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Regional Impact Models

William A. Schaffer

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Regional Impact Models

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PREFACE

This survey of regional input-output models and their use in impact analysis has evolved from over twenty years of experience in constructing regional economic models and in teaching about them. My objectives are to present this family of models in an easily understood format, to show that the models we use in economics are well-structured, and to provide a basis for understanding applications of these models in impact analysis. I have tried to present the models in such a way that understanding the logic and algebra of the simplest economic-base model leads to an understanding of the only slightly more complex regional and interregional input-output models in common use today. The advanced models become matrix-algebra extensions of the simple models.

I have greatly benefited from the guidance of Professor Kong Chu over the years. He first introduced these models to me in 1967 and has helped with interpretations and tedious explanations of mathematical points until only recently; now he teaches me about life and philosophy. I am in debt to a number of Georgia Tech students as well. While they have been assistants and students in title, they have been my best teachers as well. To name a few: Richard Dolce was my first programmer; Malcolm Sutter spent three years with me programming models in Hawaii and for Georgia; Clay Hamby maintained Sutter's programs and helped with several impact studies; Larry Davidson, now Professor of Economics at Indiana, has remained a colleague for over 25 years; Ross Herbert spent two summers in Nova Scotia thrashing out a completely new system; Steve Stokes had the pleasure of reconstructing both the Hawaii and Nova Scotia models; and John McLeod continues to improve my computing skills and graphics and managed data collection and organization in a recent study of amateur sports in Indianapolis with Davidson. In addition, John converted this document to its HTML format. Thanks to all of these, to a set of astute but anonymous reviewers, and to Scott Loveridge, the Regional Research Institute, and West Virginia University for making this experiment in electronic publication possible.

I would appreciate your reporting of all errors of communication and expression in this document.

William A. Schaffer
June 1999

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1 PLACE AND SPACE

The place of space in economics

Economic activity is dispersed around the globe. And this dispersion is uneven and discontinuous. Resources and population are spread unevenly around the world. Production and consumption concentrate in centers of different sizes and structures. Some activities are concentrated and others are distributed.

But, even though these observations are easily made, mainstream economic theory has still neglected space. Almost every author of a general text in regional economics has decried this neglect: Isard (1956), Bos (1965), and Richardson (1969) among others. (Richardson did it best, and our discussion in the next section follows his.) Why should we complain?

Neglect of space in economic thought

The catalogue of complaints against economists contains at least six items: an emphasis on time, the classical bias, a belief in noneconomic factors of location, reliance on marginal analysis, a preoccupation with national issues, and data deficiencies. Let's look at each of these.

The Anglo-Saxon tradition: an emphasis on time

Walter Isard begins his catalogue of complaints with a quote from Alfred Marshall:

> The difficulties of the problem depends chiefly on variations in the area of space, and the period of time over which the market in the question extends; the influence of time being more fundamental than that of space.

Decrying this statement by Marshall, Isard continues to say:

> Thus spoke Marshall, in line with Anglo- Saxon tradition, and in the half century to follow Anglo-Saxon economists were to harken to his cry (Isard 1956, p. 24)

This emphasis on time could be for a number of reasons. One is analytic: Time can be treated rigorously. It is regular and one-dimensional, while space is three-dimensional and possibly irregular. Another reason could be that space was then regarded by English economists as trivial and manageable with traditional theories. Or it could be that economists then simply explained the world as they saw it, a world concentrated in very small areas.

A counterpoint to this complaint can be found in the following quotation from Peter J. Ling (1990)

> David Harvey has recently reminded us of Marx's observation that under capitalism, 'even spatial distance reduces itself to time: the important thing is not the market's distance in space, but the speed ... with which it can be reached' [T]he automobile served a dual need within capitalism: first, by breaking down spatial barriers to exchange it expanded the scope of the market; and secondly, by increasing the speed of travel, it increased what Marx termed the 'annihilation of space by time'. This phrase does not mean that the spatial aspect becomes irrelevant, instead, it implies a process by which space is organised to meet the time-discipline of capitalism.[1]

A related note comes from a book on wars in North America by the British author John Keegan (1996). It is worth quoting from a recent review:

> Now, when "American exceptionalism" has become unfashionable here, he draws on a lifetime of observations to insist that American culture is in fact distinctive, and that one reason lies in the vast land we occupy. "a people who live in space, not time," for whom space consumes time (in airports, at car-rental returns, on interstate highways) and is measured by units of time (places are "an hour" or "a day" away), become different from others," particularly Europeans, whose wilderness disappeared 4,000 years ago.

[1] Quotation from David Harvey, *The Urbanization of Capital*, 1985, p. 37.

> ...
>
> The book concludes with a detailed portrait of the Wright brothers. They were "excellent practical engineers," Ohio bicycle manufacturers who managed to solve the problem of flight, which had puzzled men for centuries — just the kind of can-do Americans Mr. Keegan admires. Their achievement, too, was "quintessentially *American*": "America needed the aeroplane and the aeroplane was made for America" in that it had the "potentiality to defeat distance, the enemy of American collective action." Ardent Christians, the Wright brothers hoped the airplane would, by bringing people together, end warfare. But "human ingenuity all too swiftly serves the devil."[2]

Thus, time is the enemy as well.

The quest for a "wonderland of no spatial dimension"

Isard also complained in 1956 that modern general equilibrium theory ignores space, and that major theorists have assumed that all factors, producers, consumers, etc. are concentrated at a point. This complaint had less validity in the late 1950's and the 1960's, for many more spatial models had been developed by then showing how space could be inserted into the general equilibrium model (Takayama and Judge 1971).

It is no big deal to be left out of formulations of general equilibrium theory. But a more important complaint is in the classical assumption that perfect competition makes space irrelevant! If you assume pure competition, that is, if you assume price and wage flexibility and factor mobility, you wipe out all regional differences in prices, wages, etc. (except those due to transportation costs). But a spatial world is characterized by imperfections, and it is a world in which perfect competition doesn't necessarily apply. Distance yields monopolistic protection, as the existence of general stores in small towns may attest. And a strong resistance to movement of resources and population exists. The almost annual investigation of North-South wage differentials is a clear indication of this resistance.

This puzzle has been addressed at length by Paul Krugman, a professor at MIT. Krugman has wondered why spatial issues have been so long ignored by mainstream economists. He contends that economies of scale and oligopolistic behavior, both critical topics in the economics of location, pose almost insurmountable barriers to the development of sound theory.

> And so how did the mainstream cope with spatial issues? By ignoring them. Never mind that the importance of location confronts us continually in daily life Like geologists who could not really look at where mountain ranges are located because they knew they had no model of mountain formation, economists avoided looking at the spatial aspect of economies because they knew they had no way to model that aspect. (Krugman 1995, pp.36-7)

I recommend Krugman's writings for insight into both spatial economics and mainstream economics. He is a frequent contributor to the national press.

Noneconomic factors of location

General economists have frequently tended to assume that noneconomic factors determine location: natural resources determine locations, and people choose where to live, work, play, and produce for noneconomic reasons. Such assumptions mean that other disciplines such as geography, sociology, demography, and regional science are welcomed to the study of location factors, and that such study can be safely ignored by the mainstream in economics.

But this is no excuse for economists to ignore location theory. And it is pleasant to note that economists have begun to consider location factors in economic studies. This may be pleasing, but it is also unfortunate, for the stimulus for these studies has been rising transportation costs and a realization that location is important.

[2] From Pauline Maier, "Continent of Conquest," New York Times Book Reviews, July 14, 1996, a review of John Keegan, *Fields of Battle: The Wars for North America*, New York: Alfred A. Knopf, 1996.

The marginal analysis

Economists have long relied on the marginal analysis in microeconomic theory. This is a difficult theory to overcome.

The Latin preface of Marshall's *Principles of Economics* (Marshall 1890) was *"Natura Non Facit Saltum,"* which translates as "Nature does not leap." With this start, Marshall subordinated discrete change and made marginal analysis the basic tool of almost all economists.

Richardson notes that marginalism frequently does not apply in studies of location and space. This complaint however may depend on the size of the margin. The movement of manufacturing plants is discontinuous and clearly the infinitesimal calculus does not apply, but a discrete calculus might. Price relationships in spatially separated markets are best expressed as inequalities. Transportation networks developed along limited routes, clearly distorting the smooth surface along which a calculus might depend, and settlements of space across the world are highly irregular.

The importance of national issues

Since the great depression and the rise of macroeconomic analysis at the hands of John Maynard Keynes and his followers, it has been difficult for economists to gain national fame by discussing any but national issues.

Fiscal policy and monetary policy examine manipulation to achieve full employment or national economic stability and are topics more likely to attract national attention than would analysis of issues of purely regional concern. Other topics of (almost faddish) concern, such as inequities in income distribution or poverty or debt management are likely to attract the attention of the media, and are thus more likely to produce fame and fortune for an economist on the cocktail circuit than are insignificant purely regional concerns.

Data deficiencies

A final, and legitimate, reason for ignoring regional questions is the data deficiencies which have so frequently hindered regional investigations. But this is less of a problem now than it used to be.

For example, before the 1960's regional employment patterns were simply not available in any level of detail. Now, the Bureau of Economic Analysis reports employment in industry detail as well as personal income for all counties in the nation, with little more than two year's delay. Changes in wage patterns and consumer cost of living indices are similarly well documented now and are reasonably timely, thanks to the Bureau of Labor Statistics, a couple of decades of procedure development, and modern electronic data processing.

The importance of space in economic life

After this long, and somewhat depressing, listing of excuses for economists in their neglect of space, it might be worthwhile to consider why space might be important in economic life.

One very important reason to consider space is that we fight wars for it -- territorial issues are frequently the most important bases for conflict. In *The Territorial Imperative*, Robert Ardrey (Ardrey 1966) starts his inquiry into the animal origins of property and nations by defining a "territory . . . {as] . . . an area of space, whether of water or earth or air, which an animal or group of animals defends as an exclusive preserve." He proceeds to review both creature behavior and human life in terms of the drive for space.

“Lebensraum," or "living room," is the concept around which German wars have been fought. And while it is popular to credit more noble issues with the beginning of the War between the States it might be plausible to credit more crass economic issues for conflict between the industrial and commercial north and the agrarian south. The settlement of the new world and the fights between the English and French and Portuguese and Spanish are clear indications of the economic importance of space.

Another reason to concern ourselves with spatial questions is the rising cost of energy. Declining energy cost and declining transportation costs have lulled us into thinking that space has been conquered. But the energy crisis made us nervous, and we can now realize the tenuous grounds on which our society rests.

Another issue which makes space important is simply population growth. By the year 2050, world population is expected to double. Despite our philosophical inclination towards free enterprise, such growth may force us to plan the spatial configuration of our society. Should we centralize or decentralize our population? Should we continue to consume space and potentially valuable agricultural land in our short-run pursuit of suburban happiness, or should we take a long-run view and preserve our options for agricultural use of land? Should we develop new towns or expand old ones? Where should new activity be located? How are locations interdependent? With pollution and externalities a real concern, which industries should be permitted or encouraged in what places? These are all questions which make space a regional concern.

A final reason gets down to man himself. Expressing a geographer's point of view, Michael Elliot Hurst contends that man can only define his actions in spatial terms and that space can only be defined in terms of mans' behavior. "An individual is not distinct from his place; he is that place." (Hurst 1972, p.23)

What is regional economics?

As 'regional science' evolved as a broad academic discipline encompassing the space-related aspects of economics, geography, city planning, political science, sociology and other fields of study, the definition of regional economics was an early topic of discussion. The best approach appeared in 1964 from the hand of a then-young economics professor, Vinod Dubey (1964). These comments rely heavily on his.

The definition of economics itself has followed the path blazed by Sir Lionel Robbins (1932). Robbins argued that economics is defined less by its subject matter, "the ordinary business of life" (which was one of Alfred Marshall's favorite definitions), but by its point of view. The definition which evolved from Robbins is that *economics is the study of the allocation of scarce resources among alternative uses or competing ends.*

Dubey's first cut, then, was to define regional economics as the study of the problems of regions from the economic point of view. He makes it clear that a list of economic problems is not adequate, suffering from too many defects: (1) a list is never complete, (2) a list may fail to bring out its distinguishing characteristic, and (3) a list definition is classificatory and not analytic. By appending "the economic point of view" he brings out the need to consider problems regarding the allocation of resources.

Another alternative is to consider regional economics to be "the economics of spatial separation." This approach suffers from two weaknesses. One is that it emphasizes location problems, and is thus too narrow. The other is that "spatial separation is a necessary but not sufficient condition for the existence of problems studied in regional economics." In a world of uniformly and evenly distributed production and consumption with no indivisibilities, each of us could be self-sufficient and isolated. Regional economics would not exist at all.

A final alternative is that the field may be considered to be "the economics of regional resource immobility." Resource immobility, however, is not a sufficient condition. It must be jointly applied with an uneven distribution of resources over space.

Dubey concludes that:

> The ultimate justification for regional economics derives from three fundamental and ubiquitous facts about human existence. First, human activity and its concomitants occupy space. Resources, markets, and products are not located at mythical points having no length and breath. There is spatial separation. Secondly, resources and their production and consumption are not evenly distributed over space. Not only do real differentials exist, but they also vary over time. Uneven distribution of resources is not merely a matter of resource immobility. In a plane in which initially resources and activities are spread evenly, in which resources are completely mobile, but in which indivisibilities (i.e., increasing returns) exist, production would concentrate at certain points. The initial areal uniformity would be replaced by areal differentiation .... The existence of regional resource immobility inhibits the erosion of areal differences, but it is conceptually distinct. Thirdly, the ends of human activity are many, the resources to attain them scarce and capable of alternative uses. In ...[other] words, there exists the economic problem of allocation and augmentation of scarce resources. All of these fundamental conditions must exist together for

> regional economics to develop. Spatial separation or resource immobility by themselves are not enough ... .
>
> Spatial separation, uneven distribution of resources, lack of perfect mobility, and the necessity to economise should all be included in a complete definition of regional economics. Regional economics is, therefore, the study from the viewpoint of economics, of the differentiation and interrelationship of areas in a universe of unevenly and imperfectly mobile resources. (Dubey 1964, pp. 27-8)

This review focuses on regional macroeconomics. Like national macroeconomics, it can be attacked as ignoring the question of resource allocation in that it tends in large part to ignore the impact of prices. The models used in regional impact analysis treat the populations and features of regions as homogeneous, concentrating on relations to other regions and outside forces.

2 WHAT IS A REGION?

What is a "region?" The simplest definition, and possibly the most attractive definition for the theoretical economist, is that a region is "... that area within which there is perfect mobility of factors" (this is the view held by Bertrand Ohlin in his book *Interregional and International Trade*, as paraphrased by Isard (1956)). Another attractive definition is stated by Harvey Perloff, an early stalwart in regional science. Perloff defined a region as an "... area of distinctive group consciousness . . . ." (Conference on Research in Income and Wealth 1957) This definition would be the basis on which a "folk region" such as the "South" would be defined. But, while attractive in a theoretical or conceptual sense, these definitions are inadequate bases for delineating regions in the real world.

For the statistical delineation of regions, two principles are commonly used. One is the principle of homogeneity while the other is the principle of functional integration.

Homogeneous regions

A homogeneous region is defined on the basis of some uniform characteristic or characteristics, which might be economic or social or geographic or political or some combination thereof. Statistically, a nation would be divided into a set of homogeneous regions by some procedure which minimized the variation within the region while maximizing variations between these economic units. Analysis of variance might be used in defining a set of regions on the basis of some single characteristic, while analysis of covariance or factor analysis might be used for defining homogeneous regions on the basis of sets of characteristics.

Typically, homogeneous regions would be specialized and interdependent one with the other. External trade would be very important for each region. In fact, with an increase in trade, the homogeneity of producing regions would become stronger as they used their factors of production to comparative advantage.

Examples of homogeneous regions include: the corn belt in the Midwest, the cotton belt of the old South, the coal- producing regions of Appalachia and Pennsylvania, the iron-producing regions such as the Great Lakes or the Ruhr Valley in Germany, the Black Forest in Southern Germany, the Rocky Mountain range. Sometimes homogeneous regions are defined in terms of per capita income levels. Examples of these are Appalachia, the Coastal Plains region, the Great Lakes development region, the Ozark mountain region.

Regional macroeconomics is essentially based on a system of homogeneous regions. The nation is viewed as a set of spatially separated points. Analysis under these conditions thus excludes consideration of local transportation and congestion issues and focuses on long-distance relationships.

Data is compiled by the Bureau of the Census frequently on the basis of the homogeneity principle. Its essentially homogeneous areas include, for example, census tracts, urbanized areas, and census geographic regions and divisions.

Nodal regions

The principle of functional integration is the basis for defining nodal regions, which are sometimes called "polarized" regions or "core" regions. In general, functional integration means a high degree of diversification or intraregional interdependence. This is in contrast to the interregional interdependence characteristic of homogeneous regions. A nodal region, as the name would indicate, is usually based on a nucleus in an area of influence.

The nodal region is based on a number of characteristics ignored in the definition of a homogeneous region. Some of these are the functional inter- relations between units in a society, population distribution, the facts of agglomeration, interactions of heterogeneous units, and the existence of hierarchies of activities.

Metropolitan Statistical Areas before 2003

The most common example of a nodal region is the Metropolitan Statistical Area (MSA). An MSA always includes a central city of some specified population, the county in which it is located and possibly, contiguous counties when they meet criteria of the metropolitan character and integration. An MSA is defined on the basis of three criteria. One is the size of the central city, generally 50,000 in population. The second is its metropolitan character, defined in terms of its nonagricultural labor force, its urban population, its increase in total population or its population density. And the third is integration, defined in terms of commuting patterns. The definition as it stands is summarized in Appendix 1.

Core-Based Statistical Areas after 2003

The system for defining statistical areas at the Bureau of the Census was substantially revised in 2000. Its implementation now seems complete, with earlier delays associated with streamed release of Census 2000 data.

Core-Based Statistical Areas (CBSAs) are defined around urban clusters of 10,000 population or more. Metropolitan Statistical Areas (MSAs) are based on urbanized areas of 50,000 population or more. Micropolitan Statistical Areas (mSAs) are based on urban clusters of at least 10,000 but not more than 50,000 population. Both include the surrounding county and may include other counties based on commuting patterns as determined by journey-to-work statistics (currently from Census 2000).

A summary of these standards is attached as Appendix 2 along with maps showing Georgia areas.

An economic-base approach

In Chapter 3, the concepts underlying economic-base models are pursued in more detail. Here it is interesting to note the relationships between these concepts and the definition of regions, in particular city- regions. All of this has its origins in the writings of Werner Sombart between 1902 and 1927 (Krumme 1968).[3]

The following material is based on an article by the Polish economic geographer Kazimierz Dziewonski (1967), who attempts to retreat from the current trend of using economic-base analysis in studying already-defined city-regions to the defining of regions with the concept itself.

Werner Sombart was looking for a definition of "city" ("town" is the more appropriate English term) as an economic phenomenon. He defined it as a "territorial human community" firmly related to its economic base:

> To exist, it must import from the outside world food as well as other goods, specifically raw materials. Its economic base lies, therefore, in its inhabitants and in those elements of their activities which enable it to pay for its imports. ... The urban economic base was, to him [Sombart], the most characteristic feature of urban change and development throughout the ages (Dziewonski 1967, p. 139)

Dziewonski proceeds from this beginning to define a region as "*a subspace of socio-economic time-space.*"

> A subspace is characterized in turn by some of its elements and relations being a part of the larger set —a space—and by other associated elements, and relations or additional relations between the first elements forming together a separate, although obviously smaller, set. ... [T]o define a subspace we have to define how it is integrated into a larger set—a space—and how it forms its own separate community. In mathematical terms, we may say that a subspace is 'closed' as to certain elements and relations and is 'open' as to others.
>
> Turning to the economic region and to its economic base, this last concept enables us to answer to what extent the economy of an area is open or participates in the larger economy of the nation or of the world. But to indicate the open elements and relations is not enough: the parallel closure of the regional economy must be defined, for otherwise there is no subspace, no economic region. Moreover, the closure cannot be accidental. If we take any part of the earth occupied by men, we will probably find it closed as to some socio-economic activities and open as to others. But this is not sufficient to make this area an economic region. To call it a region, the elements and relations

[3] Günter Krumme provides an interesting study of the development of ideas and the effect of academic carelessness on proper attribution of credit. Much of what appears in the "economic-base concepts" appendix to the following chapter had its origins in Sombart although credited to Frederick Nussbaum, who had based his book on Sombart's works with the publisher's permission but without proper citation.

> closed within have to be significant for the given community, and the closure must have some features of stability and permanence. By definition, too, the open part should not be accidental either in structure or in time. (Dziewonski 1967)

Other classifications

Physical regions

Regions are frequently defined on the basis of geography or natural resources. The Tennessee Valley, the Coastal Plains, Appalachia, the Ozarks, and the Mississippi Valley are just a few of the physical features around which development regions have been organized. But the difficulties with such definitions are well recognized:

> According to one dictionary, a region is "a major indefinite division of inanimate creation." These words imply that there are regions which exist without any effort of man and that there are no definite natural limits to them. When one begins to define the limits of such regions, however, one must select which natural phenomena are to be considered and ignore the others. Hence, a geographer, Derwent Whittelsy, could write: "A region is not an object self-determined or nature given. It is an intellectual concept ... created by the selection of certain features that are considered to be relevant."[4] (Thompson 1972)

Political regions

Regions organized for purposes of governance or administrative convenience suffer from the same problems as geographic ones when we attempt to use them as "economic regions" (maybe that is why they are called political regions!). State boundaries have little relationship to economic activities. In fact, with rivers often used as boundaries, the communities that grew because of the rivers frequently interact more with their out-of-state cousins than with other state communities. (E.g. the Augusta metropolitan area on the Savannah River in Georgia has always included the adjoining Aiken County in South Carolina, and Chattanooga has a close affinity to Walker County in Georgia (which occasionally threatens to secede from Georgia when tornado emergency aid comes from their Tennessee neighbors and is denied by Georgia!)

Congressional districts are frequently gerrymandered to meet pressing political needs, making them poor candidates for lasting regions.

Counties have a better chance to stand the test, although changes in transportation and the urbanization of the economy have shifted the focus of (at least in Georgia) relatively small counties from their county seats, which functioned as central places in more agrarian times, to the central counties in metropolitan areas.

Territories

A relative of the political classification deserving brief mention is the concept of "territory," as in "Louisiana Territory" or "Northwest Territory." A territory is defined arbitrarily, often with no particular feature save possession determining its boundaries. Perhaps the anthropological definition used by Ardrey (1966) is good enough: a "territory ... [is] ... an area of space, whether of water or earth or air, which an animal or group of animals defends as an exclusive preserve." For us, of course, the animal is *homo sapiens*.

Regions of convenience

Other regions may be specified as a matter of administrative convenience. The Federal government has many overlapping regional divisions: thus, the regions of the Environmental Protection Agency are not the same as the districts of the Corps of Engineers, and Federal Reserve Districts differ from almost all other definitions.

[4] Quoted from Whittelsy, Derwent. "The Regional Concept and the Regional Method." In *American Geography -- Inventory and Prospect*, eds. Preston F. James and Clarence F. Jones. Syracuse: University of Syracuse Press, 1954, p.30

Business firms define sales regions to minimize costs of travel or to maximize sales. Their regions must obviously differ in size according to the firm's sales volume, the intensity of personal contact required to close sales, the density of population, etc.

Data regions

A special region of convenience commonly used by academics and consultants is the data region. Early recognition of this was in the very first volume of the *Papers of the Regional Science Association* by Joseph L. Fisher then Associate Director of Resources for the Future and shortly before he became a member of Congress: "Here the region is selected simply because it is the only geographic area about which relevant data are available or can easily be made available. Thus, economists, as well as others, frequently are forced to use states or groups of states as their regions simply because the relevant data of income payments, employment, and other aspects are not to be had on any other basis." (Fisher 1955, p. W-7)

Appendix 1: Metropolitan Area Concepts before 2000 (from U.S. Statistical Abstract, 1994)

The following paragraphs reproduce the condensed description of metropolitan area concepts reported in the *U.S. Statistical Abstract , 1994* (U.S. Bureau of the Census 1993). For the official standards, see the geographic concepts and codes presented in the *State and Metropolitan Area Data Book 1997-98*, Appendix B; for area definitions, see Appendix C (U. S. Bureau of the Census 1998).

Although replaced by new standards published in 2000, they are included here since much of the literature still refers to these concepts.

> Statistics for metropolitan areas (MA's) shown in the *Statistical Abstract* represent areas designated by the U.S. Office of Management and Budget (OMB) as metropolitan statistical areas (MSA's), consolidated metropolitan statistical areas (CMSA's), and primary metropolitan statistical areas (PMSA's).
>
> The general concept of an MA is that of a core area containing a large population nucleus, together with adjacent communities having a high degree of economic and social integration with that core. Currently defined MA's are based on application of 1990 standards (which appeared in the *Federal Register* on March 30, 1990) to 1990 decennial census data. These MA definitions were announced by OMB effective June 30,1993.
>
> ... As of the June 1993 OMB announcement, there were 250 MSA'S. and 18 CMSA's comprising 73 PMSA's in the United States. (in addition, there were 3 MSA's, 1 CMSA, and 3 PMSA's in Puerto Rico; MA's in Puerto Rico do not appear in these tables.) ... New England county metropolitan areas (NECMA's) [are] the county-based alternative metropolitan areas for the city- and town- based MSA's and CMSA's of the six New England States.
>
> Standard definitions of metropolitan areas were first issued in 1949 by the then Bureau of the Budget (predecessor of OMB), under the designation "standard metropolitan area' (SMA). The term was changed to "standard metropolitan statistical area" (SMSA) in 1959, and to "metropolitan statistical area" (MSA) in 1983. The current collective term "metropolitan area" (MA) became effective in 1990. OMB has been responsible for the official metropolitan areas since they were first defined, except for the period 1977 to 1981, when they were the responsibility of the Office of Federal Statistical Policy and Standards, Department of Commerce.
>
> The standards for defining metropolitan areas were modified in 1958, 1971, 1975, 1980, and 1990.
>
> **Defining MSA'S, CMSA'S, and PMSA'S.** The current standards provide that each MSA must include at least: (a) One city with 50,000 or more inhabitants, or (b) A Census Bureau-defined urbanized area (Of at least 50,000 inhabitants) and a total metropolitan population of at least 100,000 (75,000 in New England).

Under the standards the county (or counties) that contains the largest city becomes the central county (counties), along with any adjacent counties that have at least 50 percent of their population in the urbanized area surrounding the largest city. Additional "outlying counties" are included in the MSA if they meet specified requirements of commuting to the central counties and other selected requirements of metropolitan character (such as population density and percent urban). In New England, the MSA's are defined in terms of cities and towns rather than counties.

An area that meets these requirements for recognition as an MSA and also has a population of one million or more may be recognized as a CMSA if: 1) separate- component areas can be identified within the entire area by meeting statistical criteria specified in the standards, and 2) local opinion indicates there is support for the component areas. If recognized, the component areas are designated PMSA's and the entire area becomes a CMSA. (PMSA's, like the CMSA's that contain them, are composed of individual or groups of counties outside New England, and cities and towns within New England.) If no PMSA's are recognized, the entire area is designated as an MSA.

The largest city in each MSA/CMSA is designated a "central city," and additional cities qualify if specified requirements are met concerning population size and commuting patterns. The title of each MSA consists of the names of up to three of its central cities and the name of each State into which the MSA extends. However, a central city with less than one-third the population of the area's largest city is not included in an MSA title unless local opinion desires its inclusion. Titles of PMSA's also typically are based on central city names but in certain cases consist of county names. Generally, titles of CMSA's are based on the names of their component PMSA's.

A 1990 census list, CPH-L-145, showing 1990 and 1980 populations for current MA's and their component counties or New England subcounty areas is available through the Statistical Information Office, Population Division, (301) 763-5002. A 1990 census Supplementary Report, 1990 CPH-S-1-1, *Metropolitan Areas as Defined by the Office of Management and Budget, June 30, 1993,* contains extensive population and housing statistics and is available from the U.S. Government Printing Office GPO) (stock number 003-024-08739-3). Also available from the GPO is the Census Bureaus wall map for the 1993 MA's (stock number 003-024-08740-5).

Defining NECMA'S. The OMB defines NECMA's as a county-based alternative for the city- and town-based New England MSA's and CMSA'S. The NECMA for an MSA or CMSA includes: 1) the county containing the first-named city in that MSA/CMSA title (this county may include the first-named cities of other MSA's/CMSA's as well), and 2) each additional county having at least half its population in the MSA's/CMSA's whose first- named cities are in the previously identified county. NECMA's are not identified for individual PMSA'S. There are twelve NECMA'S, including one for the Boston- Worcester-Lawrence CMSA and one for the portion of the New York-Northern New Jersey-Long Island CMSA in Connecticut.

Central cities of a NECMA are those cities in the NECMA that qualify as central cites of an MSA or a CMSA. NECMA titles derive from names of central cites of MSA's/CMSA's.

Changes In MA definitions over time. Changes in the definitions of MA's since the 1950 census have consisted chiefly of (1) the recognition of new areas as they reached the minimum required city or area population; and (2) the addition of counties or New England cities and towns to existing areas as new census data showed them to qualify. Also, former separate MA's have been merged with other areas, and occasionally territory has been transferred from one MA to another or from an MA to nonmetropolitan territory. The large majority of changes have taken place on the basis of decennial census data, although the MA standards specify the bases for Intercensal updates.

Because of these changes in definition, users must be cautious in comparing MA data from different dates. For some purposes, comparisons of data for MA's as defined at given dates may be appropriate. To facilitate constant-area comparisons, data for earlier dates have been revised in tables where possible to reflect the MA boundaries of the more recent data.

Appendix 2: Defining Metropolitan and Micropolitan Statistical Areas

The following is copied from the website of the Bureau of Business and Economic Research at the University of Alabama and amended as appropriate. Similar condensations appear at other sites. The location (as of 2010) of the original documentation of the standards appears in the last paragraph of the statement.

OMB's Standards for Defining Metropolitan and Micropolitan Statistical Areas

Summary of the Notice in the Federal Register, December 27, 2000

The new standards replace and supersede the 1990 standards for defining Metropolitan Areas. These new standards will not affect the availability of federal data for states, counties, county subdivisions, and municipalities. The new standards apply only to defining metropolitan, and now micropolitan, areas.

The new standards will consider statistical rules only when defining Metropolitan and Micropolitan Statistical Areas. Local opinion carries no weight, except in one instance detailed below.

Census 2000 data will be published using the old definitions. For the near term, the Census Bureau will tabulate and publish data from Census 2000 for all Metropolitan Areas in existence at the time of the census (that is, those areas defined as of April 1, 2000). OMB plans to announce new definitions of metropolitan and micropolitan areas based on the new standards and Census 2000 data in 2003. Federal agencies should begin to use the new area definitions to tabulate and publish statistics when the definitions are announced.

The new standards are not an urban-rural classification. The Metropolitan and Micropolitan Statistical Area Standards do not equate to an urban-rural classification. All counties included in Metropolitan and Micropolitan Statistical Areas and many other counties contain both urban and rural territory and populations. OMB recognizes that formal definitions of settlement types such as inner city, inner suburb, outer suburb, exurb, and rural are useful to researchers, analysts, and other users of federal data. However, such settlement types are not considered for the statistical areas in this classification.

Core Based Statistical Areas (CBSAs). Metropolitan and Micropolitan Statistical Areas will be called collectively Core Based Statistical Areas (CBSAs). Metropolitan Statistical Areas will be based on urbanized areas of 50,000 or more population and Micropolitan Statistical Areas will be based on urban clusters of at least 10,000 but less than 50,000 population. The location of these cores will be the basis for identifying the central counties of CBSAs. The use of urbanized areas as cores for Metropolitan Statistical Areas is consistent with current practice. Urban clusters, used to identify the Micropolitan Statistical Areas, will be identified by the Census Bureau following Census 2000 and will be conceptually similar to urbanized areas.

Counties will be the geographic building blocks. Counties will be the geographic building blocks for defining CBSAs throughout the United States and Puerto Rico. (Cities and towns will be the geographical building blocks for defining New England City and Town Areas (NECTAs).) Using counties as the building blocks continues the current practice.

Commuting patterns will determine how many counties are part of the CBSA. Journey to work, or commuting, will be the basis for grouping counties together to form CBSAs. A county qualifies as a CBSA county if (a) at least 25 percent of the employed residents of the county work in the CBSA's central county or counties, or (b) at least 25 percent of the jobs in the potential outlying county are accounted for by workers who reside in the CBSA's central county or counties. Measures of settlement structure, such as population density, will not qualify outlying counties for inclusion in CBSAs.

Some contiguous CBSAs will be merged to form a single CBSA. Contiguous CBSAs will be merged to form a single CBSA when the central county or counties of one area qualify as outlying to the central county of another.

OMB will use the same minimum commuting threshold—25 percent—as is used to qualify outlying counties. Patterns of population distribution and commuting sometimes are complex and, as a result, close social and economic ties, as measured by commuting, exist between some contiguous CBSAs. Strong ties between the central counties of two contiguous CBSAs, similar to the ties between an outlying county and a central county, should be recognized by merging the two areas to form a single CBSA.

Some contiguous CBSAs can be combined. When ties between contiguous CBSAs are less intense than those captured by mergers, but still significant, those CBSAs can be combined. Combinations of CBSAs can occur with an employment interchange measure of at least 15 percent, but less than 25 percent, only if local opinion in both areas is in favor. Because a combination represents a relationship of moderate strength between two CBSAs, the combining areas will retain their identities as separate CBSAs within the combination.

Principal Cities will be used to title areas. The new rules ensure that at least one incorporated place of 10,000 or more population is recognized as a Principal City. The new rules also allow a fuller identification of places that represent the more important social and economic centers within a Metropolitan or Micropolitan Statistical Area. Under the previous recommendations, there were instances in which an incorporated place of at least 10,000 population accounted for a larger amount of employment than the most populous place, but lacked sufficient population to qualify as a Principal City. With the new emphasis on commuting patterns and place-of-work destinations, the new guidelines will recognize approximately 100 additional Principal Cities nationwide. There are four specific criteria for determining which places will be designated as Principal Cities. These criteria are found in Section 5 of the new standards.

Metropolitan Divisions can contain the names of up to three Principal Cities, in order of descending population size.

Local opinion. There is only one instance where local opinion plays any part in these standards, and that will be in the designation of and naming of Combined CBSAs. Where employment interchange measures at least 15 percent and less than 25 percent, the measured ties may be perceived as minimal by residents of the two areas. In these situations, local opinion is useful in determining whether to combine the two areas, and if so, what to name the combined area.

Current metropolitan areas will not be "grandfathered" in the implementation of the new standards. "Grandfathering" refers to the continued designation of an area even though it does not meet the standards currently in effect. To maintain the integrity of the classification, OMB will objectively apply the new standards rather than continuing to recognize areas that do not meet the standards. The current status of a county as being within or outside a Metropolitan Area will play no role in the application of the new standards.

New CBSAs will be defined and existing CBSAs will be redefined between censuses. The first areas to be designated using the new standards will be announced in 2003. In the years 2004 through 2007, OMB will designate new CBSAs if they meet certain qualifications, spelled out in the guidelines. It should be possible to use the Census Bureau's American Community Survey in 2008 to update the definition of all existing CBSAs at that time.

For More Information

The "Standards for Defining Metropolitan and Micropolitan Statistical Areas Notice" appears in the Wednesday, December 27, 2000, *Federal Register*. Internet users can access the notice online by going to the Census Bureau's web page at *http://www.census.gov.* There a plethora of definitions and specifications are available as are state and national maps at some detail.

Source: https://cber.culverhouse.ua.edu/

3 REGIONAL MODELS OF INCOME DETERMINATION: SIMPLE ECONOMIC-BASE THEORY

Economic-base concepts

Economic-base concepts originated with the need to predict the effects of new economic activity on cities and regions. Say a new plant is located in our city. It directly employs a certain number of people. In a market economy these employees depend on others to provide food, housing, clothing, education, protection and other requirements of the good life. The question which city planners and economists need to answer, then, is "what are the indirect effects of this new activity on employment and income in the community?" With these estimates in hand, we can work toward planning the social infrastructure needed to support all of these people.

Economic-base models focus on the demand side of the economy. They ignore the supply side, or the productive nature of investment, and are thus short- run in approach. In their modern form, they are in the tradition of Keynesian macroeconomics. In an introductory economics course, we might start with a simple model of a closed economy, usually with some unemployment. In regional economics we deal with an open economy with a highly elastic supply of labor.

It is appropriate to start this chapter first with a look at the place of economic- base theory in the history of economic will then look at methods of estimating the values of multipliers.

Antecedents

We commonly divide economies into two often opposing parts. In action, it's us against them; in primitive life, it is hunters and gatherers; in analysis, it will be primary and secondary, productive and nonproductive, basic and nonbasic, export and support, fillers and builders, productive and sterile workers, necessary and surplus labor, etc. The following notes trace obvious antecedents.[1]

Mercantilistic thought is a prime example. During the period in which the mercantilists were dominant, normally considered to be from 1500 to 1776, the nation-states of Europe were consolidating their power and gaining strength to resist or conquer others. The writers who documented the times emphasized a philosophy not unlike that of a modern merchant or chamber of commerce.

The mercantilists stressed accumulating a supply of gold with which to pursue the nation's political and military objectives. The economic base of a nation included the sectors which created a favorable balance of trade. Goods were produced for export despite the needs of a poor population, export of unprocessed materials was prohibited, shipping in local bottoms was forced whenever possible, and colonies were exploited as a source of raw materials.

