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A Consumer's Guide to Regional Economic Multipliers

PROPONENTS of major construction projects, such as a stadium, airport or convention center, point to their potentially large and widespread benefits. Since these projects are costly and may require public funds, estimates of their economic benefits are used by the community to assess their desirability. Similarly, the closing of a major manufacturing facility—or a large cutback in its production—is of interest throughout the community because of its anticipated adverse consequences. In a hypothetical, but realistic, example discussed later in this paper, a $50 million decline in aircraft sales by a St. Louis manufacturer is estimated to cause a $132 million reduction in output in the St. Louis economy and the elimination of 1,130 jobs. Upon hearing such a prediction, some basic questions come to mind. Where do numbers such as these come from? How accurate are they likely to be?

Often, such numbers are obtained using "regional economic multipliers," which is a standard way to identify the potential effects of a major change in a region's economy. These measures estimate the changes in output, income and employment resulting from an initial change in spending. In this article, we provide an elementary discussion of regional multipliers and explain why they should be viewed with both caution and skepticism.

Our consumer's guide begins by discussing the basics of an input-output model; such a model identifies the relationships among different sectors in an economy and, thus, is used to calculate regional multipliers. We then describe different kinds of regional multipliers and discuss their major shortcomings.

A NON-MATHEMATICAL LOOK AT MATHEMATICAL INPUT-OUTPUT MODELS

An input-output model is a mathematical description of how all sectors of an economy are related. In lieu of a technical discussion of this topic, we describe the structure of input-output models using two approaches.[1] In the text, we present an intuitive discussion; in the appendix, the discussion has more detail, but remains accessible to readers comfortable with elementary algebra.

[1]See Miller and Blair (1985) for a technical discussion of input-output models.

In constructing an input-output model, one begins by separating economic activity in a region (any geographic area, such as a country, state or metropolis) into a number of producing sectors. These sectors may be highly aggregated—for example, manufacturing, services, mining and construction—or fairly disaggregated—automobile production, hospitals, coal mining and new office construction. The value of products flowing from each sector as a producer to each sector as a purchaser provides the essential information for a model. A model with steel and automobile sectors, for example, would include the dollar value of the steel produced in the region that is sold to regional auto manufacturers, as well as the dollar value of the automobiles produced in the region that are sold to the region's steel industry.

An industry's demand for inputs from other industries is related closely to its own level of output. For example, the automobile industry's demand for steel is related closely to the number of automobiles produced. Thus, steel sales are related to automobile production. Indeed, input-output models assume that, for each industry in the region, there is a constant relationship between the value of its output and the value of inputs it purchases from all other industries in the region. Suppose that the value of automobile production in a given year is $1 million and the auto industry purchased $200,000 of steel. If automobile production were to double to $2 million, the input-output model then assumes that the auto industry's steel purchases would double as well, in this case, to $400,000.

In contrast, these models make no explicit assumption about the relationship between the value of the output and purchases of inputs of groups other than the region's industrial firms. The demand of these external units is referred to as final demand because the outputs are leaving the region's processing sectors. Final demand includes purchases by government, purchases by households and firms from other regions and, in some cases, purchases by households in the specific region under consideration. Thus, the value of total output of each industry in the region is divided into that which is used in the production of other goods in the same region (called interindustry sales) and that which is purchased by final demanders.

An input-output model, however, goes beyond describing the flows of goods and services between sectors and to final demand. It also allows the user to determine the values for the gross output of each industry necessary to meet these final demands. This information allows the calculation of regional multipliers.

REGIONAL MULTIPLIERS

One primary use for an input-output model is the estimation of the total effect on an economy of changes in the components of final demand for the goods and services produced within the region. The term "impact analysis" is used to characterize such a study, particularly when the change is due to a single event that occurs within a relatively short period of time.

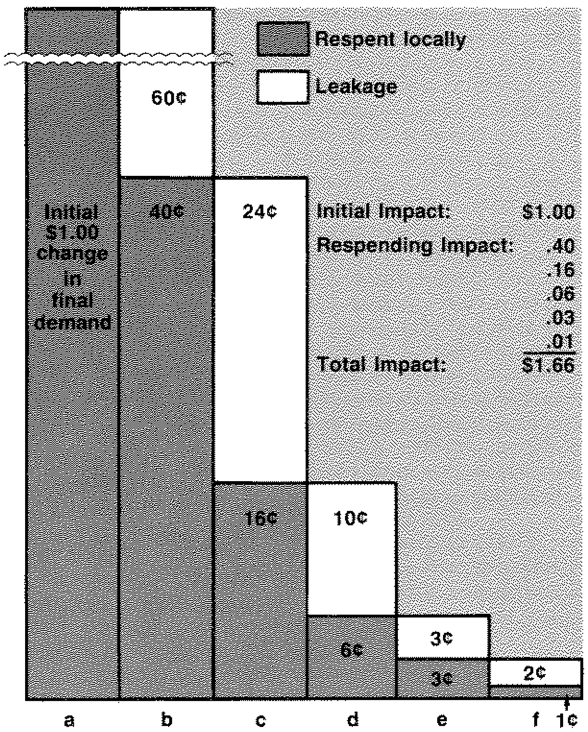
A change in final demand, like a change in federal government demand for aircraft, sets a region's economy in motion, as productive sectors buy and sell goods and services from one another. These relationships cause the total effect to exceed its initial change in final demand. The ratio of the total economic effect on a regional economy to the initial change is called a regional multiplier.[2] The total effect is measured in terms of output, income or employment, giving rise to output, income and employment multipliers.

