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Author(s): Michael W. Babcock and John C. Leatherman
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Methodology for Measuring Output, Value Added, and Employment Impacts of State Highway and Bridge Construction Projects

by Michael W. Babcock and John C. Leatherman

The purpose of this paper is to present a methodology to measure some of the economic impacts of state highway programs. State departments of transportation (DOTs) need such a methodology for a variety of reasons, including long-term highway planning as well as advising state policymakers concerning the economic impacts of highway programs. The specific objectives of this study are: (1) describe a procedure to measure the output, value added, and employment impacts of specific types of highway and bridge improvement, and (2) illustrate an application of the model using data from Kansas.

The objectives of the research are accomplished with input-output modeling. An 11-step procedure is described for adjusting the Kansas IMPLAN input-output model so that it is capable of measuring economic impacts for specific types of highway and bridge improvement. The model is illustrated using data from a recently completed study of the Kansas Comprehensive Transportation Program (CTP), which included expenditure of $5.24 billion on state highway system projects. Data from this study are used to demonstrate the calculation of output, value added, and employment impacts for five different highway and bridge improvement categories.

INTRODUCTION

In 2008 and 2009, nearly every U.S. state significantly reduced their budgets as a result of the 2008 financial crisis followed by severe recession in 2009. In 2010, nearly 10% of the U.S. labor force was unemployed. Since states can't have deficits in their budgets, legislators have difficult decisions to make in allocating diminishing funds to state programs. Although politics and policies will always be the primary factor in government budget decisions, in recent years, benefit-cost analysis has been given some weight in these decisions. While there is near unanimous agreement among economists that government programs whose benefits exceed their costs are an efficient use of resources, practical application of this technique has been limited by the difficulty in measuring the benefits of government programs. The purpose of this paper is to present a methodology to measure some of the benefits of state highway programs.

State Departments of Transportation (DOTs) need such a methodology for a variety of purposes. State policymakers often request DOTs to supply economic impact information for highway programs. Currently, many DOTs are unable to supply this information. In the current financially austere environment, state DOTs attempt to justify their budget requests by estimating the economic benefits of their proposed highway programs. The model presented in this paper could be used to measure some of these benefits. State DOTs also need economic benefit and impact information for long-term highway planning, and the model in this paper could be helpful for this purpose, although the model is not intended to be a substitute for an in-depth analysis of future transport demands.

A very large literature exists in the area of the impact of highways on regional output, income, and employment, as well as the role highways play in regional economic development. A partial list of these studies from the 1970s include Dodgson (1974), Humphrey and Sell (1975), Kuehn and West (1971), and Miller (1979). Numerous contributions to the literature in this area occurred in the 1980s, including Allen et al. (1988), Briggs (1981 and 1983), Carlino and Mills (1987), Eagle and Stephanedes (1988), Isserman et al. (1989), Lichter and Fuguitt (1980), Politano and Rodifer

(1989), Stephanedes (1989), Stephanedes and Eagle (1986a, 1986b, 1987), and Wilson et al. (1982). Highways and their effect on economic development continued to attract research interest in the 1990s, including Allen et al. (1994), Babcock et al. (1997), Babcock and Bratsberg (1998), Boarnet (1995), Brown (1999), Crane and Leatham (1993), Garrison and Souleyrette II (1996), Holleyman (1996), Holtz-Eakin and Schwartz (1995), Khanam (1996), Midwest Transportation Center (1990), Mullen and Williams (1992), Singletary et al. (1995), Repham and Isserman (1994), and Talley (1996). More recent contributions to this area of the literature include Babcock et al. (2010), Chi and Cleveland (2006), Chandra and Thompson (2000), Van de Vooren (2004), and Peterson and Jessup (2008).

The consensus of this literature is that highways have their greatest economic impact during the construction phase with a smaller lagged impact over the long run (Eagle and Stephanedes [1988], Stephanedes [1989], and Stephanedes and Eagle [1986a, 1986b, and 1987]). Economic impacts vary widely by region, industry, and time period. Highways have economic impacts in rural areas but good highways do not guarantee economic development if the region lacks other resources that are necessary for growth.

This study differs from most of the previous studies in the literature which addressed whether highways affected growth and which provided an aggregate estimate of how much impact highways had on regional growth. In contrast, this study describes how state DOTs can estimate output, income, and employment impacts of specific types of road and bridge improvements.

