CHAPTER 9

Economic Development Impacts

The chief business of the American people is business.
—Calvin Coolidge (1872–1933)

INTRODUCTION

Transportation plays a vital role in the economy of any nation. On the whole, this is reflected in its large contribution to national gross domestic product (GDP), its consumption of a large amount of goods and services, employment of a large number of people, and the revenue it makes available to federal, state, and local governments. Summary statistics indicate strong relationships between gross domestic product and travel (Figure 9.1). Since the 1930s, growth in the GDP and vehicle-miles of travel (VMT) have exhibited similar patterns, even during the period of energy disruptions of the 1970s (USDOT, 2005). The economy and transportation have a bidirectional relationship: increased economic output leads to an increased amount of travel, and increased travel leads to higher economic output. Such a relationship suggests that the econometric phenomenon known as *simultaneity* exists between transportation and the economy.

Studies have demonstrated that investments in highways and other public transport capital reduce the costs of transportation and production, and consequently, contribute to economic growth and productivity. The USDOT (2005) reported that every $1 billion invested in transportation infrastructure generates more than $2 billion in economic activity and creates up to 42,000 jobs. It has been estimated that highway construction directly generates an average of 7.9 jobs per $1 million spent (1996 dollars) on construction (Keane, 1996); public transportation directly supports an average of 24.5 jobs per million passenger-miles; and air transportation supports as many as 1000 on-site jobs per 100,000 annual passengers, depending on site-specific factors (Weisbrod and Weisbrod, 1997).

In general, economic development impacts should be considered when the transportation project requires substantial investment and/or when public concerns are significant. In this chapter we present the concept of economic development as a performance criterion for transportation system evaluation and we provide a methodology for assessing the economic development impacts of transportation projects.

9.1 ECONOMIC DEVELOPMENT IMPACT TYPES

9.1.1 Economic Development Impact Types

Economic development impact types or performance measures can generally be categorized as follows (Bendavid-Val, 1991; De Rooy, 1995; McConnell and Brue, 1999; Weisbrod, 2000):

1. Impact types relating to overall area economy, such as economic output, gross regional product, value added, personal income, and employment
2. Impact types relating to specific aspects of economic development such as productivity, capital investment, property appreciation, and fiscal impacts that include tax revenues and public expenditure

Economic development impact types are strongly related to each other, and in some cases, two or more impact types present different perspectives of the same type of economic development changes. For example, increased number of jobs in a region is often strongly correlated with higher wages and higher income tax revenue. Increased capital investment in a region is also often associated with increased property values and higher levels of tax revenue from businesses and property tax. As such, evaluation by simple addition of the individual impacts may lead to double-counting. For example, the benefits of truck travel time savings should not be counted separately from increased industrial competitiveness (due to lower transportation costs) resulting from time savings. It seems therefore, reasonable for transportation agencies to utilize only a few economic development impact types in evaluating transportation projects or programs, and the selection of these impact types should be made on the basis of project or program objectives and data availability. Weisbrod and Beckwith (1990) presented an evaluation technique that helps to avoid double-counting. In that technique, economic development benefits are measured in terms of changes in disposable income,

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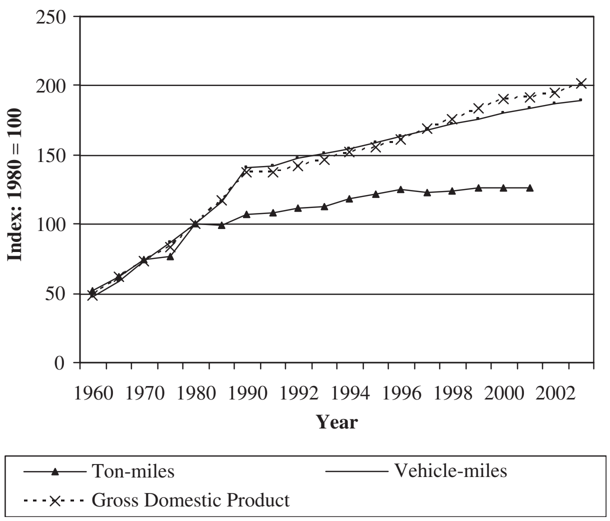


Figure 9.1 U.S. travel and GDP trends, 1960–2003). (From US DOT, 2005.)

and all other impacts not embodied in that performance measure, such as travel time and safety, are estimated separately.

9.1.2 Economic Development Impact Mechanisms

The mechanisms by which transportation projects can impact the economy can be broadly classified as follows (Forkenbrock and Weisbrod, 2001):

(*a*) *Direct Mechanism* The most significant impact of transportation investments on the economy is the reduction of transportation costs. With increased direct benefits (reduction in crashes, travel time, and vehicle operating costs) offered to users of improved transportation facilities, businesses in the region are afforded improved accessibility to markets and resources (labor, materials, and equipment) and consequently, reap the benefits of reduced business costs and enhanced productivity. Other direct effects include temporary impacts such as short-term wealth and job creation from spending on construction and ongoing operations. Construction-period impacts can be important, especially if they are large in relation to the economy affected, as in some developing countries.

(*b*) *Indirect Mechanism* Any significant change in business activity due to direct effects will in turn have impacts on "secondary" entities such as local businesses that supply materials and equipment to businesses that are affected directly. Detailed guidelines for estimating the indirect effects of proposed transportation projects are presented by NCHRP (1998).

(*c*) *Induced Mechanism* Increased personal wages in a region may induce increased spending. This would lead to induced benefits to businesses that provide utilities, groceries, apparel, communications, and other consumer services in the region.

(*d*) *Dynamic Mechanism* This involves long-term changes in economic development and related parameters such as business location patterns, workforce, labor costs, prices, and resulting land-use changes. These changes in turn affect income and wealth in the area. In some cases, such changes in economic development invites growth that would have occurred elsewhere if the transport investment did not take place. Thus, the geographic scope of the evaluation is an important aspect of such analyses, as discussed in the next section.

The total impact on the economy is estimated as the sum of benefits accrued through all four mechanisms. The ratio of total effect and direct effect is generally termed an *economic multiplier*. Effects that are not direct are often referred to as *multiplier effects*. Figure 9.2 illustrates the functional interrelationships between different economic development impacts types that are typically used in calculating economic multipliers.

9.1.3 Selection of Appropriate Measures of Economic Impact

The outcome of economic development impact assessment of transportation projects can be influenced by the *spatial scope (geographic scale)* selected for the evaluation. For relatively small study areas, the location movements of businesses will probably be perceived as "new activities," while for relatively larger areas, such movements will probably be seen as "internal redistributions" of business activity within the study area (Weisbrod, 2000). In large study areas, it has been found that internal redistributions of activity typically have little or no impact on total regional economic activity.

Closely related to the spatial scope of the analysis is the *project/program scope*. Available literature suggests that the nature and magnitude of economic development impacts of transportation investments depend on whether the transportation stimulus is just a means of providing access (typically, a microlevel stimulus that is relatively small in impact area), a program-level stimulus (typically, affecting a network of transportation facilities in a relatively large area), or a project-level stimulus that falls between these two extremes. Construction of a new interstate highway interchange is an example of microlevel stimulus.

