Input-Output Models for Impact Analysis:
Suggestions for Practitioners Using RIMS II Multipliers

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Presented at the 50th Southern Regional Science Association Conference
March 23-27, 2011
New Orleans, Louisiana

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Abstract: Input-output models, when applied correctly, can be powerful tools for estimating the economy-wide effects of an initial change in economic activity. To effectively use these models, analysts must collect detailed information about the project or program under study. Analysts also need to be aware of the assumptions and limitations of these models. In this paper, we will focus on these assumptions and on the information that is required to use regional input-output multipliers correctly. We focus specifically on multipliers generated by the Regional Input-Output Modeling System (RIMS II) developed by the Bureau of Economic Analysis.

1. Introduction

This paper discusses the proper use of regional input-output (I-O) models. These models provide multipliers that can be used to estimate the economy-wide effects that an initial change in economic activity has on a regional economy. The initial change involves a change in final demand such as a new construction project, an increase in government purchases, or an increase in exports.

Regional I-O multipliers share similarities with what are commonly termed macroeconomic (Keynesian) multipliers. Both types of multipliers provide a way to estimate the economy-wide effects that an initial change in economic activity has on a particular economy. Both types are based on the idea that an initial change in economic activity results in diminishing rounds of new spending as leakages occur through saving or spending outside the local economy. The size of both macroeconomic multipliers and regional I-O multipliers is smaller when there are more leakages.

Despite their similarities, regional I-O multipliers are not a substitute for national-level macroeconomic multipliers. Macroeconomic multipliers are based on behavioral assumptions related to how individuals adjust their labor supply, saving, and consumption decisions when there is an initial change affecting their income. The value of these multipliers is constructed from empirical estimates of the interrelationships between related economy-wide measures of economic activity.

The size of macroeconomic multipliers is closely linked to the marginal propensity to consume, which quantifies the relationship between changes in income and consumption expenditures. In more extended models, the size of the multipliers may also be affected by the degree to which individuals are forward looking and shift consumption, labor supply, and savings across time in response to anticipated changes in taxes, interest rates, or asset prices that lead individuals to feel wealthier or poorer. Many of these models

account for supply constraints. As competition for scarce resources increases, prices for these resources increase and the size of the multiplier decreases.

Regional I-O multipliers are constructed from a detailed set of industry accounts that measure the commodities produced by each industry and the use of these commodities by other industries and final users. By incorporating information about inter-industry relationships, regional I-O multipliers can highlight the impact of demand changes on particular industry sectors within a region. However, I-O models do not account for prices changes that may result from increased competition for scarce resources.[1]

The relationships between consumption and income in I-O multipliers are based on personal consumption expenditures measured in I-O tables for a given year. Regional I-O multipliers use the same spending response for all types of changes in regional final demand, whether an increase in investment, an increase in government spending, or an increase in consumer spending.

Under certain technical assumptions, the two different types of multipliers can be related to one another.[2] The results calculated from the two different types of models are more likely to be similar when resources are more readily available in an economy.

Despite some of the restrictive underlying assumptions of regional I-O models, which are explained in this paper, one of their main advantages is that they can be used to estimate the sectorial impact of industry-specific changes in final demand. Examples of studies where regional I-O models can be useful include:

- A refrigerated warehousing company expands its facility.
- Exports increase for a local winery that has "gone green" by installing solar panels to generate its own electricity.
- A local alpaca apparel manufacturer expands its online business by hiring new employees and investing in additional computers to meet an increase in demand.
- A construction project is undertaken with federal grant money to replace an existing high school.
- An amusement park installs a new rollercoaster and sees an increase in ticket sales.
- A local tractor manufacturer must lay off 100 of its employees due to a decrease in demand.

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[1] Two types of models have been developed to relax the assumptions of fixed prices in I-O models— Computable general equilibrium (CGE) models and hybrid conjoined models. One disadvantage of these models is that they are complex enough that usually only a low-level of industry detail is used. Additional information on these two types of models can be found in many standard textbooks on regional analysis, such as Schaffer, Deller, and Marcouiller (2004).

[2] For a further discussion on how the two different types of models can be related, see ten Raa (2005).

In each of these cases, care needs to be taken to ensure that the results are correctly interpreted in light of the assumptions underlying these models. These examples are used throughout the paper to help illustrate the use of regional I-O models.

This paper adds to the literature by offering suggestions on the appropriate use of the regional I-O model maintained by the Bureau of Economic Analysis (BEA), the Regional Input-Output Modeling System (RIMS II)[3]. These suggestions are offered after providing a brief review of the literature and an overview of the model.

2. Literature Review

Literature on the calculation of Keynesian multipliers traces back to Richard Kahn's (1931) description of an employment multiplier for government expenditure during a period of high unemployment. At this early stage, Kahn's calculations recognize the importance of supply constraints and possible increases in the general price level resulting from additional spending in the national economy. More recently, Hall (2009) discusses the way that behavioral assumptions about employment and spending affect econometrically estimated Keynesian multipliers.

The literature on the calculation of I-O multipliers traces back to Leontief (1941), who developed a set of national-level multipliers that could be used to estimate the economy-wide effect that an initial change in final demand has on an economy. Isard (1951) then applied input-output analysis to a regional economy. According to Richardson (1985), the first attempt to create regional multipliers by adjusting national data with regional data was Moore and Peterson (1955) for the state of Utah.

In a parallel development, Tiebout (1956) specified a model of regional economic growth that focuses on regional exports. His economic base multipliers are based on a model that separates production sold to consumers from outside the region to production sold to consumers in the region. The magnitude of his multiplier is based on the regional supply chain and local consumer spending.

In a survey of input-output and economic base multipliers, Richardson (1985) notes the difficulty inherent in specifying the local share of spending. He notes the growth of survey-based regional input-output models in the 1960s and 1970s that allowed for more accurate estimation of local spending, though at a large cost in terms of resources. To bridge the gap between resource intensive survey-based multipliers and "off-the-shelf" multipliers, Beemiller (1990) of the BEA describes the use of primary data to improve the accuracy of regional multipliers.

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[3] For more information on RIMS II, see U.S. Department of Commerce, Bureau of Economic Analysis (1997).