This study doesn't measure other important benefits of highway investment, each of which is a formidable research task. For example, the study doesn't measure reductions in congestion that result in lower vehicle operating costs such as maintenance, fuel, tires, and depreciation. It does not measure the benefits of lower accident costs fostered by road improvements. Also, the study does not directly measure the benefit of travel time savings resulting from highway investment (Allen, Baumel, and Forkenbrock 1994). These latter benefits are indirectly measured since it is the lower transport costs (time) generated by the highway investment that leads to economic growth (impacts) in the affected region. Nevertheless, the study does measure some important impacts of different types of highway and bridge improvement. The specific objectives of this paper are to:

1. Describe how to measure the output, value added, and employment impacts of specific types of highway and bridge improvements.
2. Illustrate an application of the model using data from the state of Kansas.

INPUT-OUTPUT METHODOLOGY

The objectives of the research are achieved with input-output modeling. An input-output model is a quantitative framework of analysis for examining the complicated interdependence within the production system of an economy. There are three components to the standard input-output model: an interindustry transactions matrix; a direct requirements matrix; and a direct, indirect, and induced requirements matrix. Each of these can be explained with the aid of a simple illustrative example from Professor Steven Deller (Deller and Williams 2009).

The transactions matrix describes the flow of goods and services between all individual industries of the economy in a given year. The columns show purchases by a particular industry from all other industries. For example, in the highly simplified example of an input-output transaction matrix appearing in Table 1, the data in the Agriculture sector column show that, in order to produce its \$50 million output, that sector purchases \$10 million from farm enterprises, \$4 million from manufacturing firms, and \$6 million from service establishments. Agriculture firms also made purchases from non-processing sectors of the economy, such as the household sector (\$16 million) and imports from other regions (\$14 million). Purchases from the household sector represent value added or income to people in the form of wages, salaries, and investment returns. The data in the Agriculture sector row indicate that Agriculture sold \$10 million to farm enterprises, \$6 million to manufacturing, \$2 million to services, and the remaining \$32 million was sold to households within the region or exported out of the region. In this case, $20 million was sold to households within the region and $12 million was sold to firms or households outside the region. Note that total agriculture output (sum of the row) is exactly equal to Agriculture purchases (sum of the column), or demand equals supply. This is the case for each sector.

The transactions table is significant because it provides a quantitative framework for the region's economy. Not only does it show the total output of each sector but also the interdependencies between sectors. It also reveals the degree of "openness" of the region through imports and exports. More open economies have a high percentage of total expenditures devoted to imports and, thus, smaller multipliers.

The direct requirements matrix indicates the input requirement from each industry for a particular industry to produce an average $1 of output. These purchase coefficients are obtained by dividing purchase data in each industry column of the transactions matrix by the corresponding output value for that industry. The resulting purchase coefficients, or input ratios, may be thought of as production recipes for a particular product. From the data in the simplistic transactions matrix in Table 1, a direct requirements matrix can be calculated (Table 2). As an example, the first column (Agriculture) shows that to produce an average $1 of output, the Agriculture sector buys $.20 from farming enterprises, $.08 from manufacturing firms, and $.12 from services firms. The Agriculture column also shows that the sector makes payments of $.32 to households and $.28 to imports. Households and imports are referred to as final payments sectors.

Table 1: Illustrative Input-Output Transactions Matrix (Millions of Dollars)

	Purchasing Sectors (Demand)			**Final Demand**		
Processing Sectors (Sellers)	Agr.	Mfg.	Serv.	HH	Exports	Total Output
Agriculture	10	6	2	20	12	50
Manufacturing	4	4	3	24	14	49
Services	6	2	1	34	10	53
Households	16	25	38	1	52	132
Imports	14	12	9	53	0	88
Total Inputs	50	49	53	132	88	372

Table 2: Illustrative Direct Requirements Matrix

	Purchasing Sectors (Demand)		
Processing Sectors (Sellers)	Agr.	Mfg.	Serv.
Agriculture	0.20	0.12	0.04
Manufacturing	0.08	0.08	0.06
Services	0.12	0.04	0.02
Households	0.32	0.51	0.72
Imports	0.28	0.24	0.17
Total Inputs	1.00	1.00	1.00

The direct and indirect requirements matrix is one of the two matrices that measure the interaction among industries. The other, the direct, indirect, and induced requirements matrix, is similar but includes the effects of household income and spending in addition to the interindustry interaction. It is referred to as the total requirement matrix. The data in the columns of Table 3 for each industry indicate the total requirements of all industries necessary for that industry to deliver $1 of output to final demand. As an example, for the Agriculture sector to increase output to final demand by $1, it must increase its overall output by $1.28 (including the initial $1 increase), the Manufacturing sector must increase its output $.12 and the Services sector must increase its output $.16. The total output increase of Agriculture in this simplistic economy is the sum of these three values, or 1.56 times larger than the initial output expansion in Agriculture. The corresponding values for Manufacturing and Services are 1.35 and 1.16, respectively. These numbers are output multipliers.