An output multiplier of 1.66, for example, indicates that, if a firm's sales in one region to buyers in another region increase by $100 million, total sales throughout the region are expected ultimately to increase by $166 million. The additional $66 million in regional economic activity is generated because the $100 million change in spending, by affecting production, income and employment in the region, stimulates additional changes in spending that cause further changes in production, income and employment in the region.

Suppose the initial change in spending in a regional economy occurs as an apparel manufacturer receives payment for sales to a wholesaler

[2]The regional multiplier is analogous to the standard Keynesian multiplier used in macroeconomics: an initial increase in demand leads to an even greater expansion of regional income, as the income received from this demand is spent, creating income for others who spend and create additional income for still others. This process of respending comes to an end when the demand increase is offset by "leakages" through saving, taxation and imports.

Figure 1
The Multiplier Process



in another region. As figure 1 shows, for every such dollar of spending that enters this hypothetical region (column a), 40 cents is respent within the region (column b). In our example, this respending includes payments to other firms within the region for inputs such as cloth, buttons and electricity and for services such as legal and janitorial services.

The remaining 60 cents of the initial dollar is considered a "leakage", as it is spent outside of the regional economy. Leakages include payments for inputs the manufacturer buys from other regions, tax payments to all levels of government and dividends distributed to stockholders in other regions. In the second round of respending (column c), 16 cents of the 40 cents is respent within the region, while the remaining 24 cents is leakage. One example of local respending would be purchases of regionally produced goods by the suppliers of the apparel manufacturer using the payments they receive from the apparel manufacturer.

This process continues until any additional spending within the region is inconsequential. The change in total business activity can be calculated by adding the initial dollar to the total respending within the region. In our example, this would total $1.66 ($1 + $0.40 + $0.16 + $0.06 + $0.03 + $0.01). Thus, the apparel sector's multiplier indicates that $1.66 of total business activity is generated for each dollar of additional external sales by the region's producers.[3] Conversely, for each dollar reduction in final demand, total regional business activity is expected to decline by $1.66.

Input-output models enable researchers to calculate multipliers for various sectors of the economy. Each sector has a unique multiplier because each has a different pattern of purchases from firms in and outside the region.

Open and Closed Models

In practice, the value of multipliers depends on whether households are considered part of the interrelated processing sectors or a component of final demand outside the regional economy. The separation of households from processing sectors is arbitrary; households as consumers and workers are enmeshed with the industrial sectors. Households earn their incomes by providing their labor services and spend their incomes as consumers. Naturally, the amount that consumers spend is a function of their incomes, which depend on the receipts of the sectors.

If an input-output model classifies households as part of final demand rather than part of the region's productive economy, then income received by households is considered a leakage, and household respending does not contribute to the multiplier effect. If households are included in the interrelated processing sectors, the spending of income received by households within the region adds to the total effect. Thus, multipliers derived from so-called "closed models," in which regional households are included, are larger than those derived from "open mod-

[3]A given sector's multiplier is smaller for a region than for the nation of which it is a part. This reflects the greater interindustry linkages at the national level. A region's multiplier for a specific sector tends to be smaller because, relative to the nation, a region tends to purchase a higher proportion of its inputs from other regions. In other words, leakages are greater.

els," which treat households as part of final demand.[4]

Output Multipliers

An output multiplier for a given sector is the total value of sales by all sectors of the regional economy necessary to satisfy a dollar's worth of final demand for that sector's output. An important point is that this value of total business activity is larger than the market value of currently produced goods and services because some of the respending in input-output models is for the purchase of intermediate goods and services. The value of these inputs are counted again when the final goods they are used to produce are sold. Thus, Stevens and Lahr (1988) conclude that output multipliers are almost always misleading because of this double-counting.

A hypothetical example may clarify how output multipliers are used. Table 1 presents multipliers for the St. Louis Metropolitan Statistical Area (MSA) derived from one frequently used input-output system, the Regional Input-Output Modeling System (RIMS II) developed by the U.S. Department of Commerce.[5] Suppose the federal government cuts orders for military fighter jets produced in the St. Louis area by $50 million. To estimate the total output effect, the $50 million reduction of sales is multiplied by the total output multiplier for aircraft, 2.64, resulting in a total change of −$132 million.[6] Thus, total output in the St. Louis MSA would be expected to fall by $132 million because of the initial reduction in aircraft production.

This total multiplier effect is the sum of the output effects on each of the sectors of the St. Louis economy. Not surprisingly, the transportation equipment (except motor vehicles) industry, which includes aircraft production, is affected the most. For every dollar change in final demand for aircraft, output of the transportation equipment industry changes in the same direction by $1.09. As table 1 shows, the effects go beyond this industry. For example, for every dollar change in final demand for aircraft, output of the real estate sector changes by $0.09 and the output of the retail trade sector changes by $0.07.