The literature on the use and misuse of regional multipliers and models is extensive. Coughlin and Mandelbaum (1991) provide an accessible introduction to regional I-O multipliers. They note that key limitations of regional I-O multipliers include the accuracy of leakage measures, the emphasis on short-term effects, the absence of supply constraints, and the inability to fully capture interregional feedback effects.

Three other papers on the general topic of the use and misuse of regional multipliers are briefly noted. Grady and Muller (1988) argue that regional I-O models that include household spending should not be used and argue that cost-benefit analysis is the most appropriate tool for analyzing the benefits of particular programs. Mills (1993) notes the lack of budget constraints for governments and no role for government debt in regional I-O models. As a result, in less than careful hands, regional I-O models can be interpreted to over-estimate the economic benefit of government spending projects. Hughes (2003) discusses the limitations of the application of multipliers and provides a checklist to consider when conducting regional impact studies.

Additional papers focus on the uses and misuse of regional multipliers for particular types of studies. Harris (1997) discusses the application of regional multipliers in the context of tourism impact studies, one area where the multipliers are commonly misused. Siegfried, Sanderson, and McHenry (2006) discuss the application of regional multipliers in the context of college and university impact studies, another area where the multipliers are commonly misused.

3. Overview of RIMS II

Since the 1970s, BEA has produced regional I-O multipliers that show the inter-industry purchases resulting from changes in final demand. The RIMS II model is created by adjusting national I-O relationships with regional data[4]. Earnings-by-industry and personal consumption expenditure data are used to expand the model to include households as both suppliers of labor and purchasers of final goods and services.

The multipliers produced by the model are customized to account for the economic activity in any set of contiguous U.S. counties. These multipliers represent ratios of total to partial changes in economic activity—for example, a total change in employment to an initial change in final demand. When these ratios are multiplied by a change in final demand that is specific to a local economic event, the result is an estimate of a total change in the local economy.

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[4] For a complete discussion of the methodology used to create the RIMS II multipliers, see Appendix A of the RIMS II Handbook (1997).
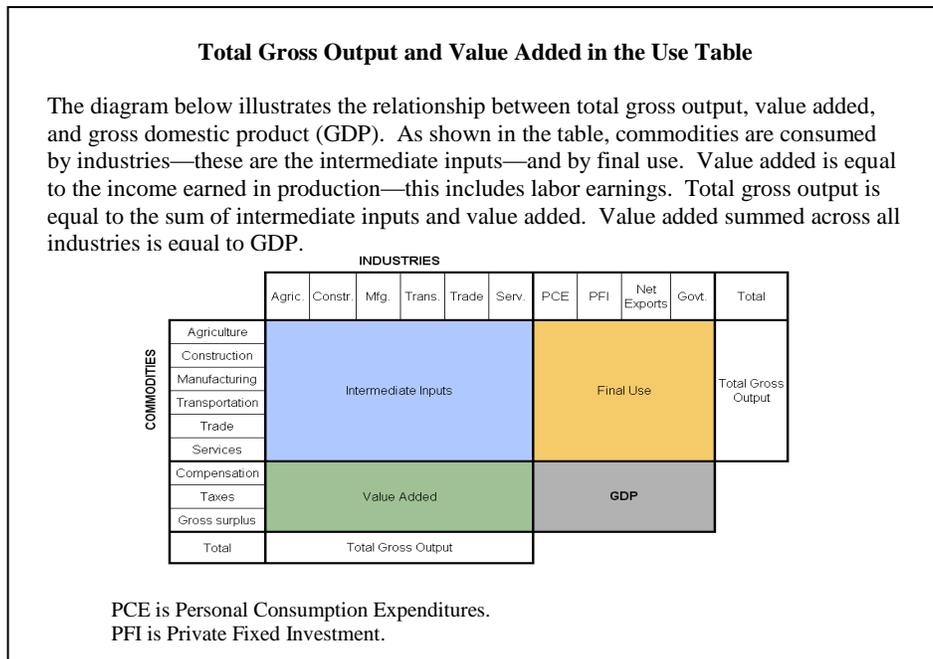
3.1 Measured Impacts

When using RIMS II, there are four measures of changes in total economic activity that can be estimated—gross output, value added, earnings, and employment.

Gross output is equal to the sum of the intermediate inputs and value added[5]. It can also be measured as the sum of the intermediate inputs and final use. Gross output is a duplicative total in that goods and services will be counted multiple times if they are used in the production of other goods and services.

Value added is defined as the value of gross output less intermediate inputs. The value of this measure is equal to the sum of compensation of employees, taxes on production and imports less subsidies, and gross operating surplus.

RIMS II earnings consist of wages and salaries and proprietors' income.[6] Employer contributions for health insurance are also included. Personal contributions to social insurance and employee pension plans are excluded because the model must account for only the portion of personal income that is currently available for households to spend.

Employment consists of a count of jobs that include both full-time and part-time workers. Whether an employee works 40 hours a week or 4 hours a week, they are counted the same in the RIMS II model.

Total Gross Output and Value Added in the Use Table

The diagram below illustrates the relationship between total gross output, value added, and gross domestic product (GDP). As shown in the table, commodities are consumed by industries—these are the intermediate inputs—and by final use. Value added is equal to the income earned in production—this includes labor earnings. Total gross output is equal to the sum of intermediate inputs and value added. Value added summed across all industries is equal to GDP.

						INDUSTRIES						
		Agric.	Constr.	Mfg.	Trans.	Trade	Serv.	PCE	PFI	Net Exports	Govt.	Total
COMMODITIES	Agriculture											
	Construction											
	Manufacturing				Intermediate Inputs				Final Use			Total Gross Output
	Transportation											
	Trade											
	Services											
	Compensation											
	Taxes				Value Added				GDP			
	Gross surplus											
	Total				Total Gross Output							

PCE is Personal Consumption Expenditures.
PFI is Private Fixed Investment.

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[5] Intermediate inputs are goods and services that are used in the production process of other goods and services and are not sold in final-demand markets. (BEA glossary)
[6] Proprietors' income is the net earnings associated with non-corporate businesses.

3.2 Type I and Type II Multipliers

RIMS II provides both Type I and Type II multipliers (table 1). Type I multipliers account for the direct and indirect impacts based on how goods and services are supplied within a region. Type II multipliers not only account for these direct and indirect impacts, but they also account for induced impacts based on the purchases made by employees.