In addition to the spatial scope of the economic development impacts of the transportation investment, the

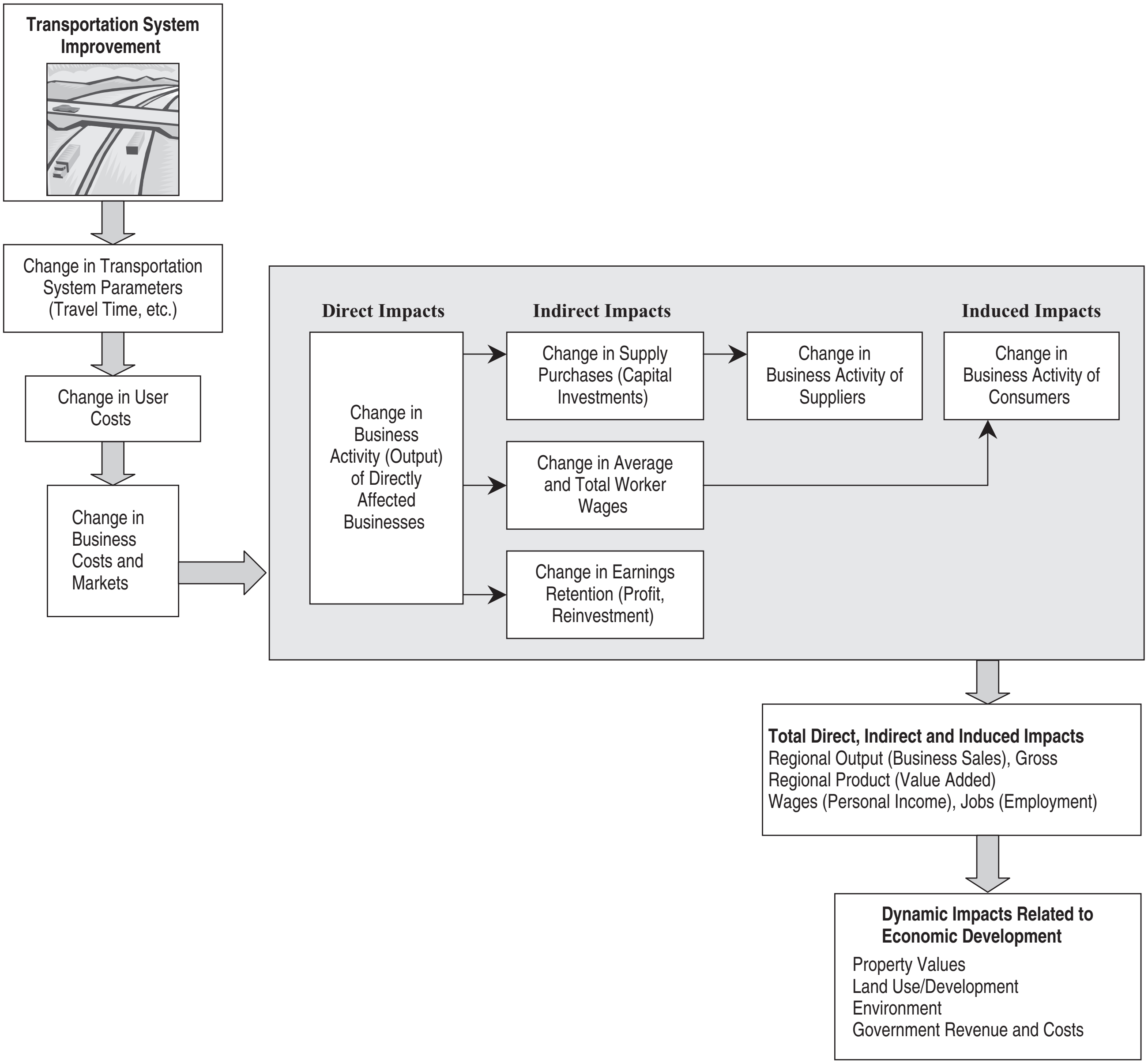


Figure 9.2 Types and mechanisms of economic development impacts.

relative maturity of a transportation system at the time of the investment needs to be considered (Forkenbrock and Foster, 1996). The introduction of new transportation infrastructure into an area with a relatively undeveloped transportation system will generally have a larger impact than when it is implemented in an area with a mature system. The same could be said regarding the relative size and "maturity" of the underlying economy itself. Impacts of transportation investments in poor sustenance economies are likely to differ from those in wealthy industrialized economies. In the latter case, impacts can be marginal (CUBRC et al., 2001).

9.2 TOOLS FOR ECONOMIC DEVELOPMENT IMPACT ASSESSMENT

The tools that have typically been used to assess economic impacts range from highly qualitative and less data intensive (i.e., surveys and interviews) to highly quantitative (i.e., economic simulation models), as shown

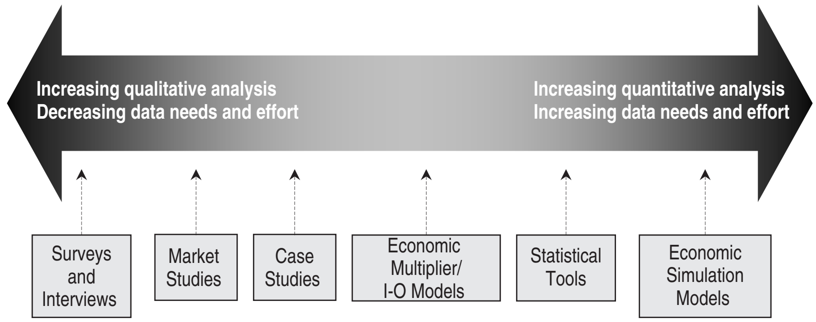


Figure 9.3 Tools for economic development impact assessment. (From CUBRC et al., 2001.)

in Figure 9.3. The latter group of approaches typically involve greater levels of effort, special staff training, specialized software, and more reliance on quantitative data. The selection of tools for assessing economic development impacts depends to a large extent on the scope of the project. Expensive projects such as a new highway or a rapid transit line typically would require a more quantitative approach to support investment decisions than would routine projects such as an interchange improvement or a transit route expansion. The adoption of specific tools is also influenced by the type and amount of resources available, including the level of analytical expertise. A discussion of the tools presented in Figure 9.3 is provided below. Further information on these tools is available in NCHRP Report 456 (Forkenbrock and Weisbrod, 2001) and Weisbrod (2000).

9.2.1 Surveys and Interviews

One method of assessing the expected economic development impacts from transportation investments is to conduct interviews with local businesses, local governmental officials, and community or neighborhood leaders. Survey-type methods used for economic development impact analysis include:

- Expert interviews
- Business surveys
- Shopper origin–destination surveys
- Corridor inventory methods using vehicle origin–destination logs

The first two tools (interviews and surveys of personnel involved in economic development analysis, affected businesses, and facility users such as trucking operators) typically provide valuable insights to potential impact types and mechanisms. Such tools also provide a direct and practical basis for establishing impact scenarios of the physical stimulus or policy change proposed. Also, these tools can indicate whether there will be increased local competition among businesses or improved overall regional competitiveness.

(*a*) *Expert Interviews* Expert interviews involve soliciting the judgment of knowledgeable persons regarding the expected impacts of a change in the transportation system on business activities in a region. Experts may include economic planners at local or state government level and economic development organizations who have acquired accumulated experience in business conditions at a particular locality or region. This tool has been used widely, for example, in Florida (Cambridge Systematics et al., 1999b) and in Scotland (Halcrow Fox, 1996). The application of both interview-based methods and forecasting models (Cambridge Systematics, 1996; EDRG and Bernardin, 1998; N-Y Associates and EDRG, 1999) allows an agency to cross-check impacts predicted using either tool, thereby increasing confidence in study findings.

How to Carry Out an Expert Interview: The analysis begins with the development of one or more scenarios representing how travel conditions, business costs, and market access may change after implementation of a transportation project. Key business representatives, developers, and planners are then asked about their perceptions of existing transportation needs, existing barriers, constraints, or threats to economic growth in the community, and how the project under consideration would likely affect economic growth prospects of existing businesses and new businesses that might be attracted to the area. The discussion can also include economic development transfer effects, such as long-term population gains, long-term employment gains, and long-term property value increases. Building or improving a highway corridor may reduce the benefits derived from existing highways in the transportation network (Forkenbrock and Foster, 1996). Also, if any of the economic activity attracted to the corridor is shifted from other sites within the state, that activity cannot be viewed as new economic development but rather as a transfer from one location to another within the same study region. Identification of such transfer effects are critical in the evaluation process (Forkenbrock, 1991). Expert interviews typically focus on specific topics which may include locations (such as particular neighborhoods in a city or different communities in a region) and industries (which represent existing dominant sectors in the economy or special growth opportunities). The interviews can take the form of one-on-one conversations, written surveys, or focus-group discussions that bring a range of participants together to exchange ideas on the likely impacts of an investment. Inconsistency of survey results, a disadvantage of group interviews, can be reduced with use of a Delphi process (Dickey and Watts, 1978). In this process, experts are interviewed individually, informed of the initial results obtained from the group of experts, and given the opportunity to revise their responses in light of the responses from the other experts. This process can help the experts to achieve a consensus. Impact types commonly used in expert interview methods are business sales and property values. Changes in employment and wages are typically assumed to be proportional to changes in business sales. A drawback of the expert interview method is that expectations for change, adverse or beneficial, can be subject to misrepresentation due to local political or other agenda (Forkenbrock and Weisbrod, 2001).

