

Interindustry Analysis

INTRODUCTION

This Appendix presents the computational procedure used in the calculation of the employment generated per \$1 million of production in four industries (Public Transit, Bus Manufacturing, Rail Car Manufacturing, and Rapid Transit Construction) as reported in chapter VI.

Basically the procedure involved the calculation of the total employment generated by the production of goods and services by the industries. Total employment includes not only the employment in the industry itself but also the multiplier effect, which includes jobs in industries directly supplying the main industry plus the suppliers of the suppliers, as well as jobs created by the expenditure of wages and salaries. This analysis separately calculated the employment generated in the main industry, the direct supplying industries and the indirect supplying industries.

No published data is available which would show the employment multiplier generated by the four main industries of interest here:

1. The Public Transit Industry
2. The Bus Manufacturing Industry
3. The Rail Car Manufacturing Industry
4. The Rapid Transit Construction Industry

However, the Input-Output Structure of the U.S. Economy: 1967¹ presents information on the multiplier in terms of value of production rather than employees. The basic task of this analysis has been the conversion of the dollar values of production attributable to the four industries into employees.

The Input-Output (1/0) Tables divide the whole U.S. economy into 367 industries. The industries most closely resembling the four industries investigated here are:

- 11.03 New Construction, Public Utilities approximating Rapid Transit Construction.

- 59.03 Motor Vehicles and Parts approximating Bus Manufacturing
- 61.04 Railroad and Street Cars approximating Rapid Transit Cars
- 79.01 Local Government Passenger Transit approximating Public Transit

Although the industries as defined for the Input/Output Tables do not correspond exactly to the transit industry and its major capital goods suppliers, the distribution of material purchases of these industries is approximately the same. For example, the Input/Output industry "Railroad and Street Cars" uses approximately the same proportion of steel, iron, plastics, wages, salaries, etc. as the rapid transit car manufacturers, such as Rohr and Pullman. Thus, both industries will purchase from the same industries and generate the same amount of employment per dollar of production.

The 1/0 Tables are printed in three volumes; the first and third volumes were used in this analysis. The first volume, "Transactions Data for Detailed Industries" records the purchases and sales of every industry to every other industry in 1967. The total of all purchases by an industry (inputs) plus the value added in production (labor, profit, interest, etc.) equals the production or total output of the industry. For example, the Public Transit Industry (79.01) made purchases of \$1.4 million from the Industrial Controls Industry (53.05) in 1967. The transit industry's direct purchases from other industries, totaled \$333.7 million. These purchases combined with a value added (wages, salaries, taxes, profit, etc.) of \$640.5 million equals a total output of **\$974.2** million for the Local Government Passenger Transit Industry in 1967. The purchases by the transit industry create employment in the direct supplier industries which is part of the employment generated as a result of the existence of the transit industry. The calculation of the amount of employment which can be credited to the transit industry and the other three industries is explained in detail in the following section entitled "Direct Employment Generated."

¹U.S. Department of Commerce, BEA, 1975

The third volume of the 1/0 Tables "Total Requirements for Detailed Industries" lists the amount of output required both directly and indirectly from each industry for a dollar of final output by each other industry. Thus every dollar of final output by the Railroad and Street Car Industry (61.04) is responsible for direct and indirect purchases from the Blast Furnaces and Basic Steel Products Industry (37.01) of 31.662\$. Since these values in Volume III include both direct and indirect purchases, the summation of the requirements (direct and indirect purchases from each industry) will equal the multiplier. The summation of the direct and indirect requirements (from Volume 111) for the four industries is listed below,

<u>Industry</u>	<u>Multiplier</u>
11.03 New Construction, Public Utilities	2.36
59.03 Motor Vehicles and Parts	2.61
61.04 Railroad and Street Cars	2.60
79.01 Local Government Passenger Transit	1.67

Thus, one dollar of final output in the Motor Vehicle Industry requires total output of \$2.61 from the total of all industries when direct and indirect purchases are summed. It should be cautioned that the multiplier shown here is expressed in dollars, not jobs. The number of jobs generated per dollar of output varies greatly from industry to industry, and thus employment and dollar value of output cannot be assumed to be closely related.