Table 3: Illustrative Total Requirements Matrix

	Purchasing Sectors (Demand)		
Processing Sectors (Sellers)	Agr.	Mfg.	Serv.
Agriculture	1.28	0.17	0.06
Manufacturing	0.12	1.11	0.07
Services	0.16	0.17	1.03
Total Inputs	1.56	1.35	1.16

PROCEDURES

Measurement of the economic impacts of specific types of highway improvement requires the following 11-step procedure, developed by the authors, which is illustrated with Kansas data (Babcock et al. 2010).

1. Establish objectives
2. Conduct secondary data search
3. Tabulate the population of construction firms eligible to obtain state highway contracts
4. Select highway improvement types
5. Measure the total state expenditure for each highway improvement type
6. Select highway construction firm samples
7. Design the questionnaire
8. Conduct the survey
9. Perform consistency check
10. Calculate output, value added (income), and employment multipliers for each highway improvement type
11. Calculate output, value added (income), and employment impacts

Any study must start with clear objectives to provide a framework for the research effort. In this type of study, the objectives are determined by the information needed by the state DOT. In a study recently completed for the state of Kansas, the following objectives were established by the Kansas Department of Transportation (KDOT):

1. Measure the direct output, value added, and employment impacts by highway improvement type of the Kansas Comprehensive Transportation Program (CTP).
2. Measure the indirect and induced output, value added, and employment impacts by highway improvement type of the Kansas Comprehensive Transportation Program (CTP).

The Kansas CTP extended from July 1999 to July 2009 and included expenditures of $5.24 billion for state highway system projects, including interstate highways (Babcock et al. 2010).

A secondary data search helps provide insight regarding the potential outcome of the research project. For example, the U.S. input-output model (Minnesota IMPLAN Group 1999) was examined. The model contains input data for construction of new highways as well as maintenance and repair of highways. Analysis of this data indicated the types of inputs and approximate cost structure that should emerge from the state survey of highway contractors.

The third step is to tabulate the population of construction firms eligible to obtain state highway contracts in order to draw a sample for the survey. Every state DOT maintains a list of construction firms eligible to bid on state highway construction contracts. In the Kansas CTP study, the list of firms supplied by KDOT was supplemented by a directory published by the Kansas Contractors Association (KCA). These directories are likely available in the great majority of states.

The next step is the selection of highway and bridge improvement categories. The general principle with respect to classification of highway and bridge improvement types is homogeneity. Highway and bridge improvement types with similar cost structures and requiring similar inputs should be placed in the same class. For the Kansas CTP study, the research team and KDOT categorized and selected the following highway and bridge improvement types for analysis.[1]

Category	Highway Improvement Type
1	Resurfacing
2	Restoration and Rehabilitation; Reconstruction and Minor Widening
3	New Bridges and Bridge Replacement
4	Major and Minor Bridge Rehabilitation
5	New Construction; Relocation; Major Widening
6	Safety/Traffic Operations/Traffic Systems Management; Environmentally Related; Physical Maintenance, Traffic Services

The fifth step is measurement of total expenditure for each highway and bridge improvement type during the time frame of the study. These data are needed to expand the state survey sample data to population totals. Every state DOT has records that tabulate total annual expenditure by highway and bridge improvement type. For the Kansas CTP study, the value of construction contracts by highway and bridge improvement type is as follows:

Category	Value of CTP Construction Contracts, July 1999-July 2009 (Millions of Dollars)
Resurfacing	$1,240.9 (23.7%)
Restoration and Rehabilitation; Reconstruction and Minor Widening	$2,684.8 (51.3%)
New Bridges and Bridge Replacement	$439.1 (8.4%)
Major and Minor Bridge Rehabilitation	$199.8 (3.8%)
New Construction; Relocation; Major Widening	$503.2 (9.6%)
Safety/Traffic Operations/Traffic Systems Management; Environmentally Related; Physical Maintenance; Traffic Services	$169.2 (3.2%)
Grand Total	$5,237.0