The output multiplier for households (industry 39) indicates a $0.62 change in household earnings resulting from every dollar change in final demand for aircraft. The household earnings effect reflects the sum of earnings paid to households employed in the other 38 industries listed in the table. In other words, some portion of the $1.09 multiplier effect listed for transportation equipment is distributed as payments to households. A similar statement can be made about the other industries. An estimate of exactly how much is distributed to households is listed in the column for the earnings multiplier, which is related closely to the income multiplier discussed in the next section.

Income Multipliers

Income multipliers translate the effects of changes in final demand into changes in household income. Two kinds of income multipliers can be constructed: those that indicate regional income changes associated with an initial change in *output* and those that indicate income changes associated with an initial change in *income*.[7]

The first approach converts an initial $1 final-demand change into the total change in income. This conversion is straightforward. The $1 final-demand change in a specific sector causes changes in that sector and all other related sectors. These final-demand changes lead to changes in household income in each of these sectors. Summing the household income changes over all sectors yields the total change in household income. The income multiplier is simply the ratio of the total change in household income to the $1 change in final demand.

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[4]Multipliers derived from open models are referred to as Type I or simple multipliers, while those derived from closed models are called Type II or total multipliers. The same distinction applies to income and employment multipliers. In addition to households, other sectors can be shifted from final demand to the region's productive sectors. Bourque (1969), for example, creates multipliers for the Washington economy that account for the induced effects of state and local government spending.

[5]See U.S. Department of Commerce (1986) for a description of RIMS II. The St. Louis MSA includes the City of St. Louis and Franklin, Jefferson, St. Charles and St. Louis counties in Missouri as well as Clinton, Jersey, Madison, Monroe and St. Clair counties in Illinois.

[6]Prof. Fredrick Raines of Washington University provided valuable assistance on the use of the RIMS II model for this example.

[7]Income multipliers can also be distinguished on the basis of whether households are considered part of the interrelated processing sectors or a component of final demand.

Table 1

Multipliers for the St. Louis Area Aircraft Industry

Industry Aggregation	Output[1]	Earnings[1]	Employment[2]
1. Agricultural products and agricultural, forestry and fishery services	$0.0034	$0.0010	0.1
2. Forestry and fishery products	0.0000	0.0000	0.0
3. Coal mining	0.0043	0.0013	0.0
4. Crude petroleum and natural gas	0.0002	0.0000	0.0
5. Miscellaneous mining	0.0004	0.0001	0.0
6. New construction	0.0000	0.0000	0.0
7. Maintenance and repair construction	0.0203	0.0089	0.3
8. Food and kindred products and tobacco	0.0377	0.0054	0.2
9. Textile mill products	0.0004	0.0001	0.0
10. Apparel	0.0087	0.0023	0.1
11. Paper and allied products	0.0061	0.0013	0.0
12. Printing and publishing	0.0126	0.0040	0.2
13. Chemicals and petroleum refining	0.0512	0.0041	0.1
14. Rubber and leather products	0.0102	0.0024	0.1
15. Lumber and wood products and furniture	0.0019	0.0005	0.0
16. Stone, clay, and glass products	0.0027	0.0008	0.0
17. Primary metal industries	0.0438	0.0083	0.2
18. Fabricated metal products	0.0279	0.0075	0.3
19. Machinery, except electrical	0.0243	0.0090	0.3
20. Electric and electronic equipment	0.0231	0.0081	0.3
21. Motor vehicles and equipment	0.0208	0.0028	0.1
22. Transportation equipment, except motor vehicles	1.0935	0.3485	9.0
23. Instruments and related products	0.0092	0.0031	0.1
24. Miscellaneous manufacturing industries	0.0030	0.0008	0.0
25. Transportation	0.0554	0.0232	0.8
26. Communication	0.0247	0.0064	0.2
27. Electric, gas, water, and sanitary services	0.0414	0.0040	0.1
28. Wholesale trade	0.0666	0.0253	0.9
29. Retail trade	0.0715	0.0345	2.4
30. Finance	0.0273	0.0087	0.3
31. Insurance	0.0240	0.0083	0.3
32. Real estate	0.0914	0.0024	0.3
33. Hotels and lodging places and amusements	0.0169	0.0056	0.5
34. Personal services	0.0121	0.0055	0.6
35. Business services	0.0564	0.0282	1.2
36. Eating and drinking places	0.0507	0.0154	1.7
37. Health services	0.0354	0.0199	0.8
38. Miscellaneous services	0.0346	0.0129	0.7
39. Households	0.6231	0.0024	0.4
Total	$2.6374[3]	$0.6231	22.6

[1]Dollars per dollar of final sales

[2]Number of jobs per $1 million of final sales (1987 dollars)

[3]The output multiplier is 2.0143 for open models, that is, when the induced effects of the household sector are excluded.

The second approach uses a different denominator in the calculation of the income multiplier. A $1 change in final demand for a specific sector's output initially becomes a $1 change in output by that sector. In the first approach, this dollar's worth of output is used as the denominator in the income multiplier. The second approach replaces the denominator with the initial additional income received by workers in the sector. The resulting multiplier indicates the total change in income resulting from the initial change in income.

