Hybrid Approach to Estimating Economic Impacts Using the Regional Input-Output Modeling System (RIMS II)

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A hybrid approach for estimating economic inpacts uses survey information on the direct output effects in conjunction with Regional Input-Output Modeling System (RIMS II) multipliers. The approach is demonstrated using hypothetical direct coefficients and multipliers. The increased accuracy of the approach is then assessed by comparing survey and nonsurvey impacts estimated for two states. As an example, the hybrid RIMS II approach is applied to the impacts of a General Electric plant in the Charlottesville, Virginia, Metropolitan Statistical Area.

Effective planning for public- and private-sector projects at the state and local levels requires systematic analysis of the economic impacts of these projects on affected regions. This analysis, in turn, must take into account interindustry relationships within regions because these relationships largely determine regional responses to project changes. Regional input-output (I-O) models, which reflect such relationships, are a useful tool for regional economic impact analysis.

Most regional I-O models use an accounting framework called an I-O table, which shows inputs purchased and outputs sold for each industry. Direct requirements coefficients, which show the inputs of goods and services required to produce $1.00 of output, can be estimated from an I-O table and are the basis for deriving I-O multipliers. I-O multipliers show the regional economic impact that would result from a $1.00 change in the output delivered to final demand (i.e., to ultimate purchasers, such as consumers outside the region) by a given industry. Comprehensive discussions of I-O multipliers are provided by Miernyk (*1*), Miller and Blair (*2*), Richardson (*3*), and Schaffer (*4*).

I-O tables have previously been constructed by surveying regional firms to determine their inputs and outputs. However, time and cost are major obstacles. For example, Glickman (*5*) notes that approximately $250,000 was expended over a 5-year period for the collection and processing of data in a 1958 I-O study of 500 industries conducted in Philadelphia.

The time and cost disadvantages of survey-based models have been largely overcome by nonsurvey models, which typically use direct requirements coefficients for the nation as a basis for estimating industry relationships in a region. However, comparisons of nonsurvey and survey models have generally indicated that the advantages of nonsurvey models are gained at the expense of a loss in multiplier accuracy. This result has spawned a well-documented debate over the relative costs and benefits of the two approaches. A discussion of selected nonsurvey models is provided by Brucker et al. (*6*).

In the mid-1970s, the Bureau of Economic Analysis (BEA) developed a nonsurvey method known as RIMS (Regional Industrial Multiplier System) for estimating regional I-O multipliers, that was based on the work of Garnick (*7*) and Drake (*8*). More recently, BEA completed an enhancement of RIMS known as RIMS II (Regional Input-Output Modeling System) (*9,10*). In RIMS II, direct requirements coefficients are derived mainly from two data sources: (a) BEA's national I-O table, which shows the input and output structure of more than 500 U.S. industries, and (b) BEA's four-digit Standard Industrial Classification (SIC) county wage-and-salary data, which can be used to adjust the national direct requirements coefficients to show a region's industrial structure and trading patterns (*11,12*). Regional multipliers for industrial output, earnings, and employment are then estimated on the basis of the adjusted coefficients.

Comparisons of RIMS II multipliers with those derived from survey I-O tables have shown that the multipliers are similar for a number of industries, whereas for others there are differences that may be considered unacceptable. (The accuracy of a nonsurvey technique is typically judged by comparing the estimated I-O relationships with those in a survey table. However, the survey data are themselves estimates of the true I-O relationships in the economy. Because measurement errors may be associated both with survey and nonsurvey estimates, to ascribe the entire difference to nonsurvey estimation errors is incorrect.)

Stevens (*13*) and others have found that the effect of a multiplier error on an estimated impact can be mitigated by gathering primary data on the direct (first-round) effects associated with the initial impact. These data are then used with I-O multipliers to estimate the additional, or indirect, effects.

A hybrid RIMS II approach is evaluated. Primary data on the direct effects are used in conjunction with RIMS II multipliers to estimate economic impacts. [A discussion of several hybrid approaches is provided by Richardson (*14*).] The hybrid approach is demonstrated using hypothetical direct coefficients and multipliers. The increased accuracy of the hybrid approach is then assessed by comparing survey and nonsurvey impacts estimated for Texas and Washington. Finally, an application of the hybrid RIMS II approach is described.