Thomas Mun, a merchant in the Italian and Near Eastern trade and a director of the East India Company, was probably the most famous of these writers. His exposition of mercantilist doctrine in *England's Treasure by Foreign Trade*, written in 1630, explained how "... to enrich the kingdom and to encrease our Treasure." He emphasized a surplus of exports as the key:

> Although a Kingdom may be enriched by gifts received, or by purchase taken from some other Nations, yet these are things uncertain and of small consideration when they happen. The ordinary means therefore to encrease our wealth and treasure is by Forraign Trade, wherein wee must ever observe this rule; to sell more to strangers yearly than wee consume of theirs in value.(from Oser 1963 p.14)

The Physiocrats, led by François Quesnay and briefly prominent in France in the second half of the 18th century prior to the French Revolution, responded to the excesses of the mercantilists with several points important to later thought. They considered society subject to the laws of nature and opposed governmental interference beyond protection of life, property, and freedom of contract. They opposed all feudal, mercantilist,

[1] This section is based on (Oser 1963) and (Kang and Palmer 1958). Oser's *The Evolution of Economic Thought* is one of the best short histories of economic thought in print.

and government restrictions. "*Laissez faire, laissez passer,*" the theme phrase for the free enterprise system, is from the Physiocrats. They opposed luxury goods as interfering with the accumulation of capital.

But, for our purposes, they were precursors of economic-base thought in two ways. First, they were important in their treatment of the sources of value. To the Physiocrats, only agriculture was productive. The soil yielded all value; manufacturing, trade, and the professions were sterile, simply passing value on to consumers. This classification of productive and sterile activities is similar to the basic and service classification in economic-base discussions.

And second, the Physiocrats visualized money flowing through the economic system in much the same way as blood flows through the living body. Quesnay's *tableau economique* was a predecessor of the circular-flow diagrams popularized in Keynesian macroeconomics.

Adam Smith, writing in 1776, and heavily influenced by these French authors, took a less extreme but nevertheless strong position. He emphasized production of material or tangible goods and considered service and government as unproductive.

Karl Marx, in *das Kapital*, also divided the economy into two parts. To Marx, *necessary labor* was the source of wealth and was paid for with a wage barely sufficient to maintain its provider. *Surplus labor* was also provided by workers but its value was appropriated by the capitalists in the form of surplus value. Workers had to produce not only what they consumed but also a surplus for the capitalist. Menial servants, landlords, the Church, and commercial activities were unproductive – they added nothing to total value.

Others of the nineteenth century were more generous. Jean Baptiste Say in his *Treatise on Political Economy* (1803) popularized Adam Smith in France. Say's famous Law of Markets, paraphrased as "supply creates its own demand," required that all work be productive, that all compensated activity creates utility.

Nevertheless, we can see a strong line of thought dividing economic activities into two parts, and we can see economic-base concepts as fitting into a centuries-old pattern.

Modern origins

Modern literature on the economic base has been voluminous, but plagued occasionally by scholastic sloppiness in appropriate citations.

It seems that Werner Sombart, a German (historical) economist writing in the early part of this century, should receive major credit for modern concepts.[2]

Sombart was responsible for the distinction between "town fillers" and "town builders," ("Städtegründer" and "Städtefüller") which appeared in Frederick Nussbaum's *A History of the Economic Institutions of Modern Europe* (with full permission). But in a series of articles in the early 1950's, Richard B. Andrews quoted extensively from Nussbaum without mentioning the fact that Nussbaum had based his book on Sombart's work. Andrew's work was widely circulated and became the standard reference.

The structure of macroeconomic models

It is convenient to begin with a review of the basic elements of model building. We can start with the simplest of all macroeconomic models, the Keynesian model of a closed economy. This model is presented algebraically in Illustration 3.1 and follows the standard format we will use in all of our models: we outline definitions, behavioral or technical assumptions, equilibrium conditions, and finally the solution. Since this is a process we will follow with each new model considered, it may be worthwhile to review the nature of these model elements.

A *definition* is a statement of fact. By definition, it is always true. In mathematics, the proper term is *identity*. One of the more important identities in macroeconomics is the national income identity: realized national income (actual expenditures) is the sum of realized consumption and realized investment. In the

[2] I rely on Gunter Krumme for this statement (Krumme 1968). Professor Krumme points out that, according to Marc de Smidt, Sombart himself traces the concept back to a 1659 manuscript by the Dutch mercantilst Pieter de la Court. Wang and Hofe(2008) also refer to de la Court's contributions."

simple national model, this has to be a true statement—it is a tautology. Actual expenditures have to equal their sum!

Another important identity in the simple model is that income (which is another term for 'output') is equal to the sum of consumption and savings. We, as recipients of incomes, either spend our incomes or we save (don't spend). This identity can also be taken as a definition of saving as the difference between income and consumption.

Behavioral assumptions are equations describing the behavior of certain groups, or actors, in the economy. In this case, the key behavioral relationship is the consumption function, which postulates consumption as dependent on, or caused by, income:

$C = f(Y)$

which in its linear form may be expressed as:

$C = a + cY$

where a represents autonomous consumption and c is the marginal propensity to consume (dC/dY). The parameters of the equation are a and c. Recall that if $a > 0$, $dC/dY < C/Y$. An incidental but important result of this assumption is that saving is also a function of income:

$S \equiv Y - C = -a + (1 - c)Y$

The other important behavioral assumption in this simple model is that investment, I, is determined outside the system. It is planned. In terms common to model building, it is an *exogenous* variable in contrast to consumption, which is determined *endogenously* (that is, 'within the system').

Illustration 3.1 The simple Keynesian model

Definitions or identities:

Planned Expenditures = Consumption + Investment (*Planned sources of income*)

(1) $E \equiv C + I$

Actual Income = Consumption + Savings (*Actual disposition of income*)

(2) $Y \equiv C + S$

Behavioral or technical assumptions:

Consumption = A linear function of income (*Both planned and actual*)

(3) $C = a + cY$ ($c < 1$ = the marginal propensity to consume)

Investment = Planned investment (*an exogenously determined value*)

(4) $I = I'$

Equilibrium condition:

Income = Expenditures, or actual income is equal planned expenditures

(5) $Y = E$

or,

with $C + S = C + I$, we can subtract C from both sides to form an equivalent equilibrium condition:

Drains = Additions

(6) $S = I$

Solution by substitution:

$Y = C + I$	Substitute (1) into (5)
$Y = a + cY + I'$	Substitute (3) and (4)
$Y - cY = a + I'$	Gather the Y, or income, terms
$(1 - c)Y = a + I'$	Factor out Y
$Y = \{1/[1 - c]\} * (a + I')$	Isolate Y through division

The simple Keynesian investment multiplier is:
$dY/dI = 1/[1 - c]$

(An example of a *technical assumption* in economics is the production function. A production function describes the relations between inputs and outputs. A familiar example is $Q = F(K, L)$, commonly used to describe how capital and labor are combined to produce output.)

Equilibrium is a condition in which the expectations (plans) of decision- makers (actors) in the system are met. In this simple model, the equilibrium condition is that income equals planned expenditures, or, what is the same thing, that saving (which sets the limits on actual investment) equals planned investment.

The point is that planned investment and saving do not have to be equal (even though, in the end, actual saving has to equal actual investment—this is a fundamental principle of accounting). When they are equal, then all parties are satisfied. When they are not, forces are at play which will take income to a lower or higher level, bringing saving into equality with planned investment.[3]

Good introductions to the art of model-building can be found in several readily available books (e.g. Bowers and Baird 1971; Kogiku 1968; Neal and Shone 1976). The simple Keynesian model is outlined in almost all texts on the principles of economics. A good reference is (Case and Fair 1994).

The "strawman" export-base model

It is common in economics to construct a "strawman" against which to rail and argue. Nowhere is this practice more common than in the regional literature. The "export-base" model, in which the sole determinant of economic growth is exports, is often built to represent the arguments of other practitioners. However, you can seldom find an "export-base" theorist who is not also an "economic-base" theorist readily acknowledging many other determinants of growth than exports alone.

Now let us construct this strawman and see how a pure export-base stance is untenable. We move into an open economy and make exports the sole exogenous factor. If any autonomous expenditure is included (the easiest is for consumption), then regional income can exist even when exports are zero (Ghali 1977).

Presented in Illustration 3.2, the model differs only slightly from the simple Keynesian model. With Keynes, the key leakage was savings. He explained the underemployment of a depressed economy as resulting when planned investment fell below full- employment equilibrium levels due to a lack of confidence in investment markets. His endogenous variable was consumption, through which most income flows occurred—the flows became disconnected in the saving- investment path.

In the export-base model, the endogenous flow remains consumption, redefined now as “domestic expenditures.” We completely ignore saving and hide investment expenditures within domestic expenditures (we are concerned not about explaining depression in the whole economy but about explaining changes in regional income). The function of saving in creating a leakage from the economy is now assumed by *imports*, which is defined as a function of income. The function of investment is now assumed by *exports*, the driver of the export-based economy.

This model obviously stresses openness and dependence of the region on events beyond its reach.

Illustration 3.2 The pure export-base model

Definitions or identities:

Total expenditures ≡ Domestic expenditures + Exports (inflows)

(1) $E \equiv D + X$

[3]This paragraph brings “Say’s Law” into play. Stated by Jean Baptiste Say in the early 1800s as the “Law of Markets,” the idea that “supply creates its own demand” was named in 1909 by Frederic Taylor. Keynes succinctly restated it as above and argued that it did not apply. In Say’s time, since saving and investment were often done by the same landed people, it might have been more valid. But in modern times with complex banking systems, saving is done by many people who do not buy capital goods and investment is done by people who borrow those savings. So the possibility of actual savings differing significantly from planned investment became real.

Income $\equiv$ Domestic production +Imports

(2) $Y \equiv D + M$, or $D \equiv Y - M$

Behavioral or technical assumptions:

Imports = a linear function of income

(3) $M = mY$ ($m < 1$, the marginal propensity to import)

Exports = an exogenously (outside-region) determined value

(4) $X = X'$

Equilibrium condition:

Income = Total expenditures

(5a) $Y = E$

or

Drains = Additions

(5b) $M = X$

Solution by substitution:

$Y = Y - M + X$	Substitute (1) and (2) into (5a)
$Y = Y - mY + X'$	Substitute (3) and (4)
$Y - Y + mY = X'$	Gather the Y, or income, terms
$mY = X'$	Reduce
$Y = (1/m) * X'$	Isolate Y through division

The export-base multiplier is:

$dY/dX = 1/m$

The typical economic-base model

To make the model slightly more realistic (or, rather, less simplistic!), saving and exogenously determined investment can be added back into the system. Illustration 3.3 includes these to develop an almost typical economic-base model. Only minor interpretive comments are required.

The missing element is autonomous consumption (which appeared in the simple Keynesian model). Whether or not it is included seems to me to be a matter of personal preferences. On the one hand, it might be nice to be complete and consistent with the Keynesian model. In addition, it serves to warn us that the consumption function is probably curvilinear, originating at the origin and rising at a decreasing rate with respect to income. The marginal propensity to consume at the range of incomes over which we might work is less than the average propensity to consume. A positive autonomous consumption permits us to simulate this case.

On the other hand, we already have one exogenously determined nonexport variable, investment. The investment multiplier is identical to that which would be calculated for autonomous consumption—we have the results without the bother. While this is a logic which might reduce a model to pulp if pursued too rigorously, I have left autonomous consumption out of this illustration.

Illustration 3.3 The pure economic-base model

Definitions or identities:

Total expenditures$\equiv$ Domestic production + Exports + Investment

(1) $E \equiv D + X + I$

Income $\equiv$ Consumption + Saving

(2) $Y \equiv C + S$

Consumption $\equiv$ Domestic expenditures + Imports

(3) $C \equiv D + M$, or $D \equiv C - M$

Behavioral or technical assumptions:

Consumption = a linear function of income

(4) $C = cY$ (c = the marginal propensity to consume)

Imports = a linear function of income

(5) $M = mY$ (m = the marginal propensity to import)

Exports = an exogenously (outside-region) determined value

(6) $X = X'$

Investment = an exogenously (outside-system) determined value

(7) $I = I'$

Equilibrium condition:

Income = Total expenditures

(8a) $Y = E$

or

Drains = Additions

(8b) $M + S = X + I$

Solution by substitution:

$Y = C - M + X + I$	Substitute (1) and (3) into (8a)
$Y = cY - mY + X' + I'$	Substitute (4), (5), (6) and (7)
$Y - cY + mY = X' + I'$	Gather the Y, or income, terms
$(1 - c + m)Y = X' + I'$	Factor out Y
$Y = \{1/[1 - (c - m)]\} * (X' + I')$	Isolate Y through division

The economic-base and investment multipliers are:

$dY/dX = 1/[1 - (c - m)]$, and $dY/dI = 1/[1 - (c - m)]$

Techniques for calculating multiplier values

Comparison of planner's relationship and the economist's model

Concentrating purely on the practical need to develop an easy way to forecast community change, early planners developed economic-base ratios (T/B for the average ratio, and $\Delta T/\Delta B$ for the marginal ratio, where the letters represent total (T) and basic (B) income (or employment) by pure observation as rules of thumb. By 1952, economists (Hildebrand and Mace 1950) had developed export-base models in the same analytic framework as the Keynesian macroeconomists, with multipliers expressed as $(1/(1 - PC_L)$, where PC_L represents either the average propensity to consume locally produced goods (APC_L) or the marginal propensity (MPC_L). Could these approaches be equivalent? Yes. Charles M. Tiebout showed us how (Tiebout 1962). Tracing the metamorphosis for average propensities,

$$T/B = 1/(B/T) = 1/((T - NB)/T)) = 1/(1 - NB/T) = 1/(1 - APC_L)$$

Here, the ratio of nonbasic activity to total activity (NB/T) is the equivalent of the average propensity to consume locally produced goods.

So, if we can obtain values of total and basic variables over a period of years, we can estimate marginal export- base multipliers by regressing the total on the basic values. With the regression line formulated as $T = a + bB$, the slope b is the marginal multiplier ($\Delta T/\Delta B$) for the region.

The survey method

Of course, the most straight-forward method is simply to ask businesses in the area to specify how much of their revenues is basic and to use their responses to accurately divide local business activities into basic and service components. In practice, this is seldom done.

The neglect of the survey approach is easy to explain. It is the most expensive and time-consuming of approaches. Questionnaires on sensitive issues such as revenues, employment, and markets are seldom answered freely; to obtain even a smattering of responses the study team must resort to personal interviews. And even then, the interviewers must be skilled and persuasive.

In addition, if the area is of any size, the survey would require careful planning. A canvass would be prohibitive and the sample must be carefully stratified and selected to represent the broad spectrum of activities represented in modern communities. Such care and expense would meet the test of rationality only if data collection were in the context of a much larger study. The limit to the value of a simple export-base ratio is fairly low, in the hundreds of dollars.

A final argument against this simple approach is that the survey would probably yield data for only one year, leading to calculation of an average multiplier when a marginal multiplier is the most appropriate.

The ad hoc assumption approach

The easiest and least expensive of methods is simply to rely on arbitrary assignment of activities to basic or nonbasic categories. This could be done by assignment of, say, employment or payrolls for entire industries into categories, or it could be accomplished with a little more finesse by estimating proportions of employment involved in basic activities.

Needless to say, the chance of errors is large even for experienced analysts, and the multiplier will again be an average one with limited use in analyzing the effect of change.

Location quotients

The location quotient is probably responsible for the long life and continuing popularity and use of economic-base multipliers. These quotients provide a compelling and attractive method for estimating export employment (or income).

A location quotient is defined as the ratio

$$LQ_i = (e_i/e)/(E_i/E),$$

where e_i is area employment in industry i, e is total employment in the area, E_i is employment in the benchmark economy in industry i, and E is total employment in the benchmark economy. Normally, the "benchmark" economy is taken to be the nation as the closest available approximation to a self-sufficient economy.

Assuming that the benchmark economy is self-sufficient, then a location quotient greater than one means that the area economy has more than enough employment in industry i to supply the region with its product. And a quotient less than one suggests that the area is deficient in industry i and must import its product if the area is to maintain normal consumption patterns.

Surplus or export employment in industry i can be computed by the formula

$$EX_i = (1 - 1/LQ_i) * e_i, LQ_i > 1,$$

which is easily shown to be the difference between actual industry employment in the area and the "necessary" employment in the area.

In fact, then, excess employment can be computed without reference to location quotients through this reduction of the formula:

$$EX_i = e_i - (E_i/E) * e$$

It is convenient to retain the initial formula as a reminder of the logic, and to compute location quotients as reminders of the strengths of exporting industries.

Now it is easy to estimate export employment for each industry in the area and to sum these estimates to yield a value for export employment for the area in some particular year. With this number and total employment, an average multiplier for the area can be computed. With a set of these values over 10-20 years, the more acceptable marginal multiplier can be estimated by simple regression.

While it is common to use employment as the primary basis for these calculations, other measures such as wages and salaries are just as appropriate. Indeed, wage data is more accessible electronically, especially on CD-ROM. *County Business Patterns*, a standard source of employment and payroll data, is available for years since 1986, two years per disk. In considerable detail, this is the best data for recent years, but skill with mainframe computers, tapes, and programming is required to gain access for earlier years. The *Regional Economic Information System (REIS)*, updated on CD-ROM annually by the U.S. Department of Commerce with a two-year lag, includes a relatively aggregated 16-category employment series for the years 1969-2000 as well as a more detailed earnings series for every county in the nation (categories are based on the old Standard Industrial Classification (SIC) system). This data makes earnings-based location quotients a snap, especially if historic estimates are desired. The REIS files can be accessed at https://apps.bea.gov/regional/.

From 2001 on, the industry categories are based on the new North American Industry Classification System (NAICS), with 23 categories of employment and even more categories for earnings. This shift in industry definitions means that categorical data is not available in time series. Everything starts anew in 2001.

Location quotients have been in use by regional analysts for over 50 years now, and have been commented on at length. We should look at the assumptions involved in their use as well as the advantages and disadvantages.

The literature records at least three specific assumptions: (1) that local and benchmark consumption patterns are the same, (2) that labor productivity is a constant across regions, and (3) that all local demands are met by local production whenever possible.

The first assumption is not serious: not only can we not discern differences in consumption patterns without extraordinary expense but we can suspect that differences in production patterns are more important. Purchases of intermediate goods by producers differ for regions depending on industry mix. (It turns out that we can account for industry mix with input-output models, so this difference has been accounted for by the march of time.).

The constant-labor-productivity assumption is difficulty to avoid. Its impact can be ameliorated slightly through using earnings data, which can be assumed to reflect regional productivity variation through differences in wage rates. (This assumption could in turn be attacked if wages vary more by area cost of living than by productivity.)

The assumption that local demands are met first by local production is the more tenuous of the three. It is obviously not true, as any visit to a grocery or clothing store will attest. But it is common, and a better alternative is hard to come by.

In addition to the disadvantages accruing from these assumptions, another major fault is that the method is dependent on the degree of aggregation of the data, making comparisons among various studies of little value. To illustrate the problem, consider the food and kindred products industry in Atlanta. The location quotient computed for this broad industry should be less than one, and if excess employment were computed based on this classification, none would be credited to the food industry. But if the classification were more detailed, the soft-drink industry would show a large number of excess employees, since the headquarters of Coca-Cola is in the city.

The overpowering advantages of using location quotients are that the method is inexpensive and the exercise of computing excess employment may give the analyst an opportunity to gain insights of interest in themselves.

Minimum requirements

In the 1960's, when available computing technology favored frequent use of economic-base models, one of the alternatives to the use of location quotients was the minimum- requirements approach (Ullman and Dacey 1960). This variation involved a slight revision of the location-quotient formula to

$$EX_i = e_i - (E_i/E)^{\min} * e,$$

where$(E_i/E)^{\min}$ is the minimum employment proportion for industry i in cities of size similar to the subject city. You can readily see that we have substituted a varying benchmark employment proportion for a constant one:

$$LQ_i = (e_i/e)/(E_i/E)^{\min}.$$

While still appearing in various forms in the literature, the method suffers from two major criticisms. One is that, if enough cities are included in the selected set, all regions will be exporting and none may be importing. The other is similar in that, if we use data defined in a fine level of detail (which should be an improvement, as it was in location- quotient estimates), we may reduce local needs to near zero and make almost all production for export (Pratt 1968).

At any rate, the method is not commonly used now. The location- quotient method remains the virtually sole survivor as a simple means of identifying export industries.

"Differential" multipliers: a multiple-regression analysis

Another approach which has been used in estimating economic-base multipliers is to fit a multiple-regression equation to regional data. The first of these studies arose in a study of the impact of military bases on Portsmouth, New Hampshire in 1968 by Weiss and Gooding (Weiss and Gooding 1968).

Simple economic-base models ignore the possibility that different industries may have different impacts on their communities. The regression technique eliminates this simplifying assumption. Weiss and Gooding set up an equation

$$S = Q + b_1 X_1 + b_2 X_2 + b_3 X_3,$$

where S represents service employment, Q is a constant, and the X terms are, in order, private export employment, civilian employment at the Portsmouth Naval Shipyard, and employment at Pease Air Force Base.

With data fitted from 1955-64, their results were

$$S = -12905 + \underset{(.31)}{.78}\, X_1 + \underset{(.23)}{.55}\, X_2 + \underset{(.14)}{.35}\, X_3$$

The multipliers are $1 + b_i$ for each sector.

Weiss and Gooding used a mixture of assumption and location quotient methods in allocating export employment and assumed that the export sectors were independent and that workers in the export sectors demanded similar services.

This variation on economic-base modeling has not fallen into widespread use for several reasons: its flexibility (in number of exogenous sectors) and the statistical significance of coefficients are limited by the number of observations available; determining the export content of industry employment remains a demanding chore; and with the rise of desktop computing, input-output models are better sources of industry-specific multipliers and are similar in cost.

Critique: advantages, disadvantages, praise, criticism

Economic-base models suffer from old age: they have been built by so many analysts with varying levels of quality and they have been criticized so often that little remains except the concept.

The indictment would include the following phrases:

> Short run
>
> Nonspatial
>
> Simple adaptations of national models
>
> Data is normally available for administrative units (counties) which may be poorly defined as economic regions.
>
> Ignores capacity constraints
>
> Assumes perfect elasticity of supply for inputs
>
> Pits the area against the rest of the world, showing no interdependence between regions
>
> Multiplier varies with size of region. (As a region grows it diversifies, importing less and so increasing local consumption and the multiplier (Sirkin 1959)). Also, larger regions tend to influence neighbors more and so to enjoy larger feedback effects (Richardson 1972)
>
> An employment multiplier is often used to discuss income changes. (But this assumes that employment and per capita income are perfectly correlated -- in a simple economy with perfectly elastic supplies of labor this might be the case although, of course, the world is not simple.)
>
> Assumes that exports are the sole determinant of economic growth. (It is not reasonable for us to take the rap for this.) Any rational person can see that the determinants of growth are many -- the simple model just emphasizes one determinant. Perhaps the fault lies in early attempts to formulate multipliers and the ease with which the simple multipliers could be constructed. (Ghali 1977; Sirkin 1959))
>
> Direction of dependence may be questionable: which comes first, export growth or a strong service sector, or interdependence? Should we be concerned with preconditions for export growth (setting up an attractive service sector) in this simple model? Are we planning growth or explaining the true basis?

Although castigated for decades, the economic-base model has survived as a very succinct expression of the power of demand in regional income determination. The most current, and perhaps the clearest and most complete, statement of its status is found in a recent review by Andrew J. Krikelas (1992), reprinted below with permission from the Atlanta Federal Reserve Bank..

Appendix A: Review of Economic-Base Literature

The following article appeared in the *Economic Review*, Federal Reserve Bank of Atlanta, July/August 1992, pp. 16-29 , and represents the latest in reviews and critiques of economic-base literature.

Why Regions Grow: A Review of Research On the Economic- Base Model
Andrew C. Krikelas

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Regional economic models are used in a variety of decision-making contexts. Government officials use them to prepare annual budgets. Businesses rely on them for producing short-run market demand forecasts and for analyzing longer-term growth strategies. Urban planners and transportation officials use them to develop long-range plans for urban and regional development. Finally, state and local policymakers turn to them to get new ideas for programs and policies to promote long-run regional growth.

Although it would be convenient if a single model had been developed to serve all these purposes simultaneously, no such model is ever likely to exist. Instead, regional models tend to be highly specialized in terms of the issues that they are able to address and the time horizons over which their analytical results are most reliable. For example, a short-run forecasting model might serve the needs of state or local government officials engaged in the annual budgeting process, but it would contribute little information relevant to long-run local economic development issues confronting planners and policymakers. Only rarely is a regional model able to perform well in more than one of these distinct decision-making contexts.[1]

The rapid pace of urban growth during this century, along with the challenge it has presented for planners trying to anticipate and influence this growth, has ensured a healthy demand for regional economic models, particularly since 1945. Unfortunately, models supplied have been inadequate.

At the beginning of the postwar period, the economic base model was probably the only such instrument generally available for regional economic analysis. This model focuses on regional export activity as the primary determinant of local-area growth; it is one of the oldest and most durable theories of regional growth, with origins extending at least as far back as the early 1900s. However, economic base theory received the greatest amount of attention from scholars in regional science between 1950 and 1985. Despite the model's acceptance over such a long period, when the noted regional scientist Harry W. Richardson, writing for a special twenty-fifth anniversary issue of the *Journal of Regional Science,* reflected upon the more than forty years of research conducted within this paradigm, he concluded that "the findings on economic base models are conclusive. The spate of recent research has done nothing to increase confidence in them The literature would need to be much more convincing than it has been hitherto for a disinterested observer to resist the conclusion that economic base models should be buried, and without prospects for resurrection" (1985, 646).

Like Richardson, others over the years have expressed concern with the narrow focus of economic base theory on exports—just one portion of the demand side of the regional growth equation—to the exclusion of important supply-side factors and constraints. Many have suggested that economic base theory, its analytical and methodological techniques, and the public policies that it promotes should be abandoned in favor of other, more comprehensive theories of regional growth and development.

Nevertheless, economic base research continues. Most notably, James P. Lesage and J. David Reed (1989) and Lesage (1990) have provided empirical evidence in support of the economic base hypothesis as both a short-run and long-run theory of regional growth. These authors suggest that their models could be used both for short-term forecasting of regional employment, income,

[1] Structural econometric models are often used for purposes of both forecasting and policy analysis. However, the great expense required to specify and maintain such models has generally led economists either to develop less complex models that focus narrowly on a small set of policy issues or to develop theoretical time-series models that perform well for purposes of short-run economic forecasting.

and product and for longer- range regional economic planning and policy analysis. If these claims were valid, then the economic base model, rather than being of little value, would be one of the few regional models that might be useful in each of these very different but crucially important decision-making contexts.

Because regional economic models play such an important role in planning and policy discussions, it is important to have a clear understanding of their strengths and weaknesses. Limitations of the economic base model in particular, because it tends to be widely used, should be recognized. Recent research has provided evidence suggesting substantial improvement in traditionally static economic base model specifications through the adoption of techniques routinely employed in the macroeconomics time-series literature. However, this author's research suggests that these studies may have overstated the usefulness of these new economic base model specifications (Andrew C. Krikelas 1991).

The purpose of this article, therefore, is twofold. First, a concise analytical history of the old and extensive economic base literature generated by a variety of professional and academic disciplines is provided in order to place recent research in perspective. The discussion then turns to the central question addressed in Krikelas (1991): Can techniques borrowed from statistical time-series literature successfully breathe new life into the traditional economic base model?

Definition of the Economic Base Concept

As originally formulated, the economic base model focused on regional export activity as the primary source of local- area growth. According to this theory total economic activity, E_T is assumed to be dichotomous, with a distinction being made between basic economic activity, E_B (activities devoted to the production of goods and services ultimately sold to consumers outside the region), and nonbasic economic activity, E_{NB}, which includes activities involved in producing goods and services consumed locally:

$$E_T = E_B + E_{NB} \tag{1}$$

This division of regional economic activity into these two distinct sectors is the central concept of the model.[2] A serious empirical concern is immediately raised by this approach, however, because appropriate export data are available at any subnational level only at high cost and with long lags. Various alternative measures have been proposed and analyzed in the literature over the years, but none has been found entirely adequate. Data problems, therefore, have always complicated economic base research.

While the central concept of the economic base model is the duality of regional economic activity, its fundamental behavioral assumption is that nonbasic economic activity depends on basic economic activity. In this perspective, external demand for a region's exportable goods and services injects income into the regional economy, in turn augmenting local demand for nonexportable goods and services. The model assumes that the income injected into the regional economy and the accompanying potential for developing locally oriented, nonbasic industries are in proportion to the size of a region's export base. Static and demand-oriented, the model ignores factors that affect the supply of a region's output and other changes, such as the introduction of new products, that affect demands.

$$E_{NB} = f(E_B) = \alpha + \beta * E_B. \tag{2}$$

Equations (1) and (2) can then be combined into the reduced-form expression in equation (3),

[2]Besides the terms basic and nonbasic, a number of others have been proposed to distinguish between the two types of economic activity: town builders/town fillers, exchange production/own production, primary/ancillary, export/local, as well as others. Andrews (1953b) directly addresses the issue of the profligate and confusing terminology of the economic base paradigm.

which indicates that total economic activity is primarily a function of basic activity:

$$E_T = \alpha + (1 + \beta) * E_B \tag{3}$$

The expression $(1+\beta)$ is commonly referred to as the economic base multiplier, and the parameter, β, is called the economic base ratio.

When applied to analyzing regional growth, the economic base model suggests that the growth process will be led by industries that export goods and services beyond regional boundaries. It even offers a prediction, captured in the multiplier, of the total regional impact likely to result from a change in basic economic activity generated outside the region. Understanding the future path of a regional economy, the model implies, requires simply concentrating on the prospects for the base industries. These few important industries are often dubbed "engines of regional growth."

This simple model captures the essence of economic base theory. Although the model has been enhanced over the years to include additional variables as well as to capture more explicitly the dynamic nature of the regional growth process, most changes have been made within the scope of this simple demand-oriented specification. In general, economic base models have not evolved to acknowledge the potential impact of many important variables that may affect regional growth—interregional capital flows; labor migration patterns; changes in products, tastes, and production processes; demographic shifts; and changes in state and local tax laws, to name a few. Because these issues are generally too important to ignore, many regional scientists have concluded that economic base theory lacks the complexity to provide a useful framework for analyzing many regional economic issues and policies. The following review of the development and testing of the model will summarize where the debate on this topic stands at this point.

History of the Economic Base Literature

Five fairly distinct chronological periods characterize the history of the economic base literature: (1) the origin of the concept, 1916-21; (2) early development, 1921-50; (3) the first round of serious debate, 1950-60; (4) the second round of debate, 1960-85; and (5) a third and perhaps final round of debate begun in 1985 and continuing today. Decades of research within the economic base paradigm have created a body of conventional wisdom concerning the uses and limitations of the model, both in theory and in practice. Nonetheless, as yet another round of discussion has begun, it seems that few lessons of the past have been learned and that a brief summary of the history of this literature might be useful.

Origin of the Economic Base Concept.

The essential duality of regional economic activity that is central to the simple model expressed in the equations above was first articulated in 1916 by the German sociologist Werner Sombart, who wrote of "actual city founders," identified as the "active, originative, or primary city formers"—those whose positions of authority, wealth, or occupation allowed them to draw income from outside the city—and the "passive or derived or secondary city founders," whose livelihood depended on the city formers (Gunter Krumme 1968, 114).[3]

In 1921 M. Arrousseau made a similar observation in commenting on the relationship between what he distinguished as a town's primary and secondary occupations: "The primary occupations are those directly concerned with the functions of the town. The secondary occupations are those concerned with the maintenance of the well-being of the people engaged in those of primary nature" (John W. Alexander 1954, 246).[4] Also in 1921, landscape architect Frederick Law Olmsted

[3]Krumme was translating Werner Sombart's *Der Moderne Kapitalismus, Erster Band: Die Vorkapitalistische Wirtschaft*, 2nd rev. ed. (Munich: Duncker and Humblot, 1916). Sombart identified the city formers as "a king who collects taxes; a landlord who receives rent payments; a merchant who profits from trade with outsiders; a craftsman, a manufacturer, who sells industrial products to the outside; an author, whose writings are being bought outside the gates; a physician, who has clients in the countryside; a student, who is supported by his parents in another place, etc. These are the people who live and let live."

[4]Alexander was citing M. Arrousseau, "The Distribution of Population: A Constructive Problem," *Geographical Review 11* (1921).

distinguished between what he called primary and ancillary economic activity in an urban area (Alexander 1954, 246.)[5]

Thus, although Sombart was apparently the first to observe formally the seeming duality of urban and regional economic activity, the remarks of his contemporaries Arrousseau and Olmsted make it abundantly clear that the concept was ripe for expression. By the early 1920s, therefore, the economic base concept had generally surfaced as a potential theory for explaining the regional growth process.

Early Development of the Theory.

Following establishment of the theory, the next logical step should have been the empirical testing of the validity of the model's central hypothesis. However, this step was almost universally ignored and the model adopted as useful as the rapid growth of cities early in the century pressured state and local officials to improve the way in which they developed plans for urban expansion and the provision of public infrastructure and government services. The economic base model provided a much-desired framework for developing such plans, and studies designed to identify and measure basic industries— economic base studies—quickly became primary tools employed in acquiring information for long-range planning.

After identifying a region's export base, economic base studies calculate a local- area economic base ratio,β. Once calculated, the economic base ratio can be used with forecasts of the future growth of the region's export base industries to predict the region's overall growth. The study's focus on the smaller number of industries identified as regional export industries helps streamline the process of forecasting total regional economic activity. In addition, by identifying those industries considered most important to the regional growth process, an economic base study provides information that adds insight to discussions of regional industrial policies and programs.

Sombart's analysis of the Berlin economy, published in 1927, was the first economic base study conducted during this period. Sombart, complaining that "nobody makes the effort to sit down with a pencil and figure out with the help of occupational statistics how much there actually is of a city-forming industry in a city such as Berlin," developed an empirical approach for dividing an urban economy into its dual parts (Krumme 1968,116).[6]

Lacking detailed information on regional export activity, Sombart relied upon industry employment data collected in Berlin in 1907 to estimate the basic and nonbasic sectors of the city's economy. Relying mainly upon his personal judgment, Sombart estimated that approximately 262,000 of Berlin's total work force of 543,000 were employed in export base industries (Krumme 1968, 113). These calculations placed Berlin's nonbasic/basic ratio, β, at 1.07, an approximately one-to-one relationship. Although Sombart did not use this information to forecast Berlin's growth, he could have done so. Making a more limited forecast of the prospects for those industries he had identified as being part of the city's export base and multiplying that total by the city's economic base multiplier $(1 + \beta)$ of 2.07 (assuming that the city's base ratio had remained relatively stable in the intervening twenty years since the census was conducted) would have provided a forecast of the change in total economic activity expected in Berlin as a result of some externally generated change in demand for its export product.

[5] Alexander cites a letter dated February 21, 1921, to John M. Glenn, a member of the New York Regional Planning Committee in which Olmsted wrote, "The multiplicity of their productive occupations may be roughly divided into those which can be considered primary, such as carrying on the marine shipping business of the port and manufacturing goods for general use (i.e., not confined to use within the community itself), and those occupations which may be called ancillary, such as are devoted directly or indirectly to the service and convenience of the people engaged in the primary occupations."

[6] According to Krumme's translation, Sombart wrote, "It is necessary to find out for each trade how much of it is engaged in work for local consumption and how much in work for exports out of the city. This figure then is the city-forming ratio for the individual trade. Naturally, the ratio can be found accurately only with the assistance of an extensive enquete (survey). However, one could gain at least an approximate impression of the shares of the export industries in the total gainful employment by a careful investigation of the results of the occupational census" (1968, 116). The empirical study cited by Krumme was published for the first time in the second revised edition of Sombart's *Der Moderne Kapitalismus, Drifter Band: Das Wirtschaftsleben im Zeitalterr des Hochkapitalismus*, in 1927. Krumme, however, was quoting from the third printing of this edition, published in Berlin in 1955.

The reliance on secondary data sources for Sombart's study of Berlin's economic base is typical of most such research. As pointed out earlier, even today the appropriate regional export data required to conduct an adequate economic base study are available only at relatively high cost. The comprehensive economic analysis of the city of Oskaloosa, Iowa, published in *Fortune* magazine in 1938 illustrates this point ("Oskaloosa. . ." 1938).

Although published in a popular magazine, this study represents an important contribution to research on the economic base theory. The magazine staff conducted a complete census of the town's 3,000 families in order to determine the origin and destination of income flows within the city. They also conducted a census of the town's businesses, including an accounting of the destination of their output and the source and value of the most important inputs into the local-area production process.

The results of the study indicated that in 1937 Oskaloosa was a net exporter of goods and services to the rest of the world and that manufactured goods and professional services were the town's leading export industries. The study's findings are interesting because they were based upon a census that provides a relatively accurate portrayal of Oskaloosa's export activity during the year studied. Even by present standards this study represents one of the most thorough economic analyses of a small community ever published.

The great effort required to collect these data, however, explains why a survey- or census-oriented approach to economic base identification generally has been abandoned for the nonsurvey identification techniques made popular by Homer Hoyt in the late 1930s. Working with the Federal Housing Administration during the mid-1930s, Hoyt developed and employed an economic base methodology for producing forecasts of local housing market demand. His techniques became known to a wide audience with the original publication of his textbook, *Principles of Urban Real Estate (coau*thored with Arthur M. Weimer in 1939), which Richard B. Andrews called the first "complete statement of the theory of the economic base." In commenting on the impact of this work, Andrews continued, "This statement included much material that was new outside of technical reports. For example, it introduced in formal fashion the idea of a mathematical relation between basic employment and service employment Hoyt considered the economic base idea to be a tool that might be employed in analyzing the economic background of cities with the objective of forecasting the future of the entire city" (1953a, 163).

In this text Weimer and Hoyt distinguished between "urban growth" and "urban service" industries, suggesting that a region's potential for growth depended primarily upon the prospects for the region's urban growth industries. They provided a six-step procedure for identifying such industries. Using relatively accessible income and employment data, the authors developed a methodology that represented a combination of what has become known as the assignment technique and the location-quotient technique of economic base identification. The assignment technique is essentially identical to Sombart's methodology, in which personal judgment is used to assign industries within a particular regional economy to basic and nonbasic sectors. The location- quotient technique, on the other hand, relies upon regional economic data to make such distinctions.

