Working Paper Series

Center for Transportation Studies

BOSTON UNIVERSITY

Working Paper # CTS2001A

http://www.bu.edu/transportation/WPSeries.html

Estimating Employment Generation by Federal-aid Highway Construction Projects

William P. Anderson
Center for Transportation Studies
Boston University
675 Commonwealth Avenue
Boston, MA 02115
Phone: (617) 358-0208
Fax: (617) 358-0205
Email: bander@bu.edu

T.R. Lakshmanan
Center for Transportation Studies
Boston University
675 Commonwealth Avenue
Boston, MA 02115
Phone: (617) 353-7551
Fax: (617) 358-0205
Email: Laksh@bu.edu

Brenda Kuhl
Center for Transportation Studies
Boston University
675 Commonwealth Avenue
Boston, MA 02115
Phone: (617) 358-0204
Fax: (617) 358-0205
Email: bkuhl@bu.edu

Abstract

This paper reports on a model developed for the estimation of direct and indirect employment generated by expenditures on federal-aid highway improvement projects. Data from the Federal Highway Administration's Form 47 database is combined with input-output data from the Transportation Satellite Accounts to generate employment estimates for 14 distinct categories of highway improvement. This makes it possible to adjust employment estimates for shifts in the distribution of federal aid expenditures across improvement types.

KEY WORDS: economic impacts, employment impacts, highway construction, input-output analysis.

INTRODUCTION

There is a heightened interest in assessing the economic benefits conferred by major expenditures of public money. Highway construction and improvement is a major expenditure category that can yield economic benefits in a variety or ways. Better highways may make firms more productive by making flexible and efficient freight services possible. They may also enhance the utility of individual consumers by providing access to new places and reducing time wasted in congestion. Finally, highway projects yield benefits in their construction phases by creating new jobs and expanding income. The focus of this paper is on quantitative assessment of this latter category of benefit. We present an analytical framework for assessing the number of jobs and amount of employment income generated by specific categories of federal-aid highway construction expenditures.

Highway construction is a relatively labor intensive activity that directly employs a variety of people including laborers, equipment operators, vehicle drivers, engineers, managers and supervisors. Thus, assuming that there is slack labor supply, each construction project creates a number of new jobs directly. It also creates a number of jobs indirectly through its incremental demand for inputs such as steel, concrete, aggregates, lighting equipment etc. Labor is required to produce all of these inputs and to produce inputs to the production of these inputs.

Estimating employment impacts of highway expenditures requires a comprehensive accounting of all direct and indirect employment requirements. Making such assessments on an *ad hoc* basis for each highway project would be prohibitively complicated. Fortunately, *input-output* analysis makes it possible to calculate direct and indirect output and employment impacts of highway expenditures based on a set of economic accounts provided by the U.S. Department of Commerce.

These accounts are somewhat limited as relates to highway construction activity. All such activities are aggregated into two industries: one for new construction and one for repair and maintenance. It is therefore not possible to take account of differences in input structure – and thereby differences in employment generation – among different types of highway construction activities. For example, a new bridge project will require more steel per million dollars of construction expenditure than a new road project, which in turn will require more bituminous inputs than the bridge project. The existing accounts, however, include both projects in the same industry and fail to account for these differences. This could lead to errors in estimates of direct and indirect employment.

This paper reports on a project, conducted with the cooperation and support of FHWA, whose objective is to expand upon and improve the existing input-output accounts so as to make possible better employment impact projections for highway infrastructure projects. This is accomplished by supplementing the data in the accounts with information from two databases on the input structure of individual federal-aid highway projects that are available from FHWA. This makes it possible to disaggregate the two highway construction industries in the existing accounts into 14 more detailed industries and to estimate employment impacts for each industry separately.

INPUT-OUTPUT ANALYSIS

Input-Output (I/O) analysis is an analytical framework for assessing the economic impact of exogenous stimuli such as public sector expenditure on infrastructure. It starts by dividing the economy into a mutually exclusive and exhaustive set of n industries. The output of each industry i is defined by the following accounting relation:

$$x_i = \sum_{j=1}^{n} z_{ij} + y_i \qquad (1)$$

where z_{ij} is the sales of industry i to industry j and y_i is the sales of i to final demand. The former category represents intermediate demand, whereby the output of one industry becomes an input to another, while the latter includes sales to final consumers and the public sector, investment in capital goods, and net exports. Expenditure on a publicly funded highway project would be represented in this framework as sales by the construction industry to final demand.

The critical technical assumption in I/O analysis is that the input structure of demand can be defined by fixed technical relations

$$z_{ij} = a_{ij} x_j \qquad (2)$$

where the technical coefficient a_{ij} is the amount in dollars of the output of industry i required to produce one dollar's output by industry j. Since these coefficients are fixed, complications such as input substitution and scale economies are precluded. Using (2), (1) is rewritten

$$x_i = \sum_{j=1}^{n} a_{ij} x_j + y_i \qquad (3)$$

and the production accounts of the entire economy can be defined by the following set of interrelated linear equations:

$$x_1 = \sum_{j=1}^{n} a_{1j} x_j + y_1$$

$$x_2 = \sum_{j=1}^{n} a_{2j} x_j + y_2$$

.

.

.

$$x_n = \sum_{j=1}^{n} a_{nj} x_j + y_n \qquad (4)$$

This can be rewritten in matrix form as

$$\mathbf{x} = \mathbf{Ax} + \mathbf{y} \qquad (5)$$

where **x** is an *(nx1)* vector of output levels, **y** in an *(nx1)* vector of final demand levels and **A** is an *(nxn)* matrix of the techncal coefficients a_{ij}.

I/O analysis assumes that final demand for each industry is exogenous and the objective is to predict the vector of outputs **x** generated by a given vector of final demand **y**. By rearranging the terms of (5) it is possible to define output as a function of final demand only:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} \qquad (6)$$

The *(nxn)* matrix $(\mathbf{I} - \mathbf{A})^{-1}$ is called the matrix of direct and indirect multipliers. The typical element of this matrix defines the total input required *both directly and indirectly* from some industry. For example, a highway construction project may require steel as a direct input as structural elements or for reinforcement of concrete. It may also require steel indirectly as an input to the construction of lighting, signals, or guard rails. The coefficient in this matrix includes all of these requirements.