(*b*) *Business Surveys* Business surveys are typically designed to collect quantitative and qualitative data regarding the potential short-term impacts during construction as well as long-term effects of a proposed project on business activities. Business surveys can be implemented using questionnaires that are mailed to target groups or by interviews conducted in person or by telephone. Also, the Internet is increasingly being used to post such surveys. The target groups for business surveys include local business leaders, representatives of business organizations, and transportation-related organizations such as individual or corporate truckers. Advantages of the questionnaire survey tool over the more personal interview tool include a larger number of respondents, but a disadvantage is that it generally requires greater follow-up efforts to mitigate selection bias and to achieve sample-size targets. Some business surveys may also involve a panel of experts. Interview methods are probably more effective than questionnaires in avoiding panel attrition and therefore are often used for panel surveys. Available literature contains several examples of business surveys (Peat Marwick Main & Co., 1988; W.S. Atkins et al., 1990; Bechtel Corporation, et al., 1994; Gillis and Casavant, 1994; N-Y Associates and EDRG, 1999).

How to Carry Out a Business Survey: A group of business establishments along the transportation corridor can be selected through stratified random sampling on the basis of size and type of business establishment. The survey can include employees, customers, business owners, and managers. Survey participants can be asked about their current commuting patterns (i.e., transportation mode and residential location) and how the proposed transportation improvement could impact their commutes. Business owners and managers can be asked about their customer and delivery markets and the possible business cost savings associated with the transportation project proposed. The responses should be analyzed and interpreted with caution as some survey respondents may tend to provide unsubstantiated opinions motivated by parochial interests.

A business survey was conducted using a questionnaire to assess the economic impact on businesses during the reconstruction of I-65/70 in downtown Indianapolis (Sinha et al., 2004). Affected businesses in the study area were comprised mostly of restaurants, retail stores, entertainment-related establishments, motels, and hotels. The questionnaire was mailed to 504 businesses on a list furnished by the Indianapolis Downtown Business Association. The extent of financial impacts was assessed through a five-point-scale question. In a retrospective study, Palmer et al. (1986) used business surveys to estimate the effects of road construction on adjacent economic activities.

(*c*) *Shopper Origin–Destination Surveys* The impact of a proposed transportation facility on a community's economy can be estimated by surveying shoppers either by interviews or by self-administered questionnaires. Surveys of shoppers can also provide information on how their trip-making characteristics could be affected by changes in cost, convenience, or time involved in accessing various shopping areas during or after the project implementation. Examples of application include Cambridge Systematics (1989a), Yeh et al. (1998), EDRG and SRF Consulting Group (1999), and Lichtman (1999).

How to Carry Out a Shopper Origin–Destination Survey: A bus rapid transit line is proposed to serve passengers traveling from a suburb to a new shopping mall 10 miles away. A household survey can be conducted in the suburb to identify current shopping locations, frequency of shopping trips, origin and shopping trip time, and how the proposed new transit line may affect shopping patterns.

(*d*) *Corridor Inventory Methods* Corridor inventory methods include windshield surveys, vehicle origin–destination logs, and business activity data collection. Windshield surveys are inventories of business activity types and levels (such as sales volume), and conditions existing along a transportation route. These are typically conducted by traveling through the corridor where changes are proposed and using origin–destination logs of trucks to describe how the existing transportation network is used by businesses and to identify the type and value of shipments. This tool can yield general information on economic vitality in a corridor or area. Vehicle origin–destination logs can be used to gather data on shipment types and values. Geographical information systems (GISs) are used increasingly to store business activity data and vehicle origin–destination logs in a geo-coded format, and to map the travel patterns of business suppliers, customers, and "on-the-clock" workers.

After the data on local businesses have been collected and collated, the dependence of each type of business establishment on the mode of travel is assessed, and the potential reduction in transportation-related business costs due to the proposed transportation project, can be estimated. Spreadsheet-based models have been developed to assess separately business dependence on traffic flow changes that either (1) inhibit businesses' local access, (2) bypass them, or (3) take their property (Cambridge Systematics, 1996; Weisbrod and Neuwirth, 1998). A number of studies have utilized business vehicle logs for assessing the economic development impacts of proposed transportation facilities (Cambridge Systematics, 1989b; EDRG and Bernardin, 1998). Windshield surveys have been conducted as part of the Wisconsin Highway 29 Study (Cambridge Systematics, 1989b) and the Southwest Indiana Highway Corridor Study (Cambridge Systematics, 1996).

How to Develop a Spreadsheet-Based Model: For purposes of illustration, consider a highway corridor improvement that increases traffic throughput and total volumes in an area network. The project also reduces direct driveway access to some area businesses. A four-step spreadsheet-based model can be used to assess the vulnerability of local business establishments to future accessibility losses associated with the proposed transportation change, as follows (Weisbrod and Neuwirth, 1998):

1. Compile an inventory of businesses along the affected route. This corresponds to column A of Table 9.1.
2. Use business or customer interview data to estimate the extent to which each business along the route depends on the volume of area traffic. Alternatively, professional judgment based on direct observations or results from prior studies may be used to estimate the degree of business sensitivity to area traffic. This corresponds to column B in Table 9.1. In this example it is assumed that a business's customers are persons with an original intent of visiting that business or persons who were attracted to that business only because they perceived the business sign from a distance and thus decided to visit that business.
3. Obtain estimates of the change in traffic levels expected along the corridor and of accessibility losses of businesses due to changes such as new median islands that block access to from the other side of the road and left-turn restrictions. This corresponds to columns C and D in Table 9.1.
4. Use a spreadsheet collation of the data (such as shown in Table 9.1) to calculate the overall effect on business sales. The basic formula for estimating

Table 9.1 Sample Spreadsheet Computation of Pass-by Traffic Effect

(A) Inventory of Business	(B) Percent of Customers from Pass-by Traffic	(C) Expected % Change in Total (Both Directions) Pass-by Traffic	(D) Expected % Change in Bypass Traffic Unable to Access Store	(E) Overall % Change in Retail Sales
Double X Gas Station	100	35	55	−39
Big Bun Fast Food	70	35	0	25
Comfort Hotel	15	35	5	4
Fishbone Restaurant	100	35	30	−6

the overall change in retail sales is

$$\text{col. E} = \left\{ \frac{\text{col. B}}{100} \left[\left(1 + \frac{\text{col. C}}{100}\right) \left(1 - \frac{\text{col. D}}{100}\right) \right] - \frac{\text{col. B}}{100} \right\} \times 100$$

9.2.2 Market Studies

Market studies are typically smaller-scale analyses that typically relate to redistribution within a region, not across regions. Market studies can help estimate the existing levels of supply (i.e., land or business locations) and demand (i.e., sales) for key business activities in the analysis area, and typically are able to forecast potential future growth in specific business markets and to estimate how much business growth could be expected with improved transportation services and reduced costs. An inherent assumption is that the proposed project changes the size of the customer market (i.e., change in the level of pass-by traffic or in the breadth of the market area). Such markets for key business activities in an area include those for offices, tourism, and real estate. Using market studies for retail businesses, for instance, an analyst can predict the area (in square feet) of new retail development likely to occur after implementation of the transportation project, and the increase in property values, increase in tax revenues from the new retail businesses, and job increases due to the new development. Market studies generally use site analysis tools or corridor-specific tools, such as the windshield survey discussed in Section 9.2.1(d), to complement other evaluation tools. *Gravity models* are also used in market studies to predict effects on business activities by estimating changes in accessibility to market opportunities, represented as residential access to workplaces or shopping centers, or business access to labor markets or customer markets. Changes in business activities are assumed to be proportional to changes in accessibility resulting from the proposed transportation project. A gravity measure of accessibility to a business location can be obtained by weighting market opportunities by the impedance (e.g., travel cost or travel time) to reach the markets, as follows (CUBRC et al., 2001):

$$A_i = \sum_j \frac{D_j}{t_{ij}^{\alpha}} \qquad (9.1)$$

where A_i is the accessibility of location i, D_j is the number of market opportunities of a particular type (shopping, business, or other commercial) at location j, t_{ij} is the generalized time or cost of travel from i to j, and α is a calibrating factor, typically between 1.5 and 2.0.