The sixth step is selection of survey samples for each highway and bridge improvement type. The general principle is to concentrate research efforts on the construction firms with the largest highway contracts simply because they are the firms that account for the majority of the construction activity. For example, suppose there are 10 firms performing a certain type of highway work in a particular year, and total state spending on this highway improvement type is $50 million. Also assume that one firm has a contract for $25 million, while the remaining $25 million is split equally among the other nine firms. If random sampling is employed, there is only one chance in 10 that the firm with the $25 million contract will be selected. A better and more useful strategy is to select the firms with the large contracts. These samples were drawn from state DOT records which tabulate each construction contract by amount, highway improvement type, and name of construction firm. The research team selected the construction firm samples by highway and bridge improvement type from these records.

KDOT and the research team selected the highway contractors who obtained Kansas CTP highway construction contracts during the period January 1, 2004, to December 31, 2007. The total value of the sample contracts let during the 2004-2007 period was $1.98 billion, 37.9% of the total CTP contract value of $5.24 billion (Babcock et al. 2010). Of the $1.98 billion of contracts let in the sample period, $1.42 billion was obtained from sample contractors, which was 71.4% of the $1.98 billion and 27% of the 10-year CTP total contract value of $5.24 billion (Babcock et al 2010). Members of the research team conducted personal interviews with the highway contractors who received the larger contracts in each highway and bridge improvement category. In the CTP study it was not uncommon for the large construction firms to be in the sample for more than one highway improvement category.

The seventh step is designing the questionnaire. The general principles are brevity and clarity. It should have any necessary explanatory notes as well as definitions and examples of each of the industry sectors in the model. The questionnaire for the Kansas CTP study had four pages (see Appendix A). The first page lists the highway contracts for which purchase and cost information is requested, and space is provided for the firm to provide the final contract amount and total labor hours for each contract. The contract amount is required for a consistency check since the sum of the purchases and retained earnings from the second page of the questionnaire must equal the total contract amount of the first page. Total labor hours are needed to calculate the average wage per hour for each improvement type. The second page of the questionnaire pertains to input purchases and other costs of the highway construction firms. On this page the firm lists the name of each supplying industry, the total purchases from that industry, and the percent of total purchases supplied by firms located in the state.[2] This page of the questionnaire also requests amounts of other expenditures such as amounts paid to subcontractors, wages and salaries, taxes, and depreciation. The latter figure is combined with retained earnings to preserve profit confidentiality, a necessary ingredient in obtaining the cooperation of the sample construction firms. The third and fourth page of the questionnaire contains definitions and examples of the input supplying sectors which the construction firms are requested to use in classifying their purchases.

The next step is to conduct the survey, which begins with sending a letter to the presidents of the sample construction firms explaining the objectives of the study and how the research project could benefit the company. The letter is followed by a call to the presidents of the firms to discuss the project. During the call, explain the research objectives thoroughly, emphasize confidentiality, and ask for an appointment. At the interview they explain the questionnaire in detail and answer all questions.

The ninth step is performing consistency checks. After receiving the questionnaires, they should be checked for errors, inconsistencies (such as the value of the contract not matching the contract-related expenditures), and omitted data. Call the respondent to clarify any problems. After resolving any data problems, the input-output tables were constructed.

The next step is the calculation of output, value added (income), and employment multipliers for each highway and bridge improvement type. Output multipliers are a good indicator of the degree of economic interaction between each state industry sector and the rest of the state economy as well as exports to and imports from other regions. The output multipliers are calculated by summing the columns corresponding to each highway improvement type of the total requirements matrix.

Value added (income) is the sum of employee compensation (total payroll including value of benefits), proprietors' income (payments to self employed individuals), property income (such as rents, royalties, dividends, and corporate profits), and indirect business taxes (excise taxes, property taxes, licenses, fees, and sales taxes paid by business). Value added multipliers indicate the total value added generated from the construction projects of a given highway or bridge improvement type, including direct value added within the construction industry as well as the indirect value added of the industries that supply the construction industry with materials, goods, and services. The value added multiplier also includes the induced value added in various consumer markets produced by the increased spending of people employed both directly and indirectly as a result of state construction projects.

The employment multipliers for each highway or bridge improvement type represent the sum of three effects: the direct employment within the construction industry itself, the indirect employment in the input supplier industries, and the induced employment in various consumer markets generated by increased consumer spending of people employed directly and indirectly on state highway construction projects.