Table 1. Composition of Total Impact

Type I Multipliers	Type II Multipliers
Final-demand change	Final-demand change
+ Direct impacts	+ Direct impacts
+ Indirect impacts	+ Indirect impacts
	+ Induced impacts
Total impact	Total impact

4. RIMS II Assumptions

The accounting conventions that form the basis of an I-O model impose assumptions that analysts need to be aware of when using these models. I-O models are also typically based on assumptions related to local supply conditions. Since many of these assumptions can lead to an overstatement of the impacts of a project or program, many consider the estimates as upper bounds.

Analysts can work around some of these assumptions of the RIMS II model by using a bill-of-goods approach, which uses the purchases of goods and services (including labor) by the initially affected industry (see appendix B). However, one drawback with this method is that it requires the use of detailed information that can be difficult to gather for a particular study.

4.1 Backward Linkages

Impact models can measure the effect an industry's production has on other industries in the economy in two ways. If an industry increases its production, there will be increased demand on the industries that produce the intermediate inputs. Models that measure impacts based on this type of relationship are called backward-linkage models. If an industry increases its production, there will also be an increased supply of output for other industries to use in their production. Models that measure impacts based on this type of relationship are called forward-linkage models.[7]

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[7] For a full discussion of backward- and forward-linkage models, see Miller and Blair (2009).

The RIMS II model is backward-linkage model. To clarify this concept, consider the refrigerated warehouse facility example from the introduction. When using RIMS II multipliers, the estimated impacts include increases in the supply of inputs to the warehouse but exclude the effects that any additional food manufacturers locating near the expanded warehouse facility might have on local economic activity.

4.2 Fixed Production Patterns

I-O models typically assume that inputs are used in fixed proportion, without any substitution of inputs, across a wide range of production levels. In others words, the model assumes that an industry must double its inputs to double its output without substitution. If these assumptions are inconsistent with the true production patterns in the local economy, then the impact of the change on the local economy will differ from that implied by a regional multiplier.

The assumption of fixed production patterns relates to labor inputs as well. I-O models typically assume that changes in output will result in a proportional change in jobs based on the average production patterns for the industries in a local economy. However, if an industry can increase its output by extending mainly the number of hours that existing employees work, then the results estimated with RIMS II multipliers will overstate the actual increase in local employment.

Tourism and recreation studies commonly neglect to take into account that increases in sales often do not result in a large increase in jobs—for example, the addition of a new rollercoaster at an amusement park may drive up ticket sales, but the increase in sales does not necessarily require hiring additional park employees.

4.3 Industry Homogeneity

I-O models typically assume that all firms within an industry are characterized by a common production process. If the production structure of the initially-affected local firm is not consistent with the average relationships of the firms that make up the industry in the I-O accounts, then the impact of the change on the local economy will differ from that implied by a regional multiplier.

To clarify this concept, consider the example from the introduction where there is an increase in export demand for a local winery that has "gone green" with the installation of solar panels. Since the local winery no longer purchases electricity from local providers like most wineries, its purchase patterns for intermediate inputs differ from those that underlie RIMS II. As a result, using a RIMS II multiplier to estimate the impact of the change in demand will yield misleading results.

To make adjustments that account for the winery's own production of electricity, a bill-of-goods approach can account for the winery's particular purchases.

4.4 Fixed Prices and No Supply Constraints

I-O models are typically referred to as fixed-price models because they assume there will be no price adjustment in response to supply constraints or other factors. In other words, firms can increase their use of inputs, including labor, as needed to meet additional demand for their products.

The model assumes that the firms in the local economy are not operating at full capacity. To clarify this concept, consider the alpaca apparel manufacturer example from the introduction. The company needs to hire additional workers to meet an increase in internet sales. The model assumes that these employees are available for hire at the existing wage rate for alpaca apparel workers.

4.5 Local Supply Conditions

Regional I-O tables that are based on national I-O relationships need to make adjustments to account for local supply conditions. The basic idea behind these adjustments is that industries in the region are not likely to produce all of the intermediate inputs required to produce the change in final demand. In these cases, local industries must purchase intermediate goods and services from producers outside the region, thereby creating leakages from the local economy.

RIMS II accounts for these leakages by adjusting national I-O relationships with regional location quotients (LQs). For most industries, LQs consist of the ratio of an industry's share of regional earnings to the industry's share of national earnings.

If the LQ for the industry is one or greater, then the industry's national coefficients are used for the region. If the LQ for an industry is less than one, then the national coefficients are reduced by the ratio to account for leakages.

Location Quotients

$$LQ_i^k = \left(\frac{E_i^k \Big/ \sum E^k}{E_i^N \Big/ \sum E^N} \right)$$

$$R_i^k = \begin{cases} LQ_i^k & if \quad LQ_i^k < 1.0 \\ 1.0 & if \quad LQ_i^k \geq 1.0 \end{cases}$$

$$A^k = \hat{R} A^N$$

Where:
LQ = Location Quotient
E = Earnings
R = Regionalizing Index
A = Direct Requirements Matrix
k = Region
i = Industry
N = Nation

The use of LQs to adjust the national coefficients does not explicitly account for what is typically referred to as cross hauling. Cross hauling refers to the phenomenon where goods and services are imported from outside a region even though there is an adequate supply of these goods and services produced within the region.

To show how cross hauling can adversely affect results, consider the case where a warehouse purchases its janitorial services from outside the region. If there is a high concentration of local janitorial service providers in the region, RIMS II will assume the

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warehouse industry is using these local providers, producing multipliers that are too high. To make adjustments for services purchased outside of the economy, a bill-of-goods approach can be used to exclude the impact of janitorial services from the increase in warehouse purchases.

4.6 No Regional Feedback Effects

RIMS II is a single region I-O model. It ignores any feedback effects that may exist among regions.

To clarify this concept, consider the high school construction example in the introduction. If the construction of a new high school in region A requires the purchase of windows from region B, then this purchase is a leakage from region A. The purchases of goods and services associated with the production of the windows are also excluded from the multiplier. That is to say, if the window manufacturer in region B requires accounting services from region A, then the impact of the increase in demand for accounting services from region A is also excluded from the multiplier because the multiplier does not include feedback affects.

It is unclear how the results are affected by this feedback effect without knowing the details of how a local economy might be related to its neighbors. However, it does demonstrate the importance of choosing a study region that encompasses most of these possible relationships.