By multiplying the multiplier by the final industry output, the total requirements (both direct and indirect) can be calculated for each industry. Thus, for Public Transit the total requirements equal: 1.67 X \$974.2 million = \$1,624.8 million. If the final output of the transit industry itself and the direct requirements are subtracted from total requirements, only the indirect requirements remain. The calculation of the employment generated by the indirect requirements of each of the four industries is contained in a section below entitled "Indirect Employment Generated."

The employment calculations for main industry itself in the production of its final output is contained below in "Main Industry Employment."

The summation of the indirect, direct, and main industry employment equals the total employment generated by each industry. This employment and the calculation of the total employment generated

per \$1 million of production is in the last section of this appendix.

Direct Employment Generated

This section explains the procedure used to calculate the employment generated by the direct purchases of the four industries examined here. Four steps were required: 1) calculation of percent of the direct supplying industry's output generated by the four industries; 2) determination of the total employment in the direct supplying industries; 3) calculation of the employment generated in the direct supplying industries by the four industries; and 4) summation of the direct employment generated.

Step 1:

It was assumed that the proportion of purchases by the four industries to total output of direct supplying industries would be equal to the proportion of employment attributable to these purchases to total employment in the direct supplying industries. Thus, according to Volume I of the 1/0 Tables the Railroad and Street Cars Industry (**61.04**) directly purchased \$312.8 million of the total output of \$25,155.9 million of the Blast Furnaces and Basic Steel Product Industry (37.01), or 1,243 percent. Thus, 1.243 percent of the employment in the Blast Furnaces and Basic Steel Products Industry is generated by the purchases of the Railroad and Street Car Industry. These percentages were calculated for every direct purchase made by the four industries investigated in this study.

Step 2:

The next step was to calculate the total employment for each of the direct supplying industries, so that the percentages (described in the previous paragraph) could be applied. Application of the percentages was the final step in calculating the direct employment generated by the four industries.

The Bureau of Economic Analysis (BEA), the same group which produces the 1/0 Tables, also produced employment figures which are internally consistent with 1/0 data. Unfortunately these employment figures are for 2-digit Standard Industrial Classification (SIC) industries, and most of the 1/0 industries correspond to 4-digit SIC's,

Four-digit SIC industries employment data for 1967 is available from the Census of Manufacturers

prepared by the Bureau of the Census. These data contain the number of employees in each of the 4-digit and 2-digit SIC industries in 1967.

In order to maintain internal consistency it was necessary to use the 2-digit BEA employment figures as control totals. These totals were divided among the 4-digit SIC's by using the relationships of the Census of Manufacturers (CM) 4-digit employment to 2-digit employment,

$$\frac{\text{CM 4-digit SIC Employment}}{\text{CM 2-digit SIC Employment}} = \frac{\text{BEA 4-digit SIC Employment}}{\text{BEA 2-digit SIC Employment}}$$

Thus, the **1967 total** employment in SIC 33 (Primary Metal Industries) is 1,281,000 according to the Census of Manufacturing (CM) and 1,326,000 according to the BEA. 1/0 industry 37.01 "Blast Furnaces and Basic Steel Products" is made up of SIC's **3312, 3313, 3315, 3316,** and 3317 with a combined employment of 617,300 according to the CM. This employment is 48.19 percent of the Census of Manufacturing 2-digit total (1,281,000). 48.19 percent of BEA's 2-digit SIC employment is 638,999 which is the total employment used for 1/0 industry 37.01 "Blast Furnaces and Basic Steel Products" in this analysis.

Total employment for most of the direct supplier industries was calculated in this manner. In some industries for which 4-digit employment was not available, it was necessary to calculate employment by using the value added of the 1/0 industry. This procedure is described below in the calculation of main industry employment.

Thus, total employment in each of the direct supplying industries was calculated in a manner internally consistent with the 1/0 data.