The output, value added, and employment multipliers for five highway and bridge improvement types are displayed in Table 4.[3] Using resurfacing as an example, the multipliers are interpreted in the following manner. In the case of the output multiplier, for every $1 increase in resurfacing contract value, total Kansas production increases by $1.74 (including the initial $1 increase). With respect to the value added multiplier, for every $1 increase in value added in the Kansas construction firms performing road surfacing, total Kansas value added increases by $1.78 (including the initial $1 increase). In the case of the employment multiplier, for every job generated in Kansas construction firms involved in resurfacing work, total Kansas employment increases by 1.91 jobs (including the initial one job increase).

Table 4: Output, Value Added, and Employment Multipliers of the Kansas CTP Study

Highway Improvement Type	Output Multiplier	Value Added Multiplier	Employment Multiplier
Resurfacing	1.74047	1.78454	1.90737
Restoration, Rehabilitation, Reconstruction and Minor Widening	1.60446	1.68217	1.89845
New Bridges and Bridge Replacement, Major and Minor Bridge Rehabilitation	1.50128	1.64579	1.69373
New Construction; Relocation, Major Widening	1.52279	1.62144	1.76020
Safety/Traffic Operations/ Traffic Systems Management; Environmentally Related, Physical Maintenance, Traffic Services	1.54372	1.63245	1.89454
Total	1.61929	1.69779	1.86215

Source: Babcock et al. (2010).

The multipliers were calculated with a 345 sector input-output model calibrated to 2006, roughly the mid-point of the project investment period, using the IMPLAN modeling system originally developed by the U.S. Forest Service (Minnesota IMPLAN Group, Inc. 1999). IMPLAN creates a detailed model of the economy that charts the financial flows between all production sectors and institutions, i.e., government, households, and capital. The purchase and cost information from the contractor survey was placed in the appropriate sector of the 90 sectors most closely associated with highway construction. The national production function of highway, street, bridge, and tunnel construction was used for this purpose. This production function provides a national average "production recipe" of inputs required to produce the output associated with highway construction. Thus, we can apportion total reported spending to each of the industry sectors associated with highway construction activity.

The first step in this process was to bridge the 43 sector contractor survey expenditures and the 90 IMPLAN highway industry input sectors that were present in Kansas. For example, Kansas contractors reported spending for non-metallic minerals such as sand and gravel. In the IMPLAN system, non-metallic minerals is represented by two sectors, stone mining and quarrying, and sand-gravel-clay and refractory mining. To determine how much of the Kansas contractor spending on non-metallic minerals that each IMPLAN sector gets, we examined the national production function and observe that stone mining gets 77% of the non-metallic minerals spending while sand-gravel-clay and refractory mining gets 23%. Thus, if a total of $10 million had been spent on non-metallic minerals, $7.7 million was assigned to stone mining and $2.3 million was assigned to sand-gravel-clay and refractory mining. There is a direct correspondence between agricultural services and agriculture and forestry support activities. Thus, the IMPLAN sector for agriculture and forestry support activities gets 100% of the spending reported by the highway contractors for agriculture services. In this way the inter-industry input patterns for Kansas highway construction closely approximate national input patterns yet retains the distinctive expenditure distribution reported by Kansas contractors.

Following this procedure, total in-state spending for each of the construction categories was input into the 90 highway construction input sectors represented in the Kansas input-output model. With the introduction of the spending into the model, IMPLAN calculates the associated indirect and induced impacts associated with the activity. At the same time, it generates the various economic multipliers reported in Table 4 that summarize the total economic activity associated with the new highway spending.

CALCULATION OF OUTPUT, VALUE ADDED, AND EMPLOYMENT IMPACTS

The last step of the procedure is calculation of impacts. Once the various multipliers have been determined, the output, value added, and employment impacts of state highway programs can be easily calculated. To compute output impacts, the researcher obtains from the state DOT the value of construction contracts by highway and bridge improvement type awarded during the time frame of the study. The values of contracts spent in the state by highway improvement type are multiplied by their respective multipliers to obtain the output impacts. The output impacts by highway and bridge improvement types for the Kansas CTP study are in Table 5. Examination of the table reveals that the $5.24 billion Kansas CTP generated a total output impact of $6.7 billion (includes the $5.24 billion direct impact).

Value added impacts by highway and bridge improvement type are calculated by multiplying direct value added (value added generated within the construction industry) by their respective multipliers. In the Kansas CTP study, the total Kansas direct value added of $1.83 billion resulted in a total value added impact of $3.11 billion (Table 6).