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HYBRID APPROACH FOR ESTIMATING ECONOMIC IMPACTS

As previously explained, regional I-O multipliers are derived from direct requirements coefficients, which show the inputs of goods and services required from the region's industries to produce $1.00 of output. The coefficients do not necessarily reflect the total input requirements; rather, they reflect the inputs supplied by industries in the region. Input requirements not supplied locally are imported from outside the region. Table 1 presents direct requirements coefficients for a hypothetical region having three industries, including households. [Regional I-O multipliers account more fully for the regional economic repercussions of project expenditures if households are included as an industry (*1–4*).] As shown in Table 1, to produce $1.00 of output, Industry 1 requires 6 cents of inputs from regional firms in the same industry, 12 cents from regional firms in Industry 2, and 18 cents from regional households.

Gross output multipliers for a region are derived on the basis of direct coefficients. [In technical terms, gross output multipliers are calculated by taking the difference between an identity matrix and the direct requirements matrix, and from this computing a transposed inverse matrix (*1*).] Compared with direct requirements coefficients, gross output multipliers account more fully for the regional economic repercussions of producing $1.00 of output. For example, they reflect (a) the initial $1.00 of final demand for the output of a given industry, (b) direct requirements coefficients, and (c) indirect requirements coefficients. Indirect requirements coefficients for a given industry in a region reflect the regional production required both to produce the industry's direct requirements and to meet the increased consumer demand generated by payments to households for their labor inputs. Earnings and employment multipliers, in turn, can be derived from gross output multipliers. Respectively, they reflect the household earnings paid and the number of jobs provided, both directly and indirectly, to deliver $1.00's worth of output to final demand.

Table 2 presents earnings multipliers for the industries from Table 1. The earnings multipliers are calculated by multiplying gross output multipliers by industry-specific ratios of earnings to gross output (*9*). As shown in Table 2, for Industry 1 to deliver $1.00 of output to final demand, regional firms must pay 20 cents of earnings to households employed in the same industry, 3.7 cents to households employed in Industry 2, and 1.5 cents of earnings to household employees. For Industry 1, the total earnings impact is 25.2 cents per $1.00 of output delivered to final demand. Therefore, the total earnings impact (direct plus indirect impact) associated with a final demand change in Industry 1 can be estimated by multiplying the change in final demand by 25.2 cents.

Alternatively, the indirect portion of the total earnings impact for the industries in Table 1 can be estimated by treating the direct requirements as final demand changes and applying

TABLE 1 INDUSTRY-BY-INDUSTRY DIRECT REQUIREMENTS FOR A HYPOTHETICAL REGION

	Purchasing industry		
	1	2	Households
1.............	0.06	0.15	0.08
2.............	.12	.02	.10
Households.....	.18	.23	.06

NOTE.--Each entry represents the input required directly from the row industry for each dollar of output of the column industry.

TABLE 2 INDUSTRY-BY-INDUSTRY EARNINGS MULTIPLIERS FOR A HYPOTHETICAL REGION

	Purchasing industry		
	1	2	Households
1..................	0.200	0.035	0.021
2..................	.037	.247	.029
Households.........	.015	.018	.067
Total...........	.252	.300	.117

NOTE.-- Each entry represents the earnings paid, directly and indirectly, to the households employed by the row industry for each dollar of output delivered to final demand by the column industry.

them to the appropriate earnings multipliers. Similarly, the indirect impact on output (employment) of an additional $1.00 of output delivered to final demand can be estimated by treating the direct requirements as final demand changes and applying them to the appropriate output (employment) multipliers.

As previously noted, Table 1 indicates that the direct requirements of Industry 1 per $1.00 of output are 6 cents from other firms in Industry 1, 12 cents from Industry 2, and 18 cents from households. The indirect earnings impact that results from these output changes is estimated by multiplying the direct requirements by the respective column of earnings multipliers presented in Table 2. For example, entries in the first column of Table 2 are multiplied by the element in the first row and first column of Table 1 (6 cents). Entries in the second column of Table 2 are multiplied by the element in the second row and first column of Table 1 (12 cents), and entries in the third column of Table 2 are multiplied by the element in the third row and first column of Table 1 (18 cents). The results of these multiplications are presented in Table 3.