Total labor requirement can also be calculated by defining a set of coefficients $l_1, l_2, \ldots, l_n$ such that l_i is the labor requirement (in hours or person years) per dollar of output in sector *i*. The sum of employment in all *n* industries can now be defined:

$$L = \mathbf{l}'\mathbf{x} = \mathbf{l}'(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} \quad (7a)$$

Similar coefficients can be used to project total employment income.

$$E = \mathbf{e}'\mathbf{x} = \mathbf{e}'(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} \quad (7b)$$

where **e** is a vector of payments to labor per dollar of output.

Since all the relations in the I/O model are linear, it can be applied to estimating the incremental output and employment effects of a particular final demand stimulus such as the expenditure of public finds on a highway infrastructure project. This is achieved by constructing a special final demand vector

$$\tilde{\mathbf{y}} = \begin{bmatrix} 0 \\ \vdots \\ y_j \\ \vdots \\ 0 \end{bmatrix} \quad (9)$$

where *j* is the appropriate construction industry. Putting this vector in place of **y** in (6) and (7) will produce the estimated output and employment respectively generated directly and indirectly by the project.

DATA RESOURCES

The data required for the analyses described above are drawn from three principal sources. The first is a database of submissions of FHWA Form 47, which includes purchases of labor, material, and supplies. (Form 47 data were used earlier in an employment study conducted by Apogee Research (4). That study, however, was limited to calculation of direct employment impacts.) The second is FHWA's Fiscal Management Information System (FMIS) which includes financial information and classifies projects according to improvement types. The third is the national input-output accounts provided by the Department of Commerce. In addition, data on commodity prices are drawn from a set of supplemental sources.

FHWA Form 47 *Statement of Materials and Labor Used by Contractors on Highway Construction Involving Federal Funds* must be filed by all projects for which the construction cost of roadway and bridge is one million dollars or more.

What follows is a summary of the information on the form.

1. *Project Description*: The state and county in which the project is located is provided, whether it is urban or rural, and the start and completion dates. The length in miles for roadways and both miles and number for bridges is also included, as is the total project cost. The form has an entry for "construction type codes" in a section to be completed by FHWA or state highway personnel.
2. *Labor Inputs:* Only two pieces of information are provided: total labor hours and gross earnings. There is therefore no way to break down labor input by skills level or functional category. The instructions stipulate that this should include labor for operation and maintenance of equipment.

3. *Material and Supplies:* A single value is given for the total cost of materials and supplies. This does not include rental, leasing, or depreciation cost of equipment, but it does include the cost of fuel and lubricants used for the equipment. Materials and supplies are broken down into the categories shown in Table 1.
4. *The Total Project Cost* including both the federal-aid and state components.

The sum of the costs for labor and materials and supplies should be substantially less than the total project cost. This is because the latter includes the costs of equipment, overhead and profit – items that are not reported on Form 47.

FHWA Form 47 data records have two important weaknesses. The first is that projects below one million dollars are excluded. The second is that the information on the forms does not provide an adequate basis for calculation of separate input-output ratios for different types of highway improvement projects. For example, it is not possible to distinguish between roadway resurfacing projects, reconstruction projects, and new highway construction. It is because of this second problem that matching of Form 47 records with records from the FMIS is necessary.

FHWA's Fiscal Management Information System (FMIS) keeps track of financial information for each highway project for which federal aid is provided. It records details of the aid including the program under which it is authorized, the date it is approved, and the amount of federal funds. It identifies the state, county, and rural/urban status of the project as well as several codes identifying the nature of the highway improvement. For ongoing projects it keeps track of federal transfers to date and the steps along a project life-cycle. For completed projects it includes the total cost and the federal share, as well as the date of completion. It does not, however, include costs breakdown into expenditure categories.

The critical piece of information that is found in FMIS but *not* in Form 47 is a construction type code for each project. To get an accurate indication of improvement type, therefore, it is generally necessary to match the federal project number included on each Form FHWA 47 record with the corresponding number on the FMIS records to obtain an improvement type code for each project. (The 15 improvement type codes found in the FMIS are listed in Table 2.)

Because of inconsistencies in the format of project identification numbers, it was only possible to make definitive matches for a small proportion of the FHWA Form 47 records (1266 of 10,604). While this number is small relative to the total size of the Form 47 database, it constitutes a sufficiently large sample for statistical purposes of observations for all the improvement types listed in Table 2 with the exception of type 14, Bridge Program Special Action.

A detailed set of I/O accounts for the US economy are needed to complete the analysis. The *1992 Benchmark Input-Output Accounts of the United States*, which are compiled and distributed by the U.S. Department of Commerce, are the standard basis for estimating the direct and indirect employment and output impacts of highway construction projects. (See Lawson, 1,2.) The most disaggregate version of these accounts are the "six-digit" accounts which break all economic activity into 498 different industries. The six-digit level defines two industries that reflect the input-output structure of highway projects: 11.0400 New Construction of Highways and Streets and 12.0214 Maintenance and Repair of Highways and Streets.

Recently, the 1992 Benchmark Accounts have been revised in order to expand the number of transportation services industries. This revision is known as the Transportation Satellite Accounts. The rationale behind this revision was the fact that a large proportion of the transportation services provided to US businesses are not accounted for properly in the IO data. Many firms provide much or most of their transportation services “in house” using vehicles that they own and drivers that they employ. The purchases and employment associated with this type of transportation is not assigned to transportation industries in the Benchmark Accounts, but rather to the industry of the firm in question (usually some category of manufacturing, construction, wholesale, or retail.) Thus transportation activities are under-represented. The Transportation Satellite Accounts (TSA) reassign input purchases across industries so that all in-house transportation services are assigned to a transportation industry. (See Fang (3).)

Price data for labor, materials, and supplies were needed to create new input-output coefficients (see below) which are calculated as the ratio of the dollar cost for each type of input to the total cost of the project. Since most non-labor input data in the Form 47 database is reported in physical units, unit prices are needed to calculate the cost of all inputs. Price data were acquired from a variety of sources including government and trade publications. A list of the sources used in the analysis is provided in Table 3.

METHODS

The main analytical task in this study was the construction of new sets of input-output coefficients for each of 14 federal-aid highway improvement types. Construction of the expanded matrix of technical coefficients is based on observed information on individual projects obtained from Form FHWA 47 and the FMIS. Each project type c = 1,2,…14 corresponds to a new input-output industry group. For each project type there are a number of individual observed projects o = 1,2, … , O_c .