Although the RIMS II model does not provide income multipliers, it does furnish closely related earnings multipliers that can be applied to the current example. (Income generally includes transfer payments, dividends, interest and rent in addition to earnings.) Table 1 shows that the earnings multiplier for aircraft manufacturing is 0.6231, indicating that for each $1 change in output from the aircraft industry in St. Louis, earnings throughout St. Louis will change by approximately $0.62, other things equal. Approximately $0.35 of this change occurs in the transportation equipment (except motor vehicles) industry. Multiplying the hypothesized $50 million reduction by 0.623 yields an estimated decline in regional earnings of $31.15 million.

Employment Multipliers

In many cases, citizens are as interested in employment as in output or income, that is, the number of regional jobs a particular economic change is expected to generate or eliminate. If the relationship between the value of a sector's output and its employment level can be estimated, then employment multipliers can be calculated.

As with the discussion of income multipliers, there are employment multipliers that translate initial *output* changes into regional employment changes and, using a different approach, employment multipliers that translate initial *employment* changes into regional employment changes.

As Stevens and Lahr (1988) note, most employment multipliers are estimated in terms of jobs rather than "full-time equivalent" employees. Unfortunately, the relationship between jobs and full-time equivalent employees is not the same, either across economic sectors or across regions for the same sector. Thus, not only are all comparisons of employment multipliers suspect, but employment multipliers do not identify the mix of full- and part-time workers.

Returning to our example, if the employment multiplier for St. Louis' aircraft sector of 22.6 jobs per $1 million of final sales, shown in table 1, is applied to the $50 million reduction in aircraft sales, the estimated regional employment effect will be a loss of 1,130 jobs.[8] In addition to the reduction of employment in the transportation equipment (except motor vehicles) industry of 450 (9 times 50), there are noteworthy employment effects in retail trade (120 jobs) and restaurant services (85 jobs).

To summarize, the estimated effects of the hypothetical $50 million spending cut for aircraft would be: total spending (output) declines by $132 million; earnings, by $31.15 million; and employment, by 1,130 jobs. From a different perspective, these results suggest that, for each job lost, regional earnings will fall by $27,566 and total spending by $116,814. While the earnings per job figure seems reasonable, the spending decline of $116,814 per job is of little practical value because this figure is not the loss in actual output per worker. The region's output will fall by substantially less than total sales losses.

HOW ACCURATE ARE REGIONAL MULTIPLIERS? MORE REASONS TO BE CAUTIOUS

The widespread use of input-output multipliers in regional impact analysis suggests that many economists, government officials, firms and others have found them useful. Yet, multiplier analysis has important limitations stemming from both the theoretical basis of input-output models and measurement problems. A few of these problems have already been identified; more are discussed below. An awareness of these limitations is necessary to accurately interpret such multipliers.

Transitory Effects

Multipliers estimate short-term economic changes; they do not take into account a regional economy's long-term adjustments. Thus, many

[8]To be consistent with the St. Louis RIMS II model, the $50 million reduction is measured in 1987 dollars.

of the economic effects identified by multipliers are likely transitory. For example, while a reduction in federal government purchases of aircraft will cause a reduction in regional employment, at least some of this reduction will be temporary as workers whose jobs were eliminated find new jobs in the region.[9] Thus, multipliers may overstate the loss of jobs, if one looks beyond the immediate effects.[10]

Recent research by Taylor (1990) stresses this transitory effect. Taylor estimates that all 50 states would experience at least a small reduction in employment in the short run if real federal defense spending was cut by 10 percent. In all but 17 states, however, these losses would be more than offset by the creation of new jobs.[11]

Supply Constraints

The input coefficients measuring the interindustry flows between sectors are "fixed" in input-output models; in other words, at any level of output, an industry's relative pattern of purchases from other sectors is unchanged. When the initial change considered is an increase, this assumption requires that excess productive capacity exists in regions in which inputs are purchased. In addition, a sufficient surplus of labor with adequate skills is also assumed to be available at unchanged wages.[12]

If these assumptions are invalid, producers will have to alter their purchasing patterns to increase production. For example, suppose a region's auto assembly plant plans to increase its production and sales to other regions by 50 percent. If the plant's suppliers within the region were operating at, or near, full capacity, the assembly plant would have to buy a larger proportion of its inputs from firms outside the region, at least until local suppliers could expand their production. In this case, the input coefficients expressing the flows from each regional industry to the assembly plant would overstate the true short-run relationship, and multipliers derived from the model would also be too large. If the supply of unemployed, adequately skilled workers were insufficient, the assembly plant might substitute capital for labor in its production or hire workers from other firms in the region.[13] In this case, estimated impacts based on earlier multiplier relationships could overstate the actual consequences.

Of course, the magnitude of this problem varies from case to case. It is more severe when considering a substantial increase in output, especially in a small nonmetropolitan region; it is less important when analyzing larger, more complex economies. Supply constraints in most industries also are a bigger problem closer to business cycle peaks than during recessions.