The total earnings impact is the total indirect impact of 7.2 cents from Table 3 (the sum of entries in Column 4) plus the direct earnings impact in Industry 1 of 18 cents (from the household row of Table 1). Again, this sum is 25.2 cents.

As described, the two approaches yield the same result; either can be used to estimate the total impact that results from a final demand change. [A generalized proof that the two approaches yield the same result is provided by Miller and Blair (*2*).] Using the first approach, the total impact is estimated by multiplying the change in final demand by the appropriate column of multipliers. In the second approach, the indirect impact is estimated by multiplying the direct impacts that result from the final demand change by the appropriate column of multipliers. The indirect impact is then added to the direct impact to obtain the total impact. In effect, the multipliers are used to estimate the indirect impact of secondary, or derived, final demand. The direct impacts can often be obtained through a survey of the initially affected industry, requiring only that the indirect impact be estimated using nonsurvey techniques.

As discussed in the following section, a combination of survey and nonsurvey techniques is likely to reduce error in estimating impacts because a large share of the total impact is the direct impact; as mentioned, these data are obtainable through surveys and are presumably more reliable than nonsurvey data.

A COMPARISON OF THE RIMS II HYBRID AND NONSURVEY APPROACHES

The accuracy of the two approaches is evaluated here by using each to estimate the earnings impacts for the states of Texas and Washington. The estimated impacts are compared with the earnings impacts estimated by the respective survey-based state models (*15*,*16*).

The total earnings impacts are estimated for each state using the RIMS II nonsurvey approach to measure the direct and indirect impacts; these results are then expressed as ratios of the total earnings impacts derived from the survey-based state models. Figure 1 shows the distribution of the ratios estimated for 52 industrial sectors in Washington State. As shown, 34 percent of the RIMS II estimates differ by 10 percent or less from the survey-based estimates, and 44 percent differ by more than 20 percent. Similar results for Texas are shown in Figure 2, in which the distribution of ratios calculated for 139 industrial sectors is shown. Figure 2 shows that 38 percent of the RIMS II estimates differ by 10 percent or less from the survey-based estimates, and 32 percent differ by more than 20 percent.

For both states, the industries with the largest differences are quite dissimilar, making it difficult to characterize them. For example, the four Washington industries with differences greater than 50 percent are forestry; petroleum refining; motor vehicles; and finance, insurance, and real estate. In addition, a comparison of differences, by industry, between states is complicated by the different levels of industry aggregation used for each state.

Figures 3 and 4 show the distribution of ratios using the RIMS II hybrid approach. Information on the direct requirements is simulated using the direct requirements coefficients from survey I-O tables for the two states. The coefficients are used as final demand changes and multiplied by RIMS II earnings multipliers to estimate the indirect impacts. These ratios cluster around 1.00, with 88 percent of the multiplier estimates differing by 10 percent or less from the survey-based estimates for Washington (see Figure 3) and 68 percent differing by 10 percent or less from the estimates for Texas (see Figure 4).

TABLE 3 INDUSTRY-BY-INDUSTRY INDIRECT EARNINGS IMPACTS FOR A HYPOTHETICAL REGION

	Purchasing industry			
	1	2	Households	Total
1....................	0.012	0.004	0.004	0.020
2....................	.002	.030	.005	.037
Households..........	.001	.002	.012	.015
Total............	.015	.036	.021	.072

NOTE.-- Each entry represents the earnings paid, indirectly, to the households employed by the row industry for each dollar of output delivered to final demand by industry 1.