Define:

y_{oc} : the dollar value of type *c* project *o*

s_{koc} : the physical quantity of input *k* used by type *c* project *o*

p_{koc} : the unit price of input *k* used in type *c* project *o*

Define a technical coefficient – representing the dollar value input *k* per dollar of expenditure on type c projects – as a weighted average across observed type *c* projects *o*

$$a_{kc} = \frac{\sum_{o=1}^{O_c} \frac{s_{koc} p_{koc} \omega_{oc}}{y_{oc}}}{\sum_{o=1}^{O_c} \omega_{oc}} \tag{9}$$

where O_c is the number of type *c* projects in the data set and ω_{oc} is a weight assigned to project *o*. The projects are weighted according to their dollar values y_{oc}, so equation (9) simplifies to

$$a_{kc} = \frac{\sum_{o=1}^{O_c} s_{koc} p_{koc}}{\sum_{o=1}^{O_c} y_{oc}} \tag{10}$$

Each input class *k* is associated with one and only one input-output industry *i*. Technical coefficients that can be used directly in the input-output accounts are calculated

$$\mathrm{a}_{\mathrm{ic}} = \sum_{k \in K_i} a_{kc} \tag{11}$$

where K_i is the set of all inputs *k* produced by industry *i*.

For a number of inputs, no information is available from Form 47. (This is especially true for service inputs.) In these cases, the technical coefficients are set to default values for the most appropriate of the two road construction categories in the current input-output accounts. Specifically, each new industry *c* is assigned to either a set of new construction industries *N* or a set or repair and maintenance industries *R* – for example new route construction belongs to the N set and restoration and rehabilitation belongs to the R set .

$$\begin{aligned} a_{ic} &= a_{in} \forall c \in N \\ a_{ic} &= a_{ir} \forall c \in R \end{aligned} \qquad (12)$$

These coefficients must be scaled, however, to ensure that all expenditure coefficients sum to 1.

The method described above can be used to provide input coefficients a_{ic} for each of the newly defined industries, but reveals nothing about the role of these sectors as providers of outputs to other industries (i.e. the a_{ci}). Fortunately this is not a problem since in general it is not expected that highway construction industries provide inputs to other industries – that is, assume that $a_{ci} = 0$ for all *c* and *i*. This is borne out by the fact that, with a very few exceptions, values of a_{in} and a_{ir} are zero in the existing input-output accounts. Assuming that all $a_{ci} = 0$ is consistent with assuming that $x_c = y_c$ which implies that industry *c* has no intermediate output.

A coefficient l_c representing the value of labor input per dollar of output for project type *c* can be calculated in an analogous fashion:

$$l_c = \frac{\sum_{o=1}^{O_c} l_{oc} y_{oc}}{\sum_{o=1}^{O_c} y_{oc}} \qquad (13)$$

where l_{oc} is the labor coefficient in person hours per dollar of output of type c project o. Similar coefficients are calculated for employment income. A vector of labor coefficients for all other industries is calculated based on TSA input-output accounts and supplementary data from the 1997 U.S. Economic Census. Total job and employment income generation is then calculated using equation (7).

RESULTS

In order to calculate I/O technical coefficients, all measures of labor and material inputs were first converted from physical to real dollar values. The dollar value of payroll for each project was given in the FHWA Form 47 data set. However, to be consistent with the I/O accounts, labor compensation should include both wages and the costs of personal benefits. The payroll values were therefore scaled up to include non-wage compensation, which was assumed to be 27% of total employee compensation — a conservative estimate since, according to the 1997 U.S. Economic Census, the benefits component in goods-producing industries (e.g., mining, construction, and manufacturing) is 30.7%.

Physical measures of material inputs were converted to real dollar values by determining price per physical unit in any given year. Sources of price data are listed in Table 3. Since price observations were available in only one or a few years for most inputs, the Producer Price Index was applied to create price estimates for all years covered in the data set.

The technical coefficients of inputs — the monetary value of each input used to produce one dollars' worth of construction output — were determined as the ratio of the dollar values of the input to the total construction costs for each highway improvement type (equation 10). The Form FHWA 47 database provided sufficient data to calculate new input coefficients for 12 categories of material inputs and for labor for each of the 14 improvement types. (Note that while 13 input categories may seem a small proportion of the possible 498 coefficients, they in all cases sum to more than .5, which means they account for at least one half of total expenditures.)

Figures 1 thorough 6 show the calculated values of the I-O coefficients for labor and a sample of important commodity inputs. They illustrate that there is significant variation across improvement types. Figure 1 shows that the coefficient for the most labor intensive improvement type (13: environment related) is about 45% higher than that of the least labor intensive type (6: restoration / rehabilitation). Variations in the coefficients for material inputs are much greater. For example, Figures 4 and 6 indicate that widening, restoration, and resurfacing projects have much higher than average coefficients for bituminous inputs while new road construction, new bridge construction, and environment related projects have higher than average coefficients for structural steel.

The highest coefficient exceeds the lowest coefficient by a factor of 2.1 for petroleum products, 12.7 for cement, 9.1 for bituminous materials, 6.0 for ready-mix concrete and 40 for structural steel. This is ample evidence of the variability of input structures within highway construction and thus the benefits of conducting analysis at the level of detailed improvement types.

To identify the indirect economic effects of highway construction projects, the matrix of technical coefficients (**A**) from the Transportation Satellite Accounts (TSA) was used as a base, or reference, case. A new matrix was then created for each improvement type by substituting the calculated technical coefficients for the corresponding TSA coefficients. For consistency, remaining coefficients were adjusted by a scalar multiplier term, such that the sum of all input coefficients for road construction was one. By this means, fourteen **A** matrices, corresponding to the fourteen highway improvement types, were created. In order to estimate direct and indirect output effects, the $(\mathbf{I} - \mathbf{A})^{-1}$ matrix for each improvement type was multiplied by a vector of final demand in which every commodity other than highway construction was set to zero and demand for highway construction was set to one million dollars (see equation 9).

This yielded column vectors of the dollar values of all commodities used (directly and indirectly) to produce one million dollars' worth of each type of highway improvement. The column sums, representing the total output effect, are shown in Table 4. In general, the output multipliers based on the calculated coefficients are higher than for the default (TSA) coefficients. Also, there is significant variation in the multiplier effects across improvement types. For example, the output multiplier for minor widening is 16% higher than for environment related.

In order to calculate the *direct* employment effect the labor coefficient for each improvement type was multiplied by one million dollars. This yields the total dollar value (per million dollars of construction costs) of compensation to workers employed by the construction project.