Location-quotient methodology compares a region's concentration of economic activity in a particular industry with that of a benchmark economy, usually the entire country in which the region is located. If the regional concentration, measured in terms of the industry's share of total regional employment or income, exceeds the benchmark economy's concentration in that industry, the surplus level of employment or income is assumed to measure regional export activity. For example, if an industry accounts for 6 percent of regional employment but only 2 percent of national employment, two- thirds of that industry's employment would be called basic. (If the regional activity in an industry is less than that at the national level, the industry is categorized as nonbasic.) Making this identification requires only industry employment or income data for the region and a similar set of data for an appropriate benchmark economy.

Although Weimer and Hoyt were not the first to propose using the location quotient and assignment techniques as nonsurvey methodologies for dividing regional economic activity into its basic and nonbasic components, dissemination of the techniques through their textbook introduced these shortcuts to a wide audience. With these methodologies available it became feasible for local development officials to adopt the economic base paradigm for purposes of analyzing specific urban and regional economies. During the latter half of the 1940s, once these techniques had become more widely known, a much larger number of cities and states began to use the economic base model in urban and regional planning and economic analysis.[7]

Theoretical Debate.

By 1950 economic base theory and its methodological techniques had become established as the primary tools of regional planning. The theory itself had been accepted, uncritically, as an explanation of local- area growth and economic development. Between 1950 and 1960, however, discussion at the theoretical and methodological level turned directly to the question of the validity of the economic base hypothesis itself. Unfortunately, only a handful of empirical tests were reported during this entire decade.

The earliest and most cogent critique of economic base theory was presented by George Hildebrand and Arthur Mace (1950) in their analysis of the Los Angeles metropolitan area. This important contribution identified the theoretical model upon which the economic base paradigm was founded and performed an empirical test that provided evidence supporting the validity of the economic base hypothesis, at least for short-run forecasting.

Hildebrand and Mace's most significant contribution was their explicit formulation of economic base theory as a testable behavioral hypothesis. Their results, which demonstrated a statistically significant short-run relationship between basic and nonbasic employment in Los Angeles, represented the first empirical confirmation of the economic base hypothesis. Furthermore, the authors formulated their tests within the context of an explicitly Keynesian national income model and then outlined the inherent limitations of such a model.

Consider the familiar Keynesian relationship:

$$Y = C + I + G + (X - M) \tag{4}$$

where total regional income, Y, is divided into a number of distinct sectors, including consumption, C; investment, I; government expenditures, G; and exports minus imports, $X - M$. The reduced-form expression of this model would include some smaller set of exogenous variables, only one of which would be regional exports. (Other exogenous variables would include the autonomous components of consumption, investment, government expenditures, and imports; marginal propensities to consume locally, to invest locally, and to import; and local and federal tax policies.) It is this set of exogenous factors that would determine, theoretically, a region's total income level, Y.

The economic base model focuses on one particular aspect of this relationship, regional export activity, $X(E_B)$ in equation [1] above), and can be considered a special case of the more general Keynesian model in equation (4). Given this interpretation, it becomes clear that for exports to be considered the only exogenous determinant of regional growth, all other relevant factors, related to both demand and supply, must remain fairly constant or be functions of export activity. Although this might be a tenable assumption in the short run, it probably is an extremely poor one in the long run. Hildebrand and Mace made this observation explicit and suggested that the model was most appropriate for anticipating regional economic trends over a short time horizon.

[7] The following list identifies a few of the communities that performed economic base studies during the 1940s, the individuals or institutions that performed these analyses, and the base ratios (,B) calculated, respectively: New York, The Regional Plan Association Inc., 2.1; Detroit, Detroit City Plan Commission, 1.1; Cincinnati, Victor Roterus and the staff of Cincinnati City Planning Commission, 1.7; Washington, D.C., National Capitol Park and Planning, 1.1; Brockton, Massachusetts, Homer Hoyt, 0.8; the state of New Jersey, Homer Hoyt, 1. 1; and Albuquerque, New Mexico, Federal Reserve Bank of Kansas City, 0.9. This information was originally compiled by Edward Ullman and published in the third edition of Weimer and Hoyt's text in 1954 and was reprinted in Pfouts (1960, 30).

In addition, they listed some of the other variables that they thought should be taken into account in developing a more comprehensive model of regional economic activity: population levels and interregional migration patterns, regional capital investment levels and annual flows, state and local tax policies, and changes in the cost of transportation to reach external markets. Despite these reservations, Hildebrand and Mace offered a fairly encouraging assessment of the prospects for this type of research, based on the availability of additional census data and further empirical analysis across a ten- year span. [8]

Unfortunately, the lessons contained in Hildebrand and Mace's study were not widely disseminated. Hildebrand and Mace were among the first economists to contribute to the economic base literature. Their article was published in a journal not normally read by geographers and urban planners, who, before 1950, had played a dominant role in the research conducted within the economic base paradigm. Therefore, rather than playing the role of a seminal article to a further body of empirical research, the Hildebrand and Mace article remained relatively unknown. The debate of the 1950s brought many of their important insights to the attention of geographers and urban planners, but it took nearly a decade for all of these contributions to be uncovered.

Most of the 1950s' debate on economic base theory was conducted in the geography and planning literatures. The origin of this debate can be traced to a series of nine articles published by Andrews between 1953 and 1956 (see reference list). These articles provided a careful exposition of economic base theory and the methodologies that had been developed to analyze urban and regional economic activity. The author's stated purpose was to explore and evaluate the entire concept. "We have operated far too long on a set of ideas which appear valid but which, despite substantial conceptual omissions and difficulties of application, seem to be accepted all too blithely," he wrote, calling for "more fundamental thinking on and questioning of the reality and utility of base theory as presently conceived" (1953a, 167).

While Andrews was somewhat critical in his assessment of the economic base paradigm, he clearly was a proponent of its inherent validity and usefulness. Instead of suggesting the abandonment of the model as a tool for urban and regional economic analysis, he identified ways in which it could be improved to serve such purposes better. His recommendation included better efforts at basic industry identification and measurement, improvements in the collection of regional data, and modifications in the way in which economic base concepts were used. Given Andrews's criticism of the state of the economic base research prior to 1950, it is surprising to note he did not address one of the most fundamental shortcomings of this research: the lack of empirical verification of the underlying hypothesis. Krikelas (1991) identified only five empirical tests of the economic base hypothesis conducted during the 1950s. Three of those studies, including that of Hildebrand and Mace, supported the validity of the economic base hypothesis, at least in the short run, and two provided evidence against it. A decade of research, therefore, provided insufficient empirical evidence for determining the validity of the model's central hypothesis.

When applied to analyzing regional growth, the economic base model suggests that the growth process will be led by industries that export goods and services beyond regional boundaries.

Instead, most of the debate of the 1950s centered on questions related to theory and practice rather than testing. Hans Blumenfeld (1955) was critical of the economic base model's narrow focus on export activity as the primary source of regional growth. While he agreed that this model might do well to explain economic growth in small or highly specialized economies, he

[8] Hildebrand and Mace wrote, "The forthcoming Census of 1950 will permit further advances in this research. Recalculation of location quotients and comparisons with 1940 will indicate changes in external markets and locational concentrations during the war decade, particularly in communities undergoing large gains or losses in population. With monthly statistics of insured employment, a current record of employment in non- localized industries can be maintained. Improved multiplier analysis, with current local labor force statistics, should then permit more precise depiction of local unemployment problems, and attainment of more adequate policies at the o r-all and community levels" (1950, 249).

argued that it was inadequate to explain the growth of complex urban economies. Blumenfeld was also critical of the policy implications of the model; these focused almost exclusively on supporting existing export industries at the expense of other reasonable alternatives, such as fostering the establishment and development of industries that would compete with imported goods and services.

Charles M. Tiebout (1956a, 1956b) and Douglass C. North (1955, 1956) engaged in a short but lively debate over the short-run versus long-run applicability of the economic base model. Tiebout, explicitly recognizing the Keynesian roots of the economic base model, supported Hildebrand and Mace's (1950) contention that the economic base model was most appropriate for short-run economic analysis. He also argued that the economic base model minimized the important contribution that nonbasic economic activity made to local area growth and development. He wrote that, although export activity was important, "in terms of causation, the nature of the residentiary industries will be a key factor in any possible development. Without the ability to develop residentiary activities, the cost of development of export activities will be prohibitive" (1956a, 164).

North, however, objected to the characterization of the economic base model as an adaptation of the demand- oriented Keynesian model. Instead, he argued that the most important determinant of a region's long-run growth potential was its ability to attract capital and labor into the region from outside. Such supply-enhancing flows in turn would respond quite favorably to profit opportunities offered by regions engaged in high levels of export activity. North observed that historically "it was frequently the opportunities in manufacturing for the United States market which led to immigration of labor and capital into a region. The important point is that the pull of economic opportunity as a result of a comparative advantage in producing goods and services in demand in existing markets was the principal factor in the differential rates of growth of regions" (1956, 166).

Many regional scientists have concluded that economic base theory lacks the complexity to provide a useful framework for analyzing many regional economic issues and policies.

The economic base model proposed by North explicitly recognized the important role of supply factors in determining the nature and growth potential of a region's export base. In practice, however, most economic base models of this and subsequent periods have maintained a fairly strict demand orientation. This demand-oriented model is also the one to which Tiebout raised so many objections. As a result, although Tiebout and North found themselves on different sides concerning the validity of the model as a long-run theory of regional growth, both ultimately agreed that supply factors needed to be added to the model in order to make it relevant for long-run regional economic analysis.

One additional advance in the theoretical literature of this period that called into question the adequacy of economic base modeling techniques was the development of regional input-output models. Before 1950 the economic base model represented the primary tool available to regional planners for analyzing the impacts of anticipated changes in regional economic activity. During the first half of the 1950s, however, input-output modeling techniques first developed by Wassily W. Leontief (1951) were adapted for purposes of regional economic analysis.[9] While a regional input-output model could distinguish between the differential regional impacts that might be associated with, for example, the construction of a specialty steel manufacturer versus a mail-order catalog facility—two very different kinds of basic economic activity—the simple two-sector economic base model could not make such a distinction. Given this limitation, many urban planners began to advocate input-output techniques as more appropriate for forecasting anticipated changes in

[9] Perhaps the most often-cited contribution to the early regional input-output literature was an article coauthored by Isard and Kuenne (I 95 3).

regional economic activity.

The debate of the 1950s also focused on several important methodological issues. Papers by John M. Mattila and Wilbur R. Thompson (1955) and Charles L. Leven (1956) considered the adequacy of the location-quotient technique's ability to identify a region's economic base industries. While suggesting certain improvements to the traditional formulation of the location quotient, Mattila and Thompson concluded that "if used with care, the index of surplus workers in both its absolute and relative form should prove to be a highly useful tool in regional economic base studies" (1955, 227).[10] Leven, on the other hand, arrived at the opposite conclusion, stating that "the shortcomings of this technique render it useless as a quantitative measure of basic activity in an area" (1956, 256).

The issue of the appropriate measure to be used for calculating location quotients was also discussed. Because employment data were more readily available than wage or income data, most economic base studies of this period used employment in identifying regional export activity. This measure, however, has some serious drawbacks. In addition to placing equal weight upon part-time and full-time employment and failing to adjust adequately for productivity and wage differences between workers employed in different industries, employment data do not provide any measure of the impact that transfer payments and other sources of unearned income, such as interest payments, rents, and profits, have upon a regional economy.

Recognizing the serious weaknesses associated with the use of employment data for purposes of identifying a region's economic base, Andrews (1954a), Leven (1956) and Tiebout (1956c) all suggested the adoption of alternative measures of regional economic activity. Andrews and Tiebout advocated the use of income received by residents of the region, and Leven argued for a value-added measure. Income and value-added data, however, generally are not available for regional economies, especially at the substate level, except with long lags.

By the beginning of the 1960s professionals engaged in urban and regional economic analysis had divided into three distinct camps concerning the conduct of research within the economic base paradigm: those who still considered the economic base model to be a reasonable framework for urban and regional economic analysis; those who questioned its validity but sought more empirical evidence before abandoning the paradigm; and those who rejected the validity of the hypothesis, instead turning to the investigation of other methods of regional economic analysis, including regional input-output models. Whereas the debate of the 1950s was conducted primarily at the theoretical level, the quarter-century between 1960 and 1985 was filled with empirical examinations of a wide range of theoretical and methodological questions related to the economic base model.

Empirical Debate.

Between 1960 and 1985 a large number of articles and several books were published on the economic base model.[11] Yet while the question of the empirical relevance of the economic base hypothesis was arguably the most important issue facing the profession on the heels of the debate of the 1950s, only a quarter of these contributions actually addressed it. To provide some perspective on the extensive literature of this period, Krikelas (1991) developed a taxonomy. The six categories listed represent distinct facets of the economic base literature of this period: (1) identification of export base activity, (2) calibration studies, (3) extensions of the base model, (4) case studies, (5) theoretical works, and (6) tests of the economic base hypothesis.

A thorough discussion of the contributions that fall into each of these categories is beyond the scope of this article. However, a summary of the major developments in each category should yield insights. It should be noted that the majority of the research published during this period—that is, categories (l)-(4)—assumed, at least implicitly, the validity of the economic base hypothesis.

[10] The index of surplus workers is simply a measure of the number of workers in excess of that which would be required if the region's employment profile matched the national average.

[11] Krikelas (1991) identified eighty-four contributions to the literature during this period.

Identification of Export Base Activity. The most contentious issue facing researchers using the economic base model is the identification of regional export activity. Much attention has been paid to the development of nonsurvey techniques, and during this period seventeen studies were devoted to creating new or improving old methodologies. Edward L. Ullman and Michael F. Dacey (1960) and Vijay K. Mathur and Harvey S. Rosen (1974) introduced two completely new nonsurvey methods for identifying regional export activity, and several other researchers suggested refinements for improving both the location-quotient and assignment methods of economic base identification. Andrew M. Isserman (1980) offers an excellent survey of the developments of this period, including a critique of each methodology.

Calibration Studies. Calibration studies are research designed to test the adequacy of competing nonsurvey identification techniques. Researchers either compare nonsurvey estimates of regional exports with benchmark survey or census data on regional exports or simply compare results of several nonsurvey techniques. Another seventeen studies conducted between 1960 and 1985 can be classified as calibration studies, and Isserman provides an excellent summary of such research, concluding that although efforts to develop and refine the nonsurvey methods had been substantial, "the situation is lamentable" (1980, 179-79).

Extensions of the Base Model. During this period at least two important extensions were made to the simple economic base model. In the first, additional variables other than basic economic activity were added to the original specification in order to investigate their effects on the regional growth process. Stanislaw Czamanski's (1965) study represents the first of several in which a demographic variable—population—was explicitly included in the model specification. Paul E. Polzin (1977), on the other hand, developed a model designed to capture the effects of local-area labor supply conditions on regional economic activity, and Ron E. Shaffer (1983) and Shahin Shahidsaless, William Gillis, and Shaffer (1983) included variables designed to measure the contribution of both demographic and geographic factors. Given the fact that these authors generally found the additional variables to be very important determinants of regional growth, it is somewhat surprising that relatively few studies focused on this issue.

A second innovation, which gained a much broader acceptance in the literature, was the disaggregation of basic activity into more than one sector—manufacturing, construction, services, and government, for example.

This work was stimulated by the challenge posed by regional input-output models and their clear demonstration that changes in regional activity in different export industries were likely to have very different effects upon a regional economy. Steven J. Weiss and Edwin C. Gooding (1968) provide the first example of a multisectoral economic base model, and their work was repeated and extended in many subsequent studies. However, while the literature of this period reported the results of numerous multisectoral economic base models, the maximum number of sectors for which multipliers can be estimated has always been limited by the length of available data series, usually to ten sectors or fewer. As a result, no economic base model has ever been able to reproduce the level of industry disaggregation available in most regional input-output models.

Case Studies. In most instances the main purpose of these base studies was the calculation of multisectoral economic base multipliers intended to demonstrate the significant impact of the sectors under consideration. Early studies had focused mainly on the role of manufacturing in the regional growth process. Many of these later works were instead devoted to showing the important contribution that the trade and service sectors could also play in regional growth.[12]

Theoretical Works. Several contributions during this period were devoted exclusively to advancing the theoretical foundations of the economic base paradigm. Edwin F. Terry (1965) explicitly

[12]Some of the sectoral multiplier studies conducted and the region or project for which they were calculated, include the following, respectively: retail trade multipliers calculated by Friedly (1965) for Redondo Beach, California; trade and service sector multipliers calculated by Terry (1965) for St. Louis, Missouri; defense industry multipliers calculated by Billings (1970) for the state of Arizona and by Erickson (1977) for the Badger Ammunition Plant, near Baraboo, Wisconsin; rural area multipliers calculated by Garrison (1972) for five nonmetropolitan counties in Kansas; and university sector multipliers calculated by Wilson (1977) for Tulsa, Oklahoma.

derived the linkage between the economic base model and the Keynesian model. John Mutti (1981), on the other hand, demonstrated the close relationship between economic base and international trade models. And finally, Wolfgang Mayer and Saul Pleeter (1975) and F.J.B. Stillwell and B.D. Boatwright (1971) developed economic base theoretic models that demonstrated that the location-quotient and minimum- requirements methods of export industry identification could be derived from, and were consistent with, economic base theory. While these and other contributions provided a formal statement of the theoretical underpinnings of the economic base model and its methodological techniques, they did not provide empirical evidence in support of the theory's central hypothesis.

Tests of the Economic Base Hypothesis. In considering the empirical results of studies published during this period, it is important to distinguish between dynamic and static tests of the economic base hypothesis. Although the economic base paradigm generally has been used, implicitly, to analyze dynamic regional economic events, most specifications of the model, like that in equations (l)-(4), have been explicitly static in nature. This point was made clear first by Charles E. Ferguson (1960). Subsequently, one of the major contributions of this period was the more explicit consideration of the dynamic properties of the economic base model. Researchers began using time-series modeling and other econometric techniques to analyze the short-run versus long-run applicability of the economic base model as well as to develop practical regional forecasting models.

The majority of these studies, however, were still predicated upon explicitly static model specifications. Even some of the studies that ostensibly attempted to capture the dynamic properties of the economic base model failed to do so adequately.[13] Given that the utility of an economic base study depends upon its use for analyzing dynamic economic events, it is unfortunate—and surprising—that relatively few of these empirical studies were specified in such a way as to explore this issue.

In reviewing the literature of this period, Krikelas (1991) examined twenty-three studies that reported the results of tests of the economic base hypothesis. Eleven were static tests; twelve, dynamic. Of these, six static tests and seven dynamic tests provided results consistent with the economic base hypothesis. Many of the dynamic tests of the hypothesis were further designed to explore the issue of the short-run versus long-run validity of the economic base hypothesis. Only four studies—Harold T. Moody and Frank W. Puffer (1970), Curtis Braschler (1972), Braschler and John A. Kuehn (1975), and James E. McNulty (I977)— provided any ostensible evidence in support of economic base theory as a long-run theory of regional growth.

As Shelby D. Gerking and Isserman (1981) have pointed out, however, the model specifications adopted in three of these four studies actually tested only the contemporaneous relationship between basic and nonbasic economic activity rather than the long-run relationship purportedly tested by the authors. They further concluded that Moody and Puffer's (1970) results, which were based upon an appropriately specified dynamic model, were more likely to be attributable to the authors' choice of bifurcation methodology than to the existence of a long-run economic relationship between basic and nonbasic employment. Thus, while a narrow majority of the test results reported during this twenty-five-year period provided evidence in support of the validity of the economic base hypothesis, at least in the short run, very little empirical evidence suggested that the model could also perform well in the long run.

By 1985 the most definite and positive comment the literature could support about an economic base model was that it would perform best in providing relatively short-term forecasts of total regional economic activity. More than fifty years of research had failed to provide any substantial evidence in support of the model as a long-run theory of regional growth—a serious limitation in light of the fact that policymakers are generally more interested in long-run growth issues. It should be clear that the economic base model, because it fails to account for some of the

[13] See Gerking and Isserman's (1981) discussion of the results of Braschler (1972), Braschler and Kuehn (1975), and McNulty (1977).

fundamental determinants of the regional growth process, should not be adopted for long-range planning and policy analysis. These are the results that led to Richardson's call (cited earlier) for burying economic base models "without prospects for resurrection" (1985, 646).

Third Period of Debate.

Despite Richardson's impassioned warning, research continues to be performed within the framework of the economic base paradigm. Recently, a resurgence in such research has been fueled by a recognition that some sophisticated econometric techniques used in analysis of macroeconomics time series may be applied to the economic base model. In particular, it has been demonstrated that the essential features of the economic base model can be captured within the context of a bivariate vector autoregression (VAR) linking basic and nonbasic economic activity.[14] Once specified, such a VAR can be subjected to the time-series econometric tests and analytical procedures that have been developed over the years. Granger causality tests can be formulated in order to test the validity of the economic base hypothesis. Impulse-response functions (the response of a variable to an unanticipated increase in other variables) can be derived and given a natural interpretation as dynamic base multipliers. Forecasting competitions can be held in order to assess how well competing models improve the accuracy of a given forecast. Finally, co-integration tests can be performed in order to assess whether there might be a long-run relationship between basic and nonbasic economic activity.

Using such techniques, Lesage and Reed (1989) and Lesage (1990) found empirical evidence in support of the economic base hypothesis. Lesage and Reed reported Granger causality test results that were generally consistent with the economic base hypothesis, at least in the short run. Proceeding further, the authors used their VAR model specifications to derive impulse-response functions describing the dynamic relationships between basic and nonbasic employment in eight metropolitan statistical areas (MSAs) in Ohio. The reasonable nature of the multipliers calculated from this experiment led the authors to conclude that this methodology offered promise for regional economic forecasting and policy analysis purposes. When Lesage (1990) reported the results of co-integration tests that demonstrated a long-run economic relationship between basic and nonbasic employment in several of these MSAs, the combined results of this research effort seemed to provide evidence that such empirical work was both justified and could prove fruitful.

A third period of debate on the economic base model centers on the question of whether new techniques borrowed from macroeconomics time-series literature can revive the traditional economic base model.

The results of Lesage and Reed's (1989) and Lesage's (1990) studies are already being cited in the literature. David S. Kraybill and Jeffrey Dorfman (I992), for example, used these authors' methodology to estimate a three-sector model for the state of Georgia. These and other recent contributions represent examples of what has become a third period of debate on the economic base model, centered on the question of whether new techniques borrowed from macroeconomics time-series literature can revive the traditional economic base model.

Replicating and expanding this research, this author conducted extensive time- series econometric tests of the economic base hypothesis on models specified for the state of Wisconsin (Krikelas 1991). The results of this research, based upon a large number of two-sector and multisector model specifications, suggest that these new techniques do not provide the convincing evidence to support revival of the economic base model for purposes of long-term forecasting or planning context.

[14] A VAR model consists of an equation for each variable in which the equations are estimated by regressing each of the variables against lagged values of all the variables. By not imposing any particular theoretical connection among the variables, the VAR will capture any correlations that exist in the data. In this sense, VARs are distinct from traditional structural models, which typically include a large number of variables that are theoretically linked.

First and foremost, the fundamental problems associated with deriving adequate estimates of regional export activity remain unresolved. Although Lesage and Reed (1989) claimed that their dynamic location-quotient technique "provides a more accurate decomposition of local area employment" (1989, 616), this claim seems to be overstated. Krikelas (1991) confirms the results reported by Isserman (1980) and several others who have found that the location-quotient technique tends to underestimate the level of regional export activity and, consequently, lend an upward bias to export base multiplier estimates.

Second, in order to assess the stability of multiplier estimates derived from a bivariate VAR, Krikelas (1991 calculated impulse response functions for models that were based upon data generated from a variety of alternative sample separation techniques. The results of this experiment show that small changes in the way in which a given data set is divided into its basic and nonbasic components can lead to large changes in multiplier estimates. These results call into question the usefulness of the dynamic multipliers derived from a bivariate economic base VAR for even short-run regional impact analysis.

Finally, Krikelas (1991) explored the possibility of deriving multipliers from multisectoral VAR specifications and found similar difficulties. As the number of sectors included in a VAR is expanded, establishing identifying restrictions required in order to derive multiplier estimates becomes so arbitrary as to call into question the credibility of the multipliers derived from such specifications. As a result, any policy implications that might be implicit in a finding of significant differences between sectoral multiplier estimates would also be questionable.

More fundamentally, however, Krikelas concludes that the new techniques employed in Lesage and Reed and similar research do nothing to broaden the economic base paradigm's focus on the demand side of the regional growth equation. Past research has clearly indicated that economic base models that fail to account for important supply-side factors and constraints do not perform as well as models that try to incorporate such relationships. Labor migration patterns, interregional capital flows, and state and local tax policies all have important effects upon regional economic growth and development and need to be incorporated into regional economic model specifications for the model to have value for anything other than short-term forecasting. Although it is possible to expand the bivariate economic base VAR to include some of these important supply-side variables, this author has concluded that such research would be largely in vain because other problems would remain (see Krikelas 1991). The recent attempt to breathe new life into the economic base model seems to have failed to resuscitate the patient.

Conclusion

Given the fact that several authors have begun to report empirical results in support of the validity of the economic base hypothesis, a third round of debate on the model seems already under way in the literature. An examination of some of the claims made by the proponents of these new dynamic economic base models, however, indicates that they are apparently unaware of the scope of the literature preceding their efforts.[15] This brief analytical history should be sufficient to convince users that the economic base model has severe limitations, especially for economic planning and policy analysis, and to help make this next and perhaps final round of debate a relatively short-lived one.

References

Alexander, John W.,. "The Basic-Nonbasic Concept of Urban Economic Functions." *Economic Geography* 30 (1954): 246-6 1.

Andrews, Richard B., "Mechanics of the Urban Economic Base: Historical Development of the Base Concept." *Land Economics* 29 (1953a): 161-67.

[15] Lesage, for example, reported on one of the few empirical tests recorded in the history of the literature that supports the economic base hypothesis as a long-run theory of regional growth and wrote that "this finding would not be particularly surprising to most regional economists" (1990, 309). His is one of several comments published recently that have pointed toward the need for presentation of a comprehensive history of the extensive body of literature that exists.

______. "The Problem of Terminology." *Land Economics 29* (1953b): 263-68.

______. "A Classification of Base Types." *Land Economics 29* (1953c):343-49.

______. "The Problem of Base Measurement." *Land Economics* 30 (1954a): 52-60.

______. "General Problems of Base Identification." *Land Economics* 30 (1954b): 164-72.

______. "Special Problems of Base Identification." *Land Economics* 30 (1954c): 260-69.

______. "The Problem of Base Area Delimitation." *Land Economics* 30 (1954d): 309-19.

______. "The Concept of The Base Ratios." *Land Economics 31* (1955): 47-53.

______. "The Base Concept and the Planning Process." *Land Economics* 32 (1956): 69-84.

Billings, R. Bruce, "Regional Defense Impact-A Case Study Comparison of Measurement Techniques." *Journal of Regional Science 10* (1970): 199-216.

Blumenfeld, Hans, "The Economic Base of the Metropolis." *Journal of the American Institute of Planners* 21 (1955): 114-32.

Braschler, Curtis,. "A Comparison of Least-Squares Estimates of Regional Employment Multipliers with Other Methods." *Journal of Regional Science* 12 (1972): 457-68.

______., and John A. Kuehn. "Industry Sectors and the Export Base Determination of Nonmetropolitan Employment Change in Four Midwestern States." *Review of Regional Studies* 3 (1975): 82-89.

Czamanski, Stanislaw, "A Method of Forecasting Metropolitan Growth by Means of Distributed Lags Analysis." *Journal of Regional Science* 6 (1965): 35-49.

Erickson, Rodney A., "Sub-Regional Impact Multipliers: Income Spread Effects from a Major Defense Installation." *Economic Geography* 53 (1977): 283-94.

Ferguson, Charles E., "Statics, Dynamics, and the Economic Base." In *Techniques of Urban Economic Analysis, edited* by Ralph W. Pfouts, 325-39. West Trenton, N.J.: Chandler and Davis Publishing Company, 1960.

Friedly, Philip., "A Note on the Retail Trade Multiplier and Residential Mobility." *Journal of Regional Science* 6 (1965): 57-63.

Garrison, Charles B., "The Impact of New Industry: An Application of the Economic Base Multiplier to Small Rural Areas." *Land Economics* 48 (1972): 329-37.

Gerking, Shelby D., and Andrew M. Isserman, "Bifurcation and the Time Pattern of Impacts in the Economic Base Model." *Journal of Regional Science* 21 (1981): 451-67.

Hildebrand, George, and Arthur Mace, "The Employment Multiplier in an Expanding Industrial Market: Los Angeles County, 1940-47." *Review of Economics and Statistics 32* (1950): 241-49.

Isard, Walter, and Robert Kuenne, "The Impact of Steel upon the Greater New York-Philadelphia Industrial Region." *Review of Economics and Statistics* 35 (1953): 289-30 1.

Isserman, Andrew M., "Estimating Export Activity in a Regional Economy: A Theoretical and Empirical Analysis of Alternative Methods." *International Regional Science Review 5* (1980): 155-84.

Kraybill, David S., and Jeffrey Dorfman,. "A Dynamic Intersectoral Model of Regional Economic Growth." *Journal of Regional Science* 32 (1992): 1-17.

Krikelas, Andrew C., "Industry Structure and Regional Growth: A Vector Autoregression Forecasting Model of the Wisconsin Regional Economy." Ph.D. diss., University of Wisconsin-Madison, 1991.

Krumme, Gunter,. "Werner Sombart and the Economic Base Concept." *Land Economics* 48 (1968): 112- 16.

Leontief, Wassily W. *The Structure, of the American Economy.* New York: Oxford University Press, 195 1.

Lesage, James P. "Forecasting Metropolitan Employment Using an Export-Base Error-Correction Model." *Journal of Regional Science* 30 (1990): 307-23.

______., and J. David Reed. "The Dynamic Relationship between Export, Local, and Total Area Employment." *Regional Science and Urban Economics* 19 (1989): 615-36.

Leven, Charles L. "Measuring the Economic Base." *Papers and Proceedings of the Regional Science Association 2* (1956): 250-58.

Mathur, Vijay K., and Harvey S. Rosen. "Regional Employment Multiplier: A New Approach." *Land Economics 50* (1974): 93-96.

Mattila, John M., and Wilbur R. Thompson. "The Measurement of the Economic Base of the Metropolitan Area." *Land Economics* 31 (1955): 215-28.

Mayer, Wolfgang, and Saul Pleeter. "A Theoretical Justification for the Use of Location Quotients." *Regional Science and Urban Economics 5* (1975): 343-55.

McNulty, James E. "A Test of the Time Dimension in Economic Base Analysis." *Land Economics* 53 (1977): 359-68.

Moody, Harold T., and Frank W. Puffer. "The Empirical Verification of the Urban Base Multiplier: Traditional and Adjustment Process Models." *Land Economics* 46 (1970): 91-98.

Mutti, John. "Regional Analysis from the Standpoint of International Trade: Is It a Useful Perspective?" *International Regional Science Review* 6 (1981): 95-120.

North, Douglass C. "Location Theory and Regional Economic Growth." *Journal of Political Economy* 63 (1955): 243-58.

______. "A Reply." *Journal of Political Economy* 64 (1956): 165-68.

"Oskaloosa vs. The United States." *Fortune,* April 1938, 58ff. Pfouts, Ralph W., ed. *Techniques of Urban Economic Analysis.* West Trenton, N.J.: Chandler and Davis Publishing Company, 1960.

Polzin, Paul E. "Urban Labor Markets: A Two-Sector Approach." *Growth and Change* 8 (1977): 11-15.

Richardson, Harry W. "Input-Output and Economic Base Multipliers: Looking Backward and Forward." *Journal of Regional Science* 25, no. 4 (1985): 607-61.

Shaffer, Ron E. "A Test of the Differences in Export Base Multipliers in Expanding and Contracting Economies." *Regional Science Perspectives* 13 (1983): 61-74.

Shahidsaless, Shahin, William Gillis, and Ron Shaffer. "Community Characteristics and Employment Multipliers in Nonmetropolitan Counties, 1950-70." *Land Economics 59* (1983): 84-93.

Stillwell, F.J.B., and B.D. Boatwright. "A Method of Estimating Interregional Trade Flows." *Regional and Urban Economics 1* (1971): 77-87.

Terry, Edwin F. "Linear Estimators of the Export Employment Multiplier." *Journal of Regional Science* 6 (1965): 17-34.

Tiebout, Charles M. "Exports and Regional Economic Growth." *Journal of Political Economy* 64 (1956a): 160-64.

______. "Rejoinder." *Journal of Political Economy* 64 (1956b): 169.

______. "The Urban Economic Base Reconsidered." *Land Economics* 32 (1956c): 95-99.

Ullman, Edward L., and Michael F. Dacey. "The Minimum Requirements Approach to the Urban Economic Base." *Papers and Proceedings of the Regional Science Association 6* (1960): 175-94.

Weimer, Arthur M., and Homer Hoyt. *Principles of Real Estate.* Rev. ed. New York: Roland Press Company, 1948.

Weiss, Steven J., and Edwin C. Gooding. "Estimation of Differential Employment Multipliers in a Small Regional Economy." *Land Economics* 44 (1968): 235-44.

Wilson, J. Holton. "Impact Analysis and Multiplier Specifica*tion." Growth and Change* 8 (1977): 42-4.

Appendix B: An Economic-Base Model of Atlanta

The following article is an example of a simple economic-base multiplier, probably the last computed for Atlanta. With modern data sources and computing equipment, such models are seldom seen; but just a few decades ago they were quite common. Their virtue is the ease with which they are understood.

AN ECONOMIC-BASE MODEL OF ATLANTA, 1961-1970

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THIS ARTICLE OUTLINES the concept of an economic-base multiplier and develops a rough estimate of such a multiplier for Atlanta. In the interest of simplicity, we choose to ignore many points concerning economic-base models, which are already well documented in economic literature. [1] Instead, we discuss the principles involved and show how our estimates were derived from a general computing model applicable in other metropolitan areas.

The multiplier is useful in discussing the general importance of new economic activity in the region. For instance, a multiplier of the type developed here has been used in pointing out the economic impact of the Braves and the Falcons on Atlanta. [2] It is important to note several cautions before proceeding. First, the economic model is highly aggregated and should be used only in forming general conclusions; it is not "industry specific" and cannot be used for policy decisions which require choices between alternative actions. Economic-base multipliers have been replaced in recent years by more sophisticated and useful input-output studies so that their use can be justified "only when crude, hurried research is required."[3] While the Georgia Economic Model, a large input-output model of the state, is in use by state planners,[4] the simple model outlined here is all that is available for Atlanta.

Second, the estimating technique is one of a number of equally rough alternatives. Other techniques may yield different values for Atlanta's multiplier. But the technique which we use is as good as any requiring so little data, and its results are adequate to bridge the gap until a more detailed and realistic model of Atlanta can be developed.

Economic-base theory, a commonly held explanation of urban growth, states that export activity is crucial to the economic growth of a region. Some times called export-base theory, it divides a region's economy into two sectors, the export (or basic) sector and the local (or support) sector. The former holds the promise of economic growth, while the latter, often called the service sector, primarily serves the needs of the basic sector. Change in employment in the service sector is a function of change in employment in the export sector. Hence, growth of employment in a region can be expressed as a simple function of growth of employment in export-base industries.

Exporters such as automobile and aircraft manufacturers, hotels, restaurants, service stations, department stores, and recreation centers obtain income from customers outside the region. This export income then enters the local economy in the form of wages and salaries, purchases of materials, dividends, and so on, and becomes income to other local citizens. Since a local economy is usually dependent on its neighbors for at least some of its goods and services, a portion of this

[1] For a discussion of the conceptual basis, application, limitations , and criticisms of the economic-base multipliers, see Charles M. Tiebout, *The Community Economic Base Study* (Washington, Committee for Economic Development, 1962); Walter lsard, *Methods of Regional Analysis: An Introduction to Regional Science* (New York, John Wiley and Sons, Inc . , 1960), chap. 6; and Harry W. Richardson,*Elements of Regional Economics* (New York, Praeger Publishers, 1969), chap. 10.

[2] See William A. Schaffer, George D. Houser, and Robert A. Weinberg, *The Economic Impact of the Braves on Atlanta: 1966* (Atlanta, The Industrial Management Center, Georgia Institute of Technology. 1967); and William A. Schaffer and Lawrence S. Davidson, *The Economic Impact of the Falcons on Atlanta: 1972* (Atlanta, The Atlanta Falcons, 1973).

[3] Isard, *op. cit.*, p. 221.

[4] This study is reviewed in William A. Schaffer, Eugene A. Laurent, and Ernest M. Sutter, Jr., "The Georgia Economic Model-A Nontechnical Lesson in Input-Output Analysis ." *Atlanta Economic Review.* March-April 1973, p. 34; it is reported in full in William A. Schaffer, Eugene A. Laurent, and Ernest M. Sutter, Jr., *Using the Georgia Economic Model* (Atlanta, College of Industrial Management, Georgia Institute of Technology, 1972).

new circulating income leaks out of the local economy when goods, supplies, and services are purchased from outsiders. With each subsequent round of expenditures, local incomes increase in a continuing but diminishing chain. The impact of the original export sale persists over time and tends to decrease with each successive round of expenditures as leakages continue. This series of income and employment changes which follows the initial injection of money is known as the "multiplier effect ." This term covers both direct and indirect effects of new economic activity.

The multiplier may also be expressed in terms of employment, as we will do. Each basic employee, who brings money into the region, requires a certain number of workers who provide the services needed to support his efforts. As new economic activity requires new basic employment, employment in the service sector is also stimulated, leading to an increase in total employment which is greater than the initial change. The ratio of change in total employment to change in basic employment is the economic-base multiplier.