Employment impacts by highway and bridge improvement type are obtained by multiplying direct employment by the appropriate employment multiplier. The Kansas IMPLAN input-output model doesn't measure employment within the Kansas highway construction industry (direct employment), so it had to be estimated manually. To estimate Kansas direct construction employment, we used total state output and employment in the Kansas highway construction sector (Babcock et al. 2010). In 2006, Kansas highway construction output totaled $840,275,000 and highway construction employment was 8,100 workers. Thus, each $1million in highway construction outputs was associated with 9.64 workers (8,100/840,275). Multiplying Kansas total construction spending by highway improvement type for the 10-year CTP era by 9.64 yields an estimate of direct employment in highway construction companies. The results are in Table 7.

The employment impact by highway and bridge improvement type is obtained by multiplying the direct employment from Table 7 by the appropriate multiplier (Table 8). In the Kansas CTP study, the direct employment of 50,483 generated a total of 94,007 jobs (including the direct employment of 50,483).

Table 5: Kansas CTP Output Impact by Highway Improvement Types

(1) Highway Improvement Type	(2) Value of CTP Contracts	(3) Proportion of Contracts Spent Outside Kansas	(4) Value of Contracts Spent in Kansas	(5) In-state Output Multiplier	(6) Output Impact
1	$1,240,934,211	15.77%	$1,045,226,437	1.74047	$1,819,192,241
2	$2,684,791,829	18.84%	$2,178,896,284	1.60446	$3,495,973,173
3-4	$638,865,242	34.09%	$421,063,094	1.50128	$632,136,472
5	$503,152,560	29.46%	$354,900,856	1.52279	$540,441,136
6	$169,224,802	18.39%	$138,107,886	1.54372	$213,200,167
Total	$5,236,968,645	20.98%	$4,138,194,557	1.61929	$6,700,943,189

Column (6) is the product of Columns (4) and (5), although not exactly due to rounding of the multiplier. All data reported in dollars are measured in 2009 dollars.
Source: Babcock et al. (2010).

Table 6: Kansas CTP Value Added Impact by Highway Improvement Type

(1) Highway Improvement Type	(2) Value of CTP Contracts	(3) Direct Value Added	(4) Value Added Multiplier	(5) Value Added Impact
1	$1,240,934,211	$463,875,286	1.78454	$827,808,555
2	$2,684,791,829	$973,537,493	1.68217	$1,637,661,853
3-4	$638,865,242	$174,278,818	1.64579	$286,828,010
5	$503,152,560	$157,080,456	1.62144	$254,696,910
6	$169,224,802	$61,054,547	1.63245	$99,668,973
Total	$5,236,968,645	$1,829,826,600	1.69779	$3,106,664,301

Column (5) is the product of Columns (3) and (4), although not exactly due to rounding of the multiplier. Data measured in dollars is reported in 2009 dollars.
Source: Babcock et al. (2010).

CONCLUSION

State highway policymakers are usually very interested in the labor impacts of highway investment. The model suggested in this paper is capable of measuring some of these impacts. Suppose policymakers want to know how many jobs would be generated by annual spending of $105 million on new construction and major widening. Using data from Table 7, direct employment is 1,012 jobs (105 x 9.64). Multiplying 1,012 by the employment multiplier in Table 8 of 1.76020 results in a total impact of 1,782 jobs. According to the contractor survey of the CTP study the average wages, salaries, and benefits per hour in the New Construction and Major Widening category is $34.25 (Babcock et al. 2010). Assuming 2,000 annual work hours results in direct annual wages, salaries, and benefits per worker of $68,500. When this figure is multiplied by 1,782 workers, the result is total annual direct wages, salaries, and benefits of $122.1 million.

The model in this paper can be employed by state DOTs to advise highway policymakers regarding the economic impacts of alternative highway programs. If policymakers supply state DOTs with the proposed total contract value of the various highway improvement types (i.e., column [2] of Table 5), the state DOT can use the output multipliers to estimate the output impact of *any* proposed highway program. Even if the total contract value of alternative highway programs is the same, the economic impacts will different because the multipliers of the various highway and bridge improvement types are different.