To calculate total (direct plus indirect) employment effects, the vector of the dollar values of all commodities used (directly and indirectly) to produce one million dollars' worth of each type of highway improvement, was multiplied by the vector of labor coefficients for each commodity-producing industry (equation 7). This is the total dollar value of employment generated from one million dollars' worth of investment in the various types of highway improvement projects. Employment income effects by highway improvement type are shown in Table 5.

The total employment generation per million dollars of expenditure for the individual improvement types is generally lower than for the reference case, with the exception of 13: environment related, which is higher. There is significant variation across types. For example, 13: environment related generates about 10% more direct and indirect employment income than 5: minor widening.

The number of person-years of employment per payroll dollar was calculated from the 1997 Economic Census at the 2-digit and, in the case of manufacturing, 3-digit level. Based on this information, a vector of person-years generated per payroll dollar for each TSA industry code was created. These were multiplied by the dollars spent in each industry on employee compensation generated directly and indirectly from one million dollars' worth of highway improvements, yielding the number of person-years of employment generated by 1 million dollars invested in each highway improvement type. The total number of person-years per one million dollars' highway construction investment is presented in table 6.

Here again the employment effect is slightly lower for the individual improvement types than for the reference case. The gap between the highest and lowest improvement types (13 and 5 respectively) is about 12%.

CONCLUSIONS

The results indicate that there are significant (if not dramatic) variations across improvement types in the employment generation impacts of one million dollars of construction expenditure. This information makes it possible to make projections of aggregate employment impacts of federal-aid programs at the national or state level while taking account of changes in the distribution of funds across improvement types over time and variations in the types of construction expenditures across regions. Thus, the analytical framework described in this paper is appropriate for making a variety of estimates that are important from a policy perspective. These include:

- Estimates of the total number of jobs generated and employment income earned as a result of each year's federal highway grants. Using the model it will be possible to account for variations from year to year arising not only from changes in expenditure levels but also from changes in the distribution of funds across different types of highway improvement.
- Estimates of employment generation for individual highway projects. This will be of particular interest to state and local governments who will want to know how major projects should be factored into regional employment projections.
- Industry-by-industry breakdown of estimates of output and employment generated by one or more projects. This will be of particular interest to representatives of industrial and labor groups who want to know how federally funded highway construction activity affects their members.

We plan in the near future to extend this line of research in a number of fruitful directions. We hope to make more comprehensive estimates of the role of road construction in the economy by extending the database to include nonfederal-aid road construction projects.

Also, employment and other inputs required for highway construction may run into supply constraints, which are not addressed in our model. This is an issue of increasing policy importance in the current economic environment of high industrial capacity utilization and concern over inflationary pressures. We therefore plan to extend the modeling framework to incorporate supply-side effects.

ACKNOWLEGEMENTS

The research described here was conducted in cooperation with the Federal Highway Administration Office of Transportation Policy Studies. Arthur Jacoby of that office provided valuable support and advice.

REFERENCES

(1) Lawson, Anne M. (1997a) Benchmark Input-Output Accounts for the U.S. Economy, 1992: Make, Use, and Supplementary Tables, *Survey of Current Business,* November.

(2) Lawson, Anne M. (1997b) Benchmark Input-Output Accounts for the U.S. Economy, 1992: Requirements Tables, *Survey of Current Business,* December.

(3) Fang, Bingsong, Xiaoli Han, Ann M. Lawson, and Sherlene K.S. Lum (1998) U.S. Transportation Satellite Accounts for 1992, *Survey of Current Business,* April.

(4) Apogee Research Inc. (1995) FHWA Direct Employment Impacts: A Quantitative Analysis, prepared for the Federal Highway Administration.