The market study approach has been used in economic development impact assessments in New York (Clark Patterson Associates et al., 1998), Maryland (Maryland DOT, 1998), San Diego (SDAG, 1996), Connecticut (Bechtel Corporation et al., 1994), and Massachusetts (Cambridge Systematics, 1988).

How to Conduct a Market Study: Consider the situation described in Section 9.2.1(c). A market study can be conducted to assess the likely change in market sales due to changes in access to the shopping center associated with the new transit service in a manner consistent with the procedure described by Forkenbrock and Weisbrod (2001). The extent of customer attraction is a simple calculation that relates (1) the market share observed for shopping centers in the study area to (2) the relative travel-time and cost of accessing them from different parts of the study area, compared with the time and cost of accessing competing shopping areas. The potential shopper base in each major part of the study area can be estimated using shopping surveys. Table 9.2, an example of survey results, assumes that shopping center i is the only shopping center that gains increased accessibility and market share due to the new transit line. Accessibility indices associated with the shopping center from each of the residential market areas, as well as a composite index of accessibility to the shopping center, can be computed using the gravity model formula. The composite index is a weighted average of the area accessibility values weighted by the number of households in each area. This index can be interpreted as a proportional change in retail sales for the shopping center resulting from the proposed transportation project. For the illustrative example given, the computations are shown in Table 9.3.

9.2.3 Comparative Analysis Tools: Case Studies

In comparative analysis (or case studies), it is assumed that the impact of the proposed transportation improvement on the area economy will be a close reflection of the impacts of a past similar intervention elsewhere. This approach is appropriate in situations where the study area is small, available economic data are limited, and where parallels to experiences elsewhere can be established easily and confidently (Weisbrod, 2000). Transportation projects for which this tool has been used include community bypasses, interchanges, added transit stations, and airports. This tool is particularly compatible with public hearings because case studies facilitate understanding and appreciation by lay people compared to complex economic analyses. The primary drawback to this tool is that the

Table 9.2 Gravity Model Input Data on Accessibility to the Shopping Area

Market Area: Place of Residence, j	Total Market Opportunities at Market Area, j[a] (D_j)	Average Travel Time Between Shopping Area i and Market Area, j (t_{ij})	
		Base Case (Current), mins	With New Transit Line (Proposed), mins
Downtown	4,000	35	25
Northern suburb	7,000	30	30
Southern suburb	10,000	55	45
Eastern suburb	6,000	45	35
Western suburb	9,000	15	15

[a] Assumed to be same as the number of households. A more detailed model may incorporate market area average income or other demographic features.

Table 9.3 Gravity Model Calculations of Accessibility to the Shopping Area[a]

Market Area: Place of Residence, j	Gravity Model Market Index, D_j / t_{ij}^2		
	Base Case (Current)	With New Transit Line (Proposed)	Percent Change
Downtown	3.3	6.4	96
Northern suburb	7.8	7.8	0
Southern suburb	3.3	4.9	49
Eastern suburb	3.0	4.9	65
Western suburb	40.0	40.0	0
Composite index	13.3	14.4	8
Market share	18%[b]	19.4%[c]	+8

[a] In situations where there are other shopping areas that would become more accessible due to the new transit facility, the index values for all shopping areas in the region should be calculated and assessed for relative changes to determine the actual shifts in market shares.
[b] Initial market share measured before the new transit service.
[c] New market share estimated given the initial market share and the percent change in composite index due to the proposed transportation project.

selection of appropriate case studies to use for comparison purposes can be fairly subjective, and it is impossible to control for all the influential variables.

How to Carry Out a Comparative Case Study: Steps involved in a comparative case study are as follows:

1. *Identify case studies of similar transportation changes.* Identify similar projects in recent years and determine whether there are any existing case studies. If no such study exists, studies can be undertaken to assess postimplementation effects. For example, to estimate the impacts of the proposed Denver Airport (Colorado National Banks, 1989), case studies of the economic effects of constructed or expanded airports at Dallas–Fort Worth, Atlanta, and Kansas City were conducted.

2. *Determine the factors affecting the local context.* The local setting of the proposed transportation project may be a small town, a downtown area, a suburban area, or a rural region. Its economy may be focused on tourism, manufacturing, commerce, or agriculture, etc., or a mix thereof. The local situation for the project under investigation should be adequately described to assess the appropriateness of available case studies. For example, the Denver Airport study (Colorado National Banks, 1989) examined similarities and differences between that airport and

three previously constructed airports in terms of business mix and growth, the timing of growth, key supporting infrastructure, airport site development policies, supportive public policies, and international flights.

3. *Assess the implications of case study findings for the project proposed.* Depending on the degree of match in terms of project type and context, case studies can offer predictions of economic development impacts that may turn out to be good estimates or may deviate substantially from the true impacts. Adjustments to the predictions from case studies may be necessary.

9.2.4 Economic Multiplier/Input–Output Models

The economic multiplier approach is a quantitative impact assessment method that is most applicable to investment-driven transportation projects that impact business attraction, expansion, retention, or tourism directly. Typical multipliers are expressed in terms of regional economic output, employment, or income. Their magnitudes vary depending on the type of transportation investment and its relationship to other investments in the regional economy, and the size of the existing regional economy. As a rule of thumb, the economic output multiplier values for most transportation investments are: 2.5 to 3.5 for national impacts, 2.0 to 2.5 for state impacts, and 1.5 to 2.0 for local area impacts (Weisbrod and Weisbrod, 1997). For example, if a $10 million highway improvement takes place along a corridor, it can be expected that the net impact on the local level of economic activity in the study area would increase by 15–20 million dollars. Assessing the economic development impacts of transportation projects on the basis of economic multipliers should be carried out with caution because multipliers typically involve attractions from other regions.

The economic multiplier approach is based largely on *input–output modeling*. Input–output models are essentially accounting frameworks that track interindustry transactions such as the number of units of purchases (inputs) that each industry requires from all industries to produce 1 unit of sales (output). These models provide a means for calculating the indirect and induced effects on business sales and spending, given a set of direct project effects on business sales, employment, or wages. A limitation of this methodology is that interindustry relationships are derived from national forecasts, which are not necessarily applicable to lower levels of the analysis. Furthermore, input–output models are static. They must be used in conjunction with a broader set of techniques to forecast the effects of long-term economic development. In the United States, three major software packages have been used for input–output modeling: Implan (Minnesota Implan Group, 2004), RIMS II (US DOC, 1997), and PC input–output (Reg. Science Research Corporation, 1996).

IMPLAN and PC input–output ask the user to provide a description of the direct effects of an investment and then automatically generate estimates of the indirect, induced, and total economic development effects of the project. On the other hand, RIMS II provides a default set of input–output multipliers that users may apply to their own data. Some state transportation agencies have customized input–output models (Babcock, 2004). An example of the input–output methodology is presented below. This follows the steps given by the Minnesota Implan Group (2004) and Babcock et al. (2003).

How to Conduct an Input–Output Analysis: To illustrate the I/O analysis, a simplified transactions matrix is provided in Table 9.4 to describe the flow of goods and services among three sectors of the economy in a given region. The columns show purchases (input) for each industry, and the rows show sales (output) from each industry to others. For example, to produce $35 million output, the transportation sector purchased $3 million from construction sector, $8 million from manufacturing sector, $12 million from transportation sector, and made $12 million of payments to the *final payments* sector. Final payments are made by industries to households (workers), gross savings (interest, profit), government (taxes), and imports. In addition, the transportation

Table 9.4 Illustrative Input–Output Transactions Matrix

Sector	Construction	Manufacturing	Transportation	Final Demand	Total Output
Construction	7	9	3	21(5)	40
Manufacturing	8	20	8	24(7)	60
Transportation	6	6	12	11(5)	35
Final payments[a]	19(7)	25(7)	12(5)	0	56
Total inputs	40	60	35	56	191

[a]Values in parentheses refer to households.

sector sold $6 million to construction, $6 million to manufacturing, $12 million to transportation, and $11 million to the final demand sector (households, investment, government, and exports). Final demand consists of purchases of goods and services for final consumption in contrast to an intermediate purchase where the goods will be remanufactured further (Minnesota Implan Group, 2004).