4.7 Time Dimension

The length of time that it takes for the economy to settle at its new equilibrium after an initial change in economic activity is unclear because time is not explicitly included in regional I-O models. Some analysts assume the adjustment will be completed in one year because the flows in the underlying industry data are measured over the same length of time. However, the actual adjustment period varies and is dependent on the change in final demand and the related industry structure that is unique to each regional impact study.

The issue of time also arises in another aspect related to regional impact studies. The initial change in final demand should be permanent or at least persistent enough to allow for the shock to fully work through the economy. If the initial shock is not persistent, as may be the case with a short-term special event or construction project, then firms in the local area may increase output without hiring as many additional employees or buying as many additional inputs from the local economy as the model assumes. In these cases, the actual impact of the change on the local economy will be smaller than that estimated in an impact study.

5. User Inputs

The accuracy of impact estimates relies not only on how well the assumptions that underlie RIMS II relate to the study, but also on correctly identifying and specifying the final-demand change, the initially affected industries, and the study region.

5.1 Final-Demand Change

Final demand consists of goods and services purchased by final users and can be expressed in terms of gross output, earnings, or employment. These purchases include investments in new construction, equipment, and software; government purchases; purchases made by outside consumers (exports); and purchases made by household consumers.

Identifying the appropriate changes in final demand to use in an impact study is straightforward for changes in purchases made by government and non-local purchasers. However, identifying the changes in final demand to use in an impact study for new purchases by local consumers is more nuanced.

In studies using Type I multipliers, all changes in consumer purchases are considered final-demand changes. However, in studies using Type II multipliers, only changes in consumer purchases made by individuals who either reside outside of the region or who reside but are not employed in the region are considered final-demand changes. Purchases made by consumers who both work and reside in the region must be excluded from the change in final demand because they have already been accounted for in the model.

The expansion of business activities often requires investments in new construction, equipment, or software. Because these purchases constitute changes in final demand rather than changes in intermediate inputs, the impacts of these purchases need to be estimated separately. Investment impacts can be added to the impacts resulting from expanded operations to calculate the total impact associated with a project.

To clarify the treatment of investment purchases, consider the rollercoaster example from the introduction. The purchase of new rollercoaster cars should not be included in the final-demand change that is applied to the multipliers for new construction. This is because the cars are not an intermediate purchase for the construction industry. Instead, the value of the new cars should be multiplied by the final-demand multipliers for the industry that manufactures the rollercoaster cars.

5.2 Multiplier Selection

RIMS II provides four types of final-demand multipliers and two types of direct-effect multipliers. These multipliers all provide an estimate of the total impact across all industries, but the total obtained from using the Type I multipliers is different from the total obtained from using the Type II multipliers. This is because the Type I multipliers

quantify the cumulative effects of the direct and indirect rounds of industry spending, while the Type II multipliers quantify the cumulative effects of the direct, indirect, and household (induced) rounds of spending.

When the change in final demand is expressed as change in gross output (defined in section 3.1), the total impact across all industries can be calculated by using the final-demand multipliers (table 2).

Table 2. RIMS II Final-Demand Multipliers

Multiplier	Definition	Application
Output	Total industry output per $1 change in final demand	Final-demand output x final-demand multiplier = total gross output impact
Value added	Total value added per $1 change in final demand	Final-demand output x final-demand value-added multiplier = total value-added impact
Earnings	Total household earnings per $1 change in final demand	Final-demand output x final-demand earnings multiplier = total earnings impact
Employment	Total number of jobs per $1 million change in final demand	Final-demand output x final-demand employment multiplier = total jobs impact

An estimate of the total impact can also be calculated by using direct-effect multipliers with an estimate of the change in earnings or employment that is associated with a change in final demand (table 3). However, both the earnings and employment estimates of the final-demand changes should include full-time and part-time workers.

The direct-effect earnings multiplier is an expression of the relationship between the total earnings impact and final-demand earnings. In other words, it is an earnings-per-earnings multiplier. An estimate of the change in final-demand earnings is needed to use these multipliers. Final-demand earnings should only include the earnings of the employees who reside in the region.

The direct-effect employment multiplier is an expression of the relationship between the total jobs impact and final-demand jobs. In other words, it is a jobs-per-jobs multiplier. An estimate of the change in final-demand jobs is needed to use these multipliers. Final-demand jobs should include only the employees who reside in the region.

Table 3. RIMS II Direct-Effect Multipliers

Multiplier	Definition	Application
Earnings	Total household earnings per $1 change in final-demand earnings	Final-demand earnings x direct-effect earnings multiplier = total earnings impact
Employment	Total number of jobs per 1 job change in final-demand jobs	Final-demand jobs x direct-effect employment multiplier = total jobs impact

Regardless of the type of multiplier that is being used, the resulting estimate will include the value of the initial change in final demand.

5.3 Final-Demand Industry

To use RIMS II multipliers, the industry initially affected by the change in final demand (or final-demand industry) must be identified. There are two levels of industry detail in RIMS II—406 detailed industries and 62 aggregate industries. The detailed industry multipliers will provide better estimates if there is a concern that the production patterns of the final-demand industry differs considerably from the average production relationships measured for the aggregate industries. However, a drawback associated with the use of the more detailed industries is that they are often based on input-output relationships that are more out of date. If this second consideration is more of a concern, then the multipliers for aggregate industries should be used.

An additional consideration when selecting industries is that changes in final demand for projects that have multiple phases need to use the correct multipliers for each phase of the project—for example, estimating the impact of the construction of a new stadium requires the use of different multipliers than estimating the impacts for operating the stadium.

5.4 Study Region

The selection of a study region depends upon the purpose of the study, the location of the industry or industries that are initially affected by the change in final demand, and the location of the industries supplying direct inputs. The residence of the final-demand employees is another important consideration. The model requires that the final-demand employees both work and reside in the region, and assumes that induced impacts from household purchases occur where employees reside.

The study region should be large enough to include the industries that supply a large share of the direct inputs, but small enough so that impacts are not overestimated. Smaller, less-diversified regions usually have smaller multipliers because these areas need to import more goods and services for production.