Step 3:

The number of employees generated in each of the direct supplying industries by purchases made by the four industries was calculated by multiplying the percentage developed in Step One by the employment developed in Step Two. For example, the Railroad and Street Car Industry (61.04) purchases 1.243 percent of the output of the Blast Furnaces and Basic Steel Products Industry (37.01). Thus, of the 638,999 total employees in the Blast Furnaces Basic Steel Products Industry, 7,943 or 1.243 percent are employed due to Railroad and Street Car direct purchases.

The number of employees in each of the direct supplier industries attributable to purchases made

by each of the four industries was calculated in this manner.

Step 4:

Employees generated by direct purchases of the four industries was totaled, resulting in the following direct employment estimates:

Industry	Direct Supplier Employment Generated
New Construction, Public Utilities	243,046
Motor Vehicles and Parts	944,116
Railroad and Street Cars	41,736
Local Government Passenger Transit	11,798

Because the four industries vary greatly in size, and thus in employment generated it is necessary to reduce the industries to a common unit for valid comparisons. Therefore, by dividing the employment figures by the output of their generating industry, the following number of direct employees per \$1 million of output is calculated:

Industry	Direct Supplier Employment Generated per \$1 million output in 1967
New Construction, Public Utilities	22.3
Motor Vehicles and Parts	23.5
Railroad and Street Cars	23.4
Local Government Public Transit	12.1

Indirect Employment Generated

The calculation of the indirect employment generated was a simple process requiring only three steps: 1) calculate total requirements for the four industries; 2) calculate indirect requirements by subtracting direct requirements and total output from total requirements; and 3) calculate indirect employment generated using national averages for employee compensation, etc.

Step 1:

As described in the introduction, the summation of the total requirements for each industry (as contained in Volume III of the 1/0 Tables) produced a multiplier. This multiplier indicates the number of dollars of total production required to produce one dollar of output in each industry. The total requirements for an industry equal the multiplier times the

total output (in dollars) of the industry. The calculation of total requirements for the four industries is shown in columns 1, 2, and 3 in Table 49.

Step 2:

The total indirect requirements for the four industries is calculated by subtracting the direct requirements and total output for each industry from the total requirements, as shown in columns 3, 4, 5, 6, and 7 of Table 49. Total output and the direct requirements are taken from Volume I of the I/O Tables.

Step 3:

The indirect requirements for each of the four industries come from a wide range of supplier industries, with no one industry or group of industries dominating the indirect inputs. Rather than calculate the employment generated in each of the indirect supplying industries, it was felt that employment generated in the indirect supplying industries as a whole should be calculated.

It is felt that the indirect suppliers as a whole closely resemble the national economy, thus justifying the use of national figures to calculate employment.

In 1967, 59.23 percent of the GNP (or national output) was in the form of employee compensation. Of employee compensation, 90.55 percent is wages and salaries. By assuming that these same percentages apply to the total indirect requirements of the four industries, the amount of wages and salaries

can be calculated. Then by dividing the wages and salaries by the 1967 average wage and salary (\$6,230) the number of employees is computed. This is shown in Table 50.

The amount of indirect employment generated per million dollars of output for the four industries is shown below:

Industry	Indirect Employment generated by \$1 million output in 1967
New Construction, Public Utilities	63.7
Motor Vehicles and Parts	78.7
Railroad and Street Cars	75.3
Local Government Passenger Transit	28.0

Main Industry Employment

The final component of the employment generated by the four industries is in the industry itself. Since the employment in the main industry is a large proportion of total employment, it is very important to calculate the employment in the same manner for each industry, or to use the same source for the employment estimates, thereby retaining the comparability of the employment estimates between industries.