Ignoring Interregional Feedbacks

Multipliers exist because the expansion of one sector's production causes the region's other sectors to expand as well; this, in turn, may induce further expansion in the first sector. These feedback effects operate not only between related sectors within a region, but also between the economies of individual regions. Suppose, for example, as a Missouri aircraft plant expands, it purchases tires produced in Tennessee. This could cause the tire plant to buy more industrial chemicals from Missouri firms. In addition, some of the increased income that Tennessee tire plant workers receive might be spent purchasing consumer goods and services produced in Missouri. Thus, the interrelations of the two state economies would cause a

[9] Not all displaced workers, of course, will find jobs within the region, even in the long run. The loss of such workers who leave for jobs in other regions will tend to retard the region's growth. Yet, such restructuring ultimately enhances the nation's economic performance, by redistributing labor resources to the industries and regions where they are most needed.

[10] Some of the problems inherent in input-output models, including the measurement of long-run impacts and changes in multipliers over time, are addressed by linking input-output models to econometric models. Such models, however, are available for few regions. See Conway (1990) and Israilevich and Mahidhara (1990).

[11] Taylor (1990) uses a U.S. input-output model to estimate the effects of the defense spending cuts on each of the nation's industries. A state's short-run employment effects were estimated by allocating each U.S. industry's loss to a state based on its industrial composition. A state's long-run reabsorption of labor was based on the assumption that its employment continued to grow at the historical rate.

[12] The fixed relationship implies that additional material and labor inputs are available at existing prices and wage rates, respectively. That is, the increase in the quantity demanded would not bid up input prices and wages. Otherwise, an increase in production and employment in one sector may result in an employment decrease in another sector, and the multiplier will overstate the actual effect.

[13] This suggests another use of multiplier analysis: evaluating the feasibility of an expansion in light of existing regional labor pools.

larger multiplier effect on the Missouri economy than if the interregional effects were ignored.

Although they are not included in multipliers calculated from single-region models, these interregional feedbacks are captured by multipliers derived from interregional and multiregional input-output models.[14] Such models are rarely developed, however, because of their extensive data requirements.[15]

How important is this omission for single-region models? While the importance varies from region to region, evidence suggests that ignoring such feedback effects does not substantially affect aggregate multiplier values.[16] For individual industries, however, interregional feedbacks could be quite important.

Do Multipliers Change Over Time?

The multipliers used in impact studies are often generated using data based on transactions for a period that occurred five or more years earlier. In many cases, a full survey to develop new input-output coefficients is costly, so existing models, often several years old, are used. Even if a new survey is conducted, it may take several years to complete the input-output table. If the structural relationships indicated by a regional input-output model change significantly over these years, the reliability of impact analyses using the older model is diminished.[17]

There are several reasons why input-output relationships change considerably over time. First, technological changes and inventions of new products alter manufacturers' input purchasing patterns. Partly because of technological changes, for example, auto manufacturers purchase more plastic and robots and less steel and labor per unit of output than they did 10 years ago.

Second, if producers in a sector have significantly expanded their output since the input-output table was constructed, the assumed fixed relationship between the ratio of the value of input to output for each input will no longer hold. For example, the costs of inputs that are relatively insensitive to output levels, say, purchases of accounting services, could be spread over additional units of output as expansion occurs, lowering some input coefficients.

Furthermore, relative price changes across commodities induce substitution of the relatively cheaper inputs for the more costly ones. If oil prices rose relative to coal prices, for example, some manufacturers might purchase more coal and less oil. Finally, changes in interregional or international trade patterns—perhaps due to changes in transportation costs or exchange rates—could substantially alter patterns of trade and, thus, multiplier values.

If obsolete values are used as input-output coefficients, the multiplier values and impact estimates derived from them will be inaccurate. Conway (1977) provided some insights into the importance of changing multiplier values by examining three survey-based input-output models for the state of Washington. He found that, on average, simple output multipliers changed by approximately 5 percent in each of the 1963-67, 1967-72 and 1963-72 periods. Output multipliers for individual sectors changed by as much as 17.7 percent in the 1963-72 period. The change in total income multipliers was somewhat greater than the change in output multipliers; on average, they changed by roughly 10 percent in the three periods. One sector's income multiplier fell by 33.3 percent between 1963 and 1972, while another's rose by 14.1 percent.

Although these results are based on only one region, they suggest that the use of multipliers based on an older model may be misleading, especially given the dramatic changes that have influenced the way goods and services have been produced in recent decades. These changes include substantial fluctuations in oil

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[14]Examples include the nine-region interregional model of Japan (Japanese Government, 1974), the three-region Dutch interregional model (Oosterhaven 1981) and Polenske's (1980) multiregional model of the 50 U.S. states and District of Columbia.

[15]Multipliers, as shown by Stevens and Lahr (1988), can also be derived from economic base models. Such models generally divide regional economic activity into two sectors—production for export and production for local use—rather than the many sectors found in input-output models. This extreme aggregation is the source of one of several limitations of economic base multipliers. See Richardson (1985) for a critical review of these multipliers.

[16]Miller and Blair (1985), pp. 127-28, found that the average error when interregional feedbacks were ignored (averaged over all sectors in all regions) was less than 3 percent in five models, 7 percent in one model and 14.4 percent in another. Also see Guccione, et al. (1988).

[17]A related problem arises if one attempts to use input-output models for long-run regional forecasting. Such cases require so-called dynamic input-output models as described in Miller and Blair (1985), pp. 340-51, or combination econometric-input-output models such as the one described by Conway (1990).

prices, widespread technological innovation, increased use of services in production processes and heightened foreign trade.