To clarify this concept, consider the amusement park example from the introduction. Using multipliers for a single county to estimate the impact of a final-demand change for the amusement park will show the impact to the county, but it will exclude any feedback effects that may exist with industries in the surrounding counties. However, using state-level multipliers assume that the park uses inputs from the entire state, which is likely to be unrealistic for many important inputs, such as labor, and may result in estimates that are too high.

6. Common Mistakes When Using RIMS II Multipliers

In addition to understanding the limitations associated with the assumptions in RIMS II, it is important to avoid the common mistakes made when using the model's multipliers.

6.1 Excluding Offsets

An increase in final demand for one firm in a region may result in a decrease in final demand for another firm in that same region. Therefore, only the net changes in final demand should be applied to the RIMS II multipliers.

To clarify this concept, consider again the amusement park example from the introduction. If the amusement park's new rollercoaster draws customers away from another park in the region, then only the net change in the value of ticket sales should be used to estimate an impact for the region.

6.2 Confusing Gross Output with GDP

RIMS II output multipliers are used to produce estimates of changes in total gross output, which is a duplicated total.[8] However, GDP, which measures final demand expenditures, is an unduplicated total. To compare the impact results to regional measures of GDP, a value added multiplier needs to be used. Both value added and GDP exclude the impact of spending on intermediate inputs.

6.3 Confusing Changes in Investment with Intermediate Purchases

New construction and purchases of equipment and software are treated as investment, not as intermediate purchases. If an industry invests in these items to meet a change in final demand, then these purchases need to be treated as separate final-demand changes.

To clarify this concept, consider the alpaca apparel manufacturer that experiences a large enough increase in demand for its products that it has to purchase additional computers. Using the RIMS II multipliers for apparel manufacturing to estimate the impact of an increase in final demand for alpaca apparel will not reflect the additional purchases of computers, which represent investment spending. The impact associated with these purchases should be estimated separately using multipliers for computer manufacturing, transportation, wholesale, and retail services (assuming these services are produced locally.) These impacts can then be added to the impact associated with the increase in demand for alpaca apparel.

6.4 Using Final-Demand Changes in Consumer Prices

Changes in final demand that are based on output should be measured in the price paid to the producer (producer prices) rather than the consumer or purchaser price. Producer prices exclude transportation costs and wholesale and retail trade margins. These prices are used in the model because they represent the actual prices that producers must pay for

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[8] Gross output counts goods and services multiple times if they are used in the production of other goods and services.

inputs in order to increase their output. Since the transportation, wholesale trade, and retail trade industries are treated as separate industries in RIMS II, the model allows for an analysis of how these industries are separately affected by an initial change in final demand.

6.5 Using a Type II Multiplier when a Type I Multiplier is More Appropriate

Type II multipliers not only account for the direct and indirect effects associated with changes in production, but they also account for the induced impacts associated with increases in earnings. However, including induced impacts can be unrealistic for some studies.

To clarify this concept, consider the example from the introduction where the tractor manufacturer lays off 100 employees. Using a Type II multiplier would assume that the loss in household spending would equal the lost earnings associated with the employees' jobs. However, if these employees were to receive unemployment benefits, then the loss in household spending would not be as great. Using a Type I multiplier in this scenario provides a more conservative estimate because it excludes the impact of changes in household spending.

6.6 Averaging or Summing Multipliers

When analysts cannot find a suitable industry multiplier for their study, many are tempted to create their own multipliers by taking a simple average of multipliers for several industries. RIMS II multipliers are derived from the detailed I-O tables and regional data, which make them unique to the individual industries and regions and should not be averaged.

Another practice that should be avoided is summing multipliers across regions or breaking down multipliers into constituent regions. These practices do not account for the interactions between industries and the leakages from the regions.

6.7 Using Multipliers to Measure Industry Contributions

RIMS II multipliers are created to estimate the total impacts resulting from incremental changes in final demand. Because the model is based on existing industry relationships, RIMS II multipliers are not well-suited to estimate the total contribution of an existing industry to a local economy.

When multipliers are used to estimate the total contribution of an industry by applying a negative final-demand change equal to the entire output of the industry in a local economy, this change is likely to alter the basic structure of the local economy in ways that will not be accurately captured by the model.

Instead of using multipliers to estimate an industry's contribution to a local economy, simply researching the earnings and employment associated with an industry in a local

economy may be a better alternative. Albeit conservative, this alternative also provides information regarding the importance of the industry to the local economy.

7. Summary

Regional I-O models can be useful tools for estimating the total effects that an initial change in economic activity will have on a local economy. However, these models are not appropriate for all applications and care should be given to their use. Understanding the limitations of these models allows for improved impact studies and a more precise interpretation of the results.

Key assumptions of these models typically include fixed production patterns and no supply constraints. Assumptions about the amount of inputs that are supplied from the local region are also important in these models. Ignoring these assumptions can lead to inaccurate impact estimates.

Finally, bringing additional survey information into multiplier analysis may be costly in terms of time and resources, but it can provide more accurate results. For example, the bill-of-goods approach can yield more tailored results than directly applying the multipliers for a single industry.

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Appendix A: Application of RIMS II Multipliers

Suppose a private university in the Austin, TX area plans to expand its academic programs. The university expects its student population will increase by 500 because of these new programs and that these students will pay a total of $10 million in tuition. The university also knows that this increase in tuition payments will result in a proportional increase in the inputs they purchase. Furthermore, the new students do not currently reside in the Austin, TX area and they are not currently enrolled in or planning to enroll in other schools in the area.

The current residency of the new students (who are the consumers of the educational service) is important when specifying the final-demand change. Type II multipliers can be used in this case since all of the new students currently reside outside the area. If all of the students did not currently reside outside the area, the $10 million estimate of final-demand change should be adjusted downward. If all of the new students resided within the area, then it would be more appropriate to apply the $10 million in final-demand change to Type I instead of Type II final-demand multipliers.

1. Using Final-Demand Multipliers

Table A-1 shows the Type II final-demand multipliers for the "Junior Colleges, Colleges, Universities, and Professional Schools" industry that were calculated for the Austin-Round Rock-San Marcos, TX Metropolitan Statistical Area. The final-demand multipliers for this industry can be used to estimate the impacts of the $10 million increase of educational services on the local economy. The total impacts that are calculated using multipliers from this table will include the final-demand change, as well as the direct, indirect, and induced effects.