The highway construction impacts analyzed in this paper represent only a part of the benefits of highway investment. A more comprehensive view of the benefits would combine three categories of benefits that would include construction, highway user, and regional economic growth benefits. Once a highway is built it becomes an asset that yields benefits to highway users over the useful life of the asset. Many of the user benefits have been identified in the literature and include logistics cost reductions for firms using truck freight, accident cost reductions, travel time savings for motorists, and lower vehicle operating costs. However, measurement of these benefits, especially on a regional basis, is a formidable research task (Allen et al. 1994).

Table 7: Estimated Direct Construction Contractor Employment by Highway Improvement Type

(1) Highway Improvement Type	(2) Value of CTP Contracts (Millions of dollars)	(3) Direct Employment per Million Dollars	(4) Direct Employment
1	$1,240.9	9.64	11,962
2	$2,684.8	9.64	25,881
3-4	$638.9	9.64	6,158
5	$503.2	9.64	4,850
6	$169.2	9.64	1,631
Total	$5,236.9	9.64	50,483

Source: Babcock et al. (2010).

Table 8: Kansas CTP Employment Impact by Highway Improvement Type

(1) Highway Improvement Type	(2) Indirect Employment	(3) Direct Employment	(4) Employment Multiplier	(5) Total Employment Impact
1	10,854	11,962	1.90737	22,816
2	23,253	25,881	1.89845	49,134
3-4	4,272	6,158	1.69373	10,430
5	3,687	4,850	1.76020	8,537
6	1,459	1,631	1.89454	3,090
Total	43,524	50,483	1.86215	94,007

Column (5) is the product of Columns (3) and (4).
Source: Babcock et al. (2010).

APPENDIX

HIGHWAY CONTRACTOR SURVEY FORMS FOR PURCHASE-COST INFORMATION AND TOTAL LABOR HOURS

HIGHWAY ECONOMIC IMPACT PROJECT

PQ1

PRIME CONTRACT SURVEY

KDOT Contractor No.: SAMPLE

Person answering questionnaire ________________________________

We request your purchase and cost information on the highway projects listed below.

These contracts deal only with:

KDOT Contract Numbers	Route	KDOT Project Number	Let Date	Final Contract Amount (if avail.)	Total Labor Hours
92000001	K-490	K 1000-01	10/20/04	_____________	_______
93000001	U-220	K 2000-01	8/28/06	_____________	_______
			TOTALS	_____________	_______

HIGHWAY ECONOMIC IMPACT PROJECT

PQ1

KDOT Contractor No.: SAMPLE Respondent ____________________

Please provide your firm's purchases by supplying industry on only the projects on the previous page, which were let from January 1, 2004 to December 31, 2007.

Provide figures from all the projects as though they were one project.

PURCHASES:

Supplying Industries - brief description **(See attached list of industries.)**	**Total Purchases (Include both direct and overhead costs) ($ or %)**	**Percent Supplied by Producers in Kansas**
Other Expenditures:		
Paid to Subcontractors		
Wages and salaries (include both direct and overhead salaries)		
Taxes - Federal		
- State		
- Local		
Depreciation and Retained Earnings		
TOTAL EXPENDITURES		

1. Agricultural Services - landscaping, grass seeding
2. Non-Metallic Minerals - rocks, stone, sand, dirt, aggregates
3. Other Mining - Oil, gas, coal, other minerals
4. Construction Maintenance and Repair - maintenance and repair of capital assets including construction machinery and vehicles
5. Heavy Construction - general contractors engaged in the construction of highways, streets, and bridges. *Doesn't include payments to subcontractors*. Only includes purchases from other construction firms.
6. Special Trade Contractors - plumbing, plastering, painters, carpenters
7. Paper and Allied Products - paper bags, boxes, all types of paper
8. Printing and Publishing - brochures, reports, any type of published material
9. Industrial Chemicals - basic industrial chemicals such as industrial gases, pigments, dyes, etc.
10. Agricultural Chemicals - fertilizer, pesticides
11. Other Chemicals - explosives, paint, cleaning preparations, glue, ink
12. Petroleum and Coal Products - asphalt, lubricating oils, and greases
13. Rubber and Plastic Products - tires, cold plastic and thermal plastic pavement markings, plastic cones and barrels
14. Cement and Concrete Products - hydraulic cement, concrete products like pipe, pre-stressed beams, drilled shaft casings
15. Stone, Clay, and Glass Products - lime, gypsum, abrasives, cut stone products, glass products, flat glass, bricks
16. Primary Metal Products - iron, steel, aluminum, copper, iron pipe
17. Fabricated Structural Metal - rebar, structural steel, corrugated metal pipe, signs, sign supports, guard rail
18. Other Fabricated Metal - tools, containers, fasteners, wire, nuts, bolts, valves
19. Farm Machinery and Equipment - tractors, combines, bailers
20. Construction and Industrial Machinery - construction machinery parts, equipment, and rentals. *Does not include construction machinery repairs (see sector 4)*
21. Electrical Machinery - air conditioning, refrigeration, materials handling machines, power driven hand tools, lighting fixtures, electric motors, generators, batteries
22. Other Machinery - engines, turbines, machine tools
23. Motor Vehicles and Equipment - purchases of cars and car parts
24. Other Transport Equipment - railroads, boat, aircraft equipment and parts
25. Other Manufacturing - lumber and wood products, furniture, leather products, scientific instruments, metal filing cabinets, miscellaneous manufacturing
26. Railroad Transportation - transport by railroad
27. Motor Freight Transportation - transport by truck
28. Other Transportation - transport by air, water, or oil pipeline
29. Communications - phones, cell phones, internet connection fees, anything involving oral or visual communication