Let us examine the main features of Atlanta's economic base, using "location quotients" to identify the industries which are strong exporters in Atlanta. A location quotient is a ratio comparing employment by an industry in a region as a percentage of total regional employment to employment by this industry in a benchmark economy as a percentage of total employment. The benchmark is normally taken to be the rest of the nation or state, with a degree of self-sufficiency normally imputed to this economy. Let us take the retail trade industry as an example. In Atlanta, 16 .6 % of employment is in retail trade, but in Georgia, only 14.1 % is employed in retail trade . The location quotient, obtained by division, is 1.18, which means that Atlanta has 18% more retail trade employees than would be expected accorqing to national standards. Since Atlanta is a well-known regional shopping center, we can reasonably assume that these extra employees are selling to persons who live outside the metropolitan area; that is, they are exporting their services to other areas. With 101,100 retail trade employees in Atlanta, 85,760 are required to serve local needs, while 15,340, or 18% of local required employment, are involved in export sales.

Exhibit I shows employment and location quotients for industries in Atlanta in 1970. Atlanta's strengths are evident, and here its economic "base" lies primarily in the so-called "non basic" industries. Atlanta's rapid growth requires a larger than normal construction industry, and the size of her employment pool has permitted automobile and aircraft manufacturers to flourish . Transportation and communications, as seen in both public utilities and printing, are important functions of the city, as are finance, insurance, real estate, and the other service industries. But her greatest strength is in trade, especially wholesale trade, where 45,000 workers in excess of normal requirements for a region of Atlanta's size are employed. And while Atlanta has more than her share of federal government employees, Georgia's capital city, strangely, has less than her quota of state and local government employees, due primarily to the spread of highway-related employees across the rest of the state.

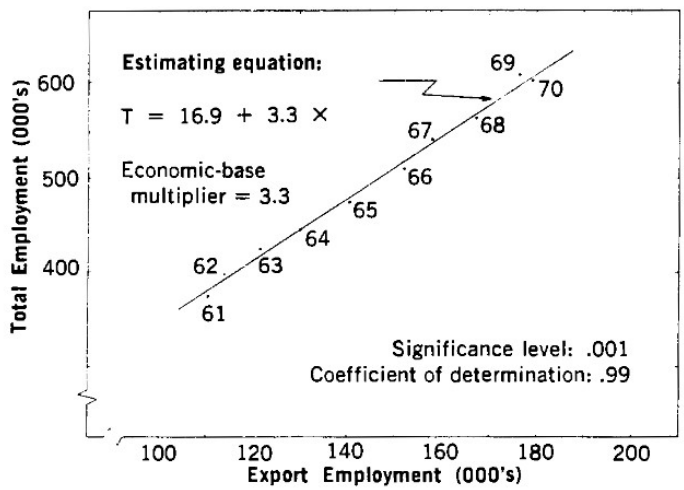
Exhibit 1: Employment and Location Quotients of Industries in Metropolitan Atlanta, 1970
[Employment in thousands]

Industry	Total Employment	Location Quotient	"Excess" employment
Contract construction	31.4	1.09[N]	2.6
Lumbar	2.7	.54[N]	–
Furniture	3.6	.91[N]	–
Stone, clay, and glass products	4.5	.82[N]	–
Primary metal industries	2.8	.80	–
Fabricated metal products	5.7	.80	–
Machinery, except electrical	5.1	.89	–
Electrical machinery	3.9	.79	–
Transportation equipment	34.3	4.25	26.2
Other durables	3.0	.72	–
Food and kindred products	15.1	.98[N]	–
Textile mill products	5.9	.71[N]	–
Apparel and other textile products	8.1	.68[N]	–
Paper and allied products	7.3	1.19[N]	1.2
Printing and publishing	9.3	2.38	5.4
Chemicals and allied products	5.5	1.07	.4
Leather and leather products	1.7	.84	–
Other nonduralbes	1.9	.30	–
Transportation and public utilities	59.2	1.92	28.3
Wholesale trade	65.8	3.15	44.9
Retail trade	101.1	1.18	15.3
Finance, insurance, and real estate	44.2	2.04	22.5
Service, miscellaneous, and mining	92.4	1.4	26.2
Federal government	26.8	1.15[N]	3.5
State and local government	68.0	.78[N]	–
Total	609.3		176.5

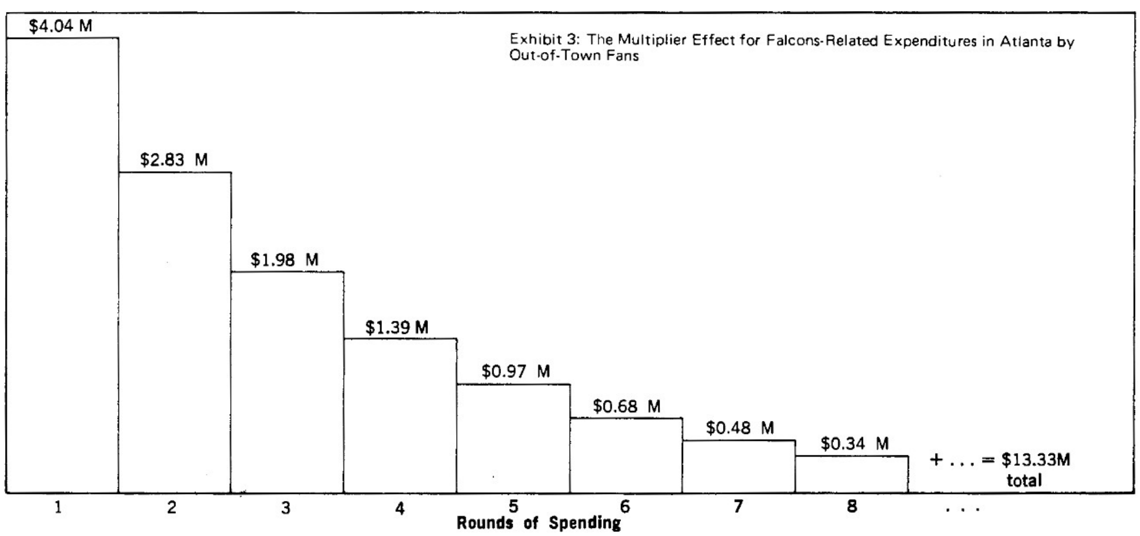
N = Based on national benchmark. The location quotient used is the greater of quotients based on national or state data.

Using location quotients, we can estimate "excess" employment in Atlanta, as seen in Exhibit 1. This employment can be used as a first estimate of Atlanta's export employment. We have made these calculations for each year from 1961 to 1970 and have plotted the relationships between total employment and export employment in Exhibit 2. The fit is remarkably good, almost a textbook illustration of simple linear regression. Since the slope of this line is the ratio of change in total employment to change in export employment, its value is the economic-base multiplier. A rough estimate of Atlanta's economic base multiplier, therefore, is 3.3.

Exhibit 2: The Economic-Base Multiplier for Atlanta, 1961-1970



We can illustrate the use of the economic-base multiplier with the results of a recent study of the economic impact of the Atlanta Falcons. In 1972, local and visiting football fans spent \$7.5 million in association with professional football games in Atlanta . The *29 %* of those fans living outside metro politan Atlanta spent \$4,040 ,000 in the area; only 30% of this total was spent at the stadium itself, while \$2,825,000 became direct expenditures with Atlanta businesses. The Falcons, then, brought at least \$4 million into the Atlanta economy in 1972. As this money circulates, it means up to 3.3 times this amount, or +13.33 million, in income for Atlanta businesses. Exhibit 3 illustrates the multiplier process, showing that an average of 70% of each dollar spent in Atlanta is recirculated locally .



Note A: Techniques for Data Analysis

Introduction

Now, with a few explanatory models under our belts, let us take a look at a couple of techniques for examining data. The term “analysis” comes from the Greek term for “a breaking up.” I like to think of it as a “laying out” of essential features for the better understanding of some phenomenon or thing. The process of analysis can involve a simple re- ordering of elements or it can involve a complex statistical tool or maybe even a model.

Sometimes, the simple approach is the best and can yield insights with great benefits at small costs. Here, I would like to re-visit our old friend the location quotient and consider a new technique, shift-share analysis. Both of these tools have their critics in academic circles, but both can be used to suggest strengths and weaknesses in an economy and both can point toward actions for developing a community.

Location quotients

A location quotient is commonly defined as the ratio

$$LQ_i = (e_i/e)/(E_i/E), \tag{a-1}$$

where e_i is area employment in industry i, e is total employment in the area, E_i is employment in the benchmark economy in industry i, and E is total employment in the benchmark economy. Normally, the "benchmark" economy is taken to be the nation as the closest available approximation to a self-sufficient economy.

As pointed out in our discussion of economic-base models, it is easily converted for use in estimating export employment. We simply assume that a location quotient greater than one means that an industry produces more than expected in a self-sufficient economy and thus would be an export industry. On this assumption and location quotients for a local economy, we built an estimate of the economic base multiplier for an economy.

But all of these computations for detailed industries can lead to questions as well as answers. The analyst could proceed to ask why the local economy varies from the benchmark economy. What resources are present or absent? What opportunities for import substitution are unexploited? What is the apparent comparative advantage signaled by a large location quotient? Could it be an impediment or an enhancement for future growth?

Obviously, this means that location quotients are suggestive in nature -- they point toward further analysis, and they force us to proceed next to understand production processes and to explore comparative advantage and ways to change the local economy and promote growth.

The popularity of location quotients has lead to a large number of variations. As Avrom Bendavid-Val points out in his excellent practitioner’s book, the list of derived measures includes “... coefficient of localization, coefficient of specialization, index of diversification, coefficient of redistribution, coefficient of geographic association, coefficient of participation, index of occupational discrimination, coefficient of deviation, friction ratio, and more. All of these amount to little more than imaginative applications of the basic location quotient technique, computing a ratio of ratios, in response to particular analytic needs.” (Bendavid-Val 1983)

Advantages and disadvantages of using location quotients are discussed earlier in Chapter 3 along with sources of data.

Shift-share analysis

Sometimes, it may be helpful to increase your general knowledge of change in the area in which you are conducting a regional impact analysis. For this task, “shift-share analysis” may be appropriate. It is the most common technique for breaking economic change in areas into components is called “shift- share analysis.”[1]

Although originating in the 1940’s, the technique was introduced to frequent use in 1960 by a team of economists undertaking a massive study of regions and economic growth (Perloff et al. 1960). Since then, it has been extended, used, criticized and revived numerous times. As a projection technique, it has been abandoned by all (including the U.S. Department of Commerce, a staunch supporter in the 1960’s) but the most faithful. As an expository technique, it has enjoyed continued life. Economists have criticized it as merely a definitional manipulation of data containing no explanation of phenomena (that is, it is simply a way to organize data) -- the explanation of change has to come from further investigation.

But its major fault is that its interpretation relies heavily on the level of aggregation of the data used. Nevertheless, it is a great and inexpensive way to start a review of the industrial structure of an area.

Now, to see how this tool works, let us try various ways to estimate regional employment in year *2* for industry i (R_{2i}), given knowledge of growth in national employment in industry i (N_{2i}/N_{1i}), growth in total national employment ($N_{2.}/N_{1.}$), and even knowledge of actual employment in industry i in the region (R_{2i}/R_{1i}). How could we proceed?

There are four alternative estimating techniques consistent with shift-share analysis. First, we could assume that employment in industry i is the same in period *2* as it is in period *1*:

$$R_{2i} = R_{1i} \tag{a-2}$$

Here, we simply have neither knowledge nor hope for growth.

Second, we could assume that the local employment in industry i grows at the same rate as does the national economy:

$$R_{2i} = R_{1i} * N_{2.}/N_{1.} \tag{a-3}$$

This, of course, is also a naîve assumption. In effect, we have assumed that both the industry and the economy have grown at the same rate, that local elements have each retained a constant *share* of national growth (hence the term).

Third, we could assume that the local employment in industry i grows at the same rate as does the employment in industry i in the national economy:

$$R_{2i} = R_{1i} * N_{2i}/N_{1i} \tag{a-4}$$

This is a little better. We can reasonably assume that local industries are subject to the same demand pressures felt by their competitors at the national level.

Fourth, we could assume that the local employment in industry i grows at the same rate as actually occurs (if we somehow could know this!):

$$R_{2i} = R_{1i} * R_{2i}/R_{1i} \tag{a-5}$$

Now, what if we try subtraction to make equations a-3 through a-5 into expressions of net change so that they can be added? We can do this by subtracting the right side of the preceding equation from each and naming the results.

[1] A clear statement of this technique is contained in an essay by Charles F. Floyd included as an appendix to (Schaffer 1976). My comments rely on Professor Floyd’s work as well as appendix B in (Jackson et al. 1981)

The change in employment due to national growth alone, assuming the region gets its share, we call the *national growth effect* (NG_i):

$$NG_i = R_{1i} * N_{2.}/N_1 - R_{1i}$$

$$NG_i = R_{1i}(N_{2.}/N_1 - 1) \tag{a-6}$$

The other two changes represent *shifts* away from the national trend. The first is called the *industry-mix effect* (IM_i) and shows the additional change due to the growth characteristics of industry i:

$$IM_i = R_{1i} * N_{2i}/N_{1i} - R_{1i} * N_{2.}/N_{1.}$$

$$IM_i = R_{1i}(N_{2i}/N_{1i} - N_{2.}/N_{1.}) \tag{a-7}$$

The last change is called *the regional- shift effect* (RS_i) and shows the additional change due to the specific characteristics of the region itself:

$$RS_i = R_{1i} * R_{2i}/R_{1i} - R_{1i} * N_{2i}/N_{1i}$$

$$RS_i = R_{1i}(R_{2i}/R_{1i} - N_{2i}/N_{1i}) \tag{a-8}$$

Total change for each industry can be summarized as:

$$TC_i = NG_i + IM_i + RS_i \tag{a-9}$$

These elements can then be summed to yield:

$$TC = \sum_i TC_i = \sum_i (R_{2i} - R_{1i}) \tag{a-10}$$

Demonstration that all of these equations fit together to form this identity is left as an exercise.

We should note that the terminology used here, while it seems the most common, is not unique. The technique has been used and reinterpreted frequently, leading to renaming of effects. "Effects" are sometimes "components." The "industry-mix effect" has been the "structural component," the "proportional shift," and the "industry-composition effect;" and the "regional-share effect" has been called the "differential shift" and the "competitive effect." (Floyd 1976)

Thoughts on writing an area profile

An area profile might be defined as an economic description which may lead to action or insight. Profiles may have many purposes. They may be intended to inform potential investors, to attract visitors, to inform citizens about the structure of their community, etc. The challenge for an analyst is to break free of the exclamatory hype associated with promotional literature. You should organize data to proclaim advantages and accomplishments, to identify problems and opportunities, or to suggest future policy, as appropriate. The following words and phrases are random points derived from a general reading of published and unpublished profiles; I suggest a scanning of collections of brochures, of Federal Reserve Economic Reviews, of the World Wide Web, etc. for further guidance:

> What is the region? Describe it absolutely and relative to other places.
>
> How is the region defined? If it is a political region, what is its economic component. If it is a statistical region, are there any unusual features?

Geography and significant landscape features, advantages, and limitations.

Demography: population, age and ethnic composition if significant, education, etc.

Employment -- Have recent changes been due to dramatic changes for particular industries, or have they occurred across the board?

Governments -- fragmented, consolidated, etc.

Subregions -- definitions and boundaries, uneven growth or population distribution?

Economic base, before, now, expected. Location quotient analysis. How similar to the nation or state? Should it change? Where is the market for its exports? Where should major imports originate? Are these other markets stable or volatile (that is, is the region subject to an interregional business cycle)?

Will the economic base help or hinder in the future?

What are the prospects for improving the industry mix to get higher personal incomes, less pollution, whatever?

Which industries lead the region's performance? Do they contribute to cycles or to stability?

What is the reason for the region's existence? Why do people live there?

What will happen in the next two, three years -- expected new industries or activities, departures, significant events?

Development policies stated by authorities and in practice.

Problems

Trends in various indicators and performance relative to nation or other regions.

Why should the region be optimistic or pessimistic about its future? (Remember that you are an objective analyst, not a promoter.)

Elements to include in a location quotient analysis

A location-quotient analysis should be carefully planned to take advantage of modern spreadsheets such as Microsoft's Excel. The challenge is to lay out the system so that you can sort and resort on the basis of the values of location quotients and on calculated surplus employment and back into industry order as needed.

You should pay careful attention to presentation of data in tabular format:

Does the table title clearly identify the region under study, the year, and the data?

Are the columns clearly identified in the caption?

Does the stub identify all rows and are sections specified and set apart?

Are columns wide enough for data?

Are decimals set consistently and at the appropriate level for discussion?

In other words, does the presentation meet the standards of good scholarship and sound workmanship?

Have you presented only data that is relevant, excluding items that are inconsequential?

The written part of the analysis is also important. Here are some points to consider:

At a very basic level, do you define "location quotients" and how they are used?

Do you show awareness of your data source, the level at which you work, and problems which may be associated with your data?

Did you experiment with several sources (e.g. both the Regional Economic Information System and County Business Patterns) to see if they yield similar results?

Did you use both quotients and estimated excess employment?

Did you set up the tables and your statements such that the reader could easily check your results and even make their own conclusions?

Did you speculate on apparently questionable results?

Did you explore changes over time? (Since REIS data is since 1969 and the CBP data is available in yearly chunks on CD-ROM since 1986, we might expect an alert and energetic analyst to look at variation over time either to show trends or to identify data problems.)

4 INPUT-OUTPUT TABLES AND REGIONAL INCOME ACCOUNTS

Introduction

This chapter presents the input-output table as an accounting system for an economy. Labeled “hypothetical”, the numeric example is actually a 5-industry aggregation of the detailed table for Georgia in 1970 (Schaffer 1976). (Although out-of-date, it fits the style of most regional input-output tables in current use in the United States. It also fits the text, which is a slight revision of that used to explain the Georgia system.) First we look at the table as a whole; then we examine in more detail the quadrant of the table which reports the income and product accounts for this regional economy.

The regional transactionstable

A regional input-output model traces the interactions of local industries with each other, with industries outside the region, and with final demand sectors. The central element in this model is a regional transactions table such as that shown in Table 4.1. This table records transactions between five broad industries, three final-payments sectors, and three final-demand sectors. (The original presentation was of transactions between 50 industries, six final- payments sectors, and 6 final-demand sectors.)

Table 4.1 Hypothetical interindustry transactions

Selling industry	buying industry	Extraction (1)	Construction (2)	Manufacturing (3)	Trade (4)	Services (5)	Total industry demand (6)	Household expenditures (7)	Other local final demand (8)	Exports (9)	Total final demand (10)	Total demand (11)
Extraction	(1)	183	31	599	6	73	892	99	88	596	782	1674
Construction	(2)	14	1	43	14	293	364	0	1803	353	2155	2520
Manufacturing	(3)	142	414	1390	110	356	2412	1275	1130	9344	11750	14162
Trade	(4)	52	224	520	72	257	1126	2563	161	970	3695	4820
Services	(5)	102	221	862	558	1990	3733	4262	523	2828	7613	11347
Total local inputs	(6)	493	891	3415	760	2969	8527	8199	3705	14091	25995	34523
Households	(7)	595	665	3696	2385	4603	11944	100	2524	0	2623	14567
Other payments	(8)	261	191	1624	1365	2402	5842	(3789.2)	(943.2)	(1097.5)	0	5842
Imports	(9)	325	773	5428	311	1372	8209	3778	1057	-12994	-8159	50
Total final payments	(10)	1181	1629	10747	4060	8378	25995	3878	3581	-12994	-5536	20459
Total inputs	(11)	1674	2520	14162	4820	11347	34523	12077	7285	1097	20459	54982

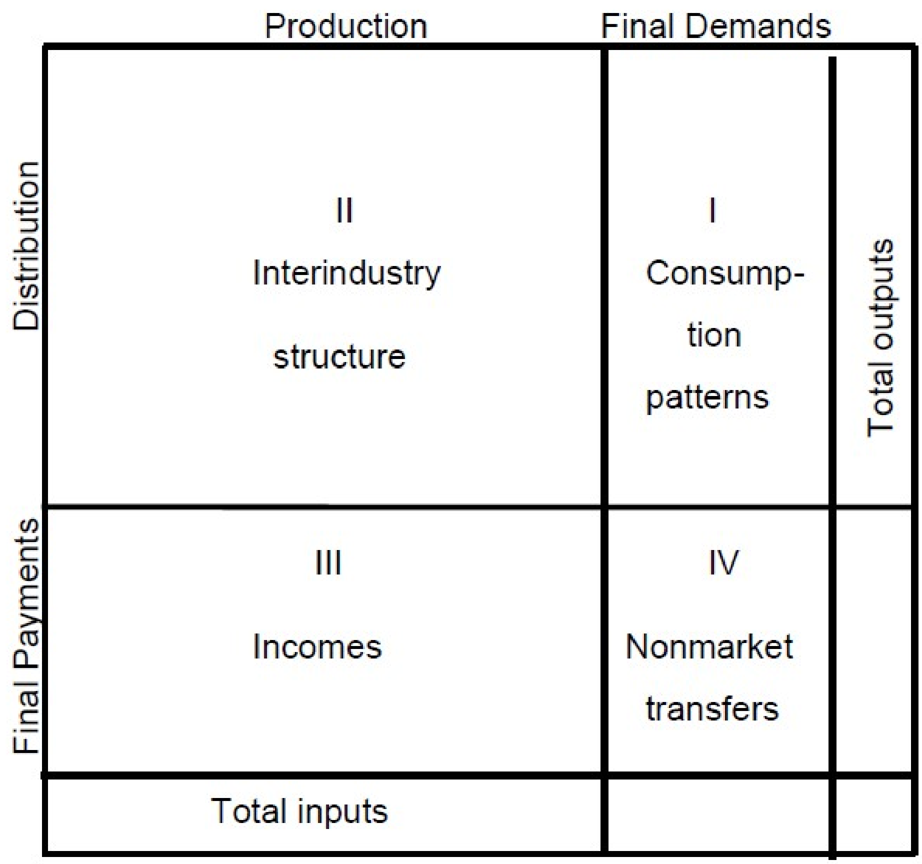
Each row in this table accounts for the sales by the industry named at its left to the industries identified across the top of the table and to the final consumers listed in the right-hand section of the table. Intermediate goods are sold to local industries for use in producing other products while finished goods are sold to final consumers. Goods exported from the region to other parts of the nation and the world are listed under exports in the final-demand section, regardless of their stage of production. The sum of a row is the total output or total sales of an industry.

Thus, sales by the extraction industry (a combination of agricultural, forestry, fishing, and mining industries) are shown in row one of Table 4.1. Of the total output worth $1,674 million, over 35 percent is sold to light manufacturing (which processes it for further sale), and over 35 percent is sold outside the region. The remaining sales are largely to other industries within the broad extractive industry itself.

Each column in Table 4.1 records the purchases, or inputs, of the industry identified at the top of the column from the industries named at the left. Payments by the industry to employees, holders of capital, and governments are contained in the first two rows of the final-payments section of the table. These payments constitute the "value added" by the industry in question. Purchases from industries outside the region are identified in the last row of the final-payments section and are called "imports." These imports may be either of goods not produced at all in the region or of goods produced in quantities insufficient to meet local needs. The sum of the entries in each column represents the total purchases by the industry in question. Since profits, losses, depreciation, taxes, etc., are recorded in the table as final payments, the total purchases and payments must equal total sales. Inputs equal outputs; hence the term "input-output."

For example, the purchases and payments of the extractive industry are shown in column one of Table 4.1. Since this industry is almost 90 percent agriculture, the column reflects large intraindustry transactions (purchases of feeder stocks, baby chicks, grains, etc.), substantial purchases from light manufacturing (feeds), and a large payment to households for labor and proprietors’ income. Local farmers also import from outside the state large amounts of feeds and other supplies. Notice that the total input is the same as the total demand identified in row one.

Figure 4.1 The transactions table as a picture of the economy



Now, with this brief introduction to a regional transactions table, let us look at the table as an accounting system for an economy. Figure 4.1 shows an input- output table in skeleton form and divided into four quadrants. Quadrant I describes *consumer behavior*, identifying consumption patterns of households and such other local final users of goods as private investors and governments. Another important part of Quadrant I is the export column, which shows sales to other industries and consumers outside the regional economy. Since these goods would not normally reappear in the region in the same form, these sales are regarded as final. According to economic-base theory, in which final demand is the motivating force in an economy, we would look in this quadrant for activity- generating forces and we would especially examine the government and export sectors.

Quadrant II depicts *production relationships* in the economy, showing the ways that raw materials and intermediate goods are combined to produce outputs for sale to other industries and to ultimate consumers. This is the most important quadrant in an input-output table. For regions, it typically ranges in size between 30 and 500 industries. Quadrant II is the basis for the input-output model itself.

Quadrant III shows *incomes* of primary units of the economy, including the incomes of households, the depreciation and retained earnings of industries, and the taxes paid to various levels of government. These payments are also called value added; since they are so hard to identify individually, these incomes are frequently recorded as one value-added row. The quadrant also includes payments to industries outside the economy for materials and intermediate goods which are imported into the region. Since all of these payments to resource owners and to outsiders leave the industrial system of the region, they are called "final payments."

Quadrant IV identifies primarily *nonmarket transfers* between sectors of the economy and might properly be labeled the "social transfers" quadrant. Here we see gifts, savings, and taxes of households; we see the surpluses and deficits of governments and their payments to households and intergovernmental transfers. The quadrant also typically includes purchases by final-demand sectors from industries outside the region.

Now, to make a major point about the hazards of aggregation, let's look at the table as originally presented, as a picture of the Georgia economy in 1970. Out of a total output of over $34 billion, Georgia's manufacturing output in 1970 was valued at over $14 billion and its service output at over $11 billion, indicating that Georgia's economy was dominated by the manufacturing and service industries. Even so, Georgia was not a major manufacturing or service economy by national standards, as can be seen in the following comparison of the industrial origins of value added in Georgia and the United States (Schaffer 1976)

	Percent of value added	
Sector	*Georgia*	*U.S.*
Agriculture, mining	4.2	5.2
Construction	4.4	5.6
Manufacturing	26.0	28.9
Transportation, utilities	7.7	8.1
Trade	18.3	14.6
Services	25.6	26.9
Government	13.7	10.7

Georgia had larger contributions to value added from trade and government than did the nation, and smaller contributions from the extractive industries, construction, manufacturing, utilities, and services. This deviation from the national pattern is an expression of the region's modest stage of development and its central position in the Southeast.

But this observation also shows that the "importance" of an industry is completely dependent on the definitions and aggregation patterns employed in constructing a table. By enlarging the table and altering sector definitions, we could change the apparent importance of industries. For example, by combining the agricultural industries with the food- processing industry (normally in manufacturing) we could make the "agriculture-based" industry larger than any of the components of the "trade" or "service" industries. In fact, in the 29- industry version (not shown here) of the Georgia table, the five largest industries in terms of output are: 1) trade, 2) finance, insurance and real estate, 3) services, 4) textile mill products, and 5) transportation equipment.

A second interesting item in Table 4.1 is the gross product of Georgia. Analogous in concept to the gross national product, *gross regional product* (GRP) can be defined as total production without duplication, or as the economic product of all factors of production residing in the region. It can also be seen as the total final payments (adjusted for imports) in the region, 20.459 billion dollars. Alternatively, it is also the total final demand by ultimate consumers of the region's products (net of imports).

In summary, an input-output table traces the paths by which incomes flow through the economy. Quadrant I is where the spending cycle begins and is where finished goods go to satisfy the needs of final consumers. Quadrant III is where the production cycle starts, with households and other resource owners, including governments, receiving payments for their contributions to the production process. Quadrant II traces production relationships, describing the technology of production in the economy. It outlines the market sector of the economy. Quadrant IV identifies nonmarket flows of money, showing purchases of labor inputs by governments, taxes paid by households, surpluses and deficits of governments, and transfers between governments and other governments and people.

Income and product accounts

The input-output table embodies not only measures of gross regional product but also a summary set of social, or income and product, accounts for the region. Like the input-output table itself, these accounts are part of a double-entry accounting system for the economy. In the same way that a businessman uses his accounts to develop a consolidated income statement for his firm, the economist uses income and product accounts to measure the performance of the economy and to compare the behavior of parts of the economy against other standards.

Table 4.2 is the transactions table rearranged to emphasize Quadrant IV, the sector in which social accounts are traced. This social-accounts table completely ignores the flows of intermediate products through the production quadrant and suppresses the details of the other quadrants. It emphasizes (1) the total final payments to resource owners for their contributions to production, (2) the aggregate demand for final products, and (3) the transfers which take place between primary units of the economy.

We have slightly rearranged the table. The row showing purchases from nonlocal industries (imports) has been moved above the final-payments rows. A row for transfers to households has been added to account for nonproductive money transfers to persons. And the one row for other payments in Table 4.1 has been expanded into four to show the details of final payments and transfers.

Six accounts are outlined in the table. The receipts side of the household account is shown in the household-income and household-transfers rows, which total to be personal income; the payments side is detailed in the household-expenditures column. The saving and investment account is shown in the capital-residual row (retained earnings, depreciation, savings) and the investment column. Local, state, and federal government accounts are shown in their rows and columns. And the rest- of-the-world account is shown in the row labeled "purchases from nonlocal industry" and the column "net exports." By placing these accounts into one matrix, we gain both economy in presentation and a feeling for their commonality.

Gross state product (GSP) may be measured in two ways, the incomes approach and the expenditures approach. Let us start with the expenditures approach.

Using expenditures, we define GSP as state output at market value as measured through the expenditures of final consumers. This approach accounts for the final demand for Georgia's product by four groups of consumers: households, investors, governments, and private units outside the state economy. In Table 4.2, GSP is seen as total purchases of goods and services for final consumption, $20,459 million. In 1970, this was 2.1 percent of GNP. In comparison to expenditures for GNP, Georgia spent less of her gross product on personal consumption (59.0 percent in contrast to 62.9 percent for the nation), less on private investment (10.7, 13.5), and less on local and state government (11.3, 12.2); she made up for this in terms of federal defense expenditures (8.4, 7.5), other federal expenditures (5.0, 3.6), and net private exports (5.3, 0.4).

Table 4.2 Income and product accounts for Georgia, 1970

Account receiving\making payment	Sales to processing sectors	Household expenditures	Private investment	Expenditures of governments: Local	State	Federal, defense	Federal, other	Net exports	Total final demand	Total receipts
Purchases from local processors	8,527.2	8,199.3	1,400.4	460.9	432.3	1,057.0	353.9	14,091.3	25,995.1	34,522.3
Purchases from nonlocal industry	8,159.3	3,777.8	802.1	138.8	115.8			-12,993.8	-8,159.3	0.0
Total purchases from industry	16,686.5	11,977.1	2,202.5	599.7	548.1	1,057.0	353.9	1,097.5	17,835.8	34,522.3
Household income	11,882.6	99.7		790.7	372.7	671.0	689.3		2,623.4	14,506.0
Total purchases of goods and services	28,569.1	12,076.8	2,202.5	1,390.4	920.8	1,728.0	1,043.2	1,097.5	20,459.2	49,028.3
Household transfers	61.0			51.3	190.7	209.0	848.0		1,299.0	1,360.0
Capital residual	3,019.1	871.6						-1,688.2	-816.6	2,202.5
Local government income	480.3	377.9			445.9		47.3	112.4	983.5	1,463.8
State government income	858.8	341.9		22.1			408.8	-55.2	717.6	1,576.4
Federal government income	1,533.9	2,197.8			19.1			533.5	2,750.4	4,284.3
External transfers										
Total outlay	34,522.2	15,866.0	2,202.5	1,463.8	1,576.5	1,937.0	2,347.3	0.0	25,393.1	59,915.3

Using incomes, we can arrive at a similar GSP by adding the "income receipts" of the various accounts. The major receipt is earned household or personal income, which consists of wages and salaries, other labor income, proprietors' income, and property incomes. Including business transfer payments (primarily bad debts) and social security contributions, this amounts to $14,567 million, or 71.2 percent of GSP; the corresponding national figure is 75.2 percent. The "capital residual," or gross business saving, of processors is $3,019 million and comprises 14.8 percent of GSP, which corresponds to 9.4 percent in the nation. The capital-residual row of Table 4.2 includes two transfers worth noting: one is personal savings; the other is a negative entry of $1,688 million in the exports column. This "export" accounts for the surpluses and deficits of the various governments and the outside world. Much of it represents flows of retained earnings and capital consumption allowances to the nonresident owners of branch plants in Georgia.

The third receipt to be added to GSP is local government income from the processing sector. At $480 million, this figure accounted for 2.3 percent of GSP. The next largest income of local governments in Georgia was a set of intergovernmental transfers from the state government (much of which is offset by a similar transfer from the federal government to the state). The deficits of local governments are shown as an "export" (primarily bonds) worth $112.4 million.

The fourth receipt to be counted as part of GSP is state government income from the processing sector of $859 million. Combined state and local revenues from industrial sources are 6.5 percent of GSP, compared to 8.5 percent on the national level. Note that the state had a surplus in 1970 of $55 million, entered as a negative value in the exports column.

The final receipt to be included in GSP is federal government income from the processing sectors. Totaling $1,534 million, this income was 7.5 percent of GSP, compared with 6.9 percent on the national level. Notice that the federal government still spent $534 million more in Georgia than it received in taxes, accounted for largely through defense expenditures.

In sum, total receipts and payments by each of the six final sectors in the economy were $25,393 million. This figure is $4,934 million in excess of GSP. Where quadrant II shows intermediate transactions in the processing sector, the transfers quadrant records duplicative transactions in the social or political sector.

Summary

A state input-output table accounts for flows of monies through the state, showing details regarding consumer behavior, the technology of production, incomes, and social transfers. The transfers quadrant of a table can be slightly modified to show the details presented in the more traditional income and product accounts.

The social accounts are useful in two ways. One is in comparisons between economies; a brief contrast of the Georgia and U.S. economies has been sketched here and Georgia has been found to be strong in trade and government and slightly below the national pattern in manufacturing and services. The other way is in comparisons over time. But to show performance over time, social accounts and input-output tables must be constructed on a regular basis by state agencies.

Appendix 1: DVD data sources: the Regional Economic Information System

One of the best sources of regional data is the *Regional Economic Information System* (REIS), produced by the Regional Economic Measurement Division of the Bureau of Economic Analysis.

Many Web sites have information from REIS available for downloading, but the most common source for the heavy user is the DVD disk. Published annually in May, it contains data for states, regions, and counties from 1969 forward, with a two-year lag. (Thus, the May 2009 disk contains data from 1969 to 2007.) Now, the data contained in the disk and much more are also available free of charge from https://apps.bea.gov/regional/. (Note that this web page is hard to find when starting from bea.gov – this may signal the demise of this product due to budget constraints.)

For counties, the disk provides data on personal income and its sources, employment (in broad industry categories), an economic profile, transfer payments, and agricultural output. In addition it contains data on the journey to work between counties in 1970, 1980, 1990, and 2000, as well as annual estimates of gross commuter incomes.

More detailed data on journey to work and place of work as developed in the 2000 Census can be found at https://www.census.gov/topics/employment/commuting.html.

Appendix 2: Measures of regional welfare: Personal Income

The problem with GSP estimates

Gross state product accounts have been established for a number of states and using a variety of methods. In Hawaii, with a long history of independence, accounts have been constructed along exactly the same lines as a nation (in fact, some of the people involved in these accounts were close associates of members of the accounts team in the U.S. Bureau of the Census.

In most other states, however, the method has been a short-cut method known as the Kendricks-Jaycox method and involves estimates based on ratios.

Estimates of Gross State Product have been assembled from all sources available to the Regional Economic Measurement Division. These are available for selected years on the Regional Economic Information System. One nice thing about this central source is that the accounts for the 50 states are consistent with the accounts for the nation as a whole. For details and availability, see http://www.bea.gov/regional/index.htm

The following statement shows the formal difference between "Gross Regional Product" (GRP) and "Gross Domestic Regional Product," (GDRP) which parallels the difference between GNP and GDP. This equation shows development of GRP as GDRP adjusted for net factor payments (including profits).

GROSS DOMESTIC REGIONAL PRODUCT

LESS	INTEREST AND DIVIDENDS TO NONRESIDENTS
PLUS	INTEREST AND DIVIDENDS FROM REST OF WORLD
LESS	WAGES EARNED BY IN-COMMUTERS
PLUS	WAGES EARNED BY OUT-COMMUTERS
EQUALS	GROSS REGIONAL PRODUCT

GROSS REGIONAL PRODUCT is the total value of goods and services produced by factors of production owned by residents of the region; GROSS DOMESTIC REGIONAL PRODUCT is the total value of production in the region.

In the United States, GNP is greater than GDP -- we own more abroad than others do here. In Hawaii, GRP is less that GDRP -- natives own less abroad than others own in Hawaii. In other states, the question has not been answered.

The point of this is that, since people always confuse lengthy titles, we just go ahead and confuse things to begin with and rename gross domestic state product as gross state product!

$$\text{GSP} = \text{GDSP}$$

The widespread use of personal income estimates

The problems associated with estimating flows of capital income from one area to another are severe. We just can't develop accurate statistics on ownership of large multi-state and multi- national corporations and thus on the flows of dividends and interest across state boundaries.

As a result of this handicap, we normally consider personal income as a better measure of individual welfare. Considerable data on journey to work and commuting across county boundaries over the last three decennial censuses has permitted the Regional Economic Measurement Division to estimate adjustments for residency, which solves part of the GRP/GDRP problem.

5 THE LOGIC OF INPUT-OUTPUT MODELS

Introduction

The logic of input-output models is analogous to that of economic-base models, and requires only an extension of mathematical sophistication from simple algebra to matrix algebra. A piece of cake. The complexities of input-output models come in devising schemes to manage the massive data sets required to build them.

We proceed here to repeat the process evolved in Lecture 3 to develop the simplest of models, a plain, square, industry-by-industry model. In Chapter 6, we will develop the multiplier system associated with this model. After this work on the model and its uses, we will return to the process of building an input-output system. By then we will have manipulated the system sufficiently to easily understand the more complex commodity-by-industry accounting system now in current use by the United States and recommended by the United Nations.[1]

The rationale for a model: analysis vs. description

While the transactions table describes the economy and yields interesting bits of information for a particular point in time, in itself it has no analytic content. That is, it does not permit us to answer questions concerning the reaction of the economy to change. Let the transactions table represent the economy in equilibrium and subject it to a shock, say an increase in tourism or a cutback in defense expenditures. When the repercussions of the shock have moved through the economy, what will be its new "equilibrium position?" In other words, which industries will be larger or smaller and whose income or employment will have changed? Such analysis requires an economic model, which we now proceed to construct.