Table A-1. Type II Total Final-Demand Multipliers
Austin-Round Rock-San Marcos, TX MSA[1]

Industry	Output (dollars)	Value Added (dollars)	Earnings (dollars)	Employ-ment (jobs)
Junior colleges, colleges, universities, and professional schools (611A00)	2.1871	1.2982	.7603	24.0

1. Composed of the following counties in Texas: Bastrop, Caldwell, Hays, Travis, and Williamson.

Using the multipliers from Table A-1 and the $10 million increase in university sales, the total impact on the region in terms of output is $21.9 million ($10 million x 2.1871). The value added portion of this $21.9 million impact is $13 million ($10 million x 1.2982). The earnings portion of the $21.9 million impact is $7.6 million ($10 million x 0.7603). When the total impact is valued in terms of jobs, the total impact of the $10 million increase in university sales is 240 jobs (10 x 24.0). These 240 jobs include both full-time and part-time workers.

These multipliers assume that the increase in earnings received by university employees is spent by households in the same pattern as personal consumption expenditures at the

national level. However, some of the university employees are students who may not make the same purchases as other households (for example, groceries, home maintenance, and motor vehicle purchases). To account for this exception, a conservative impact estimate may be calculated using Type I multipliers instead.

The increase in tuition (university sales) may be broken down into the impacts on other industrial sectors in the region using the RIMS II breakdown tables. These tables provide a breakdown of an industry's impact on 20 aggregated sectors. Table A-2 shows a breakdown of the final-demand output multiplier for the "Junior Colleges, Colleges, Universities, and Professional Schools" industry that were calculated for the Austin-Round Rock-San Marcos, TX MSA.

Table A-2. Breakdown by Sector of Type II Total Final-Demand Multipliers for Junior Colleges, Colleges, Universities, and Professional Schools (611A00), Austin-Round Rock-San Marcos, TX MSA

Line	Industry	Output (dollars)	Value Added (dollars)	Earnings (dollars)	Employment (jobs)
1	Agriculture, forestry, fishing, and hunting	.0010	.0004	.0002	.0
2	Mining..	.0101	.0051	.0021	.0
3	Utilities*	.0769	.0468	.0148	.1
4	Construction	.0143	.0071	.0052	.1
5	Manufacturing.......................................	.0562	.0206	.0112	.2
6	Wholesale trade...................................	.0558	.0377	.0174	.3
7	Retail trade	.0859	.0563	.0293	1.2
8	Transportation and warehousing*.....................	.0251	.0143	.0100	.2
9	Information	.0878	.0485	.0197	.3
10	Finance and insurance	.1062	.0612	.0290	.5
11	Real estate and rental and leasing	.2802	.2130	.0264	1.2
12	Professional, scientific, and technical Services.......................................	.0974	.0641	.0452	.7
13	Management of companies and Enterprises	.0042	.0026	.0017	.0
14	Administrative and waste management Services.......................................	.0465	.0297	.0188	1.0
15	Educational services...........................	1.0163	.5648	.4466	14.9
16	Health care and social assistance	.0845	.0523	.0396	1.0
17	Arts, entertainment, and recreation	.0092	.0055	.0032	.2
18	Accommodation...................................	.0138	.0089	.0041	.2
19	Food services and drinking places	.0403	.0210	.0128	.9
20	Other services*....................................	.0753	.0371	.0220	.8
21	Households	.7603	.0010	.0010	.1
	Total	**2.1870**	**1.2980**	**.7603**	**24.0**

* Includes Federal Government Enterprises.

Using the multipliers in Table A-2 and the $10 million increase in university sales, the increase in output for the "Agriculture, forestry, fishing, and hunting" sector is $10,000 ($10 million x .0010). The value added portion of this $10,000 increase is equal to $4,000 ($10 million x .0004) and the earnings portion is equal to $2,000 ($10 million x .0002). The resulting increase in full-time and part-time jobs in the agriculture, forestry, fishing and hunting sector is negligible ($10 million x 0.0).

Similarly, the $10 million increase in university sales results in a $10.2 million ($10 million x 1.0163) increase in sales by the "Educational services" sector. Because the initially affected university industry is part of this sector, this increase includes the initial $10 million increase of university sales. The value added portion of the $10.2 million increase is equal to $5.6 million ($10 million x .5648) and the earnings portion is equal to $4.5 million ($10 million x .4466). The resulting increase of full-time and part-time jobs in the educational services sector is 149 jobs ($10 million x 14.9).

2. Using Direct-Effect multipliers

If an estimate of the increase in earnings and employment for full-time and part-time university workers is also known, these estimates can be used with the direct-effect multipliers to provide another way of estimating the total impact. Suppose the newly expanded academic programs require 150 additional employees who earn a total of $4.2 million.

Table A-3. Type II Total Final-Demand Multipliers
Austin-Round Rock-San Marcos, TX MSA

Region	Earnings (dollars)	Employ-ment (jobs)
Junior colleges, colleges, universities, and professional schools (611A00)..................	1.7261	1.6338

Using the multipliers from Table A-3 and the initial change in earnings for the additional university workers, the total impact in terms of earnings is $7.2 million ($4.2 million x 1.7261). Using the direct-effect employment multiplier with the initial change in employment, the total impact in terms of full-time and part-time jobs for the region is 245 (150 x 1.6338)

These earnings and employment impact estimates differ slightly from the impacts estimated with the final-demand multipliers. This occurs because data used in this example for the direct earnings and employment at the university differs from the direct earnings and employment assumed by the RIMS II model. In other words, RIMS is assuming 147 direct jobs at the university whereas the example assumes from the onset that 150 jobs are required.

Deriving Direct Earnings and Employment from RIMS II Multipliers

(Final-demand earnings multiplier / Direct-effect earnings multiplier) x $10 million = $4.4 million direct earnings

(Final-demand employment multiplier / Direct-effect employment multiplier) x $10 million = 147 direct jobs

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Appendix B: Example of using a "Bill-of-Goods" Approach

If detailed data on the local purchases of goods and services (including labor) are available, then these "bill-of-goods" data should be used to estimate impacts. However, these purchases must be valued in producer prices when using the multipliers.

Purchases of inputs valued in purchaser prices must be separated into the production costs, transportation costs, and wholesale and retail margins before using the multipliers. The national distribution costs tables in the RIMS II online order and delivery system contain data that can be used to separate these costs. The example illustrating the use of national distribution costs data to separate producer costs, transportation costs, and wholesale and retail margins is included in this paper as appendix C.