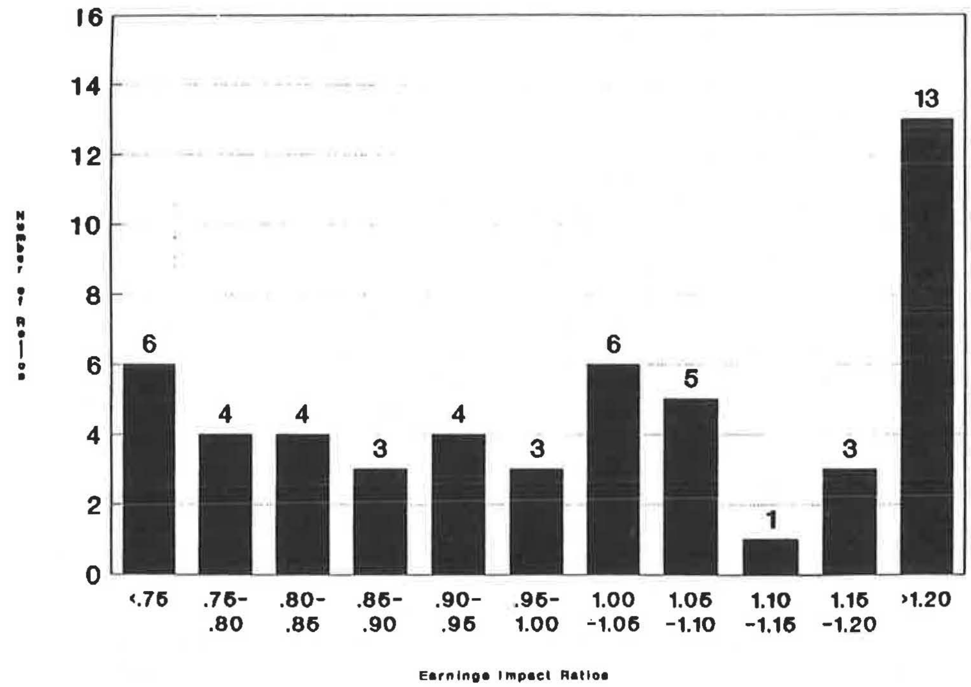

FIGURE 1 Distribution of ratios of estimated earnings impacts for nonsurvey RIMS II approach and survey approach: Washington.

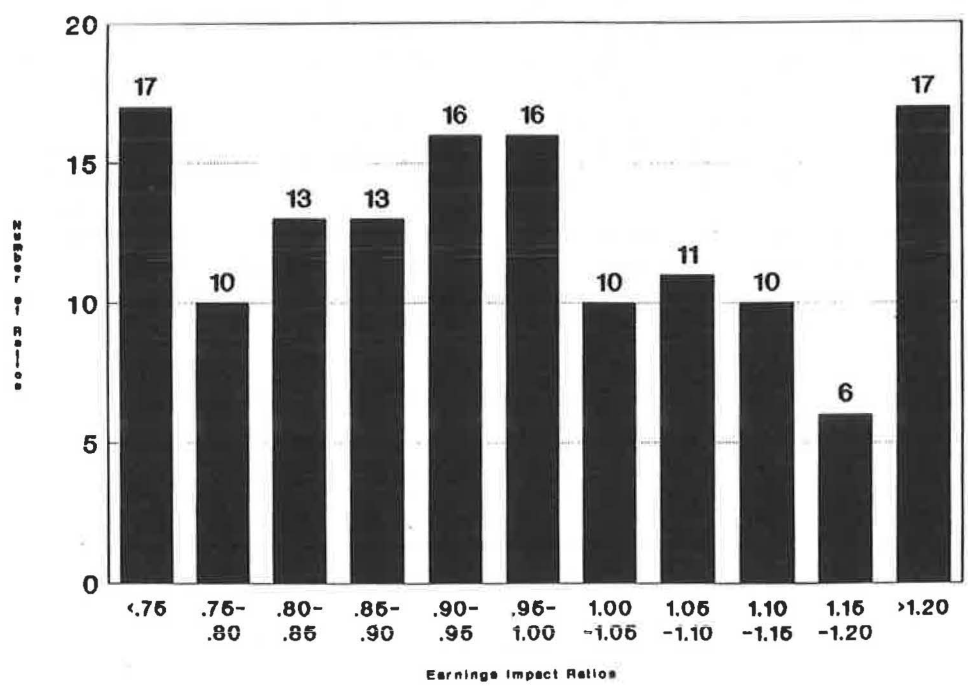

FIGURE 2 Distribution of ratios of estimated earnings impacts for nonsurvey RIMS II approach and survey approach: Texas.