Information on the region's economy is provided in Table 9.5. Given the input–output transactions matrix shown in Table 9.4 and the information provided in Table 9.5, the total (direct, indirect, and induced) output, employment, and income multipliers can be determined by applying the input–output methodology, as discussed below.

First, the *direct requirements matrix* (also known as the *A matrix*) is determined. This indicates the input (purchase) requirements of each industry to produce an average $1 of output (sales). The *purchase coefficients*, or *input ratios*, are obtained by dividing purchase data in each industry column of the transactions matrix by the corresponding output value for that industry (Table 9.6). The columns represent production functions that indicate where an industry spends (and in what proportions) to generate each dollar of its output. In the example provided, the third column (transportation) shows that to produce an average $1 of output, the transportation sector buys $0.09 (= 3/35) from construction firms, $0.23 (= 8/35) from manufacturing industries, $0.34 (= 12/35) from transportation establishments, and makes $0.34 (= 12/35) of payments to the final payments sector ($0.14 of these payments are made to households).

Table 9.5 Illustrative Employment–Output Ratios for the Three Sectors of the Economy in the Region

Sector	Employment	Output ($\times 10^6$)	Employment/ Output Ratio
Construction	10,000	$1000	0.00001
Manufacturing	6,500	300	0.00002
Transportation	8,000	800	0.00001

Then the *total (direct, indirect, and induced) requirements matrix* is estimated. This includes the direct and multiplier effects (i.e., effects of household income and spending in addition to the interindustry interaction) in the economy. These effects are defined in Section 9.1.2. The total requirements matrix (Table 9.7) derives from the direct requirements matrix A (Table 9.6) by estimating the $(I - A)$ inverse[1] (known as the *Leontief inverse*), where I is the identity matrix.

For example, for the transportation sector to increase its output by $1, it would eventually require an output of $1.765 (including the initial $1 increase). At the same time, the construction sector must increase its output by $0.375, and the manufacturing sector must increase its output by $0.797. In this grossly simplified economy, the total economic output increase due to a $1 increase in transportation sector output is the sum of these three values, or 3.347 times larger than the initial output expansion in transportation. This is the *output multiplier* concept. Consider an investment of $100 million for a highway construction project along a corridor. Assume that the construction sector will be the only beneficiary of this investment. Through the ripple effects in the economy, the investment would be expected to increase the total level of economic output by an estimated $296 million [($100)(2.96)].

Employment multipliers can be obtained by combining the information in Table 9.7 with the industry employment–output ratios provided in Table 9.5. To obtain the total (direct, indirect, and induced) employment multipliers for each industrial sector, each of the entries in the column of the Leontief inverse

[1]In matrix notation, the A matrix can be written as a series of linear equations, as follows $X = A \cdot X + Y$. This notation simply states that output X is equal to transactions (AX) plus final payments (Y). Then we have $(I - A) \cdot X = Y$ or $X = (I - A)^{-1} \cdot Y$ (Minnesota Implan Group, 2004).

Table 9.6 Illustrative Direct Requirements Matrix[a]

Input	Construction	Manufacturing	Transportation	Final Demand	Total Output
Construction	0.18	0.15	0.09	0.38 (0.08)	0.21
Manufacturing	0.20	0.33	0.23	0.43 (0.13)	0.31
Transportation	0.15	0.10	0.34	0.20 (0.08)	0.18
Final payments	0.48 (0.18)	0.42 (0.12)	0.34 (0.14)	0	0.29
Total inputs	1.00	1.00	1.00	1.00	1.00

[a]Values in parentheses refer to households.

Table 9.7 Illustrative Total (Direct, Indirect, and Induced) Requirements Matrix

A matrix	Construction	Manufacturing	Transportation	Household Demand
Construction	0.18	0.15	0.09	0.08
Manufacturing	0.20	0.33	0.23	0.13
Transportation	0.15	0.1	0.34	0.08
Household payments	0.18	0.12	0.14	0
$(I - A)$ *matrix*				
Construction	0.82	−0.15	−0.09	−0.08
Manufacturing	−0.2	0.67	−0.23	−0.13
Transportation	−0.15	−0.1	0.66	−0.08
Household payments	−0.18	−0.12	−0.14	1
$(I - A)^{-1}$ *matrix*				
Construction	1.427	0.407	0.375	0.179
Manufacturing	0.664	1.821	0.797	0.339
Transportation	0.467	0.406	1.765	0.209
Household payments	0.402	0.349	0.410	1.102
TOTAL	2.960	2.983	3.347	

in Table 9.7 is multiplied by its employment−output ratio and then the column is summed, as shown in Table 9.8. The value $(37.4)(10^{-6})[= (0.375)(0.00001) + (0.797)(0.00002) + (1.765)(0.00001)]$ is the total employment change due to a dollar of investment in the transportation sector or 38 jobs per million dollars of transportation output. The employment multipliers for the construction and manufacturing sector would be 33 jobs per million dollars of construction output and 45 jobs per million dollars of manufacturing output, respectively.

Finally, the income multipliers are calculated by dividing the value in the household row of the total (direct, indirect, and induced) requirements matrix (Table 9.7) by their corresponding values in the household row of the direct requirements matrix (Table 9.6), as shown in Table 9.9. The total income generated due to the investment of \$1 in transportation would be \$2.870 (= 0.402/0.14). This concept is known as the *income multiplier*. In the given example, the income multipliers for the construction and manufacturing sector are \$2.297 per dollar of construction output and \$2.991 per dollar of manufacturing output, respectively.

Table 9.8 Employment Multipliers

Employment	Construction $(\times 10^{-6})$	Manufacturing $(\times 10^{-6})$	Transportation $(\times 10^{-6})$
Construction	14.3	4.1	3.8
Manufacturing	13.3	36.4	15.9
Transportation	4.7	4.1	17.7
Total	32.3	44.6	37.4

Table 9.9 Income Multipliers for Each Sector

Income	Construction	Manufacturing	Transportation
Total	2.297	2.991	2.870

9.2.5 Statistical Analysis Tools

Statistical models, typically using regression analysis, are developed on the basis of either historical time series or cross-sectional data on transportation investment, public infrastructure levels, and economic indicators (e.g., employment, wages, and land values). This methodology has been used in the past to identify the relationship between transportation investment levels and accompanying changes in business location and regional development patterns (Evers et al., 1988; Duffy-Deno and Eberts, 1991; Lombard et al., 1992). In other studies, the issue addressed is how the existing stock (and not changes thereof) of transportation infrastructure has affected national economic productivity and the level of national economic growth over time (Aschauer, 1990; Munnell, 1990; Pinnoi, 1993; Toen-Gout and van Sinderen, 1994; Boarnet, 1995; Arsen, 1997; Bell and McGuire, 1997; Nadiri and Mamuneas, 1998; Fraumeni, 1999). An advantage of this approach is its ability to analyze the simultaneous effect of a large number of variables, time lag effects, and functional forms.

There are several examples of statistical models. Queiroz and Gautam (1992) used time-series regression analysis of U.S. data from 1950 to 1988 to investigate the relationship between per capita GNP and road density:

$$\text{PGNP} = \begin{cases} -3.39 + 1.24\text{LPR} & \text{(no time lag)} \\ \quad R^2 = 0.93 & \\ -2.9 + 1.22\text{LPR} & \text{(time lag of one year)} \\ \quad R^2 = 0.93 & \\ -2.5 + 1.2\text{LPR} & \text{(time lag of two years)} \\ \quad R^2 = 0.92 & \end{cases}$$

where PGNP is the per capita GNP ($1000 in 1982 constant dollars/inhabitant) and LPR is the density of paved roads (km/1000 inhabitants).

Many factors contribute to GNP growth, and the strong correlation does not necessarily mean road expansion results in GNP growth. There is also a possibility of simultaneity between road expansion and GNP growth; road expansion contributes to GNP growth and GNP growth leads to road expansion. With more recent and expanded data, the issues of causality, correlation, and simultaneity can be addressed.