In the bill-of-goods method, the initial final-demand change is added to the sum of impacts of the locally produced inputs to account for the total change in economic activity. The initial change equals the sum of the final-demand industry's intermediate purchases plus its value added, which includes labor earnings.

Example's Assumptions

Suppose that a local university develops a new program that attracts new students from outside of the region. In addition, suppose that the program requires an additional $10 million of purchases, including salaries, of which $6 million is purchased locally. In this example, the sum of intermediate purchases and labor earnings is used as a proxy for the final-demand change, which is also roughly equal to the tuition paid by the new students.

- **Final-demand change**—$10 million increase in university expenditures as a result of a new program attracting students from outside of the region.

- **Local purchases**—$6 million of local purchases, as shown in Table B-1. In addition, the university will hire 140 new employees, also shown in Table B-1.

- **Affected industries**—The university and local industries that produce and distribute the goods and services purchased by the university.

- **Affected region**— Austin-Round Rock-San Marcos, TX MSA, where a large proportion of the university employees reside and the goods and services purchased by the university are produced.

The tables below illustrate the difference between a multiplier derived from the change in the regional purchases for an industry used in a bill-of-goods approach and the final-demand multiplier for that industry. Table B-1 shows an increase of 204 part-time and full-time jobs using the bill-of-goods method. The implied multiplier based on the change in regional purchases and the RIMS II multipliers is 20.4. Table B-2 shows an increase of 240 part-time and full-time jobs using a multiplier for universities.

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**Table B-1. Estimating the Employment Impacts of a University
Using a Bill-of-goods Method**

Expenditures	Increase in Regional purchases in producers' prices	Final-demand employment multiplier (jobs)	Employment impact (jobs)
Employee earnings	$5,000,000	10.6365	53.2
Electricity	$200,000	6.6949	1.3
Gas	$110,000	6.3108	0.7
Water	$65,000	11.9699	0.8
Maintenance and repair	$180,000	18.0354	3.2
Books for sale at bookstore	$300,000	10.2733	3.1
Laboratory supplies..	$80,000	9.4066	0.8
Truck transportation	$15,000	17.9329	0.3
Wholesale margin	$50,000	11.6000	0.6
Subtotal..	$6,000,000	n.a.	63.9
Plus: Initial change	**n.a.**	**n.a.**	**140.0**
Total..	n.a.	n.a.	203.9
Implied final-demand employment Multiplier	**n.a.**	**20.4**	**n.a.**

* Calculation of implied multiplier: 203.9 ÷ $10 million = 20.4

**Table B-2. Estimating the Employment Impacts of a University Using a Multiplier for
Junior Colleges, Colleges, Universities, and Professional Schools**

Industry	Final-demand change	Final-demand employment multiplier (jobs)	Employment impact (jobs)
Junior colleges, colleges, universities, and professional schools	$10,000,000	24.0101	240.1

Appendix C: Example of Converting a Final-Demand Change in Purchaser Prices to Producer Prices

When using RIMS II multipliers, final-demand changes must be valued in producer prices instead of purchaser prices. This also applies when using the bill-of-goods method. Producer prices exclude transportation costs and the wholesale and retail margins.

In the absence of regional distribution costs, national distribution costs are an alternative data source for converting purchaser prices to producer prices. If the final-demand change is valued in purchaser prices, the final-demand change must be separated into components for production costs, transportation costs, and wholesale and retail trade margins before applying the multipliers.

Producer Price = Purchaser Price – Transportation Costs – Wholesale Margin – Retail Margin

The examples below use data from the benchmark national distribution cost tables. Table C-1 shows the producer and purchaser values of a $2 million investment purchase of computers.

Table C-1. Final-demand Changes Valued in Producer and Purchaser Prices

Commodity	Purchaser Value	Producer Value
Computers............................	$2,000,000	$1,620,000

Table C-2 shows the producer value, transportation costs, wholesale and retailer margins, and the purchaser value for investment purchases of computers at the national level. This information can be used to create ratios of the producer value, transportation costs, and trade margins to the total purchaser value at the national level. These ratios are shown in Table C-3.

The national ratios can be multiplied by the $2 million of computer purchases valued in consumer (purchaser) prices. This will provide estimates of the final-demand change for the computer producer, the transportation providers, the wholesaler, and the retailer. These estimates are shown in Table C-4.

**Table C-2. National Input-Output Commodity Composition of PES of
Computers and peripheral equipment**
[Millions of dollars]

Commodity	Producer Value	Railroad Costs	Truck Costs	Water Costs	Air Costs	Oil Pipeline Costs	Gas Pipeline Costs	Wholesale Margin	Retail Margin	Purchaser Value
Electronic computer manufacturing	31841	1	187	0	66	0	0	5338	1866	39300

Source: 2002 national benchmark Distribution Costs Table E.

Table C-3. National Ratios for Investment in Computers

Commodity	Producer Value	Railroad Costs	Truck Costs	Water Costs	Air Costs	Oil Pipeline Costs	Gas Pipeline Costs	Wholesale Margin	Retail Margin	Purchaser Value
Electronic computer manufacturing	0.81	0.00	0.01	0.00	0.00	0.00	0.00	0.14	0.05	1.00

For example, the computer manufacturing national ratio for wholesale trade is $5338 million ÷ $39300 million = 0.14.

Table C-4. Final-demand Changes Valued in Producer Prices
[Millions of dollars]

Commodity	Producer Value	Railroad Costs	Truck Costs	Water Costs	Air Costs	Oil Pipeline Costs	Gas Pipeline Costs	Wholesale Margin	Retail Margin	Purchaser Value
Electronic computer manufacturing	1.62	0.00	0.01	0.00	0.00	0.00	0.00	0.28	0.09	2.00

For example, the final-demand change for wholesale trade is $2 million x 0.14 = $0.28 million.