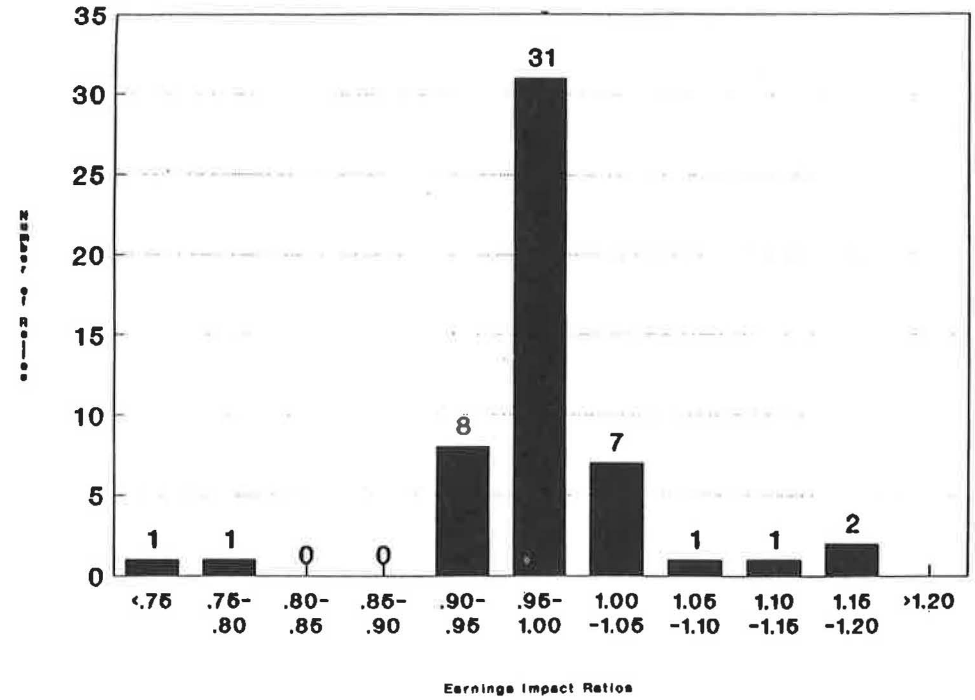

FIGURE 3 Distribution of ratios of estimated earnings impacts for hybrid RIMS II approach and survey approach: Washington.