The Census of Manufacturers (CM) 4-digit SIC employment estimates did not include either the Local Government Passenger Transit or New Construction, Public Utilities Industries. Other employment estimates from groups such as trade organizations were not generated in the same manner as the CM estimates. In addition, many of the trade groups

**TABLE 49
CALCULATION OF INDIRECT REQUIREMENTS
(\$million 1967)**

	Final output (1)	x	Multiplier (2)	=	Total reqmts (3)	less	Total output (4)	-	Direct and in- direct reqmts. (5)	less	Direct reqmts (6)	·	Indirect reqmta. (7)
New Construction Public Utilities	10,919.0	x	2.36179	=	25,768.4	-	10,919.0	-	14,669.4	-	6,790.9	·	\$8,0785
Motor Vehicles and Parts	42,316.5	x	260912	=	110,4088	-	42,316.5	-	68,0923	-	29,3932	·	\$38,705.2
Railroad and Street Cars	1,786.6	x	259748	=	4,640.6	-	1,7666	-	2,854.0	-	1,2924	·	\$1,5616
Local Government Public Transit	9742	x	1.66779	=	1,624.8	-	974.2	-	650.6	-	3337	·	\$3169

SOURCE System Design Concepts, Inc, using Input/Output Structure of the U. S Economy 1967

TABLE 50
COMPUTATION OF INDIRECT EMPLOYMENT

	Indirect Requirements (\$millions) (1)	Employee Compensation 59.230/o of (1) (2)	Wages and Salaries 90.550/0 of (2) (3)	1967 Average Wage and Salary (4)	Indirect Employment (3) / (4) (5)
New Construc- tion, Public Utilities	\$8,078.57	\$4,784.9	\$4,332.7	\$6,230	695,464
Motor Vehicles and Parts	38,705.2	22,925.1	20,758.7	6,230	3,332,050
Railroad and Street Cars	1,561.6	924.9	837.5	6,230	134,435
Local Govern- ment Public Transit	316.9	187.7	169.9	6,230	27,278

SOURCE: System Design Concepts, Inc.

did not define the industries in the same manner as the 1/0 Tables did. For example, the American Public Transit Association compiles employment estimates for the entire public transit industry, but does not list separately the employees in local government-owned public transit systems to conform with the 1/0 definition.

The only source of employment data which would include the four industries is the BEA, which publishes employment estimates in the July issues of the *Survey of Current Business*. Unfortunately these estimates are for 2-digit 1/0 Industries or combinations of 2-digit 1/0 Industries. Two-digit 1/0 Industries are made up of several 4-digit 1/0 Industries. In order to use this data it was necessary to break down these employment figures into the 4-digit industries examined in this study. It was assumed that the 4-digit industry's employment was the same percentage of 2-digit employment as the 4-digit industry's percentage of 2-digit Value Added. This is the same procedure used in "Direct Employment Generated" for those industries not listed in the CM. The calculation is explained below for three of the four industries: 1) New Construction, Public Utilities (11.03), 2) Motor Vehicles and Parts (59.03), and 3) Railroad and Street Cars (61.04). Local Government Passenger Transit (79.01) required additional calculations, as explained in that section below,

New Construction, Public Utilities (11.03)

This 4-digit 1/0 Industry is included in the BEA employment calculation of the Contract Construction Industry, which includes two 2-digit 1/0 Industries: "New Construction" (11) and "Maintenance and Repair Construction" (12). In 1967, the Contract Construction Industry had 3,268,000 employed and a Value Added of \$45,475.3 million.²

New Construction, Public Utilities (11.03) had a 1967 Value Added of \$4,128.1 million,³ or 9.0 percent of the total Value Added of the whole Contract Construction Industry. If we assume the employment share is the same, the New Construction, Public Utilities Industry had 328,617 employees in 1967. This is the employment figure used in this analysis. For each \$1 million of output 30.1 jobs are created in the main industry alone.

Motor Vehicles and Parts (59.03)

This 4-digit 1/0 Industry is included in the BEA employment estimate for Motor Vehicles and Equipment (59), which (according to the same sources noted above) had a 1967 employment of

¹*Survey of Current Business*, July 1969.

²BEA, *Input-Output Structure of the U.S. Economy*, Vol. 1.

³*Ibid.*

832,000 and a Value Added of \$13,397.5 million. Of this Value Added \$12,923.3 million or 96.5 percent was from the Motor Vehicles and Parts (59.03). The same percentage employment equals 802,547 jobs or 19.0 per \$1 million of output.