Preparing the transactions table: closing with respect to households

As we shall see, it is important to include in the interindustry structure (Quadrant II) all economic activities which make buying decisions primarily on the basis of their incomes. These activities are called *endogenous* since their behavior is determined within the system. Other activities, such as federal government expenditures or exports, are based on decisions made outside the system and so are called *exogenous* activities. Activities which are labeled "industries" are normally considered endogenous and those which are labeled "final-demand sectors" are normally considered to be exogenous. But sometimes it is not so easy to classify activities.

The household sector is a case in point. While traditionally classified as a final-demand sector, it is frequently treated in regional economic models as an "industry." Households sell labor, managerial skills, and privately owned resources; they receive in return wages and salaries, dividends, rents, proprietors' income, etc. And to produce these resources, they buy food, clothing, automobiles, housing, services, and other consumer goods. Exceeded in total expenditures only by the manufacturing sector, the household sector is obviously a critical part of the Georgia economy or of any area economy, for that matter. So we move the household row and column into the interindustry part of the transactions table and treat households as another industry. The household sector becomes the sixth "industry" in the aggregated table repeated as revised in Table 5.1.

Table 5.1 Hypothetical interindustry transactions with endogenous household sector

Selling sector	buying sector	Extraction (1)	Construction (2)	Manufacturing (3)	Trade (4)	Services (5)	Household expenditures (6)	Total industry demand (7)	Other local final demand (8)	Exports (9)	Final demand (10)	Total demand (11)
Extraction	(1)	183	31	599	6	73	99	991	88	596	684	1674
Construction	(2)	14	1	43	14	293	0	364	1803	353	2155	2520
Manufacturing	(3)	142	414	1390	110	356	1275	3687	1130	9344	10474	14162
Trade	(4)	52	224	520	72	257	2563	3689	161	970	1131	4820
Services	(5)	102	221	862	558	1990	4262	7996	523	2828	3351	11347
Households	(7)	595	665	3696	2385	4603	100	12043	2524	0	2524	14567
Total local inputs	(6)	1088	1556	7110	3145	7572	8299	28770	6228	14091	20319	49090
Other payments	(8)	261	191	1624	1365	2402	3789	9632	(943.2)	(1097.5)	0	5842
Imports	(9)	325	773	5428	311	1372	3778	11987	1057	-12994	-11937	50
Total final payments	(10)	586	964	7051	1675	3775	7567	21619	3581	-12994	-9413	20459
Total inputs	(11)	1674	2520	14162	4820	11347	15866	50389	7285	1097	20459	54982

[1] My favorite source for this logic is the dominant book on input-output models of the 1960's (Chenery and Clark 1959). It contains almost all we needed until the advent of commodity-by-industry accounts. I recommend it.

The state and local government sectors (included in "other final demand" and "other final payments" in our aggregated table) also are difficult to classify. While we leave them in the exogenous part of the table now, primarily for simplicity, they are occasionally included in the endogenous part of the table in detailed forecasting models.

The economic model

As is now familiar, an equilibrium model is based on three sets of relations: (1) definitions or identities, (2) technical or behavioral conditions, and (3) equilibrium conditions. A model thus uses a set of assumptions to extend a description of an economy so that it can be used to trace the effects of disequilibrating forces. In the case at hand, each set of relations can be easily identified.

Identities: the transactions table

The state transactions table as extended above provides our set of identities: it defines the economy for the base year. Now let's express these relations in simple algebra. Let z_{ij} be the sales of industry i to industry j, e_i the sales of industry i to other final demand (ultimate consumers), and q_i the total sales of industry i, or total demand for the output of the industry. Then we can define the sales of Georgia industries in terms of the following equations:

$$z_{11} + z_{12} + z_{13} + z_{14} + z_{15} + z_{16} + e_1 \equiv q_1$$
$$z_{21} + z_{22} + z_{23} + z_{24} + z_{25} + z_{26} + e_2 \equiv q_2$$
$$z_{31} + z_{32} + z_{33} + z_{34} + z_{35} + z_{36} + e_3 \equiv q_3$$
$$z_{41} + z_{42} + z_{43} + z_{44} + z_{45} + z_{46} + e_4 \equiv q_4$$
$$z_{51} + z_{52} + z_{53} + z_{54} + z_{55} + z_{56} + e_5 \equiv q_5$$
$$z_{61} + z_{62} + z_{63} + z_{64} + z_{65} + z_{66} + e_6 \equiv q_6$$

This set of identities can be seen symbolically in the top six rows of Figure 5.1 and numerically in the five industry rows and in the household row (now "industry" six) of the transactions table (Table 5.1). Since we are now primarily concerned with Quadrant II, we have reduced Quadrant I to one column in these tables and we have dropped the various intermediate totals.

Figure 5.1 Algebraic transactions table

Selling sector	Buying sector	Extraction (1)	Construction (2)	Manufacturing (3)	Trade (4)	Services (5)	Households (6)	Final demand and exports (7)	Total demand (8)
Extraction	(1)	z_{11}	z_{12}	z_{13}	z_{14}	z_{15}	z_{16}	e_1	q_1
Construction	(2)	z_{21}	z_{22}	z_{23}	z_{24}	z_{55}	z_{26}	e_2	q_2
Manufacturing	(3)	z_{31}	z_{32}	z_{33}	z_{34}	z_{35}	z_{36}	e_3	q_3
Trade	(4)	z_{41}	z_{42}	z_{43}	z_{44}	z_{45}	z_{46}	e_4	q_4
Services	(5)	z_{51}	z_{52}	z_{53}	z_{54}	z_{55}	z_{56}	e_5	q_5
Households	(6)	z_{61}	z_{62}	z_{63}	z_{64}	z_{65}	z_{66}	e_6	q_6
Final payments	(7)	v_1	v_2	v_3	v_4	v_5	v_6	–	–
Imports	(8)	m_1	m_2	m_3	m_4	m_5	m_6	–	–
Total inputs	(9)	g_1	g_2	g_3	g_4	g_5	g_6	–	–

In a more concise formulation, the equations may be summarized as:

$$q_i \equiv \sum_j z_{ij} + e_i \tag{5-1}$$

where the operator $\sum_j$ sums sales by industry i over all industries j.

As can be seen, Figure 5.1 and the above set of equations differ in only two ways: (1) the arithmetic operators are implicit in the table; and (2) the table includes values for other final payments (v_j) and imports (m_j), completing the accounting framework.

While the above set of equations (identities) is our basic concern, a second set may reveal insight into our equilibrium problem. For the economy to be in a state of equilibrium, row and column totals must agree. (A simple fact of double-entry accounting.) We can now define total output, or supply, for industry j as g_j , the sum of all intermediate purchases, local payments to factors of production, and imports:

$$g_j \equiv \sum_i z_{ij} + v_j + m_j \tag{5-2}$$

where $\sum_i z_{ij}$ sums purchases by industry j over all industries i.

Technical conditions: the direct-requirements table

Now, recall that the final-demand vector (e) is exogenous. The e's are free to change, outside of our control. We wish to know the effects of such change on the economy as expressed by changes in output. It is obvious that little additional information can be gleaned from the transactions table. We have six equations and 48 variables, of which only six (the e's) now have assigned values. The minimum requirement for a solution to this system is that the number of equations equals the number of unknowns; therefore, we must reduce the number of unknown variables by 42.

To do this, we introduce a set of technical conditions. Assume that the pattern of purchases identified in the base year is stable. We can now define a set of values called "direct requirements," or "production coefficients:"

$$a_{ij} = z_{ij}/g_j \tag{5-3}$$

Table 5.2 records these a_{ij} coefficients for the hypothetical model. We have simply divided each value in a column by the total inputs (output) of the industry represented in the column.

These numbers show the proportions in which the establishments in each industry combine the goods and services which they purchase to produce their own products.

Table 5.2 Hypothetical direct-requirements table

Industry		Extraction (1)	Construction (2)	Manufacturing (3)	Trade (4)	Services (5)	Household expenditures (6)
Extraction	(1)	10.9	1.2	4.2	0.1	0.6	0.6
Construction	(2)	0.8	0.0	0.3	0.3	2.6	0.0
Manufacturing	(3)	8.5	16.4	9.8	2.3	3.1	8.0
Trade	(4)	3.1	8.9	3.7	1.5	2.3	16.2
Services	(5)	6.1	8.8	6.1	11.6	17.5	26.9
Households	(6)	35.5	26.4	26.1	49.5	40.6	0.6
Total local purchases		65.0	61.7	50.2	65.2	66.7	52.3
Other payments		15.6	7.6	11.5	28.3	21.2	23.9
Imports		19.4	30.7	38.3	6.4	12.1	23.8
Total final payments		35.0	38.3	49.8	34.8	33.3	47.7
Total inputs		100.0	100.0	100.0	100.0	100.0	100.0

Notice that we can define z_{ij}, the sales by industry i to industry j, in another way. It can be written as $z_{ij} = a_{ij} * g_j$. That is, if the manufacturing sector purchases 6.1 percent of its inputs from the service sector (a_{53}), and if manufacturing purchases a total of $14,162 million worth of inputs (g_3), then its purchases from the service sector would have to amount to $862 million, or 6.1 percent of $14,162 million. If the proportions in which industries buy their inputs remain reasonably stable over time, then we can define purchases by industry i from industry j in the future as $z_{ij} = a_{ij} * g'_j$. As we shall see, this simple assumption solves our problem.

A second assumption is hidden within the definition of z_{ij} in that it is already defined as purchases from *local* industry i by *local* industry j. This is best seen by looking at the derivation of the regional production coefficients, a_{ij}. Each regional production coefficient is the product of a "technical production coefficient," p_{ij}, which shows the proportion of inputs purchased from industry i by industry j without regard to the location of industry i, and a "regional trade coefficient," r_{ij}, which shows the proportion of that purchase made in the region. Symbolically, the regional production coefficient is

$$a_{ij} = p_{ij} * r_{ij}$$

$$a_{ij} = ({}_t z_{ij}/g_j) * ({}_t z_{ij} - m_{ij})/{}_t z_{ij} \tag{5-4}$$

Here, ${}_t z_{ij}$ is purchases from industry i by industry j without regard to the location of industry i, and m_{ij} is imports of the products of industry i by industry j. This point is expanded upon both in the summary included in illustration 5.1 and in the section below on economic change.

Equilibrium condition: supply equals demand

Note that along the way we have implicitly stated the equilibrium condition. This condition is that, for all industries, anticipated demand equals supply, or that the sales of an industry equal its gross output:

$$g_j = q_j \tag{5-5}$$

Over any long period of time in a market economy, it is irrational to produce more than is used and impractical to consume more than is produced. Under normal conditions, an economy faced with a change in demand will react by changing supply. When anticipations are fulfilled, the economy is in a state of equilibrium.

Solution to the system: the total- requirements table

We can now rewrite the equation system to meet the obvious conditions for its solution. Two substitutions are required: (1) since we assume the production coefficients are stable, $a_{ij} * g_j$ can be substituted for z_{ij}, and (2) since inputs must come back into balance with outputs, q_j is substituted for g_j. Thus,

$$\begin{aligned}
a_{11} * q'_1 + a_{12} * q'_2 + a_{13} * q'_3 + a_{14} * q'_4 + a_{15} * q'_5 + a_{16} * q'_6 + e'_1 = q'_1 \\
a_{21} * q'_1 + a_{22} * q'_2 + a_{23} * q'_3 + a_{24} * q'_4 + a_{25} * q'_5 + a_{26} * q'_6 + e'_2 = q'_2 \\
a_{31} * q'_1 + a_{32} * q'_2 + a_{33} * q'_3 + a_{34} * q'_4 + a_{35} * q'_5 + a_{36} * q'_6 + e'_3 = q'_3 \\
a_{41} * q'_1 + a_{42} * q'_2 + a_{43} * q'_3 + a_{44} * q'_4 + a_{45} * q'_5 + a_{46} * q'_6 + e'_4 = q'_4 \\
a_{51} * q'_1 + a_{52} * q'_2 + a_{53} * q'_3 + a_{54} * q'_4 + a_{55} * q'_5 + a_{56} * q'_6 + e'_5 = q'_5 \\
a_{61} * q'_1 + a_{62} * q'_2 + a_{63} * q'_3 + a_{64} * q'_4 + a_{65} * q'_5 + a_{66} * q'_6 + e'_6 = q'_6
\end{aligned}$$

The prime applied to each variable indicates "future" value.

The power of our assumption that the technology of production is constant is now clear. With it, we have reduced the number of unknowns from 48 to six, the q's, and can proceed to solve the system and thus to determine the outputs of industries in our economy in the future.

Compressed, the system is expressed as

$$q_i' \equiv \sum_j a_{ij} * q_j' + e_i'. \tag{5-6}$$

A full explanation of the solution to this system can now be easily expressed in matrix algebra and, in this case, is analogous to the one in simple algebra used with economic-base models. We wish to solve the following equation for q, where q is a column vector of the q_i in the equation system above, A is a matrix of the a_{ij}'s, and e is a column vector of the e_i's. Ignoring the prime marks, equation 5-6 can be rewritten as:

$$q = A * q + e \tag{5-7}$$

Now, we subtract Aq from both sides of the equation,

$$q - A * q = e \tag{5-8}$$

factor q from the terms on the left,

$$(I - A) * q = e \tag{5-9}$$

and multiply both sides by the inverse of $(I - A)$ to get

$$(I - A)^{-1} * (I - A) * q = (I - A)^{-1} * e, \tag{5-10}$$

or, since a matrix multiplied by its inverse yields an identity matrix,

$$q = (I - A)^{-1} * e, \tag{5-11}$$

the solution for q in terms of e. Here, I is the identity matrix, which is the matrix equivalent to the number *1* and the exponent (*-1*) shows that the parenthetic expression is inverted, or divided into another identity matrix. The term $(I - A)$ is sometimes called the "Leontief matrix" in recognition of Wassily Leontief, the originator of input-output economics; $(I - A)^{-1}$, of course, is called the "Leontief inverse." A more descriptive title is "total-requirements table."

Table 5.3 Total requirements (with households endogenous)

Industry		Extrac-tion (1)	Con struc-tion (2)	Manu-fac-turing (3)	Trade (4)	Ser-vices (5)	Household expendi-tures (6)
Extraction	(1)	1.14	0.03	0.06	0.02	0.02	0.02
Construction	(2)	0.02	1.01	0.01	0.02	0.04	0.01
Manufacturing	(3)	0.19	0.26	1.18	0.12	0.13	0.15
Trade	(4)	0.17	0.21	0.14	1.16	0.17	0.25
Services	(5)	0.35	0.35	0.28	0.43	1.49	0.50
Households	(6)	0.69	0.60	0.52	0.80	0.75	1.38

Table 5.3 shows the total- requirements matrix for the hypothetical economy. Each entry shows the total purchases from the industry named on the left for each dollar of delivery to final demand by the industry numbered across the top. This sentence is complex and should be read carefully. While the direct requirements matrix recorded purchases from the industries named at the left for each dollar's (or hundred dollars' if expressed in percentages) worth of output by the industry numbered across the top, this table reports all of the purchases due to delivery to final demand. As the title shows, the table records both direct and indirect flows.

Now, let's insert summing rows into the table and add another meaning to it. The result is shown here as Table 5.4 and renamed as a table of "industry- output multipliers". The key row is labeled "total industry outputs" and included the sum of industry outputs required for the industry named at the top to deliver one dollar's worth of output to final demand (that is, to export this amount). Thus, in exporting a dollar's worth of output the manufacturing sector would cause production by other industries amounting to $1.67. This seems magical if not impossible until you recall the lessons of economic-base theory. The total double-counts the values of outputs bought and rebought as materials move from one processor to another, acquiring more value each time. We will pursue this in a little more detail in Chapter 6.

Since the household sector is not really an "industry" but has been included to assure that all internal flows related to production are counted, we exclude it from the summation of industry outputs. Later, we will treat entries in the household row as "household-income multipliers."

For many years, the total of both industry outputs and household incomes in this total-requirements table was discussed as an "output multiplier." This was incorrect, however, and most analysts avoid this error. The sum in Table 5.4 is labeled as "total activity," but it has no real meaning beyond noting the rippling of money through the economy.

Table 5.4 Industry-output multipliers (with households endogenous)

Industry		Extrac-tion (1)	Con struc-tion (2)	Manu-fac-turing (3)	Trade (4)	Ser-vices (5)	Household expendi-tures (6)
Extraction	(1)	1.14	0.03	0.06	0.02	0.02	0.02
Construction	(2)	0.02	1.01	0.01	0.02	0.04	0.01
Manufacturing	(3)	0.19	0.26	1.18	0.12	0.13	0.15
Trade	(4)	0.17	0.21	0.14	1.16	0.17	0.25
Services	(5)	0.35	0.35	0.28	0.43	1.49	0.50
Total industry outputs		1.86	1.86	1.67	1.75	1.86	0.93
Households	(6)	0.69	0.60	0.52	0.80	0.75	1.38
Total "activity"		2.54	2.46	2.19	2.55	2.60	2.32

Now that we have developed the logic of a regional input-output model and can see that it is a means for tracing the effects on local industries of changes in the economy, let us go back and examine the effect of closing the model with respect to households. Recall that we have included the household sector as the sixth industry in the model. Under these conditions, the total-requirements table traces the flows of goods and services required to accommodate changes in final demand through all industries and through households as well. What if the household sector had been left in final demand? What if we had continued to treat it as exogenous to the system rather than endogenous?

Table 5.5 reports a total-requirements table which is based on a five-industry version of Table 5.2, the direct-requirements matrix. Examination of the column sums in the rows entitled "total output" in each table reveals the importance of the household sector in generating new activity in the economy.

Table 5.5 Total requirements (with households exogenous)

Industry		Extrac-tion (1)	Construc-tion (2)	Manufac-turing (3)	Trade (4)	Services (5)
Extraction	(1)	1.13	0.02	0.05	0.00	0.01
Construction	(2)	0.01	1.00	0.01	0.01	0.03
Manufacturing	(3)	0.11	0.19	1.12	0.03	0.05
Trade	(4)	0.04	0.10	0.05	1.02	0.03
Services	(5)	0.10	0.14	0.09	0.15	1.23
Total outputs		1.40	1.46	1.32	1.21	1.35

Table 5.6 compares these tables. Just including the household sector in the inverted table leads to increases in output by the processing industries (1 through 5) of 27 to 44 percent. (When we include households as an industry and count the flows through it as "industry output," the percent increase in output rises from 66 to 111 percent of the flows based on a table excluding households.) As we shall see later in a more detailed discussion of multipliers, income flows induced by households are important to a regional input-output analysis, but we must be careful to distinguish increases in household incomes from increases in industry outputs.

Table 5.6 A comparison of output multipliers under different household assumptions

Industry		Output mutipliers with: households exogenous (1)	households endogeous (2)	Increase due to household inclusion (3)	Percent increase due to household inclusion
Extraction	(1)	1.40	1.86	0.46	33
Construction	(2)	1.46	1.86	0.40	27
Manufacturing	(3)	1.32	1.67	0.35	26
Trade	(4)	1.21	1.75	0.54	44
Services	(5)	1.35	1.86	0.50	37

Economic change in input-output models

Causes vs. consequences of change

An input-output model is designed to trace the effects of changes in an economy which has been represented in an input-output table. Such models show the consequences of change in terms of flows of monies through an economy and in terms of incomes generated for primary resource owners. The models themselves do not show the causes of change; these causes are exogenous to the system.

Economic change as traced through an input-output model can take two forms: (1) structural change or (2) change in final demand. Changes in the economic structure of an area can be initiated in several ways. It can be through public investment in schools, highways, public facilities, etc., or it can be through private investment in new production facilities, or it can be through changes in the marketing structure of the economy. Changes in final demand are basically changes in government expenditure patterns and changes in the demands by other areas for the goods produced in the region.

Structural change

Structural change in an input-output context can be interpreted to mean it changes in regional production coefficients." In turn, this can be interpreted as either changes in technology or changes in marketing patterns or both. Let us see what this means in terms of the direct-requirements matrix, or the A matrix of our earlier discussion. Recall that a_{ij} is the proportion of total inputs purchased from industry i by industry j in the region. We can treat this regional production coefficient as the product of two other coefficients and write it symbolically as

$$a_{ij} = p_{ij} * r_{ij}.$$

The "technical production coefficient," p_{ij}, shows the proportion of inputs purchased from industry i by industry j without regard to the location of industry i, while the "regional trade coefficient," r_{ij}, shows the proportion of that purchase made locally.

A change in technology, or a change in p_{ij}, could be illustrated by a shift from glass bottles to metal cans by the soft-drink industry. But a change in location of purchase, or a change in r_{ij}, would be illustrated by a shift from metal cans made in another area to metal cans produced in our region.

The above changes are couched in terms of existing industries. Another way in which change can take place is through the introduction of new plants or even new industries. The introduction of a new plant into an existing industry has the effect of changing the production and trade patterns of the aggregated industry to reflect more of the transactions specific to the detailed industry of which the new plant is a member. For example, consider the manufacturing sector of our highly aggregated five- industry model. As presented, it reflects the combination of all manufacturing activities in the region. The introduction of new plants in the transportation- equipment industry would change the combination of purchases presently made in the manufacturing sector. The same statement might be made concerning the purchase pattern displayed by the transportation equipment industry if a new aircraft-producing plant were established (or an old one were to cease operation).

The addition of a completely new industry to the system means adding another row and column to the interindustry table to represent the new industry. This is done in a manner similar to that involved in closing the table with respect to households.

To account for structural changes which are caused by changes in technology or in marketing requires a revision of the interindustry flows table and is best accomplished when a biennial revision is made.

Changes in final demand

Accounting for structural changes in an input-output model requires substantial skill and familiarity with the mechanics of the model on the part of the analyst. This is not the case when accounting for the effects of changes in final demand. It can easily be accomplished with the inverse matrix, or the total-requirements table, Table 5.3 in this chapter or, more appropriately, with its detailed equivalent.

Two kinds of changes can be traced. One form is a set of long-run changes in the demands for the outputs of all industries. This set takes the form of a vector of predicted exogenous demands (the e' vector discussed above) and represents our best judgment of the export demands for the products of our industries in some later year. Using the formula

$$q' = (I - A)^{-1} e'$$

we can easily derive projections of the expected gross outputs (q') of industries in the later year.

The other form which change in final demand might take is an assumed change in the final demand for the output of one industry. Say we wish to know the effect on the economy of a $100,000 change in the demand for floor coverings. We would simply go to the detailed tables and look for the column sum for the floor-covering industry in the total requirements matrix. Using the detailed table for our hypothetical economy (not shown here), this entry is 1.8094; multiplied by $100,000, it shows that these additional export sales of carpets would increase regional outputs by a total of $180,940. A look at the household row in that same column would have yielded a household-income coefficient of .4136, meaning that the additional carpet sales would have increased local household incomes by $41,360.

The example can be pursued on a more gross level by looking at Figure 4.1 and assuming a $100,000 increase in the output of the manufacturing sector. The output multiplier in manufacturing is 1.67, meaning that the $100,000 change in export demand yields $167,000 in additional business to local firms. The household-income coefficient of .52 means that household incomes increase by $52,000. The differences between these figures and those in the above paragraph show the consequences of aggregation, which conceals a substantial amount of variation in the detailed tables.

We discuss the multiplier model in more detail Chapter 6.

Illustration 5.1 The simple input-output model

Definitions or identities:

Inputs = Sum of purchases from other local industries and from final-payment sectors

$$g_1 \equiv z_{11}+z_{21}+z_{31}+v_1+m_1$$
$$g_2 \equiv z_{12}+z_{22}+z_{32}+v_2+m_2$$
$$g_3 \equiv z_{13}+z_{23}+z_{33}+v_3+m_3$$

or, in matrix terms,

$$g \equiv Z^T i + v + m$$

where Z^T is a transpose and i represents the summing vector.

Outputs $\equiv$ Sum of sales to other local industries and final users

$$q_1 \equiv z_{11} + z_{12} + z_{13} + e_1$$
$$q_2 \equiv z_{21} + z_{22} + z_{23} + e_2$$
$$q_3 \equiv z_{31} + z_{32} + z_{33} + e_3$$

or, in matrix terms,

$$q \equiv Zi + e$$

Behavioral or technical assumptions:

Constant production coefficients

$$p_{ij} = {}_tz_{ij}/g_j$$
$$or \quad {}_tz_{ij} = p_{ij}g_j$$

Constant regional trade coefficients

$$r_{ij} = ({}_tz_{ij} - m_{ij})/{}_tz_{ij}$$

Equilibrium condition:

Inputs = Outputs

$$g_i = q_i$$

Solution by substitution:

Problem: given final demands (e), reduce the number of unknowns to equal the number of equations.

Let $a_{ij} = p_{ij}r_{ij}$.

Then $a_{ij} = ({}_tz_{ij}/q_j)\cdot(({}_tz_{ij} - m_{ij})/{}_tz_{ij})$
$= ({}_tz_{ij} - m_{ij})/q_j = z_{ij}/q_j$ or
$z_{ij} = a_{ij}q_j$

Substituting into the output equations,

$$q_1 = a_{11}q_1 + a_{12}q_2 + a_{13}q_3 + e_1$$
$$q_2 = a_{21}q_1 + a_{22}q_2 + a_{23}q_3 + e_2$$
$$q_3 = a_{31}q_1 + a_{32}q_2 + a_{33}q_3 + e_3$$

Or, continuing in matrix terms,

$$q = Aq + e$$
$$q - Aq = e$$
$$(I - A)q = e$$
$$q = (I - A)^{-1}e$$

Output multipliers:

$dq_i/de_j = r_{ij}$, where r_{ij} is an element of R $= (I - A)^{-1}$.

Each of these partial output multipliers shows the change in local output i associated with a change in exports by industry j. Their sum over i is the total output multiplier for industry j.

Income multipliers:

$income_j =$ $Sum_i(r_{ij} * v_{jh}/q_j)$, where v_{ih} is household income.

Each of these income multipliers shows the change in household income caused by a change in exports by industry j.

6 REGIONAL INPUT-OUTPUT MULTIPLIERS

Introduction

As noted in Chapter 5, a regional input-output model can be used to provide a set of economic multipliers with which to trace the effects of changes in demand on economic activity in the region. After explaining more graphically the multiplier concept, this chapter formulates employment, household-income, and government-income multipliers and presents examples.

The multiplier concept

Input-output models are most commonly used to trace individual changes in final demand through the economy over short periods of time. In this function, they are called impact models, or multiplier models. Let us now look more closely at these models. First, we take an intuitive approach to understanding the meaning of the total- requirements table, illustrating the multiplier effect with a two-dimensional chart. Then we solve the model using the formula for the sum of an infinite series and present the results in three dimensions.

An intuitive explanation

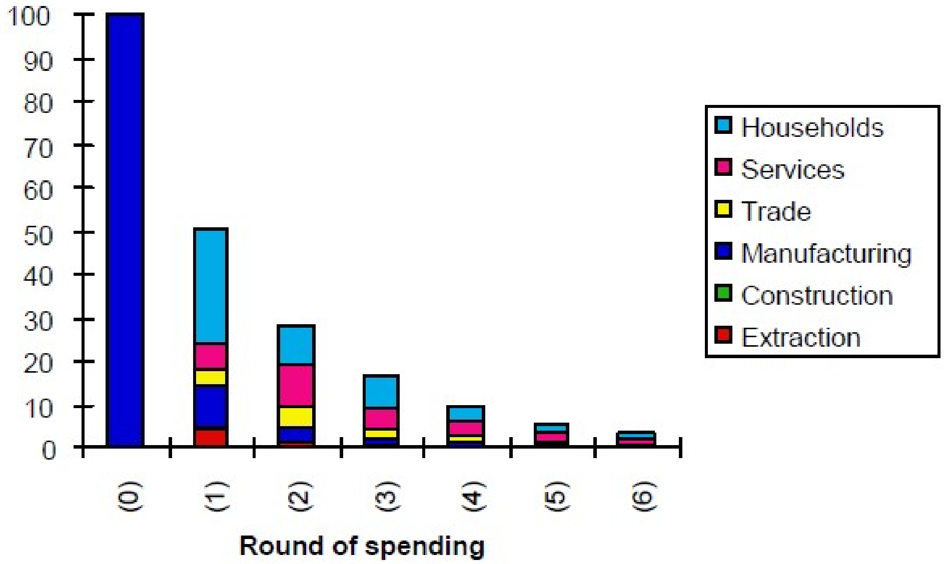
A total-requirements table for the aggregated six-industry model was presented in Table 5.3 for the previous chapter. This table shows the direct, indirect, and induced changes in industry outputs required to deliver units to final demand. A table of this type is the basic element used in estimating multipliers.

Table 6.1 Hypothetical direct-requirements table

Industry		Extraction (1)	Construction (2)	Manufacturing (3)	Trade (4)	Services (5)	Household expenditures (6)
Extraction	(1)	10.9	1.2	4.2	0.1	0.6	0.6
Construction	(2)	0.8	0.0	0.3	0.3	2.6	0.0
Manufacturing	(3)	8.5	16.4	9.8	2.3	3.1	8.0
Trade	(4)	3.1	8.9	3.7	1.5	2.3	16.2
Services	(5)	6.1	8.8	6.1	11.6	17.5	26.9
Households	(6)	35.5	26.4	26.1	49.5	40.6	0.6

To better understand the meaning of a total-requirements table and the multipliers derived from it, let us go back and trace the flow of outputs induced by a $100 purchase from the manufacturing sector through the direct- requirements table (repeated as Table 6.1). The result of this step-by-step tracing is illustrated in Figure 6.1 and reported in Table 6.2. First, $100 enters the state economy through manufacturing. (My convention is to label this initial round as “round zero” -- this is the “insertion” before the rounds of circulation begin. It is also consistent with the exponents in the solution based on the sum of an infinite series.) To produce output worth $100, firms in manufacturing purchase inputs from other industries in the economy. According to column 3 in the direct- requirements table, $4.20 goes to agriculture and mining, $0.30 goes to construction, an additional $9.80 goes to other firms in manufacturing, $3.70 goes to trade, $6.10 goes to services, and $26.10 is paid to households in wages and salaries (This is round one.). Capacity permitting, each of these industries must expand its output to accommodate this additional production load.

Figure 6.1 The activity effect of $100 sale to final demand by the manufacturing sector



Thus, in producing additional output valued at $4.20, firms in agriculture and mining buy output worth $0.46 (10.9% of $4.20) from others in this sector, $0.03 (0.8% of $4.20) from construction, $0.36 (8.5% of $4.20) from manufacturing, and so on, for a total of $2.72. At the same time, each of the other industries is purchasing the additional inputs required to produce the output requested of them. The results are summarized in Figure 6.1 as the second round of purchases. Other purchases follow in succeeding rounds, each smaller as money flows out of the interindustry sector into the hands of the owners of primary inputs (excluding labor), into government coffers, and for the purchase of imported materials.

This chain of purchases continues for all industries until the economy is again in equilibrium. The initial $100 purchase from manufacturing has led to money flows throughout the regional economy valued at $219, as shown in Table 5.4 in the previous chapter... Notice that if the value of additional output is summed through round six, most of the effect of the initial purchase has already been realized: as seen in Table 6.2, $214 has been spent at this point. The total-requirements table just counts the rounds of spending to infinity and adds them up. The total appears in Table 5.4 in the previous chapter as the column sum for manufacturing, and is labeled "total activity." The column itself has elements which show the output impact of the initial expenditure on each industry in the system.

Now, before we go on to explore mathematically this alternative approach to solution by inversion, let us reduce the "activity effect" to a "multiplier effect" focusing on industries. This reduction is accomplished simply by excluding the household row in the table of rounds of spending. Now we count only the effects on industries. This leads to Figure 6.2. The striking thing about the contrast of these two effects is the importance of the household in a regional economy. (The same relative pattern occurs in all regional models which I have encountered.)

The iterative approach

This intuitive explanation may be expressed in a more concise mathematical form as a "solution by iterations." This process uses the sum of an infinite series to approximate the solution to the economic model. In matrix algebra, the process is:

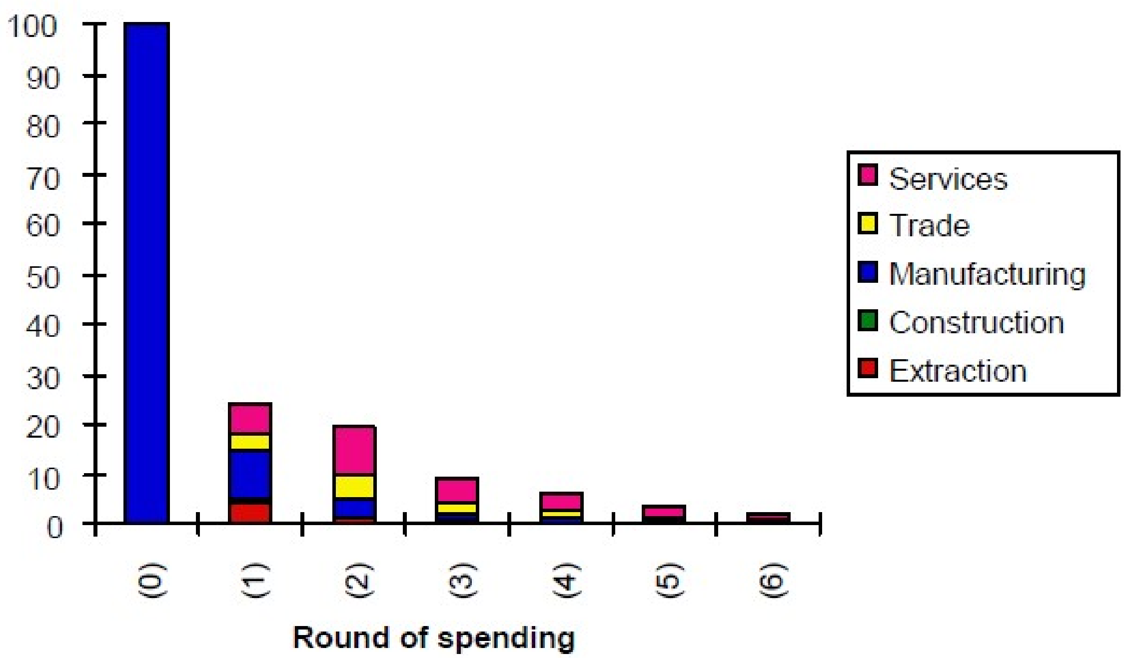
$$T = IX + AX + A^2X + A^3X + ... + A^nX$$

Here, T is the solution, a column vector of changes in each industry's outputs caused by the changes represented in the column vector X. A is the direct- requirements matrix. n is the number of rounds required to produce results approximating those obtained when n approaches infinity. (For this and most other cases, $n = 6$ is high enough to capture over 97 percent of the flows; eight rounds capture over 99 percent.)

Table 6.2 The multiplier effect of $100 in manufacturing output traced in rounds of spending through the hypothetical economy

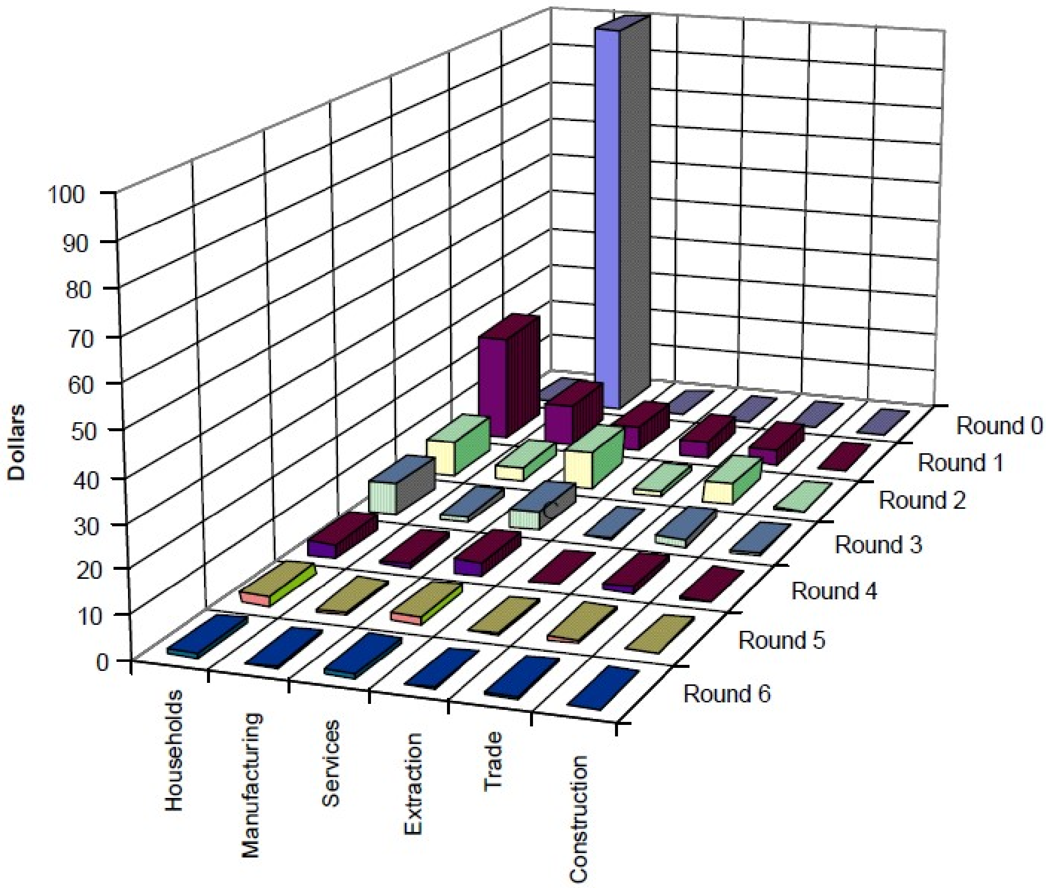
Industry		——Round of spending——							
		(0)	(1)	(2)	(3)	(4)	(5)	(6)	Total
Extraction	(1)	0.00	4.23	1.09	0.40	0.20	0.11	0.07	6.09
Construction	(2)	0.00	0.30	0.23	0.28	0.14	0.09	0.05	1.06
Manufacturing	(3)	100.00	9.82	3.74	1.60	1.05	0.57	0.35	117.13
Trade	(4)	0.00	3.67	4.93	1.87	1.48	0.73	0.48	13.16
Services	(5)	0.00	6.09	9.39	4.84	3.29	1.79	1.11	26.51
Total industry outputs		100.00	24.11	19.38	8.98	6.15	3.30	2.06	163.98
Households	(6)	0.00	26.10	8.60	7.72	3.57	2.47	1.32	49.77
Total "activity"		100.00	50.21	27.97	16.71	9.72	5.77	3.38	213.76

Figure 6.2 The multiplier effect of $100 sale to final demand by the manufacturing sector



The multiplier-effects, or "rounds-of- spending," table (Table 6.2) lays out the results of applying this equation to the problem of tracing direct expenditures. In this table, the total column is T. Round 0 is IX, the initial expenditures to be traced (I is the identity matrix, which is operationally equivalent to the number 1 in ordinary algebra). Round 1 is AX, the result of multiplying the matrix A by the vector X. It answers the question: what are the outputs required of each supplier to produce the goods and services purchased in the initial change under study? Round 2 is A^2X, which is the same as AAX, or $A(AX)$; it is the result of multiplying the matrix A by Round 1 (or AX). It answers for Round 2 the same question as was applied to Round 1: what are the outputs required of each supplier to produce the goods and services purchased in Round 1 of this chain of events? Round 3 is A^3X, which is the same as $A(A^2X)$; and the story repeats, round after round. Each of columns 1 through 6 in the multiplier-effects table represents a term in the continuing but diminishing chain of expenditures on the right side of the equation.