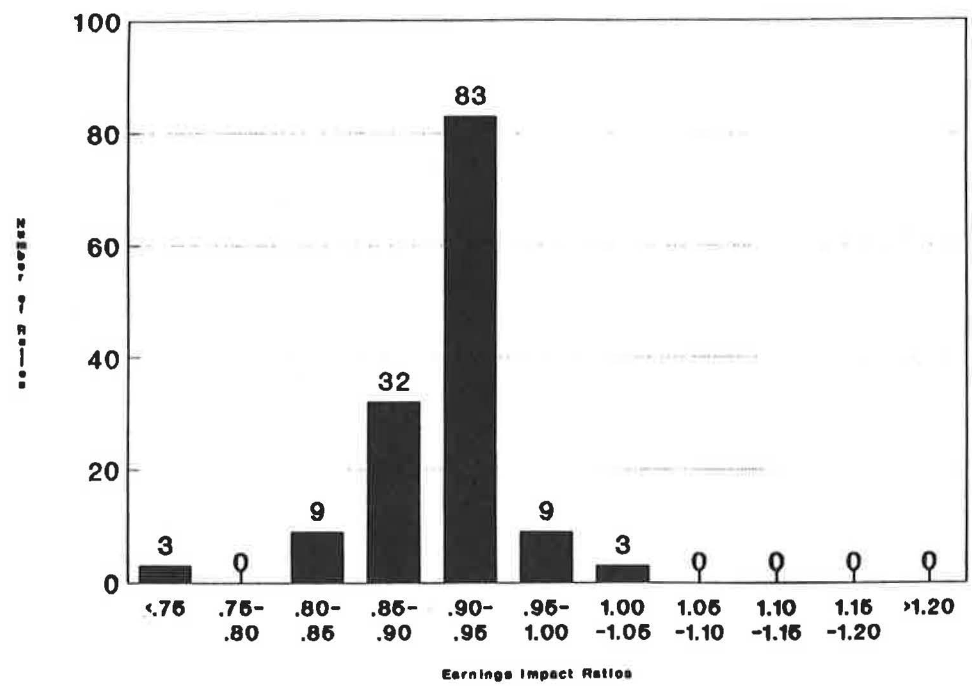

FIGURE 4 Distribution of ratios of estimated earnings impacts for hybrid RIMS II approach and survey approach: Texas.

This comparison indicates that the accuracy of impact estimates can be significantly improved by surveying the initially impacted industry for direct impacts. However, the distributions shown in Figures 3 and 4 are based on detailed knowledge of the direct impacts. For Washington, the inputs from 52 industrial sectors are known, and, for Texas, 139 are known.

Because such extensive surveys are costly, whether the same level of accuracy can be achieved with less information and, consequently, at a reduced cost is of interest. This possibility is examined for each industry by a cumulative replacement of RIMS II direct coefficients, in descending order beginning with the industry's largest input coefficient, with the corresponding survey-based coefficients. [Research indicates that the largest coefficients have the largest effects on multipliers (*17*).] Following each replacement, the new combination of RIMS II and survey-based coefficients is used as a final demand column and multiplied by the RIMS II earnings multipliers. The resulting earnings impacts are then compared with the survey-based estimates. The change in the mean and standard deviation of the ratios as the number of replaced RIMS II coefficients increases is shown for Washington and Texas in Figures 5 and 6, respectively. Figure 5 shows that, for Washington, the mean approaches unity as the number of replaced coefficients increases from 0 to 15 and remains relatively constant thereafter. Figure 6 shows that, for Texas, the mean is slightly closer to unity when there is no replacement than when all RIMS II coefficients are replaced. For both states, as indicated by the standard deviation, the ratio for any given industry at a low level of replacement is likely to be considerably above or below the mean; however, the individual

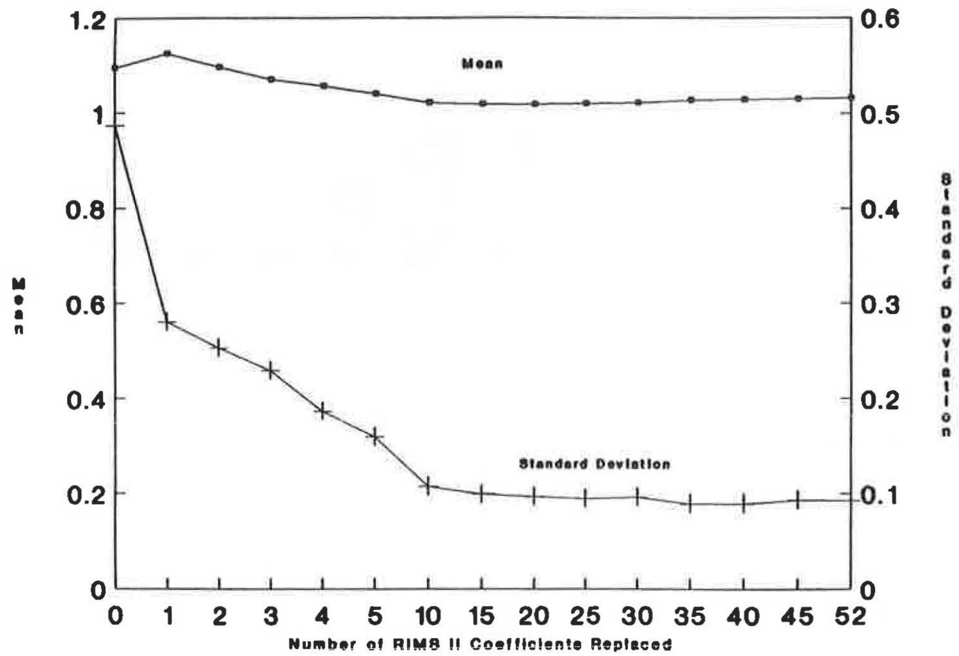

FIGURE 5 Mean and standard deviation of ratios of estimated earnings impacts with cumulative replacement of RIMS II direct coefficients: Washington.