Railroad and Street Cars (61.04)

This 4-digit 1/0 Industry is included in the BEA employment estimate for Transportation Equipment and Ordnance, except Motor Vehicles which is made up of three 2-digit 1/0 Industries: 1) Ordnance and Accessories (13), 2) Aircraft and Parts (60) and, 3) Other Transportation Equipment (**61**). In 1967, these 2-digit 1/0 industries combined had 1,458,000 employees and generated \$17,219.7 million in Value Added.

The Railroad and Street Car Industry (61.04) had a Value Added of \$94.2 million or 2.24 percent of total. The same percentage of employees equals 32,634 or 18.3 per \$1 million of output in 1967.

Local Government Passenger Transit

This 4-digit 1/0 Industry is included in State and Local Government Enterprises (79) for which BEA has estimated employment. This 2-digit 1/0 Industry (State and Local Government Enterprises) is made up of three 4-digit 1/0 industries: 1) Local Government Passenger Transit (79.01), 2) State and Local Electric Utilities (**79.02**), and 3) Other State and Local Government Enterprises (79.03), Other State and Local Government Enterprises which dominate the 2-digit industry include such things as water and sewer works and stadium management, etc.

Unlike the construction, motor vehicle and railroad car industries (discussed above) which are included in 2-digit industry made up of similar industries, Passenger Transit is combined with very different 4-digit 1/0 industries. The existence of these dissimilar industries in the 2-digit 1/0 industry BEA **employment** estimate diminish the probability that these estimates would accurately reflect the passenger transit industry which had only 10.1 percent of the total output of the 2-digit industry,

It was thus necessary to use another source for employment in the Local Government Passenger Transit Industry, The American Public Transit Association's (APTA) Transit Fact Book contains financial and employment information for the

whole transit industry, but does not list the public and private operations separately.

In spite of this inconsistency with 1/0 data, it was decided that the APTA data was compatible with the 1/0 data for two reasons, First, the BEA relied upon APTA data in preparing their 1/0 Tables. Second, employee compensation as a percentage of total output were very similar for APTA and 1/0 data,

It was assumed that the value added share of total output in the Local Government Passenger Transit Industry was nearly all employee compensation. The 1/0 Tables indicate that Value Added is **65.7** percent of total output of the industry. APTA figures indicate an amazingly similar percent. According to the Transit Fact Book, in 1967 employee compensation was equal to 65.0 percent of operating revenues plus deficit (assumed to equal total output). The similarity of these percentages tend to indicate that APTA and 1/0 data are compatible, and for the purposes of this analysis, were assumed to be interchangeable.

In order to calculate the number of employees in the Local Government Passenger Transit Industry the average employee compensation (\$7,222/year from APTA) was divided into total industry employee compensation. The total Local Government Passenger Transit Industry's employee compensation was assumed to equal the entire Value Added (from the 1/0 Tables) less the 1967 industry deficit (from APTA) or \$573.9 million. By this procedure it was estimated that 79,470 employees were in the industry or 81.6 per \$1 million of total output.

Total Employment Generated Per \$1 Million Output

The total employment for each industry in 1967 is below:

<u>Industry</u>	<u>Total employment generated per \$ million output in 1967</u>
New Construction, Public Utilities	116.0
Motor Vehicle and Parts	121.2
Railroad and Street Cars	116.9
Local Government Passenger Transit	121.7

In order to express the employment in terms of 1974's dollars, the GNP Deflator was used, The employment per \$1 million in 1974 is listed in table 51.

TABLE 51
EMPLOYMENT GENERATED PER MILLION 1974 DOLLARS

<u>Industry</u>	<u>Employment Generated Per \$1 Million in 1974</u>			
	<u>Main Industry</u>	<u>Direct</u>	<u>Indirect</u>	<u>Total</u>
New Construction, Public Utilities	20.6	15.2	43.5	79.4
Motor Vehicles and Parts	13.0	16.1	53.8	82.9
Railroad and Street Cars	12.5	16.0	51.4	79.9
Local Government Passenger Transit	55.8	8.3	19.1	83.2

Source: System Design Concepts, Inc.