Nobel Prize winner Wassily Leontief has raised serious doubts about the accuracy of models based on the federal government's input-output table of the U.S. economy.[18] The frequently used RIMS II model, for example, was derived from the 1977 U.S. input-output table, so the underlying structural relationships have had more than a decade to change. For the same reason, Leontief suggests that, when the 1982 benchmark U.S. input-output table becomes available in early 1991, it will be of only historical interest.

The Construction of Regional Input-Output Tables

Stevens and Lahr (1990) stress an even more fundamental problem: the lack of information on the relationships among producers within a region makes constructing an accurate regional input-output model very difficult. Since the appropriate coefficients are unknown, an analyst must estimate them. One way to do this is to assume that regional input-output coefficients are the same as the available, but dated, national coefficients. This method is not used, however, because regional production processes are seldom identical to national production processes and, even if they were, firms within the region are more dependent on inputs from outside the region than national input-output coefficients would indicate. Another method is to conduct a comprehensive survey of the region's firms; this, however, is rarely undertaken because of its high cost.

In most cases, regional input-output coefficients are estimated using methods that alter existing U.S. input-output models to better reflect regional transactions.[19] This alteration is accomplished by surveying key regional sectors or by using recently published regional data. These methods are imperfect, however, and the lack of accurate information remains a major obstacle in calculating regional multipliers.[20] The consumer of such multipliers is thus justified in wondering whether the value of a multiplier is accurate.

Calculating the Change in Final Demand

Multipliers are used to estimate the total effect on a region's economy of an initial change in final demand; however, estimating the initial change is not a simple exercise. Changes in final demand have financial consequences. Ignoring this fact can result in estimates of final demand changes larger than are actually warranted.

To continue with our earlier example, assume that the reduction in defense expenditures for aircraft produced in St. Louis is associated with a reduction in federal income taxes. As a result, St. Louis taxpayers will pay less in taxes and spend more on goods and services, including those produced locally, which would offset some of the negative effects associated with the decline in aircraft expenditures.

These offsetting effects are likely to be more pronounced in cases of locally funded projects. For example, suppose that a city was considering building a sports stadium and financing it by raising local taxes. In general, the larger the burden of these taxes on local residents, the larger the reduction in demand for local production. Thus, an analysis that looks at the demand effects associated with spending on the stadium alone would overstate the multiplier effects of the project.

Moreover, determining the initial change in final demand stemming from a spending change is not always straightforward. In describing the use of RIMS II, for example, the U.S. Department of Commerce (1986) illustrates the importance of determining the actual final demand change in the context of tourist expenditures in Louisiana. A first step was to estimate the anticipated increase in tourist expenditures, an exercise subject to considerable error because of the difficulty of predicting the number of additional tourists as well as the changes in their expenditure levels. In the Department of Commerce example, for instance, increased expenditures on retail goods of $280 million were predicted.

Given this figure, it was necessary to determine how much of this amount reflected final

[18]See Leontief (1990).

[19]For a description of five such models, see Brucker, et al (1987).

[20]For a critical review of nonsurvey and partial survey methods, see Miller and Blair (1985), pp. 266-316. Hewings, Israilevich and Martins (1990) have recently developed a method that might prove an improvement over past approaches.

demand for goods and services produced in Louisiana. The expenditure for retail goods is unlikely to be only for goods and services produced in Louisiana because this expenditure reflects changes for the output of wholesalers, transporters, manufacturers and retailers. Assumptions must be made about the distribution of changes among these producers and how much of the output of these producers takes place in Louisiana. Thus, estimating final demand is subject to substantial error.

Estimating the Regional Impact of a New Industry

If a regional input-output model is available and the magnitude of the initial change in final demand is known, estimating the regional impact of a change in the final demand of an existing sector is straightforward. It is more difficult, however, to estimate the regional impact of a firm in an entirely new sector. Since the existing interindustry flows do not indicate such a firm's relationships with other sectors, the existing table cannot be applied directly; additional information is needed. Detailed information is required on the new firm's sales to, and purchases from, other regional producing sectors and other suppliers of inputs.

Additional information also may be needed if a new firm produces goods or services that are substitutes for those previously produced outside the region. Suppose, for example, that a new firm produces an input that many regional firms previously purchased from other regions. The enhanced availability of the input from the new source will cause some firms to purchase more of it from within the region. The change could alter purchases from firms outside of the region and input coefficients to an extent that more survey information or new estimates of interindustry linkages would be required. A related situation would be the closing of a firm that is the sole producer of a product. If the firm sells much of its output to other regional sectors, the firm's elimination would force them to import the good, altering their external and interindustry linkages.

CONCLUSION

Economic multipliers are often used to estimate the total regional effect associated with an initial change in a regional economy, after accounting for all the relationships among the economy's sectors. Multipliers used in regional impact studies are usually based on single-region input-output models, which mathematically describe the industrial structure and linkages of the economy at one point in time. Numerous theoretical and measurement problems, however, suggest that estimates based on these multipliers should be viewed with caution.