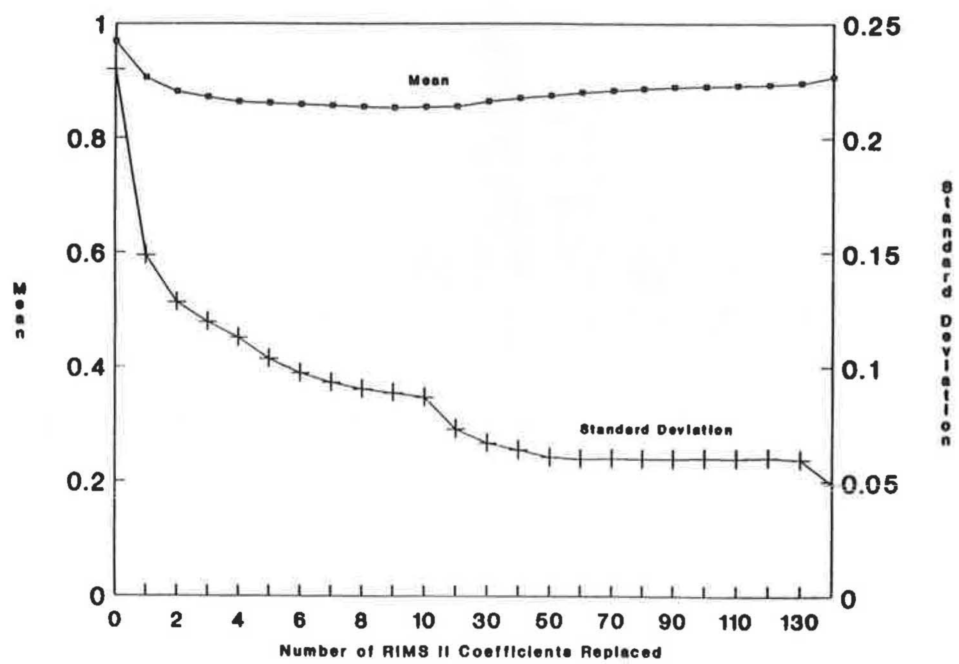

FIGURE 6 Mean and standard deviation of ratios of estimated earnings impacts with cumulative replacement of RIMS II direct coefficients: Texas.

observations become more clustered about the mean as the number of replaced coefficients increases. The largest decline in the standard deviation occurs for both states when the largest RIMS II coefficient—for most industries, the household row coefficient—is replaced. This result is analogous to surveying the industry in which the initial final demand change occurs to determine the change in payrolls (the direct earnings impact) and using RIMS II to estimate the indirect earnings impact. Figures 5 and 6 show that the standard deviation of the ratios remains relatively constant after an average of 20 to 30 percent of the coefficients in each industry have been replaced.

The preceding analysis indicates that the accuracy of impact estimates is likely to be significantly improved by surveying the initially impacted industry to determine the direct requirements and using RIMS II (or other nonsurvey approaches) to estimate the indirect requirements. When estimating earnings impacts, survey information should at least be collected on payrolls; accuracy is likely to be further improved if information is also collected on the most important material and service inputs. (The employment data associated with the payrolls should be collected if employment impacts are being estimated.)

AN APPLICATION OF THE RIMS II HYBRID APPROACH

The hybrid RIMS II approach was used by the Center for Public Service (formerly Tayloe Murphy Institute) at the University of Virginia to analyze the impacts of a General Electric (GE) plant on the Charlottesville, Virginia, Metropolitan Statistical Area. A portion of that study's results is reproduced to demonstrate the estimation of earnings impacts using survey data on the direct requirements and RIMS II multipliers. The same procedure can be used to estimate the impacts of constructing and operating transportation facilities.