Lombard et al. (1992) developed county-level cross-sectional regression models for assessing the economic impact of highway expenditure in Indiana. Another example of statistical models are those developed by Gkritza et al. (2006) to investigate the relationship between statewide changes in economic development and investments in expanded highway capacity in Indiana over a 20-year period:

$$\begin{aligned} \text{REMIEMP} = {} & -156 + 10.56\text{NEWLNMI} \\ & - 168.40\text{URBAN} + 347.21\text{I} \\ & + 43.75\text{ACCAIRP} - 90.86\text{CENTRAL} \\ & \quad \text{adjusted } R^2 = 0.55 \end{aligned}$$

$$\begin{aligned} \text{REMINCMI} = {} & -8.71 + 0.51\text{NEWLNMI} \\ & - 4.51\text{RESTURBAN} + 14.08\text{I} \\ & + 2.04\text{ACCAIRP} - 3.78\text{CENTRAL} \\ & + 0.022\text{PRCOSTMI} \\ & \quad \text{adjusted } R^2 = 0.47 \end{aligned}$$

$$\begin{aligned} \text{REMIOUTMI} = {} & -77 + 3.00\text{NEWLNMI} \\ & - 17.93\text{URBAN} + 65.85\text{I} \\ & + 15.97\text{ACCAIRP} \\ & \quad \text{adjusted } R^2 = 0.47 \end{aligned}$$

$$\begin{aligned} \text{REMIGRPMI} = {} & -27.21 + 2.18\text{NEWLNMI} \\ & - 16.16\text{RESTURBAN} + 21.43\text{I} \\ & - 19.25\text{ST} + 8.13\text{ACCAIRP} \\ & - 22.44\text{CENTRAL} \\ & \quad \text{adjusted } R^2 = 0.40 \end{aligned}$$

where REMIEMP is the net change in employment (jobs), REMINCMI the net change in real disposable income (millions of 1996 dollars), REMIOUTMI the net change in output (millions of 1996 dollars), REMIGRPMI the net change in gross regional product (millions of 1996 dollars), NEWLNMI the new (added) lane-miles, URBAN (1 for a project located in an urban area, 0 for rural projects), RESTURBAN [1 for a project located in an urban area (excluding Marion county with Indianapolis), 0 otherwise], I (1 for interstate highway improvements, 0 otherwise), ST (1 for improvements to a state highway, 0 otherwise), ACCAIRP the degree of accessibility to major airports (1, low to 5, high), CENTRAL (1 for a project located in central Indiana, 0 otherwise), and PRCOSTMI the project investment (millions of 1996 dollars).

9.2.6 Economic Simulation Models

(*a*) *Regional Economic Simulation Models* Economic simulation models, which predict economic growth in a given region in response to changes in transportation policies or projects, are extensions of the I/O model discussed in a preceding section. These models typically have four components: (1) a base-case forecast of future economic growth or decline in the region; (2) a model to estimate growth in business sectors in response to direct changes in their relative operating costs and markets; (3) estimation of overall changes in the flow of money in the regional economy, including indirect and induced effects using input–output tables or charts; and (4) a mechanism to predict the future economic growth or decline relative to the base case if the project were implemented. Modeling tools typically generate outputs that reflect changes in employment, personal income, business output, and gross regional product (value added) over a relatively long period of time, typically 20 to 30 years. A common economic simulation tool is the Regional Economic Models, Inc. (REMI) dynamic input–output model (Treyz et al., 1992). Another model is the Regional Economic Impact Model for Highway Systems (Politano and Roadifer, 1989). For long-range planning, these models are preferred over simple input–output modes due to their dynamic nature and ability to account for productivity changes that may develop as a result of transportation decisions over a

20- to 30-year planning horizon (CUBRC et al., 2001). However, data collection and analysis for such models can require considerable effort and expertise.

(*b*) *Hybrid Economic Simulation Models* A number of simulation-based models have been developed to include significant economic factors to provide more reliable prediction of how markets respond to changes in land use and transportation access. An example of such land-use/economic hybrid models is the TELUS (Transportation, Economic, and Land-Use System) developed for the North New Jersey Transportation Planning Authority (NJIT, 1998). Other examples are the METROSIM model (Anas, 1999) and the MEPLAN model (Echenique, 1994). Also, a number of state DOTs have developed integrated traffic and economic models to estimate economic impacts of their major highway corridor projects. For example, Indiana DOT developed the Major Corridor Investment–Benefit Analysis System (MCIBAS), a five-step integrated modeling system that includes a travel demand model, a user-benefit calculation model, a macroeconomic simulation model, and a benefit–cost framework (Cambridge Systematics, 1998). MCIBAS has been applied in several studies (Cambridge Systematics and Bernardin, 1998a, b; Cambridge Systematics et al., 2003). A procedure similar to MCIBAS is the Highway Economic Analysis Tool (HEAT) developed for the Montana Department of Transportation (Cambridge Systematics and EDRG, 2005). Finally, the Mid-Ohio Regional Planning Commission developed a Freight Transportation Investment Model, which utilized a REMI macroeconomic simulation model component for estimating the economic development impacts of the city of Columbus inland port (Cambridge Systematics et al., 1999a).

9.3 ESTIMATION OF LONG-TERM REGIONAL ECONOMIC DEVELOPMENT IMPACTS

A common approach for calculating the regional economic development effects of a transportation improvement is to use a regional economic simulation model in combination with a traffic (network simulation) model. For a given set of project alternatives, the traffic model estimates direct impacts of the transportation system improvement on traffic patterns, volumes, and speeds, and calculates travel cost savings by flow type (passengers and goods) and by trip purpose (business and nonbusiness). The travel cost savings (i.e., reductions in travel time, safety-related costs, or vehicle operating costs) are then translated into user benefits and expressed in terms of monetary values (as described in Chapters 5 to 7). Economic development benefits are then estimated in terms of business savings from market economies of scale, productivity, logistic opportunities for just-in-time production economies, and shift in business growth and locational factors. User benefits associated with nonbusiness trips are excluded from the economic impact analysis, as they do not affect directly the cost or productivity of doing business and are assumed to be incapable of producing any secondary economic impact. The estimated efficiency benefits of business auto, truck, and other travel modes, over the analysis period, are first translated into financial consequences and then allocated to various types of existing businesses located in the study area. These direct business cost savings are allocated among industries based on: (1) relative sensitivity to transportation cost changes, and (2) each industry's share of economic activity in the study area, in terms of employment. This methodology is discussed in detail in Weisbrod and Grovak (2001) and Cambridge Systematics (1998). The estimated business expansion impacts by the business sector are used as direct impacts for input into the regional economic simulation model.

In addition to the direct cost savings for businesses, transportation projects can potentially enhance strategic connections between specific locations and activities and can expand the size of market reach to customers and labor, thus attracting out-of state business activity and investment. Business attraction impacts are typically estimated as changes in employment by industry. The net business attraction or expansion impacts or tourism impacts can be estimated exogenously by conducting surveys of area firms or interviewing owners or operators of tourism or recreation businesses (Weisbrod and Beckwith, 1992). Also, the method of *location quotients* (*LQ*) can be applied to quantify the magnitude of business attraction effects. A location quotient is an indicator of regional specialization, or a region's competitiveness for a specific industry, measured in terms of employment (Glickman, 1977). A *LQ* of 1 means that an industry has the same share of a regional economy as it does of the national economy. The higher the *LQ*, the greater the competitive advantage of a region for the specific industry. Location quotients can be calculated using the location quotient calculator, a tool produced by the Bureau of Labor Statistics (BLS, 2005). Past studies have applied *LQ* analysis to estimate potential business attraction associated with highway investments (Cambridge Systematics, 1998a, b). It was assumed that if the location experienced strong growth without the transportation improvement (indicated by $LQ > 1$), new business attractions would be limited. However, it may be argued that an LQ exceeding 1 could, on the contrary, spur growth: the potential for business attraction might be higher in a region with competitive advantages such as a skilled labor force or agglomeration economies. In general, it is difficult to accurately predict business attraction impacts because transportation investments constitute only one of several factors in business location decisions. It is possible to make broad estimates about the types and sizes of businesses that may be attracted to a region as a result of a major transportation project; however, this should be done with caution so as not to include business attraction impacts that represent net transfers among regions within the study area.