The accuracy of multipliers depends on how accurately the model describes the current regional economy. If the structure of the economy has changed since the model was developed or if the new development itself will substantially alter the regional economy's structure, multipliers will tend to be inaccurate. In such cases, their accuracy can be improved by using additional information.

In addition, identifying the precise magnitude of an initial change in final demand is not always straightforward. The financing of a particular expenditure can offset an increase or decrease in demand for locally produced goods and services. Further complications can arise in determining how much of a change in expenditures is a change in final demand.

Despite their limitations, economic multipliers based on input-output models are popular and will continue to be used in economic impact studies. Meaningful analysis using multipliers is not clear-cut and mechanistic, but rather requires the exercise of careful judgment by an experienced and knowledgeable analyst. Such analysis allows for a degree of subjectivity and therefore, possible bias to enter the analysis, however. The consumer should be aware that estimates based on regional multipliers may be subject to considerable error.

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Appendix
Foundations of Input-Output Models

An input-output model is a mathematical description of the relationships among all sectors of an economy. To construct such a model, economic activity in a region must be separated into a number of producing sectors. These sectors may be highly aggregated, or they may be identified in considerably more detail. For example, a regional input-output model developed by the Department of Commerce contains more than 500 industries, 370 of which are specific manufacturing industries.[1] The manufacture of household furniture contains six separate categories: 1) wood household furniture; 2) wood television and radio cabinets; 3) upholstered household furniture; 4) metal household furniture; 5) mattresses and bedsprings; and 6) household furniture, not classified elsewhere.

The necessary data for a specific time period are the flows of products in monetary terms from each of the sectors as producers to each of the sectors as purchasers. A model with steel and automobile sectors, for example, requires the dollar value of steel produced in the region that is sold to regional auto manufacturers and the dollar value of automobiles produced in the region sold to the region's steel industry. An industry's demand for inputs from other industries is related closely to its own output. For example, steel sales are related to automobile production.

In contrast, no explicit assumption is made regarding the relationship between the value of sales to buyers outside the industrial sectors (such as households, government and buyers in other regions) and the quantity they produce. Thus, the sales of a specific industry are made to other producers within the region, which are called interindustry sales, and to external units, which is termed final demand. Assuming the economy consists of n sectors, the total output of sector i, x_i, can be written as:

$$(1)\ x_i = z_{i1} + z_{i2} + \ldots + z_{ii} + \ldots + z_{in} + y_i,$$

[1]See U.S. Department of Commerce (1986) for additional details.

where the z terms represent the interindustry sales by sector i to each of the n sectors (including itself) and y_i is the final demand for sector i's output. There will be an equation similar to (1) for each sector of the regional economy.

The interindustry flows of goods are summarized in table 1A. The entries in each row are the sales of a sector, such as sector 1, to itself (z_{11}) and to each other sector in the economy ($z_{12} \ldots z_{1n}$). These interindustry flows can also be considered from the perspective of any sector's purchases: each column in table 1A expresses one sector's purchases of the products of the various producing sectors in the region. For example, the first column in table 1A indicates sector 1's purchases from itself (z_{11}) and from each of the other sectors ($z_{21} \ldots z_{n1}$).

A sector's purchases of inputs, however, are not restricted to purchases from itself and other sectors. For example, labor is an input that must be purchased. A purchase of labor is an example of what is termed value-added. In addition, a sector may purchase raw materials and other material inputs from other regions.

Table 1A
Input-Output Table of Interindustry Flows

Selling sector	Purchasing sector: 1	2	. . .	i	. . .	n
1	z_{11}	z_{12}	. . .	z_{1i}	. . .	z_{1n}
2	z_{21}	z_{22}	. . .	z_{2i}	. . .	z_{2n}
.	.					
.	.					
.	.					
i	z_{i1}	z_{i2}	. . .	z_{ii}	. . .	z_{in}
.	.					
.	.					
.	.					
n	z_{n1}	z_{n2}	. . .	z_{ni}	. . .	z_{nn}

Income and Product Accounts

The transactions in table 1A are a subset of a complete set of income and product accounts for an economy. To illustrate a "complete" set, table 2A is a flow table for an economy with two industries. The z's are simply the interindustry sales between the two sectors. Final demand for the two sectors (Y_1 and Y_2) consists of three "domestic" components and one "foreign" component. In the regional context, domestic and foreign refer to within and outside of the Regional economy. The domestic demand components are: C, consumer (household) purchases; I, purchases for private investment purchases; and G, purchases by government within the region. The foreign demand component is export sales (E) that include sales of finished goods to all consumers, investors and governments outside of the region as well as sales of intermediate goods to producers in other regions. Thus, final demand for industry 1's output can be expressed as $Y_1 = C_1 + I_1 + G_1 + E_1$ and for industry 2's output as $Y_2 = C_2 + I_2 + G_2 + E_2$.