Figure 6.3 The ripple effect of a $100 export of manufacturing output



The tracing of these rounds in Table 6.2 can also be presented in three dimensions with a spreadsheet program (I used Excel.). Figure 6.3 shows once again the multiplier effects (now it might be proper to join the newspapers in discussing the "ripple effect") of a $100 export sale of manufacturing goods by our economy. Notice the large flow through households, especially in round 1, and note how quickly circulation falls off. This economy is pretty leaky!

This process has several advantages to recommend it over the inversion solution. The analyst builds a direct impact vector (Round 0) through survey or assumption and then sets the iterative process in motion on a desktop computer. He can see clearly the paths taken by indirect rounds of spending and can perform a check both on his direct impact vector and on the input-output model itself. Further, he has the material available to make a graphic presentation of his results which is easily understood by a reader.

Before the advent of microcomputers, the typical input-output study included lengthy sets of inverse matrices and multiplier tables in which the analyst looked up multipliers which applied to his problem. These numbers were then applied blindly and with faith.

Multiplier transformations

Now let us go back to the solution of the input-output model by inversion as presented in the previous chapter. This has the advantage of permitting us to generalize and produce the various kinds of multipliers possible in an input-output system.

Output multipliers

The first thing to note about Table 6.3 is that the elements of the inverse are now relabeled as "partial output multipliers." That is, in multiplier terminology, they are to be interpreted as stating the total impact on a row industry's output of one dollar brought into the economy by a column industry. The sums of these columns are output multipliers.

Note that we report three kinds of output multipliers. The first is simply 1.0, the direct sales by the industry in question, which may be called the "direct output multiplier" (sort of obvious, but included just for parallelism).

The second is a total "industrial activity multiplier", which is the sum for each column industry of the vector of partial output multipliers multiplied by direct output impacts (the 1's). To avoid considering the household as a true "industry", we violate the principles of vector multiplication by summing over industries (five rows) and not over industries and households (six rows).

$$QMULT_j = \sum_i INV_{ij}$$

where i counts through the number of industries.

The third output multiplier reported in Table 6.3 is sometimes called a "gross output multiplier." It is the sum over both industries and the household row of a column in the inverse matrix. To emphasize its mixed origin we label it as an "industry and household multiplier" and herewith declare it as improper to use. It mixes double-counted outputs and final incomes and has no meaning.

Although we have arrived at this point with little mention of earlier practice in input-output analysis, note that it was common practice several decades ago to produce a "Type 1" model, with households excluded from the A matrix, and a “Type 2" model, with households included. Output multipliers were appropriate with the Type 1 models and inappropriate with the Type 2 models. Analysts frequently became confused.

Now, almost all regional input-output analysts have abandoned Type 1 models and concentrate on the augmented models described here. If output multipliers are to have any meaning, they should be based on industrial activity alone.

The more appropriate multipliers, however, are those transformed into terms of employment and final incomes. They represent jobs and incomes to people, two important measures of the importance of industrial activities.

Table 6.3 Output, employment, income, and local and state government revenue multipliers for hypothetical economy

Industry title		Agric, mining 1	Cons-truction 2	Manu-facturing 3	Trade 4	Service 5	House-holds 6
Partial Output Multipliers (elements of inverse)							
Agriculture, mining	1	1.139	0.033	0.062	0.015	0.023	0.021
Construction	2	0.019	1.011	0.012	0.015	0.040	0.014
Manufacturing	3	0.184	0.253	1.173	0.092	0.128	0.146
Trade	4	0.165	0.207	0.138	1.159	0.166	0.245
Service	5	0.346	0.351	0.280	0.428	1.494	0.498
Households	6	0.684	0.593	0.516	0.785	0.745	1.381
Output multipliers							
Direct output		1.000	1.000	1.000	1.000	1.000	1.000
Industrial activity		1.853	1.855	1.664	1.708	1.850	0.924
Ind & households		2.538	2.448	2.180	2.494	2.595	2.305

Industry title	Agric, mining 1	Cons- truction 2	Manu- facturing 3	Trade 4	Service 5	House- holds 6
			Income multipliers			
Direct income	0.355	0.264	0.261	0.495	0.406	0.006
Total income	0.684	0.593	0.516	0.785	0.745	0.381
			Employment (per $million)			
Direct employment	30	12	16	30	25	5
Totalemployment	54	35	34	51	49	30
			Local government			
Direct revenue	0.020	0.010	0.009	0.014	0.024	0.023
Total revenue	0.051	0.038	0.032	0.046	0.057	0.049
			State government			
Direct revenue	0.001	0.004	0.008	0.120	0.016	0.021
Total revenue	0.042	0.049	0.041	0.163	0.061	0.068

Employment multipliers

The next question is how to estimate the impact on employment of new export activity. To answer this question, we must transform output impacts into employment impact. We use employment/output ratios for this.

To keep the numbers reasonable, we denominate the ratio in employees per million dollars of output. Total employment multipliers for an industry, then, are produced by multiplying the row vector of direct employment multipliers (which are the employment/output ratios) by the appropriate column vector in the inverse matrix. The formula for the employment multiplier for industry j can be stated as:

$$EMULT_j = \sum_i (n_i/q_i) * INV_{ij}$$

and can be restated in matrix terminology for all industries as

$$EMULT = n\hat{q}^{-1}(I - A)^{-1}.$$

where n is now a vector of industry employment, $\hat{q}$ is a diagonal matrix reflecting the vector q, and the other symbols are as defined previously.

Note that we have approximated current employee/output ratios to avoid results you would consider outlandish if we had used the original 1970 ratios. In fact, application of an input-output model which is usually a couple of years old (almost by definition) to a current or future statement of impact requires that we develop current or future estimates of employment/output ratios.

Income multipliers

Transformation from output terms to income terms is similar. Here, the direct income multiplier is simply the ratio of household income to output and is taken directly from the household row of the direct requirements matrix. The total income multiplier is produced by converting total changes in output to total changes in income using these ratios.

Symbolically, the household-income multiplier is written as a transformation almost identical to that used for the employment multiplier:

$$HMULT_j = \sum_i (h_i/q_i) * INV_{ij}$$

Here, h_i represents the household income of industry i.

Income multipliers are most useful compared to output multipliers. Output multipliers are "gross" in that they double-count transactions. One of the problems with economic-base multipliers was this double-counting, which led naive audiences to believe that we could magically get more stuff out of an economy than we put in, and it led sophisticated audiences into disbelief in the analyst's results. Income multipliers report the money that drops into the hands of owners of resources as income. In this case, the owners happen to be workers.

Government-income multipliers

The same process can be applied to government incomes, simply by substituting "local-government revenue" or "state-government revenue" for "household income" in the transformation formula. The resulting multipliers are relatively low because the revenue/output ratios are low.

Government-income multipliers suffer in interpretation because, while we generally consider governments as owners of resources and so treat them as we do households, they are in fact organized as businesses, and we hope they produce outputs in response to their incomes. This anomaly means that they should be interpreted as yielding excess revenue in some short-run period (in which excess capacity exists in streets, protection, utilities, etc.), but, in the long run, the piper must be paid and new capacity must be financed. Interpretation depends on your time horizon.

Appendix 1 Multiplier concepts, names, and interpretations

Introduction

This appendix examines the development of input-output multiplier concepts and the evolution of their names. It is included to show the evolution of the concepts over the last several decades. I will restrict this statement to regional input-output models mostly in North America and to multipliers commonly used in impact analysis, pointing out some preferred alternatives.[1]

It is traditional to start such an exposition with salutes both to R. F. Kahn, who introduced the employment multiplier to describe the effect upon unemployment of a net increase in home investment (Kahn 1931), and to John Maynard Keynes, who elaborated on and expanded the concept as an income multiplier in support of his arguments on national income and employment (Keynes 1936). These are familiar beginnings for economics students.

While the concept of economic-base analysis had been at play in geography and planning for a couple of decades, the economic-base multiplier did not seriously enter the literature in economics until 1950, with estimation of an employment multiplier for Los Angeles County by George H. Hildebrand and Arthur Mace, Jr. (Hildebrand and Mace do credit M. C. Daly, writing in the *Economic Journal* in 1940 for their approach.(Hildebrand and Mace 1950)) From this start, economic- base multipliers thrived in regional economics. Theodore Lane provides an excellent review of economic-base industry into its last great decade (Lane 1966).

The early literature on input-output analysis contained relatively few references to multipliers, although the inverse or interdependence matrix was well known and used with national tables. Essentially, it was left to regional economists to develop input-output multipliers. The serious literature on regional input-output multipliers starts with Frederick T. Moore in a now- classic article on "Regional Economic Reaction Paths" in 1955 (Moore 1955). And this is where I begin.

[1] This appendix is based on a paper presented at the North American meetings of the Regional Science Association in 1990.

Income multipliers

Origins of Types I and II income multipliers

Reporting on models of California and Utah developed in association with James W. Petersen, Moore defines "... the 'simple' income multiplier as the ratio of the direct-plus-indirect income effects to the direct alone" (Moore and Petersen 1955). His formula is well- known:

$$M_k = \frac{\sum_j a_{hj} d_{jk}}{a_{hk}} \tag{1}$$

where M_k is the simple income multiplier for industry k, a_{hj} is the household income coefficient for industry j, and d_{jk} is the element in the inverse showing direct and indirect purchases from industry j associated with a unit exogenous sale by industry k.

Moore explains his caution in using the term "simple" with a note that the Utah study reports multipliers based on an inverse derived from a coefficient matrix closed with respect to households (but he fails to use an adjective in describing these other multipliers). In addition, he discusses "... one more type of relationship: the effects upon investment induced by the changes in income and consumption. These effects he calls "accelerator coefficients," and he calculates them with a modification of the numerator of his simple income multiplier:

$$R_k = \sum_j b_j d_{jk} \tag{2}$$

R_k is the accelerator coefficient, and b_j is the capital-output ratio for industry j. This coefficient has apparently disappeared from the literature, probably due to data deficiencies.

Moore and Petersen report an interindustry model of Utah which remains a monument to scholarship. They go beyond Leontief's earlier- described "balanced regional model" (Leontief 1953) to develop a transactions table with pure regional transactions, albeit transactions estimated with what Schaffer and Chu later (1969) called the "supply-demand pool" technique, or the commodity-balance approach.

They proceed with development of three sets of income multipliers. Interestingly, especially given the problems we have faced over the years in terminology, they give these multipliers no specific names. The first income multiplier was the one named earlier by Moore as the "simple income multiplier." Its numerator was "income reactions to changes in demand," or the direct and indirect income effects of a unit change in final demand. The second was derived from "income reactions including induced via homogeneous consumption functions," or the direct, indirect, and induced income effects of change. The third multiplier was based on "income reactions including induced via nonhomogeneous consumption functions. This third multiplier was computed using the marginal coefficients in consumption functions estimated from national data for only three aggregations of the seven-industry model used to illustrate the study. Moore and Petersen felt that the induced effect is overstated by the homogeneous consumption functions implied by the closure of the model with respect to households.

Werner Z. Hirsch, in his model of St. Louis, moved beyond Moore and Petersen in three ways: he built the model from company records, he prepared a detailed exports matrix, and he treated the household and local government sectors as endogenous parts of the economy (Hirsch 1959). But he remained consistent in his treatment of income multipliers, although he developed only two sets and gave them parenthetic names. Moore's simple income multiplier became "multiplier (Model I)" and his second multiplier became "multiplier (Model II)."

At this point, little attention had been paid to input-output multipliers in the literature. In his *Methods of Regional Analysis*, Walter Isard, pays scant attention to them, seven pages out of over 700, devoted almost exclusively to the income and employment multipliers of the Utah study (Isard 1960). Hollis B. Chenery and Paul G. Clark, in their *Interindustry Economics,* long the comprehensive reference in the field, cite the term "multiplier" only twice in their index (Chenery and Clark 1959). Chenery and Clark do build inverses for Model I and Model II tables, as did Hirsch, with the Model II tables including households as endogenous.

But in 1965, William H. Miernyk devoted 14 pages of over 150 to multiplier analysis, and 8 of these to income multipliers. Simple, clear, and easily understood, Miernyk's *Elements of Input-Output Analysis* (Miernyk 1965) became a virtual bible to budding regional input-output analysts. Interest in regional input-output studies was intensifying in the sixties, and with this interest came a need to present in study reports some of the tools which might help others in using models produced at substantial expense and effort.

Miernyk based his table illustrating "income interactions" on a similar table from Hirsch. But he changed column headings describing multipliers for models I and II to be "Type I multiplier" and "Type II multiplier." To my knowledge, this is the beginning of the line for these names, which are still in use today. My suspicions are confirmed by P. Smith and W. I. Morrison, who calculated income multipliers "... using methods developed by Hirsch and discussed further by Miernyk, ... described (after Miernyk) as type 1 and type 2 income multipliers" (Smith and Morrison 1974, p. 57).

Type III multipliers

Moore and Petersen as well as Hirsch developed crude consumption functions for sets of industries in an attempt to reduce the impact of average propensities to consume (as expressed in a household coefficients column) on the induced income effect included in their type II multipliers. But the resulting third set of multipliers was unnamed. Miernyk obliged in his Boulder study by labeling these multipliers as "type III multipliers." Miernyk calculated consumption functions in Boulder and applied estimated marginal propensities to consume instead of household coefficients in computing income multipliers. As he expected, the resulting type III multipliers were lower than type II multipliers by slightly more than 10 percent. (Miernyk et al. 1967)

A second definition of type III multipliers is in use in Canada in the Atlantic Provinces and Nova Scotia (See Jordan and Polenske 1988 for a clear summary.). Following the lead of Kari Levitt and a team at Statistics Canada, I used three levels of closure to develop output, income, and employment multipliers for the 1974, 1979, and 1984 Nova Scotia input- output models (DPA Group Inc. and Schaffer 1989). Model I is the traditional open model, yielding direct and indirect effects; model II is closed with respect to households, yielding direct, indirect, and induced effects; model III is closed with respect to local and provincial government sectors as well, yielding direct, indirect, and extended effects. We devised the term "extended effects" to include effects induced both by households and by local and provincial governments.

This treatment of type III multipliers as reflective of greater closure seems a better use of the numbering system.

Household-income multipliers

Income multipliers are the most troublesome of multipliers. When we documented the Hawaii input-output model for 1967 the problems became obvious (Schaffer et al. 1972). Because it was by then traditional to show income and output multipliers, we did so, designating them as "simple" and "total," feeling these terms more descriptive than "type I" and "type II." (The "simple" came from the income multiplier in Moore and Petersen; the "total" came from their employment multiplier.) But we could not recall any instance in which the Department of Planning and Economic Development or any other agency had been asked to show the total effect on household incomes of a specified direct income change due to exogenous forces on an industry. People asked about the impact of new plant investment (a problem for which no convenient multipliers have been constructed) and about the impact of export sales, but none would ask about the effect of a payroll increase. So we added an "income coefficient," showing the total income effect associated with a unit change in export sales. The format of the table was Hirsch's (1959, p.366), with a total column added.

In documenting the 1970 Georgia input-output model, (Schaffer 1976), the traditional definition became "... awkward and inconsistent with the approach taken in most interpretations. Therefore, we ... defined the 'household- income multiplier' for industry j to be the addition to household incomes in the economy due to a one-unit increase in final demand for the output of industry j." The footnote explaining this move is a clear summary of the twisted path described thus far:

> The notion of an income multiplier as first introduced to the regional literature by Moore and Petersen (1955) was used to describe additional household income attributable to unit change in household income in the industry in question. This definition is far removed from the exogenous changes which precipitate additional income changes, and it forces its user to unnecessary trouble in determining, e.g., the importance of an industry to its community. We have therefore switched Although a similar concept appeared in Moore and Petersen, our point is that the label is confusing. We first saw this concept discussed as 'income coefficients' in the Mississippi study by Carden and Whittington (1964) and used the term to distinguish our multiplier from the one seen in the literature as late as 1973. (p. 67)
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> Davis (1968, p. 33) makes the importance of this distinction clear. Two old-style income multipliers may have exactly the same values but may differ substantially in terms of income change per unit change in final demand. He suggests that an emphasis on absolute changes ... rather than on relative changes, as in Moore and Petersen, be made to avoid the confusion. The caution was also expressed by Miernyk (1967, p. 101) in his Boulder study, which reported old-style income multipliers.

But despite these problems, the old- style income multipliers live on. Two not-too-distant uses are in the Delaware model produced by Sharon Brucker and Steve Hastings (1984) and in the 1984 Nova Scotia Study, where the term 'income-generated multiplier' substitutes for the above-recommended 'household- income multiplier' and 'income multipliers' are defined in the original way.

Other income multipliers

It became obvious early that other multipliers reflecting the total impact of changes in final demand on incomes could be generated.

The documentation of the 1963 Washington input-output (Bourque and others 1967) reports only one multiplier, the regional income multiplier, which includes the change in total state income per $100,000 change in final demand. The 1972 Washington study (Bourque and Conway 1977), in one of the clearest expositions of multiplier development yet written, defines type I and type II value added multipliers, along with labor-income multipliers, and jobs multipliers. In each case, the multiplier is calculated as "... a simple transformation of the output multipliers given in the inverse matrix ... ." Thus:

$$M_k = \sum_i v_{kj} b_{ij} \sum v_{kj} b_{ij} \tag{3}$$

where M_k is the income multiplier for the k^{th} factor income, v_{ki} is the input coefficient for the k^{th} factor in industry i, and b_{ij} is the inverse coefficient.

This view of the multiplier as an operator with which to transform changes in industry output into impacts on incomes of factors of production was well expressed by Hays B. Gamble and David L. Raphael (1966). In a survey- based model of Clinton County, Pennsylvania, they develop "residual income multipliers" by inverting a coefficient matrix including vectors for the nonprofit sector, three local government sectors, and four household sectors. Then by summing elements in these rows of the interdependency matrix (inverse) for each industry, they produced household multipliers, local government multipliers, and nonprofit multipliers.

In both the Nova Scotia studies and the Georgia model, I produce government-income multipliers. for local governments and for provincial or state governments.

In all these cases, the multipliers can be unambiguously interpreted as changes in incomes per change in exogenous demand. It is only the income multiplier associated with households that is ambiguous.

Employment multipliers

Employment multipliers were developed by Moore and Petersen at the same time as and analogous to their income multipliers. They estimated a set of aggregated employment-production relationships and used the coefficients showing change in employment per change in output as the a's in equation (1), transforming the multiplier from dollar terms into employment terms. Their multipliers relate total employment change to direct employment change.

Both Hirsch and Miernyk repeat this definition. In his Boulder study, Miernyk built "type III" employment multipliers as well, with a complete set of employment functions. Later, in his West Virginia Study, Miernyk apparently used simple employment- output ratios to effect the transformation from output terms to employment terms.

The first employment multipliers produced in the Washington series were for 1972. Bourque and Conway unwaveringly maintain their devotion to defining multipliers denominated with final demand changes, producing type I and type II versions to reflect levels of closure.

In Georgia, I also denominated my simple and total employment multipliers with final demand changes. In Nova Scotia, we produced both output-based employment multipliers and employment-based employment multipliers for models with three levels of closure, parallel to our other multipliers. This was largely because of a feeling that, in inflationary times, the shelf life of output-based employment multipliers was much lower than that of employment-based ones.

Output multipliers

Output multipliers are an obvious starting point for multiplier analyses. They are simply the column sums of the industry part of an inverse matrix. These columns are the essential ingredients in the other multiplier calculations. Yet, output multipliers were neither mentioned nor alluded to by either Moore and Petersen or Hirsch or Miernyk.

Floyd Harmston in his 1962 Wyoming study used a “business and industry multiplier” which was a type I output multiplier under another name (Harmston 1962). I used output multipliers in both Georgia and Nova Scotia studies. But, after a little note from Rod Jensen, Australia’a leading authority on input-output analysis, commenting on an early draft, I made explicit a warning that output multipliers should be used only as general indicators of industrial activity. While they represent the essence of interindustry models, the flows of intermediate transactions are not our basic interests in summary multipliers. Effects on income and employment are our primary concerns. Nevertheless, these by- products of useful multiplier production are common statements in many studies.

In explaining why they did not produce aggregate output multipliers for the 1972 Washington model, Bourque and Conway express this caution beautifully:

> ... we have not specified aggregate output multipliers. Although the output multipliers given by the elements of the inverse matrix are at the root of the multipliers ...[calculated] ... , it is not very meaningful to sum these elements into aggregate output multipliers for each industry In other words, given the concepts that lie behind each output measure, it does not make much sense, economically speaking, to combine, say, the shipments of pulp mills with the margins of the insurance industry into an aggregate transactions measure. Furthermore, users of the Washington tables in the past have sometimes employed aggregate output multipliers inappropriately, in at least one case confusing them with income multipliers. For these reasons, we have chosen not to present aggregate output multipliers. (Bourque and Conway 1977, p. 48)

Observations and summary

These comments are consistent with conventions used in a recent comprehensive compendium on input- output analysis by Ronald E. Miller and Peter G. Blair (1985). Multipliers have admittedly become a larger question than for earlier writers. Miller and Blair devote over ten percent of their book to regional, interregional, multiregional, and interrelation multipliers. (Only five percent is devoted to basic regional multipliers.)

They resolve my concern regarding the denominating of income and employment multipliers by relegating the terms **"type I"** and **"type II"** exclusively to multipliers with denominators in the same terms as the numerators. They then use *"simple"* to identify multipliers based on pure industry transactions tables and **"total"** for multipliers based on tables closed with respect to households. **“Income”** multipliers show changes in income per unit change in final demand and **"employment"** multipliers are expressed per unit change in final demand as well.

These statements and the explanations accompanying them are helpful indeed. But, an appropriate conclusion of this review is that analytic purposes determine the terminology to use. The problem which we might perceive comes from overall study reports which suggest through terminology the impacts which might be examined through regional input-output models. When particular questions are pursued, explanations should eliminate the ambiguities in impact interpretations.

Further extensions

The point of view taken above can be described as that of an old-line traditionalist. More multipliers continue to evolve and recirculate. I should mention two of them.

One is income-distribution multipliers. to my knowledge, efforts to develop income-distribution multipliers started with Roland Artle in his studies of the Stockholm economy (Artle 1965) and in his efforts in the early sixties to estimate such multipliers while working with a research team in Hawaii. While he conceptualized a system with the household row divided into several income classes and with the household expenditure column similarly divided, the effort failed due to complex data problems.

An effort which has yielded more fruit is that of Kenichi Miyazawa documented in several articles in the sixties and seventies and in his book (Miyazawa 1976). His "intersectoral income multipliers" have been used on numerous occasions in the last two decades. Since such studies are beyond the realm of normal economic impact analyses, we do not treat them further.

The second multiplier system that has been resurrected is the "SAM-based multiplier." Social Accounting Matrices (SAMs) evolved to a high level in the sixties in several streams of literature. One is the work of Richard A. Stone (leading to his Nobel Laureate in Economics) and extended at great detail in the United Nations social accounting literature. Another is the work at Statistics Canada as exemplified in the most exhaustive theoretical and empirical analysis of social accounts by Kari Levitt for the Atlantic Provinces (Levitt 1975a; 1975b). A third outstanding example of social accounting was executed by the late Jerald R. Barnard at the University of Iowa (Barnard 1967).

Each of these streams resulted in interindustry tables augmented by social accounts documenting incomes in various sectors of the economy (detailed income and product accounts of which the aggregated regional accounting table in Chapter 3 is a simple example) and yielding multipliers for the various sectors.

A more recent example of SAM multiplier models is the one in current use by IMPLAN, the modeling system developed by MIG, Inc. (Minnesota IMPLAN Group Inc. 1997)

A final comment is simply a caution. The proliferation of multipliers over the years and the complexity of extensions to input-output analysis can lead to substantial confusion among even knowledgeable analysts. Any multiplier analysis intended for a broad audience (or even an important decision-making audience) should be reduced to the simplest possible terms but should be sufficiently documented to permit some evaluation of its conclusions.

7 INTERREGIONAL MODELS

Now we can easily combine the economic-base and interindustry concepts to yield a quick feeling for multi-regional models. While we stop with this introduction, extensions to include transactions between industries in different regions are immediately obvious. In fact, a considerable literature has developed on interregional interindustry models and efforts have even been made to relate such models to "other worlds" such as the environment delineating the interactions of the human economy with the highly interactive elements of our land, sea, and air "economies."

Interregional economic-base models

In the following summary models, I have left implicit the definitions and identities which we labored over before. The common glossary is as follows:

Y:	income
E:	income-related expenditures
E_i:	income-related expenditures in region i
E_{ij}:	income-related expenditures in region i by residents of region j
A	autonomous expenditures
e:	marginal propensity to spend, $dE(Y)/dY = e$
X:	exports
M:	imports
m:	marginal propensity to import, $dM(Y)/dY = m$
$_i$:	subscript for region (A subscript of 0 is for "autonomous value.")

Review of one-region models

The one-region models are the Keynesian and economic-base models. Their distinguishing characteristic is that the value of income is determined by some autonomous activity out there. It may be investor behavior, as in the Keynesian model, or it may be purchases by consumers outside the region, as in the economic-base model.

Closed economy, no external trade

Assumptions:
$E = E(Y) = eY$
$A = A_0$

Equilibrium condition:
$Y = E + A$

Solution:
$Y = eY + A_0$
$Y = [1/(1 - e)]A_0$

Multiplier:
$dY/dA = 1/(1 - e)$

Open economy, with trade leakage

Assumptions:
$E_1 = E_1(Y_1) = e_1Y_1$
$X_1 = X_0$
$M_1 = M_1(Y_1) = m_1Y_1$
$A_1 = A_0$

Equilibrium condition:
$Y_1 = E_1 + A_1 + X_1 - M_1$

Solution:
$Y_1 = e_1 Y_1 + A_0 + X_0 - m_1 Y_1$
$Y_1 = (A_0 + X_0) * 1/(1 - (e_1 - m_1))$

Multiplier: $dY_1/dX_0 = dY_1/dA_0 = 1/(1 - (e_1 - m_1))$

Two-region model with interregional trade

What has been missing all along has been interaction between regions. Obviously this takes place in the real world; otherwise, there would be no regions. Exports by one region have to be imports into another economy.

Partial solution, two-region interregional model

The system can more easily be presented by laying out the system in the same form as above but stopping before the algebra requires the theory of determinants, which has either been forgotten or ignored by most of us. We will limit the statement to region one alone in this section.

Assumptions:
$E_1 = E_1(Y_1) = e_1 Y_1$
$X_1 = M_2 = M_2(Y_2) = m_2 Y_2$
$M_1 = M_1(Y_1) = m_1 Y1$
$A_1 = A_0$

Equilibrium condition:
$Y_1 = E_1 + X_1 - M_1 + A_1$

Solution:
$Y_1 = e_1 Y_1 - m_1 Y_1 + m_2 Y_2 + A_0$
$dY_1 = e_1 dY_1 - m_1 dY_1 + m_2(dY_2/dY_1)dY_1 + dA_0$
$dY_1 = e_1 dY_1 - m_1 dY_1 + m_2(dY_2/dY_1)dY_1(dM_1/dX_2) + dA_0$
$dY_1 = e_1 dY_1 - m_1 dY_1 + m_2 m_1(dY_2/dX_2)dY_1 + dA_0$

But this line of attack becomes unnecessarily complicated. We can't easily reduce the interactive term without knowing the multiplier for the other region (dY_2/dX_2)!

Multiplier:
$dY_1/dA_0 = 1/(1 - (e_1 - m_1 + m_2 m_1(dY_2/dX_2))$
$dY_1/dA_0 = 1/(1 - (e_1 - m_1 +$ interregional effect$))$

Let us take a more familiar tack. (This approach originated with Alan Metzler (Metzler 1950); Harry Richardson provides the restatement on which the above is based (Richardson 1969)

Matrix solution, two-region interregional model

This model can be more systematically expressed with the matrix algebra developed for input-output analysis. Matrix algebra permits us to immediately extend our logic from two regions as above to n regions without producing page after page of cumbersome calculations. Nevertheless, we will work with a two-region system for simplicity of discussion. We proceed as follows:

Assumptions:

As above, but now for both regions 1 and 2.

$E_i = E_i(Y_i) = e_i Y_i$
$X_i = M_j = M_j(Y_j) = m_j Y_j$

Equilibrium conditions:
$E_1 + X_1 - M_1 + A_1 = Y_1$
$E_2 + X_2 - M_2 + A_2 = Y_2$

Rewrite to align purchases from the two regions:

$E_1 - M_1 + X_1 + A_1 = Y_1$
$X_2 + E_2 - M_2 + A_2 = Y_2$

Now, observing the following definitions, we can rewrite the equation system preparatory to matrix manipulation:

$E_{11} = E_1 - M_1 = e_1 Y_1 - m_1 Y_1 = e_{11} Y_1$
$E_{12} = M_2 = M_2(Y_2) = m_2 Y_2 = e_{12} Y_2$
$E_{21} = X_2 = M_1(Y_1) = m_1 Y_1 = e_{21} Y_1$
$E_{22} = E_2 - M_2 = e_2 Y_2 - m_2 Y_2 = e_{22} Y_2$

Note that the e's now show double subscripts showing purchases from region i by region j. So the system becomes

$E_{11} + E_{12} + A_1 = Y_1$
$E_{21} + E_{22} + A_2 = Y_2$

or

$e_{11} Y_1 + e_{12} Y_2 + A_1 = Y_1$
$e_{21} Y_1 + e_{22} Y_2 + A_2 = Y_2$

which translates into matrices as

$$\begin{bmatrix} e_{11} & e_{12} \\ e_{21} & e_{22} \end{bmatrix} \begin{bmatrix} Y_2 \\ Y_2 \end{bmatrix} + \begin{bmatrix} A_1 \\ A_2 \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix}$$

or

$eY + A = Y$

where e is the matrix of e_{ij}. This solves exactly as would an input-output system:

$Y - eY = A$
$(I - e)Y = A$
$(I - e)^{-1}(I - e)Y = (I - e)^{-1}A$
$Y = (I - e)^{-1}A$

Now, to give the elements of this inverse a designation, set

$$R = (I - e)^{-1} = \begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix}$$

rewrite the solution as
$Y_1 = R_{11} A_1 + R_{12} A_2$
$Y_2 = R_{21} A_1 + R_{22} A_2$

The interregional multipliers are thus
$dY_i / dA_j = R_{ij}$

for each ith row and jth column.

Now, it is a simple matter to expand the system to treat n regions. The process is identical to that used in the two-region system but with larger matrices!

Extensions and further study

Interregional interindustry models

The obvious extension is to expand the cell entries to become interindustry transactions matrices. Thus the E_{12} entries would become ${}_{kl}E_{ij}$, showing purchases from industry k in region i by industry l in region j; where $i = j$, the regional transactions matrix for region i is inserted, and where i is not equal j, a matrix of imports is inserted.

The most commonly used multi-regional interindustry model of the United States was assembled by Professor Karen Polenske at MIT. Her model includes transactions generally for 50 industries in each of 44 states or sets of states.(Polenske 1980)

Economic-ecologic models

Economic-ecologic models append matrices depicting interaction between sectors in the natural environment and between those sectors and the industrial ones. The concept is similar to interregional interindustry analysis but implementation becomes a harrowing experience. The dominant example of this was a complex model of the Massachusetts Bay area. (Isard et al. 1972)

Both of these extensions are discussed in detail in the comprehensive input-output reference by Ronald Miller and Peter Blair. (Miller and Blair 1985)

8 COMMODITY-BY-INDUSTRY ECONOMIC ACCOUNTS: THE NOVA SCOTIA INPUT-OUTPUT TABLES

Introduction

Now that we have the basic framework of input-output analysis in hand, let's move a little closer to the format in which data is now accumulated at the national level and from which we estimate the parameters of regional models.

This format was developed in the 1960s by Richard A. Stone at Cambridge and adopted as a standard by the United Nations. Stone later received the Nobel Prize in Economics for his work in national income accounting (which includes input-output accounting). Statistics Canada (the statistical agency in Canada) pioneered in applying this format starting with their 1960 table; the Input-Output Division of the U.S. Department of Commerce produced their 1972 table in the new format. As a result, most of the state and regional models produced today are based on this format and data source. (Only two studies -- those for Washington and Kansas -- have been produced in recent decade with significant original survey inputs. And, to my knowledge, only the State of Washington has been surveyed in the past two years, under guidance of Dr. William Beyers.)

This format is called the "commodity- by-industry" format, and sometimes the "rectangular" system. It is rectangular in that the commodity dimension may be greater than the industry dimension (which poses a problem when the direct-requirements matrix must be square to provide a solvable system). It originated with a realization that firms, grouped in industries, buy commodities and that we have trouble grouping commodities into industries. Establishments often produce several commodities. They are classified into industries according to their primary products; their remaining products are secondary. An accounting scheme has to manage this problem.

I had the pleasure of building three input-output systems in Nova Scotia (1974, 1979, and 1984) during the period when the computing world moved from mainframes to desktops. The system fits exactly with the new U.S. system. Chapters 8 and 9 parallel Chapters 4 and 5 in organization and content. My intention is to make the transition to the more complex modern system easier as well as to economize on the writing chore.(DPA Group Inc. and Schaffer 1989)

The Nova Scotia input-output tables represent a complete set of social accounts for the Province. As is common with most social accounts, it is double entry in nature, but it has been organized in matrix form rather than as the traditional T-accounts. This section presents a brief schematic review of the accounting framework. In addition, the interpretation of the Nova Scotia tables is demonstrated with a set of highly aggregated (five industries) tables which duplicate the format of the more detailed tables produced in the Nova Scotia Input-Output Study itself.

A schematic social-accounting framework

The Nova Scotia input-output tables follow the form of the Canadian tables. They are of the "rectangular form" and show substantially more of the commodity detail of industry purchases than do tables of the "square" form commonly used in the United States and elsewhere. As shown in Illustration 8.1, the tables comprise six matrices. Three sets of accounts are evident in these matrices and the comments which follow are intended to identify the accounts in the tables.

Commodity accounts

For each commodity used and/or produced in the Province, accounts representing supply and demand can be constructed. Thus, the shaded row in Illustration 8.2 presents the demand side of the supply-and-demand equation for a particular commodity. It shows both the intermediate uses, or demands, expressed by domestic industries for the commodity, as recorded in Matrix 2, and the final uses, or demands, by consuming sectors for the commodity, as recorded in Matrix 1. These consuming sectors include local consumers and investors, governments, and non-local users. Total demand is the sum of total industry demand and total final demand.

The supply side of the equation for a commodity is represented in Illustration 8.2 by the shaded column, which traverses Matrix 5 and Vector 6. In Matrix 5, this column identifies the domestic industrial origins of the commodity; Vector 6 identifies imports of the commodity. The column sum is total supply, which is equal to total demand.

Industry accounts

The inputs and outputs of industries can also be traced in this system. Illustration 8.3 moves the shaded column and row to represent inputs and outputs of a particular industry. The outputs of the industry can be seen in the shaded row. This row records the values of the various commodities produced by the industry. The column in Illustration 8.3

records the production technology of the industry in terms of commodities purchased in Matrix 2 and of payments to "primary" inputs (i.e., labor, return to capital, etc.), or factors of production, in Matrix 3. Since the payments to inputs include profits, or the residual receipts by owners of establishments in the industry, total inputs equal total outputs for the industry.

Final accounts

The incomes and expenditures of "primary" sectors (e.g. household, government, etc.) of the economy can also be traced through the system. The shaded row and column in Illustration 8.4 are illustrative. The shaded row represents the incomes of a "primary" sector such as households or a government. As seen in Matrix 3, these incomes are paid by industries which use the services of the factors of production owned or provided by the sector. In addition, transfers of incomes from other "primary" sectors are recorded in Matrix 4. With the exception of wages and salaries paid by households, governments, and outside employers, these "transfers" are non-market in nature and represent such items as taxes, savings, welfare payments, intergovernmental transfers, and surpluses and deficits.