The next step is to input the results of the preceding step into the regional economic simulation model, run a simulation for the long-term impacts, and evaluate the results. The economic effects of potential business and/or tourism attraction, in terms of business sales by industry, employment by industry, personal income, population, and other variables, can be estimated separately from the direct business expansion impacts. The model is run twice and the total (direct, indirect, and induced) effects associated with the project alternative is calculated on a year-by-year basis over the analysis period with and without the business and/or tourism attractions. In general, the construction period benefits are not included because it is assumed that construction expenditures are short-term and temporary in nature, and would have been spent anyway by state and local governments—either on the project in question or on other similar projects that would yield comparable capital expenditure benefits (Weisbrod and Beckwith, 1992). The overall analysis procedure is illustrated in Figure 9.4.

How to Conduct a Long-Term Regional Economic Development Impact Analysis: To illustrate how the analytical framework presented in Figure 9.4 is used in practice, consider the case of an urban interstate widening project with geometric and operational characteristics presented in Table 9.10.

The project is scheduled for construction in 2006. The state government seeks to predict the estimated statewide economic development impact of this project 20 years after its implementation (2008–2027). It is assumed that benefits will begin to accrue in the first year of highway operation. Assume an interest rate of 5%.

First, the user benefits due to the proposed project, travel-time savings, vehicle operating cost changes, and crash cost savings are estimated. To assess the broader economic impact of these benefits, estimates on the distribution of two categories of vehicle trips, truck trips and automobile trips for business purposes, are developed. The estimation results for year 1 and year 20 of the analysis period are presented in Figure 9.5. A key issue is the use of an appropriate value of travel time. This is addressed in Chapter 5.

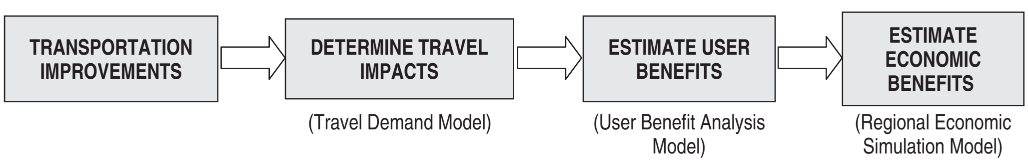
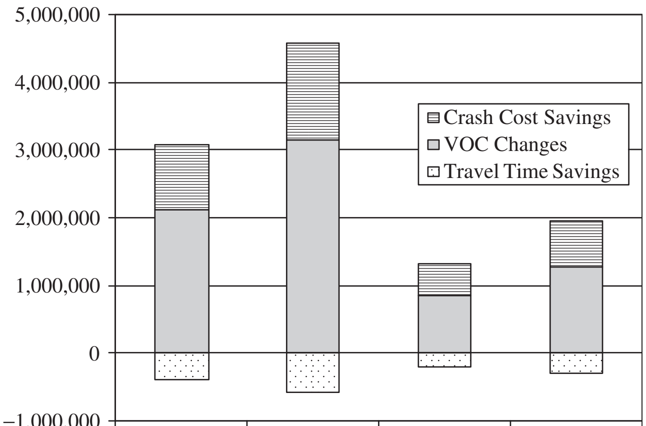


Figure 9.4 Procedure for analyzing regional economic development impact in the long term.

Table 9.10 Project Data

Type of project	Added travel lanes	Base-case average daily traffic in 2005	117,244
Functional class	Urban interstate	Base-case average daily traffic in 2025	173,843
Length of construction period (years)	2	Proposed system average daily traffic in year 1	122,635
Project costs (millions of 2003 dollars)	167	Proposed system average daily traffic in year 20	181,836
Start lanes	6	Base-case capacity (veh/h)	6,224
End lanes	10	Proposed system capacity (veh/h)	10,373
Project length (miles)	7.3	SU/combination-unit trucks (%)	5.9/5.3



	Truck-Year 1	Truck-Year 20	Auto Business-Year 1	Auto Business-Year 20
Crash Cost Savings	967,890	1,435,134	464,204	688,297
VOC Changes	−395,643	−586,638	−204,243	−302,840
Travel Time Savings	2,128,973	3,156,726	860,331	1,275,652

Figure 9.5 User benefits by mode, trip purpose, and analysis year (2003 dollars).

Table 9.11 Estimation of Business Cost Savings from User Benefits

User Benefit	Corresponding Cost Savings to Business
Time savings business travel (on-the-clock worker time)	Value of additional productive labor hours (for nonsalaried portion of workers)
Other trips (includes commuting)	(May lead to additional spending or affects wages for recruiting workers)
Operating cost savings business travel (pickups and deliveries)	Direct cost savings
Other travel (includes commuting)	Increase in disposable personal income (may also affect wage rates)
Safety improvements business travel (on-the-clock worker time)	Reduction in insurance costs and worker absenteeism
Other travel	Reduction in insurance cost, raising disposable income

Source: Weisbrod and Weisbrod (1997).

The estimated cumulative user benefits in 2003 dollars, for truck trips over the 20-year analysis period is \$24.6 million, and that for auto business trips over the same period is \$17.1 million. Consistent with the analysis procedure presented in the preceding section, these benefits are first translated into financial consequences (i.e., direct business cost savings) and then allocated to various types of existing businesses located in the study area. The direct business cost savings from travel efficiency improvements are estimated from user benefits as shown in Table 9.11.

After the estimated business expansion impacts by business sector (industry) have been quantified, they are used as direct impact input data for the REMI dynamic simulation model. The REMI model is then run and the simulation results are compared to the baseline to determine the total (including direct, indirect, and induced) economic effects associated only with business cost savings resulting from the proposed highway project over a 20-year period, as shown in Table 9.12. The economic effects of potential business and/or tourism attraction are estimated separately in the next analysis step.

Table 9.12 Economic Effects Associated with Cost Savings

Net change in employment (jobs)	112
Net change in GRP or value added[a] (millions of 2003 dollars)	46.1
Net change in real personal disposable income[b] (millions of 2003 dollars)	26.9
Net change in output[c] (millions of 2003 dollars)	88.1

[a]Change in the sum of wage income and corporate profit generated in the region; reflects the overall economic activity in a region.
[b]Change in wage income earned by workers within the region (adjusted for inflation and net of taxes).
[c]Change in business sales in the region.

Table 9.13 Results of Simulation for Highway Project

Net change in employment (jobs)	620
Net change in GRP or value added[a] (millions of 2003 dollars)	105.8
Net change in real personal disposable income[b] (millions of 2003 dollars)	55.5
Net change in output[c] (millions of 2003 dollars)	218.4

[a]Change in the sum of wage income and corporate profit generated in the region; reflects the overall economic activity in a region.
[b]Change in wage income earned by workers within the region (adjusted for inflation and net of taxes).
[c]Change in business sales in the region.

The LQ method is applied to quantify the magnitude of business attraction (Cambridge Systematics, 1998a, b). A simplified metric of the magnitude of business attraction is applied (this is assumed to be proportional to that of business expansion by a factor of $1/LQ$). The LQ for the manufacturing industry located in the urban area where the highway improvement takes place, calculated using the location quotient calculator (BLS, 2005), is 0.61. The magnitude of business attraction is proportional to that of business expansion by a factor of $1/LQ = 1/0.61 = 1.64$. Therefore, (112) (1.64) = 184 jobs are estimated to be attracted as a result of the highway improvement. For analytical purposes, it is assumed that the additional jobs created would be in equal increments over the analysis period. It is also assumed that the significant increases in accessibility due to the project would benefit manufacturers most, because manufacturers are particularly dependent on reliable truck transportation. Other industries that are expected to produce statewide attraction benefits include the wholesale trade, transportation, and warehousing industries. Finally, tourism attraction impacts associated with the highway project are anticipated to be limited at the state level.

The REMI model is then run and the simulation results are compared to the baseline to determine the total economic development impacts resulting from both cost savings for businesses and business attraction impacts associated with the highway project. The project is predicted to generate 620 (direct, indirect, and induced) jobs that would accrue to industries that benefit most from increased access to buyer and supplier markets and accrue multiplier effects from increased business and consumer spending, such as manufacturing, retail trade, and services industries. The results of the simulation performed for the proposed highway project over the 20-year analysis period are summarized in Table 9.13.