30. Electric, Gas, and Sanitary Services - expenditures for electricity, natural gas, water, garbage collection
31. Wholesale Trade, Machinery, and Equipment - purchases from wholesalers of machinery, equipment, and supplies
32. Other Wholesale Trade - purchases from wholesalers other than for machinery, equipment, and supplies
33. Gasoline Service Stations - purchases of gas or diesel fuel
34. Eating and Drinking Places - restaurant purchases
35. Other Retail Trade - all other purchases from retail stores, except fuel and food
36. Banking - interest payments on bank loans
37. Other Financial Institutions - interest on all non-bank loans
38. Insurance and Real Estate - performance bonds, liability insurance, employee health insurance, building or other rental payments
39. Lodging Services - payments to hotels and motels
40. Personal Services - services involving care of the person or person's clothing
41. Business Services - licenses, filing fees, advertising, data and word processing, professional and legal services, consulting, vehicle rental or leasing, accounting, tax preparation
42. Medical and Health Services - payments for medical or surgical services to persons. Doesn't include health insurance for employees (see sector 38)
43. Other Services - payments for all other services not enumerated above like automotive repair, entertainment, education

Endnotes

1. The highway improvement categories of the Kansas CTP study are combinations of Federal Highway Administration (FHWA) highway and bridge improvement types.

2. The questionnaire employed to obtain the purchase and cost data for the various highway improvement types requires the respondent to report the percent of each input purchase type that is supplied by in-state producers. This is done to net out imports that have no impact in the state and are thus not included in the study. For example, if a construction firm purchases $10 million of cement and 80% is purchased from an in-state supplier, the study measures only the impact of the $8 million that increases cement production within the state. The other $2 million increases cement production in an out-of-state location and is not included in the impacts measured by the study.

3. The relatively small amount of Category 4 (Major and Minor Bridge Rehabilitation) contract value in returned contractors' questionnaires resulted in combing Category 3 (New Bridges and Bridge Replacement) with Category 4.

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***Michael W. Babcock** is a full professor of economics at Kansas State University. In his 38-year career at KSU, he has published over 80 articles in professional journals, along with numerous monographs and technical reports. His research has been cited in over 75 books, the transportation press, and professional journals. He has been principal investigator or co-principal investigator on 33 federal and state research grants worth a total of $2.3 million.*

Dr. Babcock has received numerous national awards for his transportation research. He has won five best paper awards from the Transportation Research Forum (TRF) for outstanding research in transportation economics. He has received the E.S. Bagley award five times from the Economics Department of KSU for outstanding achievements in transportation economics research. In 1998 he was awarded the ISBR Senior Faculty Award for research excellence in The Social and Behavioral Science from KSU. In 2005, he received the Herbert O. Whitten TRF Service Award (the highest honor bestowed by TRF) for professional contributions to TRF, becoming only the eighth person to receive the award in the 50 year history of TRF. He has served as general editor of the Journal of the Transportation Research Forum *since 2000.*

***Dr. John Leatherman** is a professor in the Department of Agricultural Economics at Kansas State University and local government specialist with K-State Research & Extension. He also is the director of the Office of Local Government, an educational outreach and technical assistance program for city and county governments in Kansas. He has worked with the Cooperative Extension Service since 1984 in areas of community and regional economic development policy and practice, local government and public finance, and natural resources management. Research interests include economic and fiscal impact analysis, regional economic modeling, rural development and policy analysis, local public finance, and natural resource management and environmental protection.*