Illustration 8.1 Schematic input-output table for Nova Scotia

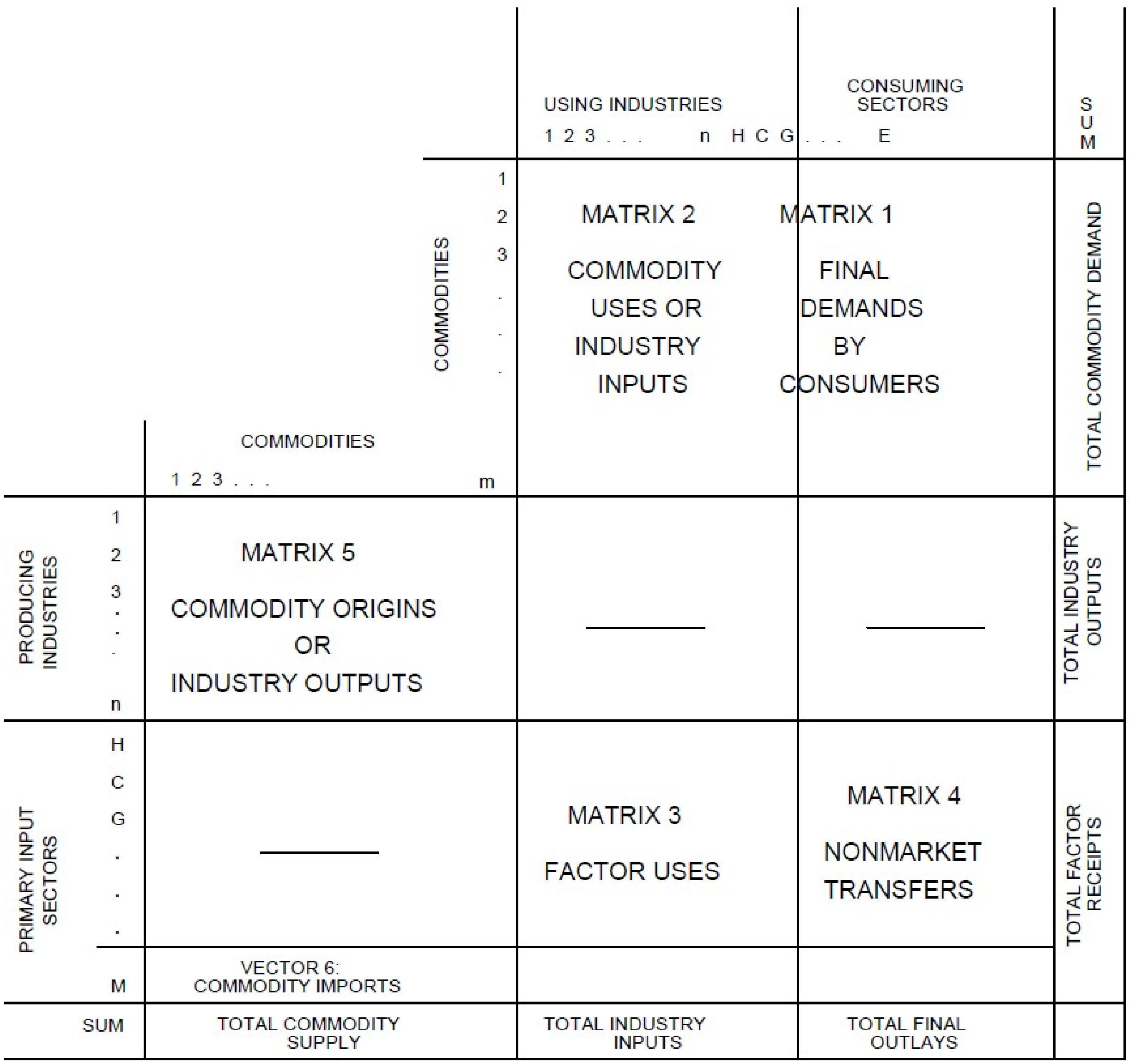


Illustration 8.2 Schematic input-output table for Nova Scotia emphasizing the commodity accounts

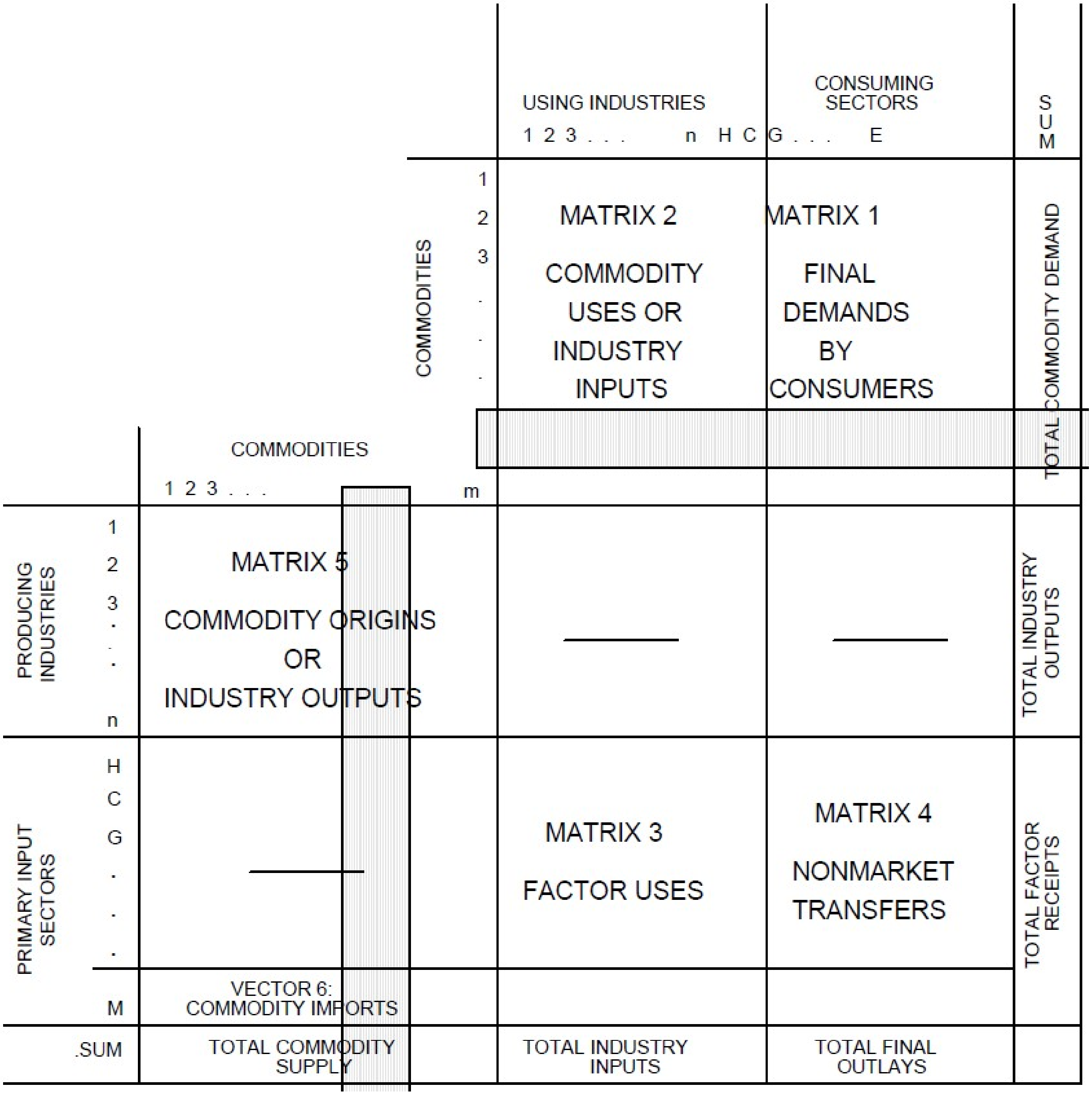


Illustration 8.3 Schematic input-output table for Nova Scotia emphasizing the industry accounts

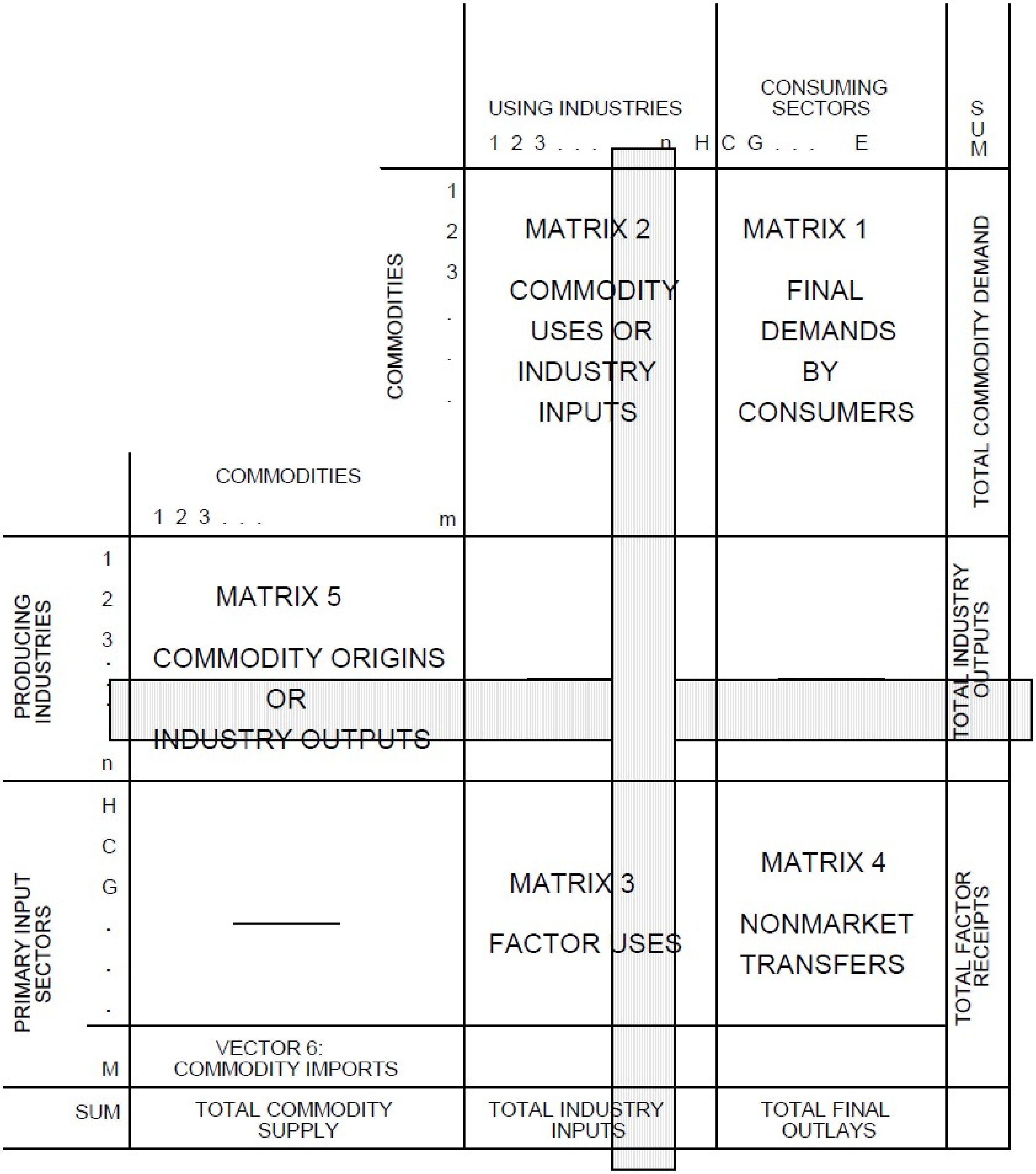
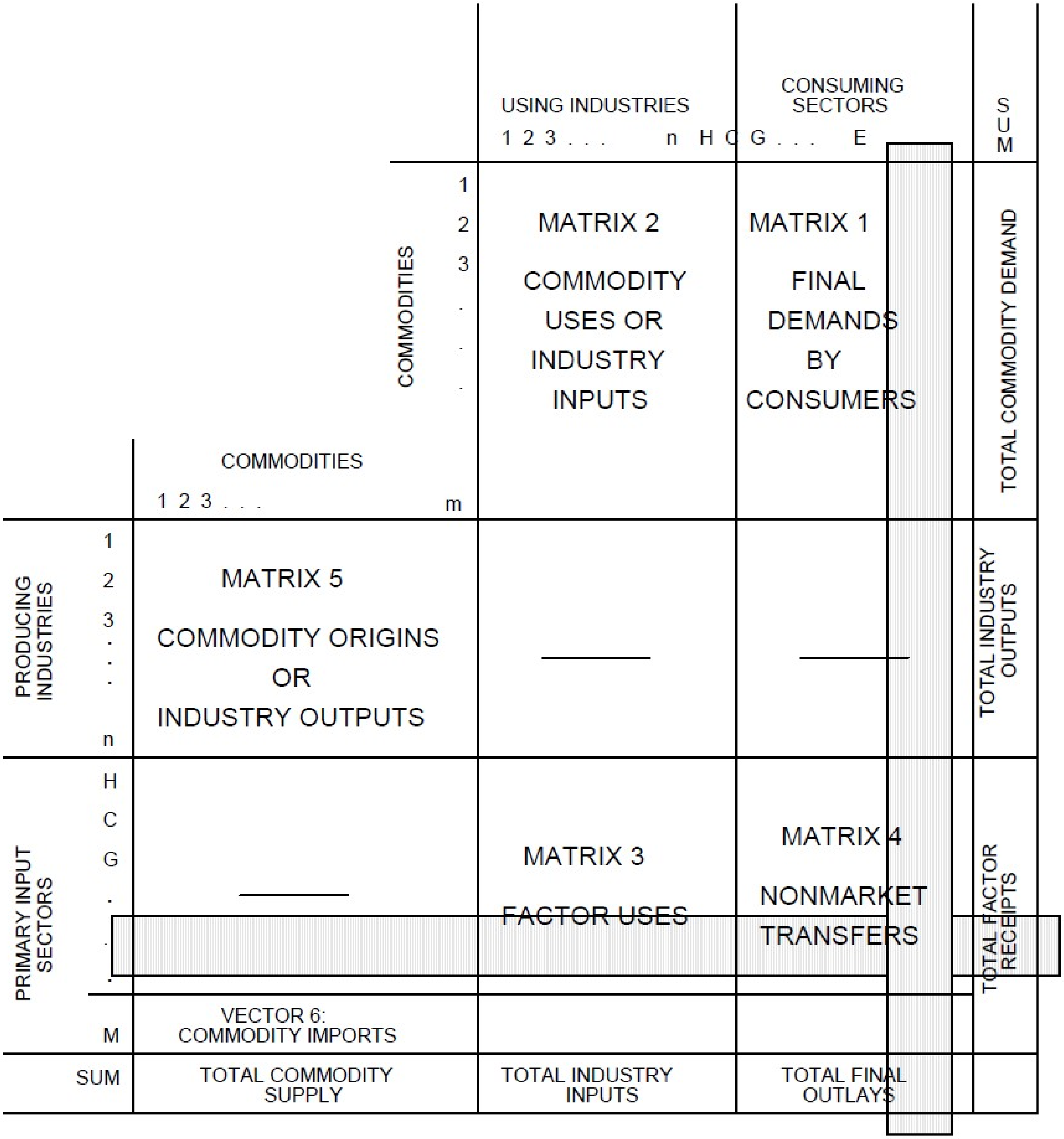


Illustration 8.4 Schematic input-output table for Nova Scotia emphasizing the final Income and expenditure accounts



In accounting for gross provincial product, the row sums of Matrix 3 represent incomes of domestic factors as paid by the private, or industrial, sectors of the economy. The addition of incomes earned by households from the consuming sectors in Matrix 4 completes the income side of gross provincial product. This tabulation of incomes represents value added in the economy.

The shaded column in Illustration 8.4 represents the final expenditures by a primary-input sector. In Matrix 1, the commodity detail of such expenditures is shown, and in Matrix 4, the transfers (including wages and salaries) to other primary sectors are recorded. The sum of these commodity purchases and transfers is total expenditures, which is equal to total receipts by the sectors.

The expenditures side of the gross provincial product account consists of the sum of total purchases of goods and services by domestic primary sectors, household incomes received from these sectors, and gross commodity exports less industry imports (or net exports).

Aggregated input-output tables

With this overall scheme in mind, consider now the format of the actual tables. Small, highly aggregated (5- industry) versions of the tables are used as illustrations.

The commodity flows table

The commodity flows table combines the use, final demand, and associated income matrices (Matrices 1, 2, 3 and 4) of Illustration 8.1. (In the national tables, the two equivalent tables are described as the "use matrix" (example Matrices 2 and 3) and the "final demand matrix" (example Matrices 1 and 4).) Table 8.1 is the aggregated commodity flows table. The boundaries between the various matrices are marked by a row for total commodity inputs and a column for total industry demands. This table is a complete description of commodity purchases by all Nova Scotia industries, all domestic and government consumers, and all non-local purchasers.

Note that the commodity flows table does not distinguish between commodities produced domestically and those imported from outside the Province. The table which embodies this distinction is called the "provincial flows table" and is presented in Chapter 9 as the first stage in developing the input-output model.

The commodity origins table

The commodity origins table combines the domestic origin matrix (5) and the imports vector (6) of Illustration 8.1 (In the national tables, the equivalent table is called the "make matrix"). Table 8.2 is an aggregated commodity origins table for Nova Scotia which is consistent with the aggregated flows table.

Note that the origins table records more than just the origins of commodities. It also includes a complete tabulation of supply and demand for each commodity used in Nova Scotia. The last seven columns of the table summarize the commodity accounts of the Province. The demands recorded here are the same as the demand totals found in Table 8.1. Also note that the industry accounts are represented by the column totals found in both tables. Total industry inputs are in Table 8.1 while total industry outputs are in Table 8.2.

For ease of production and in reading, all columns represent industries and rows represent commodities. This convention requires that the domestic origins matrix and the imports vector be transposed from their original form in Illustration 8.1.

Table 8.1 Aggregated commodity flows, Nova Scotia, 1984

	Commodity	Extraction ind.	Manufacturing ind.	Construction	Distribution	Service ind.	Total industry demand
1	Agricultural products	87	318	4	22	16	447
2	Primary fish	3	179	0	0	1	183
3	Minerals	6	1210	14	0	149	1379
4	Nondurable manuf. goods	154	648	86	85	737	1711
5	Durable manuf. goods	93	489	409	24	337	1352
6	Repair construction	10	25	1	7	225	268
7	Residential construction	0	0	0	0	0	0
8	Nonresidential const.	0	0	0	0	0	0
9	Transp., comm. and util.	80	160	11	106	735	1092
10	Distribution	36	117	81	20	182	436
11	Services	640	443	173	341	1109	2705
12	Total commodity inputs	1109	3589	779	604	3491	9573
13	Household receipts	535	899	391	877	2833	5535

	Commodity	Extraction ind.	Manufacturing ind.	Construction	Distribution	Service ind.	Total industry demand
14	Local and prov. govt rev.	23	164	62	41	278	568
15	Capital residual	92	136	52	137	704	1120
16	Federal govt revenues	0	-10	29	23	62	104
17	External transfers	-106	-79	109	151	-75	-1
18	Total primary inputs	545	1109	641	1230	3802	7327
19	Total inputs	1654	4699	1420	1834	7293	16900

	Commodity	Household exp.	Local and prov. govt exp.	Capital formation	Federal govt exp.	Domestic final demand	Total exports	Total final demand	Total demand
1	Agricultural products	115	5	0	1	121	79	200	646
2	Primary fish	2	0	0	0	2	84	85	268
3	Minerals	2	17	696	0	716	133	848	2227
4	Nondurable manuf. goods	1679	139	147	60	2025	1639	3664	5374
5	Durable manuf. goods	810	18	611	114	1553	972	2525	3877
6	Repair construction	4	25	0	33	63	33	95	363
7	Residential construction	0	0	541	0	541	0	541	541
8	Nonresidential const.	0	0	600	11	610	40	651	651
9	Transp., comm. and util.	523	194	0	84	802	203	1005	2097
10	Distribution	1174	28	112	10	1324	0	1324	1760
11	Services	2874	560	121	524	4079	49	4128	6833
12	Total commodity inputs	7182	987	2828	838	11835	3231	15066	24639
13	Household receipts	302	1839	0	2630	4771	22	4793	10328
14	Local and prov. govt rev.	921	1804	66	1230	4021	14	4035	4603
15	Capital residual	418	141	0	0	559	0	559	1679
16	Federal govt revenues	1499	12	-582	1248	2177	10	2187	2291
17	External transfers	17	0	0	0	17	0	17	16
18	Total primary inputs	3157	3796	-516	5108	11545	46	11591	18918
19	Total inputs	10339	4783	2312	5946	23380	3277	26657	43557

Table 8.2 Aggregated commodity origins, Nova Scotia, 1984

	Commodity	Extraction ind.	Manufacturing ind.	Construction	Distribution	Service ind.	Total industry supply
1	Agricultural products	353	2	0	0	0	355
2	Primary fish	267	1	0	0	0	268
3	Minerals	1032	1	0	0	0	1033
4	Nondurable manuf. goods	1	3324	0	6	0	3331
5	Durable manuf. goods	1	1367	0	4	33	1404
6	Repair construction	0	0	363	0	0	363
7	Residential construction	0	0	406	0	0	406
8	Nonresidential const.	0	0	651	0	0	651
9	Transp., comm. and util.	0	0	0	0	1980	1980
10	Distribution	0	1	0	1598	13	1612
11	Services	1	3	0	226	5268	5498
12	Total inputs	1654	4699	1420	1834	7293	16900

	Commodity	Total imports	Total supply	Total industry demand	Total domestic final demand	Total exports	Total demand
1	Agricultural products	291	646	447	121	79	646
2	Primary fish	0	268	183	2	84	268
3	Minerals	1194	2227	1379	716	133	2227
4	Nondurable manuf. goods	2044	5374	1711	2025	1639	5374
5	Durable manuf. goods	2474	3877	1352	1553	972	3877
6	Repair construction	0	363	268	63	33	363
7	Residential construction	135	541	0	541	0	541
8	Nonresidential const.	0	651	0	610	40	651
9	Transp., comm. and util.	117	2097	1092	802	203	2097
10	Distribution	149	1760	436	1324	0	1760
11	Services	1335	6833	2705	4079	49	6833
12	Total inputs	7739	24639	9573	11835	3231	24639

9 COMMODITY-BY-INDUSTRY INTERINDUSTRY MODELS: THE LOGIC OF THE NOVA SCOTIA INPUT-OUTPUT MODEL

Introduction

This section develops an economic model from the accounting tables for Nova Scotia. The process parallels that used in the traditional regional format presented in Chapter 5. It differs in that we now shift from a world in which regional economists collect their own data into one requiring vast teams of statisticians. As seen in Chapter 8, much new information and detail is now available. We need more assumptions to reduce it to a manageable format.

As the literature associated with the Canadian and Atlantic Provinces input- output studies suggests, and as demonstrated in the appendix to this chapter describing the mathematics of the U.S. system, the model could be phrased in terms of commodities. The procedures are similar, however, and the reader is referred to the earlier literature for further details. Here we do a simple sketch.

Essentially, we manipulate the new system of accounts until the number of variables in a set of simultaneous equations describing the economy equals the number of equations. The system differs slightly from the traditional square regional matrices in that now we have not only more commodities (and so more equations) than industries but also two equation systems to face! We must devise some way to redress this imbalance.

While the commodity-by-industry format traditional to the Canadian and Nova Scotia input-output systems opens up a variety of possibilities for forming this model, the approach employed here develops a solution to the model in terms of industries rather than commodities. This means that, while the economy is described initially in terms of sets of equations representing the tables of commodity-by-industry flows and origins, we must convert them to regional flows (through application of the constant-imports assumption) and then reduce the equations to a solvable form in industry-by-industry dimensions on the basis of the fixed market-share assumption. Finally, using the constant-technology assumption, we can solve the system conventionally.

The data

We start with two sets of tables defining the economy: The commodity flows table and the commodity origins table. Both are described in Chapter 8.

Technical conditions

Now say that final demands have been estimated for some future date and that we wish to identify the effect of this demand on the Province. What are the gross outputs of industries in Nova Scotia at that time? It is obvious that the system of flow equations is not prepared for solution: in the flows table, there are 11 equations, one for each commodity, and 82 variables of which only 11, the final demands, have preassigned values. Neither is the system of origins, or make equations, which consists of 5 equations and 66 unknowns.

The minimum requirement for solution of this system is that the number of equations equals the number of unknowns. One task, therefore, is to reduce the number of unknowns. Further, the system is expressed in terms of both commodity outputs and industry inputs, while our stated goal is to determine the effect of final-demand changes on industries. So a second task is to express the system in terms of industry variables alone. This conversion will both reduce the number of equations and, more importantly, permit us to establish a familiar equilibrium condition. The third and final task before solution is that of reducing the flows matrix from a statement of production technology to one of regional trade. We proceed in reverse order.

The constant-imports assumption

None of the recent regional input- output studies in this format have included survey-based or cell-specific import details. As a result, regional (or provincial, in this case) trade flows must be estimated by assumption. We know imports for each commodity in the system (Table 8.2) and we know total industry domestic final demands. And that is all, so the best way to estimate regional trade is to assume that each industry purchases imported commodities in constant proportions:

$$\mu_k = m_k / (\sum_j u_{kj} + e_k) \tag{9-1}$$

μ_k is the import coefficient for commodity k, m_k is an element in m, the imports vector, and the denominator is the sum of intermediate and local-final demands for commodity k.

Provincial flows of commodity k can thus be estimated as

$$P_{kj} = u_{kj} * (1 - \mu_k) \tag{9-2}$$

where u_{ij} is the purchase of commodity k by industry j. This yields a set of equations for sales of locally produced commodities such as the following:

$$\begin{array}{c} P_{11} + P_{12} + \ldots + P_{1m} + e_1 + x_1 = q_1 \\ P_{21} + P_{22} + \ldots + P_{2m} + e_2 + x_2 = q_2 \\ . \quad . \quad \ldots \quad . \quad . \quad . \quad . \\ . \quad . \quad \ldots \quad . \quad . \quad . \quad . \\ . \quad . \quad \ldots \quad . \quad . \quad . \quad . \\ P_{n1} + P_{n2} + \ldots + P_{nm} + e_n + x_n = q_n \end{array} \tag{9-3}$$

where P_{kj} is local sales of commodity k to industry j, e_k is sales of commodity k to final demand, x_k is export sales of commodity k, q_k is total local production of the commodity, and n and m are the number of commodities and industries, respectively. In this example, n is 11 and m is 5.

The results of this process are reported in Table 9.1, the aggregated provincial flows table, showing purchases of commodities produced by local industries. It is similar to Table 8.1, the commodity flows table. It differs in the values of commodity purchases, which are now only local in origin. It also contains a row of imports (the external transfers row). The industry outputs and final demands remain the same.

Imports were estimated at the detailed, 602-commodity level. This detail permits a level of realism not attainable when estimates of imports are made at an aggregated level.)

Table 9.1 Aggregated commodity-by-industry provincial flows, Nova Scotia, 1984

	Commodity	Extraction ind.	Manufacturing ind.	Construc-tion	Distribu-tion	Service ind.	Total industry demand
1	Agricultural products	9	184	2	8	8	210
2	Primary fish	3	179	0	0	1	183
3	Minerals	4	20	12	0	148	185
4	Nondurable manuf. goods	113	195	42	47	350	746
5	Durable manuf. goods	22	93	118	8	50	291
6	Repair construction	10	25	1	7	225	268
7	Residential construction	0	0	0	0	0	0
8	Nonresidential const.	0	0	0	0	0	0
9	Transp., comm. and util.	76	155	11	95	689	1026
10	Distribution	33	58	75	17	168	351
11	Services	122	398	110	288	826	1744
12	Total commodity inputs	392	1307	370	471	2464	5004
13	Household receipts	535	899	391	877	2833	5535
14	Local and prov. govt rev.	23	164	62	41	278	568
15	Capital residual	92	136	52	137	704	1120
16	Federal govt revenues	0	-10	29	23	62	104
17	Imports and transfers	612	2203	517	285	952	4568
18	Total primary inputs	1262	3391	1050	1363	4829	11896
19	Total inputs	1654	4699	1420	1834	7293	16900

	Commodity	House-hold exp.	Local and prov. govt exp.	Capi-tal for-mation	Federal govt exp.	Domestic final demand	Total exports	Total final demand	Total demand
1	Agricultural products	62	3	0	0	66	79	145	355
2	Primary fish	2	0	0	0	2	84	85	268
3	Minerals	2	17	696	0	715	133	848	1033
4	Nondurable manuf. goods	678	89	145	35	946	1639	2585	3331
5	Durable manuf. goods	41	3	80	17	140	972	1113	1404
6	Repair construction	4	25	0	33	63	33	95	363
7	Residential construction	0	0	406	0	406	0	406	406
8	Nonresidential const.	0	0	600	11	610	40	651	651
9	Transp., comm. and util.	496	176	0	79	751	203	954	1980
10	Distribution	1122	27	103	10	1261	0	1261	1612
11	Services	2705	445	119	436	3705	49	3754	5498
12	Total commodity inputs	5112	785	2149	620	8665	3231	11896	16900
13	Household receipts	302	1839	0	2630	4771	22	4793	10328
14	Local and prov. govt rev.	921	1804	66	1230	4021	14	4035	4603
15	Capital residual	418	141	0	0	559	0	559	1679
16	Federal govt revenues	1499	12	-582	1248	2177	10	2187	2291
17	Imports and transfers	2087	202	679	218	3187	-7755	-4568	0
18	Total primary inputs	5227	3998	163	5326	14715	-7709	7006	18902
19	Total inputs	10339	4783	2312	5946	23380	-4478	18902	35801

The constant market-share assumption

The matrix reported in the commodity origins table (Table 8.2) provides data necessary for converting from a commodity sales dimension to an industry one. If each entry (v_{jk}) in the make matrix is divided by the appropriate total commodity output, the resulting coefficients can be used as weights with which to aggregate commodity rows in the provincial flows matrix. Called "domestic market-share coefficients", these weights are computed as

$$d_{jk} = v_{jk}/q_k \tag{9-4}$$

where d_{jk} is the market share of commodity k produced by industry j, and q_k is the total domestic output of commodity k . The domestic market- share matrix, D, is comprised of these d_{jk}.

Now, assuming that market shares remain constant, the provincial flows matrix P and the vector h representing local final demand can be aggregated to industry-by-industry dimensions by matrix multiplication:

$$Z = D * P \tag{9-5}$$

$$h = D * (e + x) \tag{9-6}$$

This process means that each element z_{ij} in Z is a sum of weighted commodity sales,

$$z_{ij} = \sum\nolimits_k (d_{ik} * P_{kj}) \tag{9-7}$$

and that sales are in proportion to the industry product mixes. The provincial final-demand matrix, presented as the summed vector e and the commodity-exports vector x may be similarly aggregated, yielding the vector h.

Table 9.2 reports domestic market- share coefficients as computed from the aggregated make matrix. That the transpose of this table times the provincial flows matrices yields Table 9.3, the provincial interindustry matrices, may be verified through application of equation 9-7.

Table 9.2 Domestic market-share coefficients, Nova Scotia, 1984

	Commodity	Extraction ind.	Manufacturing ind.	Construction	Distribution	Service ind.	Total industry demand
1	Agricultural products	0.9954	0.0046	0.0000	0.0000	0.0000	1.0000
2	Primary fish	0.9962	0.0038	0.0000	0.0000	0.0000	1.0000
3	Minerals	0.9990	0.0010	0.0000	0.0000	0.0000	1.0000
4	Nondurable manuf. goods	0.0002	0.9979	0.0000	0.0018	0.0000	1.0000
5	Durable manuf. goods	0.0004	0.9736	0.0000	0.0027	0.0232	1.0000
6	Repair construction	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000
7	Residential construction	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000
8	Nonresidential const.	0.0000	0.0000	1.0000	0.0000	0.0000	1.0000
9	Transp., comm. and util.	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000
10	Distribution	0.0000	0.0008	0.0000	0.9913	0.0079	1.0000
11	Services	0.0001	0.0006	0.0000	0.0412	0.9581	1.0000

Table 9.3 Provincial interindustry transactions, Nova Scotia, 1984

	Commodity	Extraction ind.	Manufacturing ind.	Construction	Distribution	Service ind.	Total industry demand
1	Extraction	16	382	14	8	156	576
2	Manufacturing	134	287	156	55	399	1031
3	Construction	10	25	1	7	225	268
4	Distribution	38	75	79	29	201	421
5	Service	194	539	119	371	1483	2707
12	Total industry inputs	392	1307	370	471	2464	5004
13	Household receipts	535	899	391	877	2833	5535
14	Local and prov. govt rev.	23	164	62	41	278	568
15	Capital residual	92	136	52	137	704	1120
16	Federal govt revenues	0	-10	29	23	62	104
17	Imports and transfers	612	2203	517	285	952	4568
18	Total primary inputs	1262	3391	1050	1363	4829	11896
19	Total inputs	1654	4699	1420	1834	7293	16900

	Commodity	Household exp.	Local and prov. govt exp.	Capital formation	Federal govt exp.	Domestic final demand	Total exports	Total final demand	Total demand
1	Extraction	66	20	696	1	783	295	1078	1654
2	Manufacturing	719	92	223	51	1085	2583	3668	4699
3	Construction	4	25	1005	44	1079	73	1152	1420
4	Distribution	1225	45	107	27	1405	8	1412	1834
5	Service	3098	603	117	497	4314	272	4586	7293
12	Total industry inputs	5112	785	2149	620	8665	3231	11896	16900
13	Household receipts	302	1839	0	2630	4771	22	4793	10328
14	Local and prov. govt rev.	921	1804	66	1230	4021	14	4035	4603
15	Capital residual	418	141	0	0	559	0	559	1679
16	Federal govt revenues	1499	12	-582	1248	2177	10	2187	2291
17	Imports and transfers	2087	202	679	218	3187	-7755	-4568	0
18	Total primary inputs	5227	3998	163	5326	14715	-7709	7006	18902
19	Total inputs	10339	4783	2312	5946	23380	-4478	18902	35801

Table 9.4 Direct requirements per dollar of gross output, Nova Scotia, 1984

	Commodity	Extraction ind.	Manufacturing ind.	Construc-tion	Distribu-tion	Service ind.	Household exp
1	Extraction	0.010	0.081	0.010	0.005	0.021	0.006
2	Manufacturing	0.081	0.061	0.110	0.030	0.055	0.070
3	Construction	0.006	0.005	0.001	0.004	0.031	0.000
4	Distribution	0.023	0.016	0.056	0.016	0.028	0.119
5	Service	0.117	0.115	0.084	0.203	0.203	0.300
12	Total industry inputs	0.237	0.278	0.260	0.257	0.338	0.494
13	Household receipts	0.324	0.191	0.275	0.478	0.389	0.029
14	Local and prov. govt rev.	0.014	0.035	0.043	0.022	0.038	0.089
15	Capital residual	0.056	0.029	0.036	0.075	0.096	0.040
16	Federal govt revenues	0.000	-0.002	0.020	0.013	0.008	0.145
17	Imports and transfers	0.370	0.469	0.364	0.155	0.131	0.202
18	Total primary inputs	0.763	0.722	0.740	0.743	0.662	0.506
19	Total inputs	1.000	1.000	1.000	1.000	1.000	1.000

This process has yielded an industry-by-industry provincial flows table and has prepared the system for solution in terms of industry outputs. But the number of variables with unknown values, 30, is still in excess of the number of equations, 5. The equation system now takes the following form:

$$\begin{aligned} z_{11} + z_{12} + \ldots + z_{1n} + h_1 &= t_1 \\ z_{21} + z_{22} + \ldots + z_{2n} + h_2 &= t_2 \\ . \quad . \quad \ldots \quad . \quad . &= . \\ . \quad . \quad \ldots \quad . \quad . &= . \\ . \quad . \quad \ldots \quad . \quad . &= . \\ z_{m1} + z_{m2} + \ldots + z_{mn} + h_m &= t_m \end{aligned} \tag{9-8}$$

where t_i represents industry sales.

The constant-technology assumption

Now if we assume that industries continue to purchase inputs from other industries in proportion to their purchases in 1984, the number of variables can be reduced to equality with the number of equations. On the basis of this assumption, a set of provincial production coefficients is computed, defined as:

$$a_{ij} = z_{ij}/g_j \tag{9-9}$$

where a_{ij} is the proportion of purchases from local industry i by industry j. The direct-requirements matrix, A, is composed of these coefficients. For the aggregated system, this matrix is reported in Table 9.4.

Note that equation 9-7 can be rewritten as:

$$z_{ij} = a_{ij} * g_j \tag{9-10}$$

If the a_{ij} remain reasonably stable over time, $a_{ij} * g_j$ can be substituted for z_{ij} in the equation system 9-8 with the needed result:

$$\begin{array}{c} a_{11} * g_1 + a_{12} * g_2 + \ldots + a_{1m} * g_m + h_1 = t_1 \\ a_{21} * g_1 + a_{22} * g_2 + \ldots + a_{2m} * g_m + h_2 = t_2 \\ . \quad . \quad \cdots \quad . \quad . \quad . \\ . \quad . \quad \cdots \quad . \quad . \quad . \\ . \quad . \quad \cdots \quad . \quad . \quad . \\ \\ a_{m1} * g_1 + a_{m2} * g_2 + \ldots + a_{mm} * g_m + h_m = t_m \end{array} \tag{9-11}$$

The system is now reduced to a set of 5 simultaneous equations in 10 unknowns and can easily be reduced to solvable dimensions by imposing the traditional equilibrium condition.

Equilibrium condition: supply equals demand

Equilibrium occurs when anticipated supply equals demand, or when the gross outputs of an industry equal its sales. So the condition is that

$$g_j = t_j \tag{9-12}$$

(The condition could also be stated in terms of commodity outputs and demands.)

