking sector productivity growth was plotted versus mobility.

Chicago-Naperville-Joliet and Detroit-Warren-Livonia are outliers in both manufacturing GDP and construction GDP versus productivity growth and are considered economically active. They were the MSAs with the first and second highest manufacturing, construction, and trucking GDPs in 2002 and 2007. In terms of trucking sector productivity growth, however, Detroit-Warren-Livonia had the 29th highest growth rate from 2002–2007, whereas Chicago-Naperville-Joliet was ranked 28th. The Anderson MSA had a fairly large improvement in trucking sector productivity from 2002–2007, in addition to a high productivity rate in the manufacturing and construction industries. Anderson and Indianapolis-Carmel are outliers in Figs. 5(b) and 6(b) with a high level of manufacturing productivity and high rates of trucking sector productivity growth.

Case Studies

As discussed previously, there were some MSAs that experienced extraordinary changes in trucking sector productivity between 2002 and 2007. Statistical analysis of economic and transportation infrastructure indicators did not clearly identify the factors that contributed to the observed changes in trucking sector productivities in those urban areas. A brief overview of the economic profiles of three MSAs—Kankakee-Bradley and Iowa City that experienced significant increases, and Champaign-Urbana that suffered around a 40% decline in trucking sector productivity—is provided to examine the context behind those noteworthy changes in trucking productivities.

Kankakee-Bradley, Illinois

Most of the area in this MSA is within Kankakee County. The current period of economic downturn in Kankakee started in the summer of 1983 with the loss of the Roper facilities that had employed more than 2,800 persons in 1978. With the loss of these vital industrial jobs, Kankakee County unemployment skyrocketed to 21.4% by February 1984 (The Daily Journal 1986), and some manufacturers (e.g., Kroehler’s Furniture Manufacturing and the General Foods dog food plant) closed forever (The Daily Journal 1994, 1998). This economic crisis resulted in an outflow of population seeking jobs elsewhere.

The City experienced a solid recovery after the election of Mayor Donald Green in 1993. The new administration increased sales tax revenue from $2.99 million in 2002 to $6.0 million in 2007 (City of Kankakee 2007). This was achieved by entering into a Sales Tax Sharing Agreement, according to which the city shares part of the sales tax generated by firms located within the City of Kankakee. This agreement was a key reason that some major retailers came to the area and revitalized employment after the economic downturn in Kankakee during the mid 1980s.

Total GDP in Kankakee was $2,447 million in 2002 and reached near $2,967 million in only 5 years. The growing economy of the Kankakee-Bradley MSA led to a significant increase in the trucking sector GDP from $38 million in 2002 to $72 million in 2007. This introduced Kankakee-Bradley as the MSA with the highest rate of trucking industry growth in the Upper Midwest during 2002–2007. The trucking industry accounted for 1.5% of the total GDP. This contribution, however, was increased to 2.4% in 2007.

Iowa City, Iowa

Iowa City is a very special case in this study, as it is among the 10 MSAs with the highest percentages of trucking sector productivity growth and also had a decent-sized trucking sector in 2002, with a GDP of around $179 million. All other MSAs that showed a substantial growth in their trucking industries had significantly smaller trucking GDPs in 2002, somewhere between $50 million and $100 million. Iowa City has been able to sustain growth year after year, and has achieved the greatest trucking sector GDP growth in...
the Upper Midwest region. Iowa City had the second highest trucking industry GDP in 2007 after Green Bay, home to Schneider National, a large logistics and transportation services company. Meanwhile, Iowa City is home to Heartland Express, a smaller company with approximately $450 million in annual sales (Hoover’s Inc. 2010). Heartland Express is one of the largest short-to-medium haul specialists that operate mostly in the Upper Midwest states (Dayrit 2010). Although total GDP of this MSA increased approximately 34% from 2002–2007, trucking sector GDP had a huge increase of 91% during this time span. Compared with the Kankakee MSA, Iowa City produced a greater share of the trucking industry GDP at approximately 3.6% in 2002 and 5% in 2007.