FIGURE 1 I-O Coefficients: Labor

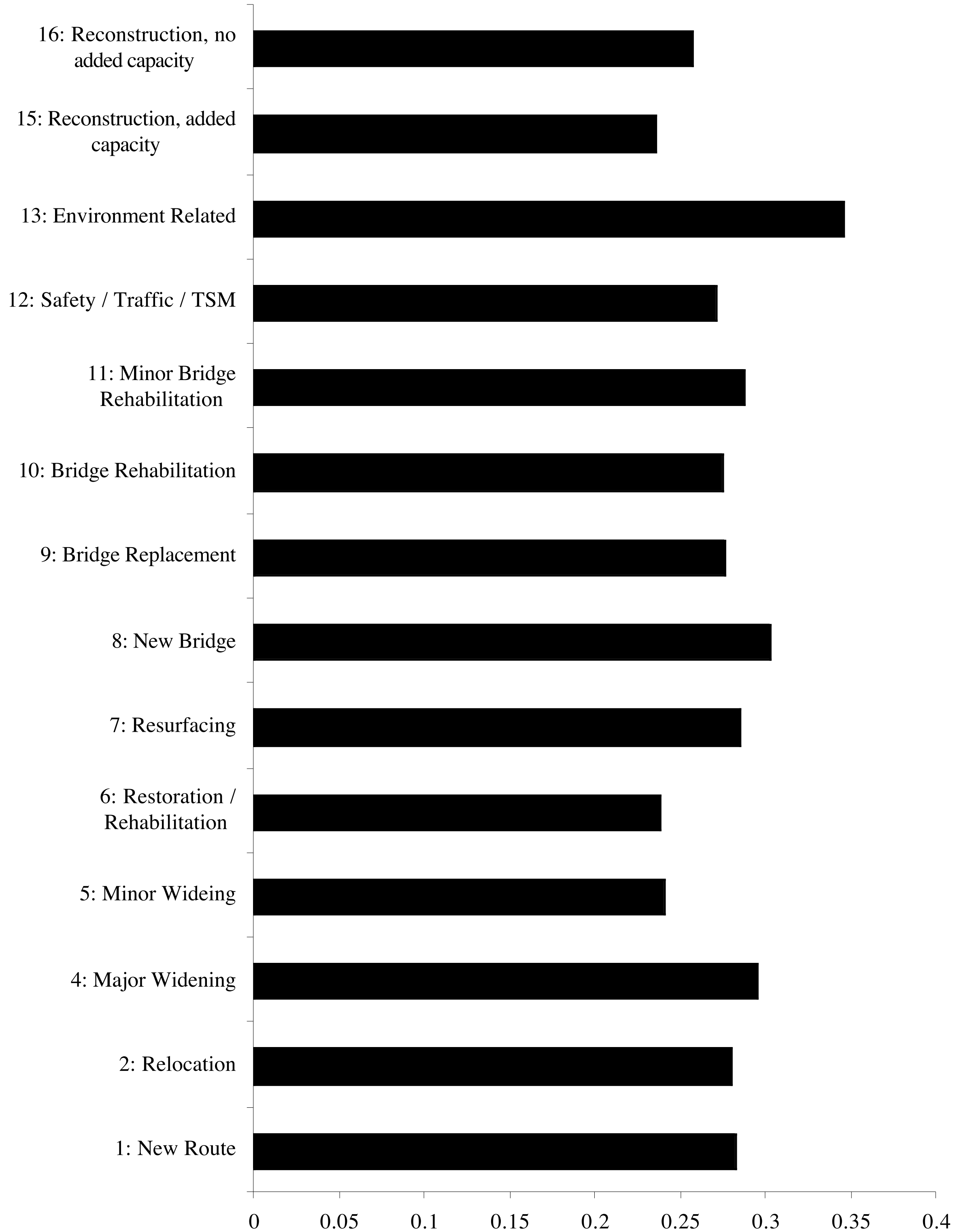

FIGURE 2 I-O Coefficients: Petroleum Products

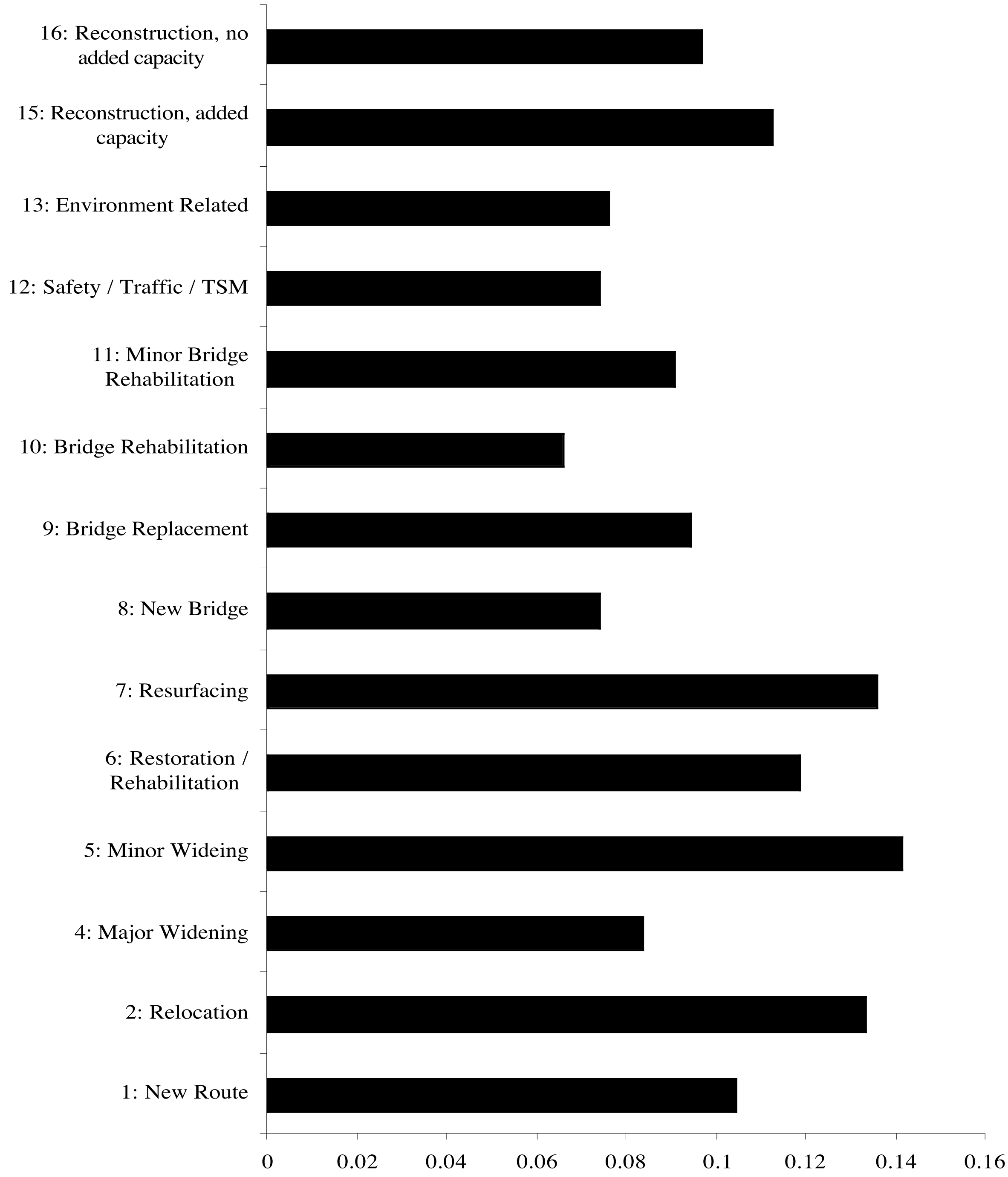

FIGURE 3 I-O Coefficients: Cement

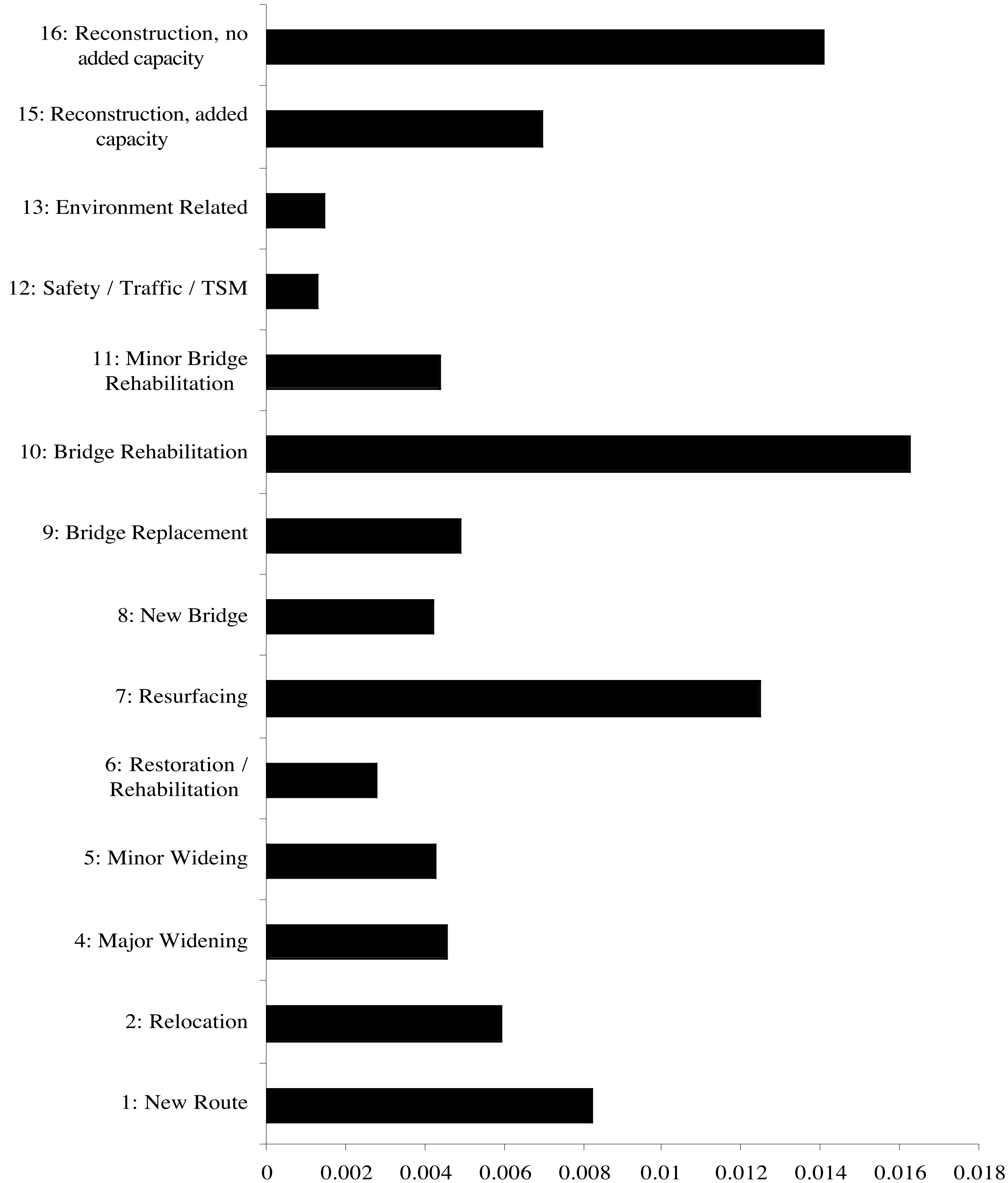

FIGURE 4 I-O Coefficients: Bituminous Materials

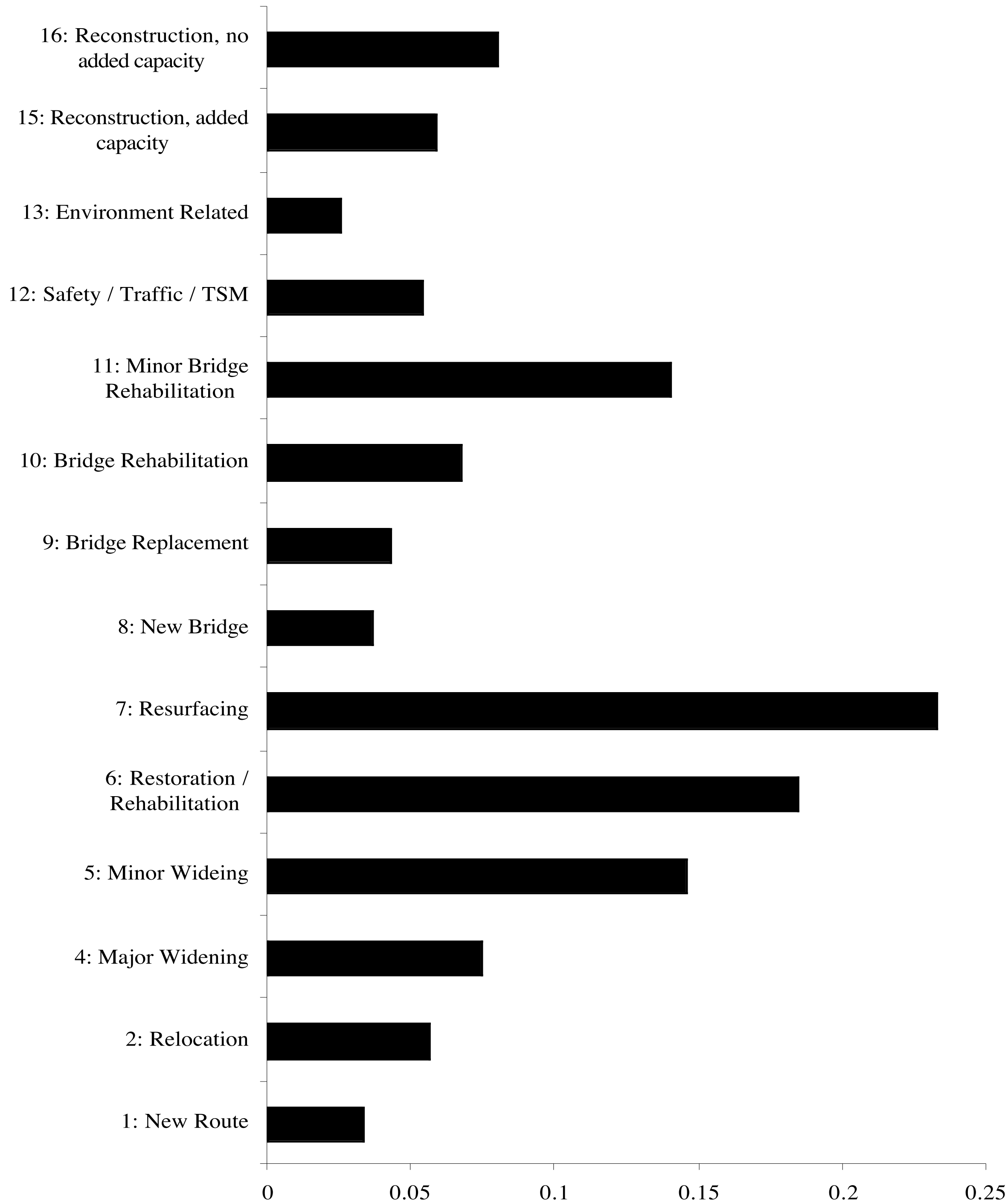

FIGURE 5 I-O Coefficients: Ready-Mix Concrete

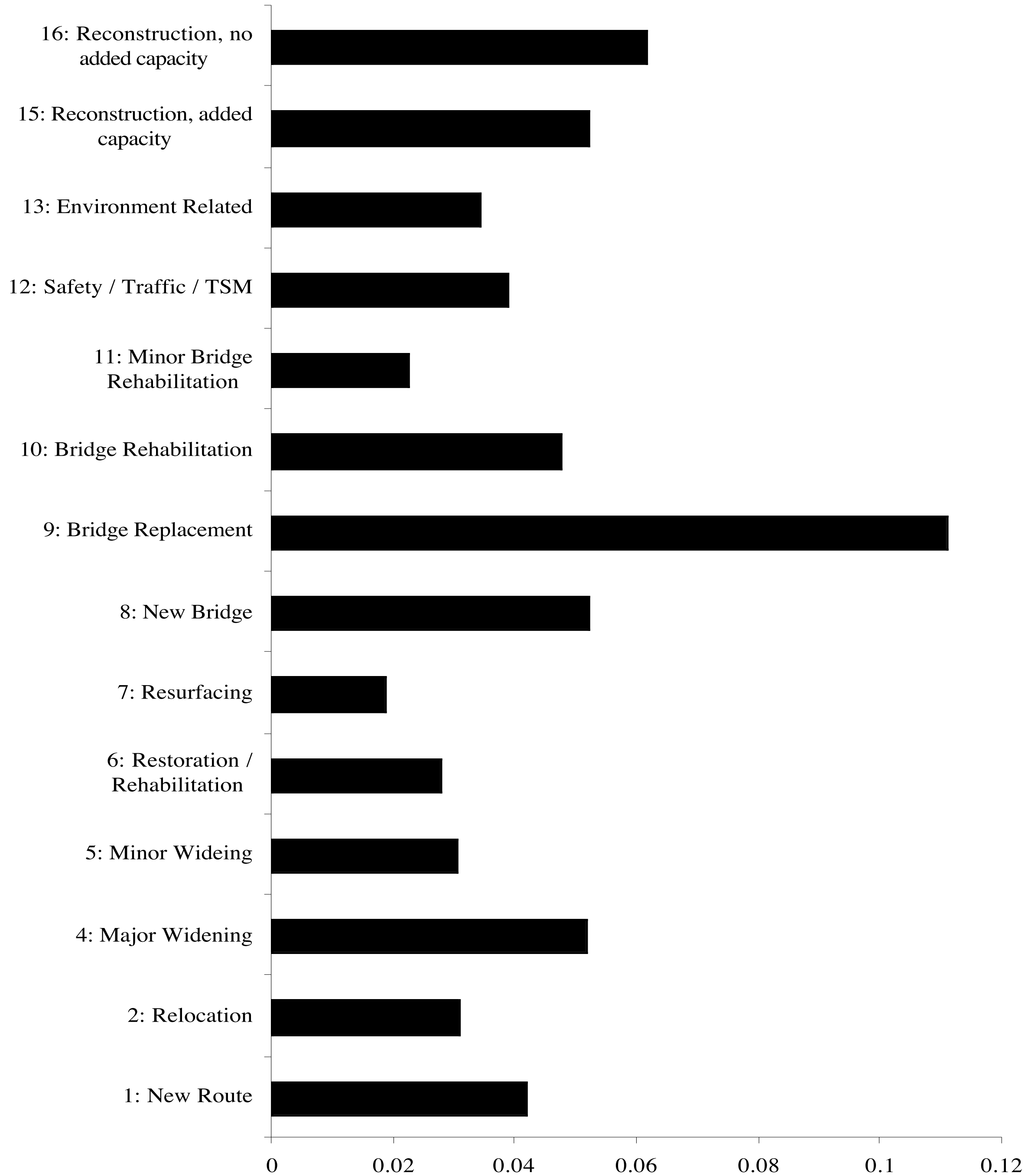

FIGURE 6 I-O Coefficients: Structural Steel

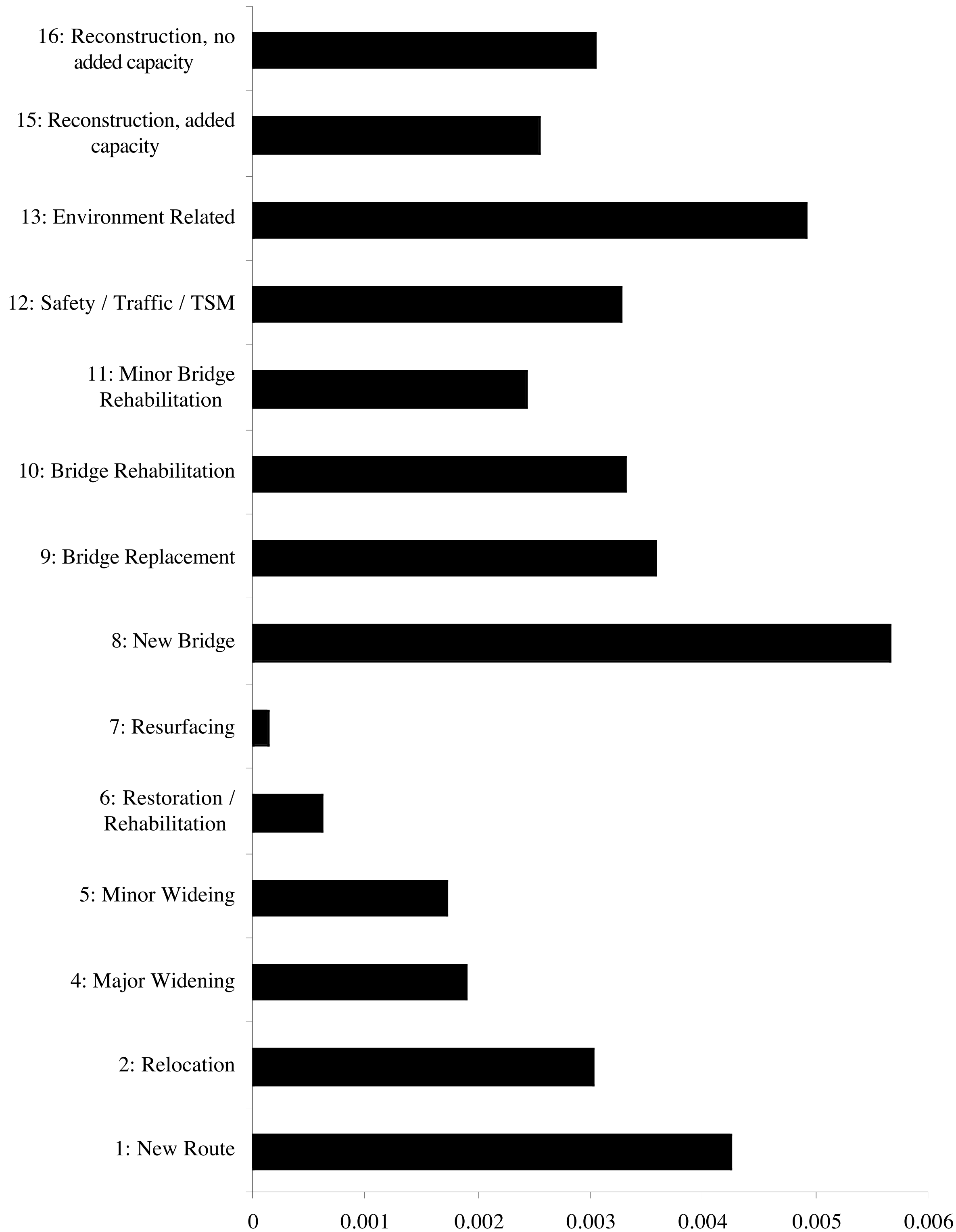

TABLE 1: Categories of Material and Supplies Identified in From FHWA-47.

Category	Reporting Units
Petroleum products	gallons
Cement	barrels of pounds
Aggregates purchased	tons or cubic yards
Bituminous materials	gallons
Lumber	thousands of board feet
Reinforcing steel	pounds
Structural steel	pounds
Ready-mix concrete	cubic yards
Premixed bituminous paving material	tons
Aggregates produced	tons or cubic yards
Miscellaneous steel	pounds
Noise barriers	linear feet
Guardrail	linear feet
Bridge rail	linear feet
Final contract amount for signs	dollars
Final contract amount for lighting	dollars
Final contract amount for traffic signs	dollars