The payments sector of table 2A identifies three categories of payments, two of which may be termed "value-added" payments. These payments equal the value of the sector's output

Table 2A
Expanded Flow Table for a Two-Sector Economy

		Processing sectors 1	2	Final demand (Y)				Total output (X)
Processing sectors	1	z_{11}	z_{12}	C_1	I_1	G_1	E_1	X_1
	2	z_{21}	z_{22}	C_2	I_2	G_2	E_2	X_2
Payments sector		L_1	L_2	L_C	L_I	L_G	L_E	L
		N_1	N_2	N_C	N_I	N_G	N_E	N
		M_1	M_2	M_C	M_I	M_G	M_E	M
Total outlays (X)		X_1	X_2	C	I	G	E	X

minus the value of the inputs it purchases from other sectors. Value-added payments by the two processing sectors consist of payments for labor services (L_1 and L_2) and for all other value-added items, such as tax payments for government services, interest payments for capital services and rental payments for land services (N_1 and N_2). The final component of the payments sector is for purchases of imported inputs (M_1 and M_2). Regional imports include all purchases from beyond the region's borders.

The entries in the intersection of the value-added rows and the final demand columns of table 2A represent payments by final consumers for labor and other services. For example, L_C includes household payments for domestic help, L_G represents payments to government workers and N_C includes interest payments by households. Lastly, the entries in the intersection of the imports row and final demand columns represent purchases of imported items by households (M_C), private businesses (M_I) and government (M_G). M_E represents imported items that are re-exported.

Summing the entries in the total output column yields the total gross output (X) of the economy

(2) $X = X_1 + X_2 + L + N + M.$

Total gross output may also be found by summing across the total outlays row. Thus,

(3) $X = X_1 + X_2 + C + I + G + E.$

Equating the two expressions for X, subtracting X_1 and X_2 from both sides and rearranging terms leaves

(4) $L + N = C + I + G + (E - M).$

The left-hand side, total factor payments, is gross regional income, while the right-hand side, the total spent on consumption and investment goods, total government purchases and net exports, is gross regional product. Thus, the equation simply expresses the equality of regional income and output.

An Input-Output Model

The preceding income and product accounts can be transformed into an input-output model rather easily. Given the flow of inputs from sector i to sector j (z_{ij}) and the total output of j (X_j), the ratio of the value of the input to the output (that is, z_{ij} / X_j) is known as an input coefficient or an input-output coefficient and is denoted by a_{ij}. Input coefficients can be calculated for each interindustry flow and are viewed as measuring a fixed relationship between each of a regional sector's inputs and its total output. For example, if one-quarter of sector 2's output was purchased from sector 1, then $a_{12} = 0.25$. This relationship is calculated from the flows of inputs and output for a given period, often one year.

The fixed nature of the relationship implies that the ratio of the value of each input to each output remains unchanged irrespective of the level of output, reflecting an assumption of constant returns to scale in production. This means that an identical percentage change in all inputs will cause an identical change in output. For instance, doubling all inputs will cause a doubling of output.

The fixed input coefficients allow the total output of sector i, X_i, to be written as:

(5) $X_i = a_{i1}X_1 + a_{i2}X_2 + \ldots + a_{ii}X_i + \ldots + a_{in}X_n + Y_i.$

The input coefficients in the preceding equation state how much of sector i's output is needed per dollar of output in each of the other sectors. Multiplying the input coefficients by the output of these sectors provides the dollar value of sector i's output that is directed to these sectors. As before, Y_i states how much of regional sector i's output is used to satisfy final demand.[2]

For each sector of the economy, there will be an equation similar to (5). These equations can be solved to yield an answer to the following question: if the final demands for each of the n sectors were known, how much output from each of the sectors would be necessary to supply them? Thus, values for the gross output of each

[2]A sector's output, say j, can also be expressed as the sum of each sector's purchases from other regional sectors and payments for value-added components and imported inputs:

$X_j = a_{1j} X_j + a_{2j} X_j \ldots + a_{jj} X_j + \ldots + a_{nj} X_j + W_j,$

where W_j is the sum of L_j, N_j and M_j. The element, a_{nj}, does not necessarily represent sector's j's total purchases of input n, but only that portion purchased within the region. Production in j may also require importing inputs from other regions or nations, which are included in the payments sector.

sector can be determined given the input coefficients and the final demands.

Open and Closed Models

The described input-output model depends on the existence of a sector distinct from the interrelated processing sectors. These final demands consist of consumption purchases by households, sales to government and gross private investment within the region as well as sales to the rest of the world. The separation of households from the processing sectors is arbitrary; households as consumers and workers are enmeshed with the industrial sectors. Households earn incomes by providing their labor services and, as consumers, spend their income in a predictable fashion. Although households tend to purchase goods for final consumption, the amount of their purchases is related directly to their income, which depends on the outputs of the sectors.

In some input-output models, the household sector is shifted from final demand to the interrelated processing sectors. Such a model is known as a closed model with respect to households, while an open model keeps the household sector as part of final demand. In the context of income and product accounts, household consumption (C_1 and C_2 in table 2A) is shifted to the processing sectors in a closed model.

A closed model requires a separate row and column in table 1A for the household sector. The row would show how the "output" of the household sector, its labor services, is used as an input by the various sectors and the column would show how the household sector's consumption purchases are distributed among the sectors.

Household input coefficients are calculated as other input coefficients are. The household sector's row entries are the value of labor services sold to each sector for a given period divided by the value of the sector's total output for the same period. The elements of the household purchases column are the value of household purchases from each sector for a given period divided by the total output of the household sector.