Appendix D: Multiplier Tables

1. Final-Demand Multipliers

Table D-1. Type I Total Final-Demand Multipliers for Junior Colleges, Colleges, Universities, and Professional Schools (611A00), Austin-Round Rock-San Marcos, TX MSA

Industry	Output (dollars)	Value Added (dollars)	Earnings (dollars)	Employ- ment (jobs)
Junior colleges, colleges, universities, and professional schools (611A00)	1.4849	.8639	.5648	18.0

Table D-2. Breakdown by Sector of Type I Total Final-Demand Multipliers for Junior Colleges, Colleges, Universities, and Professional Schools (611A00), Austin-Round Rock-San Marcos, TX MSA

Line	Industry	Output (dollars)	Value Added (dollars)	Earnings (dollars)	Employ- ment (jobs)
1	Agriculture, forestry, fishing, and hunting	.0004	.0001	.0001	.0
2	Mining..	.0074	.0038	.0015	.0
3	Utilities*	.0587	.0353	.0112	.1
4	Construction	.0075	.0037	.0027	.1
5	Manufacturing...	.0263	.0095	.0056	.1
6	Wholesale trade..	.0195	.0132	.0061	.1
7	Retail trade	.0050	.0033	.0017	.1
8	Transportation and warehousing*......................	.0131	.0080	.0056	.1
9	Information	.0431	.0241	.0102	.2
10	Finance and insurance	.0200	.0124	.0054	.1
11	Real estate and rental and leasing	.1374	.1081	.0184	.8
12	Professional, scientific, and technical Services..	.0637	.0410	.0289	.4
13	Management of companies and Enterprises	.0016	.0010	.0007	.0
14	Administrative and waste management Services..	.0276	.0172	.0106	.5
15	Educational services..	1.0039	.5577	.4416	14.7
16	Health care and social assistance	.0002	.0001	.0001	.0
17	Arts, entertainment, and recreation	.0021	.0012	.0007	.0
18	Accommodation..	.0054	.0035	.0016	.1
19	Food services and drinking places	.0086	.0045	.0027	.2
20	Other services*...	.0333	.0161	.0094	.3
21	Households	.5648	.0000	.0000	.0
	Total	**1.4848**	**.8638**	**.5648**	**18.0**

* Includes Federal Government Enterprises.

Table D-3. Comparison by Region of Type I Total Final-Demand Multipliers for Junior Colleges, Colleges, Universities, and Professional Schools (611A00)

Region	Output (dollars)	Value Added (dollars)	Earnings (dollars)	Employ- ment (jobs)
Travis County, TX..	1.4789	.8604	.4608	14.8
Austin-Round Rock-San Marcos, TX MSA[1]....	1.4849	.8639	.5648	18.0
Texas...	1.5853	.8985	.5941	18.8

1. Composed of the following counties in Texas: Bastrop, Caldwell, Hays, Travis, and Williamson.

Table D-4. Type II Total Final-Demand Multipliers for Junior Colleges, Colleges, Universities, and Professional Schools (611A00), Austin-Round Rock-San Marcos, TX MSA

Industry	Output (dollars)	Value Added (dollars)	Earnings (dollars)	Employ-ment (jobs)
Junior colleges, colleges, universities, and professional schools (611A00)	2.1871	1.2982	.7603	24.0

Table D-5. Breakdown by Sector of Type II Total Final-Demand Multipliers for Junior Colleges, Colleges, Universities, and Professional Schools (611A00), Austin-Round Rock-San Marcos, TX MSA

Line	Industry	Output (dollars)	Value Added (dollars)	Earnings (dollars)	Employ-ment (jobs)
1	Agriculture, forestry, fishing, and hunting	.0010	.0004	.0002	.0
2	Mining..	.0101	.0051	.0021	.0
3	Utilities*	.0769	.0468	.0148	.1
4	Construction	.0143	.0071	.0052	.1
5	Manufacturing..	.0562	.0206	.0112	.2
6	Wholesale trade..	.0558	.0377	.0174	.3
7	Retail trade	.0859	.0563	.0293	1.2
8	Transportation and warehousing*......................	.0251	.0143	.0100	.2
9	Information	.0878	.0485	.0197	.3
10	Finance and insurance	.1062	.0612	.0290	.5
11	Real estate and rental and leasing	.2802	.2130	.0264	1.2
12	Professional, scientific, and technical Services..	.0974	.0641	.0452	.7
13	Management of companies and Enterprises	.0042	.0026	.0017	.0
14	Administrative and waste management Services..	.0465	.0297	.0188	1.0
15	Educational services...	1.0163	.5648	.4466	14.9
16	Health care and social assistance	.0845	.0523	.0396	1.0
17	Arts, entertainment, and recreation	.0092	.0055	.0032	.2
18	Accommodation...	.0138	.0089	.0041	.2
19	Food services and drinking places	.0403	.0210	.0128	.9
20	Other services*...	.0753	.0371	.0220	.8
21	Households	.7603	.0010	.0010	.1
	Total	**2.1870**	**1.2980**	**.7603**	**24.0**

* Includes Federal Government Enterprises.

Table D-6. Comparison by Region of Type II Total Final-Demand Multipliers for Junior Colleges, Colleges, Universities, and Professional Schools (611A00)

Region	Output (dollars)	Value Added (dollars)	Earnings (dollars)	Employ-ment (jobs)
Travis County, TX...	2.0045	1.1853	.5768	18.5
Austin-Round Rock-San Marcos, TX MSA[1]....	2.1871	1.2982	.7603	24.0
Texas...	2.5082	1.4426	.8514	26.4

1. Composed of the following counties in Texas: Bastrop, Caldwell, Hays, Travis, and Williamson.

2. Direct-Effect Multipliers

Table D-7. Comparison by Region of Type I Direct-Effect Multipliers for Junior Colleges, Colleges, Universities, and Professional Schools (611A00)

Region	Earnings (dollars)	Employ-ment (jobs)
Travis County, TX	1.2599	1.2162
Austin-Round Rock-San Marcos, TX MSA[1]	1.2823	1.2250
Texas	1.3245	1.2549

1. Composed of the following counties in Texas: Bastrop, Caldwell, Hays, Travis, and Williamson.

Table D-8. Comparison by Region of Type II Direct-Effect Multipliers for Junior Colleges, Colleges, Universities, and Professional Schools (611A00)

Region	Earnings (dollars)	Employ-ment (jobs)
Travis County, TX	1.5769	1.5120
Austin-Round Rock-San Marcos, TX MSA[1]	1.7261	1.6338
Texas	1.8980	1.7611

2. Composed of the following counties in Texas: Bastrop, Caldwell, Hays, Travis, and Williamson.