TABLE 2: Construction Improvement Types Codes

Code	Improvement Type
01	New Route (New Construction)
02	Relocation
04	Major Widening
05	Minor Widening
06	Restoration/Rehabilitation
07	Resurfacing
08	New Bridge
09	Bridge Replacement
10	Bridge Rehabilitation
11	Minor Bridge Rehabilitation, Bridge Deck Overlay
12	Safety/Traffic/TSM
13	Environment Related
14	Bridge Program Special Action (Inventory / Inspection / Classification)
15	Reconstruction with Added Capacity (adding lanes especially for HOV lanes)
16	Reconstruction with No Added Capacity

TABLE 3: Sources for Commodity Price Data

Material Input	Source of Price Information	Year
Petroleum Products (#2Diesel Fuel)	DOE Energy Information Agency for prices / American Petroleum Institute for federal and state tax estimates	All
Cement	DOI Bureau of Mines	1990
Aggregates (Sand & Gravel)	DOI Bureau of Mines	1990
Aggregates (Crushed Stone)	DOI Bureau of Mines	1990
Bituminous Paving Materials	Engineering News-Record	2000
Ready-Mix Concrete	Engineering News-Record	2000
Lumber	Cahners Business Information (Purchasing Magazine)	1997
Reinforced Steel	Cahners Business Information (Purchasing Magazine)	1997
Structural Steel	Cahners Business Information (Purchasing Magazine)	1997

TABLE 4: Dollar Value of Output Generated per One Million Dollar Highway Investment: Matched U.S. Observations

	Dollar Value of Output Generated per $1M Highway Investment	Ratio of Output Value to Highway Investment Value
Default	$2,169,105	2.17
1. New Route	$2,271,428	2.27
2. Relocation	$2,321,191	2.32
4. Major Widening	$2,280,799	2.28
5. Minor Widening	$2,465,920	2.47
6. Restoration/Rehab	$2,464,060	2.46
7. Resurfacing	$2,463,166	2.46
8. New Bridge	$2,214,727	2.21
9. Bridge Replace	$2,334,581	2.33
10. Bridge Rehab	$2,277,814	2.28
11. Minor Bridge Rehab	$2,316,482	2.32
12. Safety/Traffic/TSM	$2,278,221	2.28
13. Environment Related	$2,128,438	2.13
15. Reconstruction with Added Capacity	$2,381,975	2.38
16. Reconstruction with No Add Capacity	$2,365,797	2.37

TABLE 5: Direct and Indirect Employment Income per One Million Dollars Highway Investment: Matched U.S. Observations

	Direct Employment Income ($)	Total (Direct+Indirect) Employment Income ($)	Total / Direct Employment Income