GE provided information on the direct requirements purchased locally for 22 of the 39 industrial sectors presented in Table 4 (*18*). (RIMS II can provide two series of tables of

TABLE 4 EARNINGS IMPACTS IN THE CHARLOTTESVILLE, VIRGINIA, MSA (*18*)

Industry	Local direct expenditures (thousands)	RIMS II earnings multipliers	Earnings impacts (thousands)
Agriculture	$ 90.0	0.2581	$ 23.2
Forestry and fishery products	0	.2013	0
Coal mining	0	0	0
Crude petroleum and natural gas	0	.1651	0
Miscellaneous mining	.1	.3712	0
New construction	0	.4743	0
Maintenance and repair construction	213.8	.5721	122.3
Food and kindred products and tobacco	0	.2424	0
Textile mill products	0	.2544	0
Apparel	0	.4168	0
Paper and allied products	25.1	.2512	6.3
Printing and publishing	4.6	.3804	1.7
Chemicals and petroleum refining	66.8	.2167	14.5
Rubber and leather products	0	0	0
Lumber and wood products and furniture	128.2	.3839	49.2
Stone, clay, and glass products	1.4	.3068	.4
Primary metal industries	.2	0	0
Fabricated metal products	4.3	.3121	1.3
Machinery, except electrical	23.6	.3134	7.4
Electric and electronic equipment	731.8	.4888	357.7
Motor vehicles and equipment	0	0	0
Transportation equipment, except motor vehicles	0	0	0
Instruments and related products	0	.4515	0
Miscellaneous manufacturing industries	59.1	.3882	22.9
Transportation	187.0	.6215	116.2
Communication	546.4	.3473	189.8
Electric, gas, water, and sanitary services	129.1	.1637	21.1
Wholesale trade	0	.5062	0
Retail trade	0	.5980	0
Finance	0	.4226	0
Insurance	0	.4310	0
Real estate	68.4	.1007	6.9
Hotels and lodging places and amusements	26.9	.4472	12.0
Personal services	0	.5717	0
Business services	832.5	.6706	558.3
Eating and drinking places	0	.4045	0
Health services	2397.6	.6689	1603.8
Miscellaneous services	117.4	.6123	71.9
Households	38800.0	1.2116	47010.1
Total	44454.3		50197.1

I-O multipliers: one for the 39 industry aggregates presented in Table 4 and the other for 531 industries.) Local expenditures of $44.5 million are approximately 28.5 percent of GE's total expenditures (not shown), whereas the direct coefficients estimated with RIMS II indicate that 53 percent of the total expenditures are local. Because RIMS II overestimates purchases from within the region (and, consequently, underestimates purchases from outside the region), the impacts will be overestimated if a change in the output delivered to final demand by GE is multiplied by RIMS II multipliers using the nonsurvey approach. For example, when an estimate of such a change is multiplied by the RIMS II earnings multiplier for the industry that includes GE, the total earnings impact is estimated to be $82.7 million. (The gross output associated with the expenditures in Table 4 is estimated to be $171.6 million, which is then multiplied by 0.4821—the RIMS II earnings multiplier for the electric and electronic equipment industry—to estimate the earnings impact of $82.7 million.) However, the impact error is reduced by treating the GE expenditures as changes in final demand and multiplying them by the appropriate industry-specific RIMS II multipliers (see Table 4). In this case, the total earnings impact is $50.2 million. Essentially, the same impact would have been estimated if information were collected on only five industrial sectors (households, health services, business services, electric and electronic equipment, and communications), supporting the contention that information need be collected only on the most important inputs.

SUMMARY

A hybrid approach to estimating economic impacts was described. This approach uses survey information on the direct output effects in conjunction with RIMS II multipliers. It was demonstrated that impacts can be estimated when the direct output effects of a change in final demand are themselves used as changes in final demand and applied to I-O multipliers to estimate the indirect effects. A comparison was made between the impact estimates that result when the direct output effects applied to RIMS II earnings multipliers are (a) based on survey information or (b) estimated by RIMS II. The comparison indicated that the accuracy of the impact estimates can be significantly improved when the hybrid approach is used and, further, that survey information need only be collected on the most important inputs. The hybrid approach was demonstrated by estimating the earnings impacts associated with the operation of a GE plant in Charlottesville, Virginia.

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