9.4 CASE STUDY: ECONOMIC DEVELOPMENT IMPACT ASSESSMENT

To illustrate the analytical steps involved in the procedural framework, the case of a highway corridor related to the I-69 project in the southwestern part of Indiana is considered. A set of five alternatives was identified for study in the environmental impact statement (EIS). The project involves a 142-mile expressway from Evansville to Indianapolis through multiple, mostly rural counties. The project cost is estimated at \$1.8 billion (2003 dollars). It is expected that the new highway, which is a part of the NAFTA corridor from Mexico to Canada, will provide improved accessibility and spur economic growth. The steps followed by the consultants (Cambridge Systematics and Bernardin, 2003) in the assessment of economic development potentials of the five alternatives are discussed below.

1. *Delineate the impact area.* The study area included five regions along the corridor. The impacts of the proposed highway on the rest of the state, state of Illinois, state of Kentucky, and the rest of the United States were also assessed.

2. *Select the analysis period.* Since the purpose of the analysis is an impact assessment for a proposed new facility, a future year or period of time after the new facility opens is selected. A 20-year analysis period was selected for this project.

3. *Select the economic development measures.* Economic performance measures related to economic development considered in the I-69 corridor study included: (a) net change in employment, (b) net change in real disposable income, and (c) net change in real output or business sales.

4. *Determine the existing economic conditions.* Economic data were collected from the publications of the U.S. Bureau of the Census, the U.S. Bureau of Economic Analysis, and other agencies to assess current economic conditions in terms of per capita income, population, and employment growth. Interviews of local businesses and officials were conducted to help evaluate the validity of the economic forecasts and to corroborate the economic data.

5. *Select the analysis methods.* The procedure used for assessing long-term economic impacts followed primarily the methods discussed in Section 9.3 and was based on the use of an integrated traffic and regional simulation model (MCIBAS) that includes a travel demand model, a user-benefit calculation model, a macroeconomic simulation model, and a benefit−cost framework. The travel demand model was used to get estimates of systemwide changes in vehicle-miles of travel and vehicle-hours of travel. Accessibility factors were developed for labor, customer, supplier, and tourism markets. Access of businesses to labor and customer markets was measured as the population within 45 minutes of travel time to the average business, while access of freight customer and supplier markets was measured as the number of employees within 3 hours of travel time to the average business.

6. *Estimate the benefits.* Reductions in travel time, crash costs, and vehicle operating costs for trucks and automobiles used for business purposes were estimated using the user-benefit calculation module of MCIBAS mentioned in step 5.

7. *Estimate the economic impacts.* Direct regional economic impacts, including business cost savings, business attraction benefits, and increased tourism associated with each alternative were estimated using the MCIBAS modules, as shown in Table 9.14. The size of impacts would depend primarily on traffic volumes and increases in accessibility to labor, customer, supplier, and tourism markets.

8. *Estimate the secondary economic impacts.* The macroeconomic simulation model (REMI), a MCIBAS component, was used to estimate the total economic effects (including direct, indirect, and induced) with respect to such changes as business sales (output), employment, and income due to the direct economic impacts estimated in step 7. The resulting information is given in Table 9.15.

9. *Compare the alternatives.* Tables and graphs were generated showing the economic impacts for each alternative as a result of the highway project. Alternatives were ranked against their potential economic development effects. In this example, Alternative III appears to be the

Table 9.14 I-69 Corridor Study: Direct Impacts

	Alternative				
Direct Economic Impact	I	II	III	IV	V
Reduction in annual production costs in 2025 (millions of 2001 dollars)	1.7	10.5	20.2	9.0	16.5
Increase in annual business sales in 2025 (millions of 2001 dollars)	202.8	391.7	631.8	430.1	538.8
Increase in tourism visitor-days in 2025 (thousands of days)	42.4	88.0	168.8	94.1	143.2

Source: Cambridge Systematics and Bernardin (2003).

Table 9.15 I-69 Corridor Study: Secondary Impacts

	Alternative				
Secondary Economic Impact	I	II	III	IV	V
Net change in employment (jobs) in 2025	1400	2500	4300	2700	3800
Net change in real disposable income (millions of 2001 Dollars) in 2025	52	99	165	106	142
Net change in output (millions of 2001 dollars) in 2025	245	495	808	537	679

Source: Cambridge Systematics and Bernardin (2003).

most desirable from the perspective of economic development impacts.

10. *Benefit-cost computation.* To avoid double counting, the components of benefits included in the benefit-cost ratio computation are taken only as the user benefits for non-business travelers (i.e., savings in travel time, vehicle operating cost, and crash costs, for personal travel) plus real personal income impacts (i.e., net change in real disposable income).

SUMMARY

Economic development impacts of transportation projects represent the effects on economic activity in a project area or region. These differ from economic efficiency impacts (which involve the valuation of individual user benefits) or broader social impacts. Economic development impacts occur through mechanisms that can be broadly classified as direct, indirect, induced, or dynamic. The sum of all these effects represents the total effect on economic growth. Common performance measures for economic development impacts are employment, business output (sales), value added, wealth or personal income, and property values. These measures typically overlap and should not be added to yield the total impact. The selection of appropriate performance measures and data collection techniques for the evaluation depends on the purpose of the transportation project, the project type, size of impact area, usefulness of information available for public information and for decision making, and motivation for the evaluation. The motivation for assessing economic development impacts include forecasting the future impacts of proposed projects, to estimating the current economic role of existing systems and facilities, and measuring the actual impact of projects already completed. Analytical techniques for economic development impact studies range in complexity from simple case studies to complex economic simulation models. The key is to match the analytical tool to the purpose and level of desired sophistication of the analysis, within the given resources.

EXERCISES

9.1. What is the difference between economic efficiency impacts and economic development impacts?

9.2. Discuss some typical economic benefits of transportation investments.

9.3. Discuss the detailed measurement process, merits and limitations of any performance measure used to quantify the effect of transportation investments on manufacturing productivity.

Table EX9.5.1 Transactions Matrix

Input	Manufacturing	Utilities	Trade	Final Demand	Total Output
Manufacturing	8	7	10	25(4)	50
Utilities	14	10	6	12(3)	42
Trade	12	5	4	12(3)	33
Final payments[a]	16(6)	20(7)	13(5)	0	49
Total inputs	50	42	33	49	174

[a] Values in parentheses refer only to households.

9.4. Discuss how you would establish a statistical relationship for predicting the overall impacts of transportation on economic development. Identify the statistical and economic issues that are likely to arise and suggest ways by which they could be addressed.

9.5. Input–output analysis: The transactions matrix shown in Table Ex9.5.1 describes the flows of goods and services between three individual sectors of a highly simplified economy in a given region. The illustrative employment–output ratios for the three sectors of the economy in the region that provide information on labor productivity for each sector are provided in Table Ex9.5.2. Estimate the direct, indirect, and induced output, employment, and income multipliers by applying the input–output methodology described in this chapter.

Table EX9.5.2 Employment–Output Ratios

Sector	Employment	Output	Employment/ Output Ratio
Manufacturing	50,000	$50,000,000	0.001
Utilities	40,000	20,000,000	0.002
Trade	100,000	30,000,000	0.003

9.6. A 44-mile four-lane freeway is planned for construction in 2006. The investment required includes the following costs:

- The cost associated with purchasing the land where the highway will be built (including the real estate cost): $55,060,000
- The cost of engineering services involved in project design and study: $9,730,000
- The cost of constructing the highway: $194,540,000

The total investment required is $259,330,000. All costs are in constant 2001 dollar values. Assess the economic impacts of the investment in terms of employment, earnings, and output. Use each of the following two approaches:

1. Input–output analysis: Use the RIMS II and IMPLAN software packages to estimate the output, income, and employment economic multipliers.
2. Regional economic modeling: Use the REMI software package to evaluate the regional economic impacts of the new highway construction in the long run (year 2020).

Study the outputs to evaluate the impacts and discuss the results. State any assumptions made.

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