TSA (Reference Case)	295,079	658,880	2.23
1. New Route	282,327	632,533	2.24
2. Relocation	279,132	624,498	2.24
4. Major Widening	294,356	644,457	2.19
5. Minor Widening	240,500	604,305	2.51
6. Restoration/Rehab	238,316	605,434	2.54
7. Resurfacing	284,325	624,964	2.20
8. New Bridge	302,931	648,450	2.14
9. Bridge Replace	275,697	638,501	2.32
10. Bridge Rehab	275,184	636,367	2.31
11. Minor Bridge Rehab	287,311	634,164	2.21
12. Safety/Traffic/TSM	271,108	635,856	2.35
13. Environment Related	345,113	667,716	1.93
15. Reconstr Add Capac	235,560	609,318	2.59
16. Reconstr No Add Cap	256,489	623,428	2.43

TABLE 6: Person-Years of Employment Generated per One Million Dollars Highway Investment: Matched U.S. Observations

	Person-Years
TSA (Reference Case)	20.3639
1. New Route	19.4915
2. Relocation	19.0900
4. Major Widening	19.7675
5. Minor Widening	18.2914
6. Restoration/Rehab	18.3032
7. Resurfacing	18.6180
8. New Bridge	20.0179
9. Bridge Replace	19.6831
10. Bridge Rehab	19.6527
11. Minor Bridge Rehab	19.2774
12. Safety/Traffic/TSM	19.6134
13. Environment Related	20.5467
15. Reconstr Add Capac	18.7851
16. Reconstr No Add Cap	19.1476