**Champaign-Urbana, Illinois**

Champaign-Urbana is well known as home to the University of Illinois at Urbana-Champaign, one of the largest public universities in the country. The economy of this MSA is primarily based on this university and, as declared by the Champaign County Economic Development Corporation (2010), the University of Illinois, the Carle Clinic Association, and the Carle Foundation Hospital were the top three employees in 2009. Most of the employees in this MSA have a direct association with the University, and many of them are serving the university students, professors, and staff. Kraft Foods and Kirby Foods are major businesses that are not associated with healthcare or educational services in this area, and are more dependent on the trucking industry (Champaign County Economic Development Corporation 2010). Kraft, for instance, has the largest private truck fleet in Champaign. Therefore, the shipping behaviors of Kraft Foods should be observed to better understand the underlying reasons and possible explanations for the drastic decline of around 40% in trucking sector GDP over just 5 years. Kraft Foods reduced 50 million truck miles from its global distribution operations through the use of heavier and more fully-loaded trucks. Also, refinements in supply chain management strategies (e.g., repositioning hubs and other facilities) and logistic decisions (e.g., shift to rail and waterways) drastically reduced truck VMT in this area (Cassidy 2009; Dodson 2009). Cassidy (2009) argued that Kraft could reduce the number of truck trips between a Champaign plant and a Norcross distribution center by 23%. It can be said that an increase in the efficiency of trucking operations, aggressively pursued by Kraft, has resulted in a decline in the economic base of the community. This is an example where using ton-miles as the indicator of trucking sector productivity would have failed to identify negative effects on the community.

**Fig. 5.** Trucking sector versus manufacturing productivity growth in 2002 (source of data: BEA)

**Fig. 6.** Trucking sector versus construction productivity growth in 2002 (source of data: BEA)
Conclusion

This study examines the relationship between freight transportation productivity and several indicators of transportation infrastructure and the economy at the MSA level for seven states in the Upper Midwest. A productivity measure for the trucking sector, which is the dominant freight transportation mode in the United States, was also introduced. This measure provides information for identifying factors that affect efficiency of the truck transportation system. In contrast to many industrial sectors, the freight transportation industry lacks reliable and easy-to-estimate productivity measures.

The productivity measure in this study was defined using a common approach found in the literature, which is the ratio of output over input. Trucking sector GDP was selected as the output, and the total employment in all industries was selected as the input. Manufacturing and construction sector GDPs and productivities for the year 2002 are the four economic indicators examined in this study. This study also used mobility for the year 2002 as a transportation infrastructure indicator. Trucking sector productivity growth was the dependent variable of interest in this study. To adopt a productivity measure in a specific policy analysis, one should pay close attention to the definition of the productivity ratio because different measures have different interpretations. In this study, specifically, financial benefits are given a central priority, with GDP selected as the output. In a different case where the environmental aspects of the trucking sector are of greater interest, for example, the ton-mile could be a more appealing output measure.

Outlier MSAs were identified on the basis of the Mahalanobis distance, and a brief profile of each was discussed. The following is a summary of findings and some answers to the research questions of the study.

- Muncie and Champaign-Urbana were the only MSAs that lost significant percentages, over 40%, of their trucking business between 2002 and 2007.
- Kankakee-Bradley had the highest increase in its trucking sector productivity, followed by Anderson, Decatur, and Iowa City. Champaign-Urbana and Muncie experienced significant decreases in their trucking productivities from 2002–2007.
- In terms of productivity growth in the trucking sector, the case of Iowa City is very unique in two ways. It already had a decent-sized trucking sector, with a 90% increase from 2002–2007. In addition, its growth occurred in a relatively steady manner over the five-year period.
- Some MSAs that are among the 10 most productive in the trucking sector are located close to MSAs that are among those with the lowest productivity growth. For example, Youngstown, Canton, and Parkersburg with high productivity growth are located in the same area of the state as the Akron and Wheeling MSAs that experienced some of the lowest rates of improvement.

In summary, the factors that determine which MSAs have high rates of trucking productivity growth and which have low growth or even decline seem to be influenced by the overall economic conditions, and also economic development incentives and ingenuity of the communities to attract businesses. Case studies suggest that the MSAs most successful in attracting various types of businesses have also been successful in growing their trucking sectors. This leads to competition among communities for trucking businesses. It is common to find MSAs with high growth in trucking sector GDP right next to the ones with low growth. In many cases, these situations seem to occur around major urban areas such as Indianapolis, but there are also cases where MSAs are not near a major urban area but are connected by a highway corridor.

Lack of data was the primary barrier to developing productivity measures for other modes of freight transportation such as rail. This remains a limitation of the study and, thus, a solution would be collecting reliable input and output variables for other freight transportation modes and expanding these productivity measures. Furthermore, different productivity measures should be adopted as data becomes available and their appropriateness should be examined for different situations. The ratio of freight earning per freight compensation to freight GDP per freight employment are two alternate productivity measures, which could be defined in future studies.

Because of data limitations, mobility was considered as the transportation infrastructure indicator. However, indicators such as congestion level, accessibility to different modes of transportation, density of intermodal facilities, and other variables that represent transportation network conditions should also be examined in future studies. As data becomes available, other industries such as agriculture and mining, which seem to have considerable interrelationships with the freight transportation network, can be considered in future studies.

References