Solution: the total-requirements table

The response of an economy in moving to another equilibrium position when faced with a change in demand can be seen in the solution to the set of simultaneous equations (9-11). In terms of matrix algebra, this system may be rewritten as:

$$A * g' + h' = g' \tag{9-13}$$

where A is the matrix of provincial production coefficients (a_{ij}) and g' is a column vector of gross industry outputs. h' is a column vector of final demands for industry outputs (from equation 9-6)

The solution is analogous to that of common algebra in its formulation. Grouping the g' terms yields:

$$g' - A * g' = h' \tag{9-14}$$

while factoring produces:

$$(I - A) * g' = h' \tag{9-15}$$

Multiplying both sides of this equation by the inverse of $(I - A)$ produces a solution in terms of X':

$$(I - A)^{-1} * (I - A) * g' = (I - A)^{-1} * h''$$

or

$$g' = (I - A)^{-1} * h' \tag{9-16}$$

The inverse, $(I - A)^{-1}$, is called a "total- requirements table" and shows the direct and indirect effects of a change in final demand. Table 9.5 reports such a table for the aggregated system closed with respect to households . Table 9.6 converts these numbers to “multipliers,” properly recognizing the status of households as recipient of flows of final incomes.

Now, we are at the same stage as completed in Chapter 5, and can revert to its descriptive elements. Only a few comments remain on economic change in the new system.

Table 9.5 Total requirements (direct, indirect, and induced), Nova Scotia, 1984

	Commodity	Extraction ind.	Manufacturing ind.	Construc-tion	Distribu-tion	Service ind.	Household exp
1	Extraction	1.052	0.081	0.010	0.005	0.021	0.006
2	Manufacturing	0.081	0.061	0.110	0.030	0.055	0.070
3	Construction	0.006	0.005	0.001	0.004	0.031	0.000
4	Distribution	0.023	0.016	0.056	0.016	0.028	0.119
5	Service	0.117	0.115	0.084	0.203	0.203	0.300
6	Household receipts	0.324	0.191	0.275	0.478	0.389	0.029

Table 9.6 Industry-output multipliers, Nova Scotia, 1984

	Commodity	Extraction ind.	Manufacturing ind.	Construc-tion	Distribu-tion	Service ind.	Household exp
1	Extraction	1.052	0.081	0.010	0.005	0.021	0.006
2	Manufacturing	0.081	0.061	0.110	0.030	0.055	0.070
3	Construction	0.006	0.005	0.001	0.004	0.031	0.000
4	Distribution	0.023	0.016	0.056	0.016	0.028	0.119
5	Service	0.117	0.115	0.084	0.203	0.203	0.300
	Total industry outputs	1.279	0.278	0.260	0.257	0.338	0.494
12	Household receipts	0.324	0.191	0.275	0.478	0.389	0.029
13	Total "activity"	1.603	0.470	0.535	0.735	0.726	0.524

Economic change in commodity- by-industry models

As discussed in chapter 5, economic change can take two forms in input-output analysis: structural change or change in final demand. Changes in final demand are traced as discussed. Structural change can be treated in a slightly different manner now. The following comments amend slightly the points made in chapter 5.

Structural change normally manifests itself in changes in provincial production coefficients (direct requirements) but there are a number of ways in which it can occur. Let us look at these in terms of the coefficients in the model.

First, a change in technology could occur. This would affect the relations underlying the use matrix contained in the commodity flows table; that is, it would change the relevant technical production relations of the system. Such a change could involve a shift from oil to coal for industrial fuel needs or a shift from glass bottles to cans in the beverage industry. This is admittedly a restrictive interpretation of technological change in that it only involves changes in current flows. Changes in capital intensity, or technological changes which essentially affect the man-machine relationship, are more difficult to trace through an input-output system. The initial impact of new construction or equipment expenditures may be traced as a change in final demand. And, if the increase in output associated with a change in capacity is sold to a final- demand sector, especially as exports, its total effect may be traced through the system. But many of the effects of capital accumulation on economic activity are transmitted through other means. Technological changes in the broad sense are related to the dynamic questions of economic growth. The empirical resolution of these questions involves far more than a static input- output model, and, in fact, far more than any dynamic economic model in current use.

Second, a change in import patterns, or a change in m_{ij}, might occur. The discovery of domestic oil or the entry of a major producer of plastic containers might substantially reduce imports of these commodities and thus increase the provincial flows. A program of import substitution might increase provincial flows, delaying the inevitable leakage of money flows from the economy and increasing the multiplier effect of export activity.

Third, alterations in the product mix of local producers may change domestic market shares in commodity outputs. These coefficients determine the commodity content of industry sales in the provincial interindustry matrix and thus represent one final, probably minor, cause of changes expressed in terms of the existing plant structure.

Fourth, new plants in existing industries may enter the provincial economy. A new plant would have the effect of altering production coefficients and import patterns in its industry to the extent that its technology and market areas differ from that of established producers. The significance of the alteration would depend on the size of the new plant relative to the rest of the industry. But only in exceptional cases should the impact of the structural change be more important than the impact of its sales pattern.

Fifth, a completely new industry might appear in the province. This should normally be considered part of the new-plant alternative discussed above.

In summary, structural change in input-output models is primarily a matter of changes in technical production coefficients, in domestic market-share coefficients, or in import coefficients.

Illustration 9.1 The simple commodity-by-industry input-output model for a region

Symbol definitions:

ˆ	on a vector produces a diagonal matrix with values from the vector on the diagonal and zeroes elsewhere.
e	is a vector of the sum of domestic final demands for commodities.
g	is a vector of the values of industry outputs.
i	is a unit (summation) vector containing all ones (Premultiplication by i sums columns; postmultiplication sums rows).
i	as a subscript counts producing industries.
k	as a subscript counts commodities.
j	as a subscript counts buying industries.
q	is a vector of the values of locally produced commodity outputs.
x	is a vector of commodity exports.
m	is a vector of commodity imports.
y	is a vector of household incomes from industries
B	is a commodity-by-industry matrix showing for each industry the commodity use per dollar of industry output. It is the production-coefficients matrix.
D	is an industry-by-commodity matrix showing for each commodity the proportion of the total output of that commodity produced in each industry. It is the market-share matrix.
I	is the identity matrix ($\hat{1}$)
U	is a commodity-by-industry matrix showing for each industry the amount of each commodity used.
V	is an industry-by-commodity matrix showing for each commodity the amount produced by each industry.
$\hat{\mu}$	is a diagonal matrix of commodity imports expressed as proportions of local industry and final demands. It is the import-coefficients matrix.

Definitions or identities:

Industry outputs = Sum of commodities produced

$$g = Vi \tag{1}$$

Commodity supply = Commodity output + imports

$$q_s = q + m \tag{2}$$

Commodity demand = Sum of intermediate demands, final demands and exports

$$q_d = Ui + e + x \tag{3}$$

Behavioral or technical assumptions:

Constant production coefficients

$$B = U\hat{g}^{-1} \text{ or } Ui = Bg \tag{4}$$

(Elements of commodity-by-industry B are $b_{ij} = u_{ij}/g_j$, so $u_{ij} = b_{ij}g_j$)

Constant market-share coefficients

$$D = V\hat{q}^{-1} \text{ or } g = Dq \tag{5}$$

(Elements of industry-by-commodity D are $d_{ji} = v_{ji}/q_i$, so $v_{ji} = d_{ij}q_i$.)

Constant import coefficients

$$\hat{\mu} = m(Ui + e)^{-1} \text{ or } m = \hat{\mu}(Bg + e) \tag{6}$$

(Elements of commodity-by-commodity diagonal matrix of import coefficients are $m_k/(\sum_j u_{kj} + e_k)$.)

Equilibrium condition:

Commodity supply = Commodity demand

$$q_s = q_d, \text{ or } q + m = Ui + e + x \tag{7}$$

Illustration 9.1 The simple commodity-by-industry input-output model for a region (continued)

Solution by substitution:

Problem: given final demands (e' and x'), reduce the number of unknowns to equal the number of equations.

Substitute production (4) and import coefficients (6) into the equilibrium condition (7) expressed in terms of q:

$$q = Bg + e + x - \hat{\mu}(Bg + e)$$

Multiply by D to eliminate q and express in terms of g (industry outputs) using equation (5):

$$Dq = D(Bg + e + x - \hat{\mu}(Bg + e))$$

$$g = D(Bg + e + x - \hat{\mu}(Bg + e))$$

Expand, regroup, and manipulate to solution in terms of g:

$$g = DBg + D(e + x) - D\hat{\mu}(Bg + e))$$
$$g = DBg + De + Dx - D\hat{\mu}Bg - D\hat{\mu}e$$
$$g = DBg - D\hat{\mu}Bg + De - D\hat{\mu}e + Dx$$
$$g = D(I - \hat{\mu})Bg + D((I - \hat{\mu})e + x)$$
$$g - D(I - \hat{\mu})Bg = D((I - \hat{\mu})e + x)$$
$$(I - D(I - \hat{\mu})B)g = D((I - \hat{\mu})e + x)$$
$$(I - D(I - \hat{\mu})B)^{-1}(I - D(I - \hat{\mu})B)g =$$
$$(I - D(I - \hat{\mu})B)^{-1}D((I - \hat{\mu})e + x)$$
$$g = (I - D(I - \hat{\mu})B)^{-1}D((I - \hat{\mu})e + x)$$

Note in coordination with text:

B is total production coefficients, or proportional purchases without regard to location of production, expressed in commodity-by-industry terms.

$(I - \hat{\mu})B$ is regional production coefficients, or proportional purchases of locally produced outputs, expressed in commodity-by-industry terms.

$D(I - \hat{\mu})B$ is regional production coefficients expressed in industry-by- industry terms.

$(I - D(I - \hat{\mu})B)^{-1}$ is the inverse, the solution, or the total requirements matrix equivalent to that in the simple solution presented earlier.

$D((I - \hat{\mu})e + x)$ is a vector of final demands for locally produced commodities and exports expressed (through premultiplication by D) in industry terms.

Output multipliers:

$\delta g_i/\delta x_j = r_{ij}$, where r_{ij} is an element of $R = (I - D(I - \hat{\mu})B)^{-1}$.

Each of these partial output multipliers shows the change in local output i associated with a change in exports by industry j. Their sum over i is the total output multiplier for industry j.

Income multipliers:

$\delta y_i/\delta x_j = r_{ij} * y_i/g_i)$, where y_i is household income earned in industry i.

Each of these partial income multipliers shows the change in household income in industry i caused by a change in exports by industry j. Their sum over i is the total income multiplier for industry j.

Sources:

This summary is a variation on the U.S. model (described in the following appendix) to include imports and to yield an industry-by-industry model. It also includes elements of the description of the Canadian system from several sources such as (Statistics Canada 1976). Both sources follow the standard United Nations format and symbols.

Appendix 1 The mathematics of the United States input-output model

The following mathematics is taken from the documentation of the 1987 U.S. Interindustry Study. It follows the standard United Nations commodity-by-industry system symbolically and logically.

September 1, 1993

MATHEMATICAL DERIVATION OF THE TOTAL REQUIREMENTS TABLES FOR THE INPUT-OUTPUT STUDY[1]

The following are definitions:

- q is a column vector in which each entry shows the total amount of the output of each commodity.
- U is a commodity-by-industry matrix in which the column shows for a given industry the amount of each commodity it uses, including Noncomparable imports (I-0 80) and Scrap, used and secondhand goods (I-0 81). I-0 81 is designated below as scrap.
- $\hat{}$ is a symbol that, when placed over a vector, indicates a square matrix in which the elements of the vector appear on the main diagonal and zeros elsewhere.
- i is a unit (summation) vector containing only l's; $\hat{i}$ is the identity matrix (I).
- e is a column vector in which each entry shows the total final demand purchases for each commodity from the use table (table 2).
- g is a column vector in which each entry shows the total amount of each industry's output, including its production of scrap.
- V is an industry-by-commodity matrix in which the column shows for a given commodity the amount produced in each industry. V has columns showing only zero entries for noncomparable imports and for scrap. The estimate of V is contained in columns 1 - 79 of the make table (table 1) plus columns of zeros for columns 80 and 81.
- h is a column vector in which each entry shows the total amount of each industry's production of scrap. The estimate of h is contained in column 81 of the make table. Scrap is separated to prevent its use as an input from generating output in the industries in which it originates.
- B is a commodity-by-industry matrix in which entries in each column show the amount of a commodity used by an industry per dollar of output of that industry. Matrix B is derived from matrix U.
- D is an industry-by-commodity matrix in which entries in each column show, for a given commodity (excluding scrap), the proportion of the total output of that commodity produced in each industry. D is referred to as the market share matrix.
- p is a column vector in which each entry shows the ratio of the value of scrap produced in each industry to the industry's total output.
- W is an industry-by-commodity matrix in which the entries in each column show, for a given commodity, the proportion of the total output of that commodity produced in each industry adjusted for scrap produced by the industry. This matrix is the transformation matrix.

The following are identities:

$$q = Ui + e \tag{1}$$

$$g = Vi + h \tag{2}$$

The following are assumptions:

Inputs are required in proportion to output and the proportions are the same for an industry's primary and secondary products (the industry technology assumption); then:

$$U = B\hat{g} \tag{3}$$

Each commodity (other than scrap) is produced by the various industries in fixed proportions (the market shares assumption); then:

$$V = D\hat{q} \tag{4}$$

[1]The notation and derivation of the tables presented follow the System of National Accounts recommended by the United Nations. See: *A System of National Accounts Studies in Methods,* Series F No. 2 Rev. 3, United Nations, New York, 1968; also, Stone, R., Bacharach, M. and Bates, J., "Input- Output Relationships, 1951-1966," *Programme for Growth*, Volume 3, London, Chapman and Hall, 1963.

Scrap output in each industry is proportional to total output of the industry; then:

$$h = \hat{p}g \tag{5}$$

The model expressed in equations (1) through (5) thus involves three constants (B, D, p) and six variables (U, V, h, e, q, g). The model solution is derived as follows:

Substituting (3) into (1) gives:

$$q = Bg + e \tag{6}$$

Substituting (4) into (2) gives:

$$g - h = Dq \tag{7}$$

Substituting (5) into (7) and solving for g:

$$g - \hat{p}g = Dq$$

$$(I - p)g = Dq$$

$$g = (I - \hat{p})^{-1}Dq \tag{8}$$

Let $(I - \hat{p})^{-1}D = W$, then (8) becomes

$$g = Wq \tag{9}$$

Substituting (9) into (6) and solving for q:

$$q = BWq + e$$

$$(I - BW)q = e$$

$$q = (I - BW)^{-1}e \tag{10}$$

Substituting (10) into (9) gives:

$$g = W(I - BW)^{-1}e$$

$(I - BW)^{-1}$ is the commodity-by-commodity total requirements matrix, giving commodity output required per dollar of each commodity delivered to final users.[2]

$W(I - BW)^{-1}$ is the industry-by-commodity total requirements matrix, giving the industry output required per dollar of each commodity delivered to final users.[2]

[2]Tables are prepared at the detailed and summary levels of aggregation. For the summary tables, the adjustments for secondary production were made at the detailed level, then aggregated before calculation of the total requirements tables.

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10 BUILDING INTERINDUSTRY MODELS

Regional input-output models are, with few exceptions, now produced with computer estimating techniques commonly called "nonsurvey" techniques. This phrase refers to the fact that they are based on the technology embodied in the national input-output- table and that imports are estimated based on some supplementary technique not involving extensive survey work. This chapter briefly explains the most common of these approaches.

The basic model

Let us start by restating the basic structure of the system. The equation system for a regional input-output model may be written as

$$\sum_{j=1}^{n} a_{ij} q_j + \sum_{f=1}^{t} y_{if} + e_i = x_i \qquad (i = 1 \ldots n) \tag{10-1}$$

The a_{ij} represent purchases from regional industry i by industry j (or x_{ij}) as a proportion of the output of industry j (or x_j), y_{if} is the local final demand for the products of industry i by final-demand sector f, and e_i is the exports by industry i. The equation system might be illustrated with an algebraic table similar to that in Figure 5.1.

The system can also be outlined in terms of supply, describing the production technology of a region:

$$\sum_{i=1}^{n} a_{ij} q_j + \sum_{f=1}^{t} v_{fj} + \sum_{i=1}^{n} m_{ij} q_j = q_j \qquad (j = 1 \ldots n) \tag{10-2}$$

Here v_{fj} is the value added by final-payments sector f to the product of industry i, and m_{ij} is the imports of the products of industry i by industry expressed as a proportion of the output of industry j. (Note that we have included t local final-payment sectors to match the t local final-demand sectors. This is for simplicity, since we normally have more final-demand sectors than final-payment sectors.

Now assume that we have augmented the interindustry portion of the system by treating the household sector as an industry, as in Chapter 5. The a_{ij} matrix, written as A, is called the regional interindustry coefficients matrix and is a critical part of the system since its constancy is a major technical assumption in input-output analysis. As is clear from Chapter 5, the solution to the equation system 10-1 may be written in matrix form as

$$(I - A)^{-1} * (Y + E) = X \tag{10-3}$$

We will use this form of the system to avoid repetitive algebra in the discussion of estimating techniques.

The regional coefficients matrix, A, may be regarded as the difference between a technology matrix, P, and an imports matrix, M:

$$A = P - M \tag{10-4}$$

The technology matrix records purchases from industry i (regardless of location) by industry j as a proportion of the output of industry j (p_{ij}). The imports matrix contains the m_{ij} elements in equation 10-2. The major problem confronting the regional analyst in constructing a transactions table is obtaining the P matrix and dividing it into its component parts, A and M. We now turn to this division problem.

Estimating techniques

Given the system described above, the regional analyst has several procedures available to him in constructing his empirical model. The choice between these techniques depends largely upon the resources available. This section briefly outlines these procedures and describes the means by which an inexpensive nonsurvey procedure may be evolved into a survey-based technique to fit whatever budget is available.(Schaffer 1972; Schaffer and Chu 1969)

Survey-only techniques

Properly, an input-output model is based on a *full survey* of industries and final consumers which documents both sales and purchases. Each respondent is asked to designate sales to regional industries (x_{ij}) and to final users inside (y_{if}) and outside (e_i) the region. The respondents are also asked to designate their purchases from regional industries ($a_{ij}q_j$), their purchases from industries outside the region ($m_{ij}x_j$), and their final payments (v_{fj}) to primary resource owners in the form of wages and salaries, profits, depreciation allowances, taxes, etc. These purchases and final payments outline the production technology of each industry in a usable format, already separated into a regional flows matrix and an imports matrix.

In acquiring data on both purchases and sales, the analyst has assembled the information required to produce a potentially reliable table. But the table is also very expensive and its construction is very time consuming. Notice what happens if you don't have a complete census of firms and perfect reporting in each case. In this perfect case, the row estimates of x_{ij} will be identical to the column estimates. Now notice what happens if you have sampled only a few firms: the row estimates and the column estimates now vary widely. Sampling problems and reporting errors are substantial and the analyst is forced to achieve balance by tediously assaying the reliability of responses and by juggling numbers until totals finally match.

A basic alternative to this full-survey approach is the "*rows-only*" method. First used by Hansen and Tiebout, this method assumes

> ... that firms know the destination of their outputs far better than the origin of their inputs, especially where regional breakdowns are required. In other words, in terms of input- output flows, information for the "rows" is easier to obtain than information for the "columns." The reason for this is that the bundle of inputs is usually so varied and complex that their origins are difficult even for firms involved to track down accurately. However, the same firms are especially concerned with where and to whom they sell their output. (Hansen and Tiebout 1963)

This approach permits the analyst to avoid a complex data reconciliation. It produces only one entry per cell in the transactions table; the full-survey method forces the analyst to check his work by producing two estimates of cell values.

A second alternative to the full-survey approach is what is called the "*columns- only*" method. This approach assumes that business firms know their sources of supply better than they do the locations of their customers. Harmston and Lund argue that this approach takes advantage of the detailed knowledge of expenditures required by businessmen for control and tax purposes (Harmston and Lund 1967). Producing data in the same simple form as that of the rows-only method, the columns-only approach seems well-suited for use in small regions characterized by a relatively large number of locally-owned firms.

The supply-demand pool procedure

A nonsurvey technique commonly used in the United States, the supply-demand pool technique relies on the national input-output table as a reasonable estimate of the production- technology matrix, or P matrix, of a region and proceeds to estimate regional flows and imports using the concept of regional commodity balances (Isard 1953). This method is sometimes called the Moore-Petersen technique since it was first applied to a study of Utah by Moore and Petersen (Moore and Petersen 1955).

The only additional data assumed to be available are gross outputs for the n regional industries, q_j, and the gross purchases of t final-demand sectors. Now, to avoid more complex addition, let us assume that the P matrix includes both industries and final-demand sectors, so A is of dimension $n * (n + 1)$. Value added is three rows in the national table and has been excluded from P.

Let d_i be the row sum of total demands for the products of industry i, computed from A as follows:

$$d_i = \sum_{j=1}^{n+t} p_{ij} x_j \qquad (10\text{-}5)$$

Here, of course, the p_{ij} have been computed from the national input-output table and we have simply reduced national flows to regional size.

A commodity-balance ratio comparing regional production or supply (q_i) with regional demand can be computed as

$$b_i = q_i / d_i \qquad (10\text{-}6)$$

and the P matrix can be divided into its A and M components through a simple set of rules. If b_i is greater than or equal to one, then all inputs can be supplied by local producers and we can set $a_{ij} = p_{ij}$, $m_{ij} = 0$, and $e_i = q_i - d_i$. If b_i is less than one, inputs must be imported, so $a_{ij} = b_i p_{ij}$, $m_{ij} = p_{ij} - a_{ij}$ and $e_i = 0$.

This pool procedure allocates local production, when adequate, to meet local needs; when the local output is inadequate, it allocates to each purchasing industry i a share of regional output q_i based on the needs of the purchasing industry itself $(p_{ij} q_j)$ relative to total needs for output $i(d_i)$.

Export-survey method

One of the major characteristics of a regional input-output model is its openness. Exports and imports are substantial, if not dominant, parts of the typical regional transactions table. Since simulated exports are so greatly at variance with the survey-based exports in the above comparison, it seems reasonable to believe that correction of this discrepancy could lead to a much better estimate of regional transactions.

If we can afford neither of the more powerful alternatives to a full survey as discussed above, then an export survey combined with a supply-demand pool procedure may be an adequate substitute. This approach requires that we simply canvass firms in the region, asking for three bits of information: their industry classification, value of sales for the year, and the proportion of their sales going to out-of-region purchasers. The first two answers permit the analyst to classify replies and to properly weight export proportions in constructing the transactions table.

The procedure, then, involves setting exports of each industry i at the survey-estimated value and simulating the remainder of the table. For the balance ratio used above, we simply substitute a ratio which excludes exports from the supply available for local use:

$$b_i^e = \frac{q_i - e_i}{d_i} \tag{10-7}$$

This approach satisfies export requirements first and then allocates the remainder of local production to satisfying local needs in proportion to requirements. If b_i^e is greater than one, the technology matrix may have to be adjusted, but this proves to be a minor problem.

Selected-values method

Now, if more trade information than just export estimates can be assembled, the method can be extended to permit a setting of selected values in the transactions table. We simply set observed values x_{ig}, x_{ih}, ..., x_{ik} and estimate the remaining regional flows using an adjusted balance ratio:

$$b_i^s = \frac{q_i - e_i - x_{ig} - x_{ih} - \ldots - x_{ik}}{d_i - x_{ig} - x_{ih} \ldots - x_{ik}} \tag{10-8}$$

Known-trade method

The development of the commodity- origins table in the new commodity-by-industry format suggested a slight variation on this system. What if we know some imports as well as some exports? This makes the formula into

$$b_i^k = \frac{q_i - m_i - e_i}{d_i} \tag{10-9}$$

Here the numerator contains supply available for local use (local supply is equal to local demand less imports and local supply less exports is the amount available for local use) while the denominator is simply local demands. This method would be used if a local survey provided technical coefficients and estimates of imports and exports, as was the case in our Nova Scotia study (DPA Group Inc. and Schaffer 1989).

This method is tricky when both imports and exports are "known" for the same commodity. The supply-demand equation has to balance, and this surely means that one of the known values has to be adjusted. Tricky, but that's statistics.

11 REGIONAL GROWTH MODELS

Export-base theory of regional growth

The enduring theme of mercantilism

Exporting as a source of growth is almost overbearing: we can observe it so easily, and it permeates the literature on local growth. It is appropriate to start by recalling our first model to the stage.

The shortcomings of a static model

The usual economic-base study (and certainly the usual economic-base model) makes no distinction between short-run and long-run considerations. Multiplier analyses derived from economic-base models focus on short-run changes in demand. But determinants of growth, a long-run phenomenon, must include supply-based issues as well. Natural and human resources as well as available technology ultimately underlie a region's ability to grow. (Lane, 1966, 342)

Exports and long-run growth

The relationship between exports and long-run growth can be shown with a set of production-possibilities curves taken from the typical presentation in principles of economics (based on Lane, 1966, 345-7). Consider a simple local economy. With a vertical axis representing service goods and a horizontal axis representing export goods, draw a curve concave to the origin in the positive quadrant at some arbitrary position. This curve represents the full-employment output combinations of service and export goods available at this particular time, given resources and technology. Assume we are at point X, representing production of two units of service goods to one of export goods. (This position is determined by tangency with a budget line representing total income, given prices of local and export goods. Actually, it may be much more complicated than this, since export income is spent on imported goods and the prices of these goods must be taken into consideration. But this is another exercise.) What happens when we increase production of export goods? How is economic growth illustrated in this diagram?

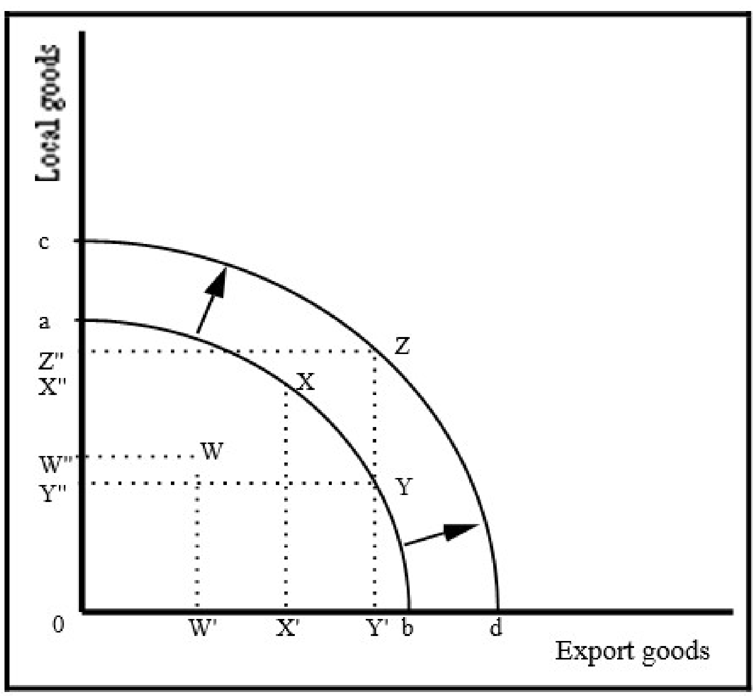

Figure 0.1. Production possibilities in a local economy

Source (Lane 1966)

Economic growth requires two sets of factors, permissive and implemental. The permissive factors are the resources available to the economy: natural resources, human resources, technology, capital, etc. They determine the position of the curve at any particular time. The curve *ab* is based on a given set of permissive factors; the curve *cd* is based on another and larger set. (They are concave to the origin because of the law of diminishing returns and the imperfect adaptability of resources.) Implemental factors are those which cause change to happen, which cause a shift from *ab* to *cd*.

The primary implemental factor in export-base theory is export demand. Any increase in aggregate demand, whether local investment or exports, may move the economy from an unemployed state (W) to a fully employed state (say X) Any further increase in export demand (with no increase in resources) will cause a shift along the production-possibilities curve (along *ab*). The cost of this increase is a decrease in production of service goods as resources are shifted from one sector to the other.

The increase in factor prices (e.g. wages) now stimulates in-migration (or even commuting). Since a region has no overpowering economic boundaries, the resources available are now increased and growth occurs: the production-possibilities curve now shifts out to a new and higher level, to point Z.

As an aside, note that the export-base multiplier describes this path. The marginal multiplier value is one plus the slope of the path from one equilibrium point to another; the average multiplier is one plus the slope of a line from the origin to the particular equilibrium point ($T/B = (B + S)/B = 1 + S/B$). If the tradeoff ratio between local and export goods remains constant and the shift in the frontier is neutral (parallel to the previous frontier, reflecting no economies of scale in producing one good or the other), the expansion path should be a straight line and the multiplier should thus be constant. If the export goods cost more to produce (in terms of service goods) or show diseconomies of scale with expansion, then the expansion path would tend to rise at a diminishing rate and the multiplier would decline.

(This could be much more complex. What we really might compare is the tradeoff in consumption between local goods and imported goods, given prices. Then we would need to look at tradeoffs in production between local goods and export goods. Where we settle is reflected by the eventual diminution of our comparative advantage in producing the export goods relative to imported goods.)

We will come back to this important issue of factor mobility and substitutability when we look at the neoclassical model.

An interesting approach to the economic base and regional growth was taken in the early literature by Charles Leven (Leven, 1964).

> The fundamental assumption underlying the economic base idea is simple and uncomplicated. Specifically, base theory assumes that the *only* reason for concentrating economic activities in a central location is the higher income made available to the inhabitants of the locality or region via increased returns to factors of production as a consequence of economies of scale. For many industries the achievement of such a scale, however, requires production far in excess of that demanded by the local market. This leads to regional specialization, and the institutional factor necessary to permit the exploitation of such scale economies is trade among regions.

Nonbasic industries are those whose economies of scale are exhausted within the region. Basic industries are those which require demand from outside markets to realize economies of scale.

Leven points out several shortcomings of the export-base approach to regional growth. One critical flaw is that it focuses on growth in output alone. With the assumption that basic and nonbasic activities grow in constant proportion, per capita income would not rise through export growth alone, even though incomes may differ in the two sectors. Growth in per capita income requires a change in productivity under these conditions. In fact, Leven builds a case for change in productivity or technology as the real basis for growth with the following simple example:

> Suppose three persons are living on a remote island. Suppose that two are barbers and one a masseur, and that they provide each other with personal services, otherwise living on wild nuts and berries. Under such conditions increased productivity in their primary occupations would lead to increased real income. This greater productivity initially might take the form of increased leisure for all of them. But it also might result in a sufficient increase in the price of entertainment (i.e., in the number of haircuts required for one entertainment), the price of massages (in terms of haircuts) remaining the same, to induce one of the barbers to forsake his shears for a fiddle. Or, in the absence of a lack of musical ability on the part of any of the aboriginal inhabitants, they might bid up the price of musical

> entertainment sufficiently high to persuade a musician to immigrate to their island. Quite clearly growth in per capita income could proceed indefinitely without external trade limited only by the productivity of the inhabitants of the island and the possible gains from the division of labor. Accompanying growth in the island's population could also increase indefinitely without external trade, limited only by the foregoing limitations and by a continued differential of per capita real income of the islanders over levels someplace else, including full allowance for detractions to real income stemming from congestion.
>
> But there is something else that is also likely to happen to the island's economy. Specifically, opportunities for the division of labor are not likely to be fully realized within the island alone. Comparative advantages in production most probably would arise and trade with other regions would occur. Moreover, so long as the possibility of gains from trade are not exhausted, the absolute volume of trade would increase along with the increase in the island's total population. Basically, then, in this example the driving force behind economic growth is rising productivity. This is hardly a very startling statement. Such increased productivity could stem from increases in the stock of physical capital, but also from increases in the stock of human capital, from discovering resources, from invention, or from a change in tastes. The increases in the volume of trade is simply an expected consequence of market adjustments to higher productivity. It is generated mainly by the proliferation rather than intensification of human wants as real income rises, and by secular changes in technology which tend to increase the technological possibilities for exploiting the division of labor.

After building his arguments regarding these two explanations of regional growth, he posits three hypotheses. The first two explain differential rates of regional growth in terms consistent with economic base theory: the "market" hypothesis and the "ignorance" hypothesis. The third hypothesis based on the productivity theory of growth may be called the "capital deficiency" hypothesis.

The "market" hypothesis says that "an area's growth rate depends upon the export demand for goods and services in which the area has a delivered cost advantage." This hypothesis leads to development policies focusing on product promotion and resource discovery. But Leven does not think these would be extremely effective. Product promotion is not necessarily place-specific, and one tends to look for specific resources wherever they may be most likely, not just for "more 'things' in Pennsylvania." He also contends that

> The search for technological advance, similarly, is related to processes rather than places. Thus there is reason to be skeptical about what could be accomplished by focusing the search for resources and technology on "places" rather than on input needs or production processes.

The "ignorance" hypothesis" assumes

> ...that lagging growth in a particular region mainly is a consequence of potential new firms or firms in other areas being unaware of the profit opportunities in the region. The resultant implied policy is the traditional regional promotion approach -- in its crudest form simply fatuous pronouncements about parks, churches, and playgrounds, the superior caliber of its workers, or its friendly attitude towards business; and more rationally, in terms of assembled information on wage rates, power costs, water quality, and other information on input costs and quality and transportation facilities and rates.

Again, he is less than sanguine on the usefulness of promotion policies.

Leven prefers policies which stem from the "capital deficiency" hypothesis. This hypothesis assumes "that the major problem is plant obsolescence, the low quality of the labor force or deficiencies in social overhead capital." To stimulate regional development we must divert resources toward internal capital improvements, toward building the social infrastructure. Leven feels that this policy would have broader effectiveness than export-base policies. Unfortunately, it involves much greater risk and financial commitment.

The Harrod-Domar model of regional growth

Illustration 11.1 outlines the evolution of an export-base model of regional growth based on the "Harrod-Domar" model.

Illustration 11.1 Comparison of economic-base and Harrod-Domar regional growth models

Simple Economic Base Model

System:

$Y = C + I - M + X$ Income

Assumptions:

$C = f_c(Y) = cY$ Consumption

$I = \bar{I}$ Investment

$M = f_m(Y) = mY$ Imports

$X = \bar{X}$ Exports

Solution:

$Y = cY + \bar{I} - mY + \bar{X}$ Substitute

$Y - cY + mY = \bar{I} + \bar{X}$ re-arrange

$(1 - c + m)Y = \bar{I} + \bar{X}$ manipulate

and

$Y = \frac{1}{1-(c-m)}(\bar{I} + \bar{X})$ solve

Harrod-Domar Regional Growth Model

System:

$Y_t = C_t + I_t - M_t + X_t$

Assumptions:

$C_t = f_c(Y) = cY_t$ Consumption

$I_t = f_I(Y) = b(Y_t - Y_{t-1})$ Investment

$M_t = F_m(Y) = mY_t$ Imports

$X_t = \bar{X}$ Exports

Solution:

$$Y_t = cY_t + b(Y_t - cY_t) - mY_t + \bar{X}$$

$$b(Y_t - Y_{t-1}) = Y_t - cY_t + mY_t - \bar{X}$$

$$b(Y_t - Y_{t-1}) = Y_t - cY_t + mY_t - \bar{X} * Y_t/Y_t$$

$$b(Y_t - Y_{t-1}) = Y_t(1 - c + m - \bar{X}/Y_t)$$

$$\frac{Y_t - Y_{t-1}}{Y_t} = \frac{(1-c) + m - \bar{X}/Y_t}{b}$$

$$= \frac{s + m - \bar{X}/Y_t}{b}$$

$$\text{Growth rate} = \frac{\text{MPS} + \frac{\text{Imports}}{\text{Income}} - \frac{\text{Exports}}{\text{Income}}}{\frac{\Delta\text{Capital}}{\Delta\text{Income}}}$$

$$\text{or} \qquad = \frac{\text{Propensity to Save} + \frac{\text{Net Imports}}{\text{Income}}}{\text{Capital Coefficient}}$$

Illustration 11.1 Comparison of economic-base and Harrod-Domar regional growth models (continued)

Harrod-Domar Regional Growth Model

System:

$Y_t = C_t + I_t - M_t + X_t$

Assumptions:

$C_t = f_c(Y) = cY_t$	Consumption
$I_t = f_I(Y) = b(Y_t - Y_{t-1})$	Investment
$M_t = F_m(Y) = mY_t$	Imports
$X_t = \bar{X}$	Exports

Solution:

$Y_t = cY_t + b(Y_t - cY_t) - mY_t + \bar{X}$

$b(Y_t - Y_{t-1}) = Y_t - cY_t + mY_t - \bar{X}$

$b(Y_t - Y_{t-1}) = Y_t - cY_t + mY_t - \bar{X}Y_t/Y_t$

$b(Y_t - Y_{t-1}) = Y_t(1 - c + m - \bar{X}/Y_t)$

$$\frac{Y_t - Y_{t-1}}{Y_t} = \frac{(1-c) + m - \bar{X}/Y_t}{b}$$

$$= \frac{s + m - \bar{X}/Y_t}{b}$$

$$\text{Growth rate} = \frac{\text{MPS} + \dfrac{\text{Imports}}{\text{Income}} - \dfrac{\text{Exports}}{\text{Income}}}{\dfrac{\Delta\text{Capital}}{\Delta\text{Income}}}$$

$$\text{or} \qquad = \frac{\text{Propensity to Save} + \dfrac{\text{Net Imports}}{\text{Income}}}{\text{Capital Coefficient}}$$

Harrod-Domar Regional Growth Model An Alternative Approach

Drains from region: **Savings + Imports**

$S_t = sY_t = (1-c)Y_t$ where $s = \text{MPS} = \text{APS}$, $c = \text{MPC} = \text{APC}$, and $1 = s + c$

$M_t = mY_t$, so

$\text{Drains} = S_t + M_t = (1-c)Y_t + mY_t = (1 - c + m)Y_t$

Additions to region: **Investments + Exports**

$I_t = b(Y_t - Y_{t-1})$

$E_t = \bar{E}$

$\text{Additions} = I_t + E_t = b(Y_t - Y_{t-1}) + \bar{E}$

Solution: **Drains = Additions**

$S_t + M_t = I_t + E_t$

$(I - c + M)Y_t = b(Y_t - Y_{t-1}) + \bar{E}$

$(I - c + m - b)Y_t = -bY_{t-1} + \bar{E}$

$$Y_t = \frac{1}{1 - c + m - b}(\bar{E} - bY_{t-1})$$

REFERENCES

Artle, R. (1965). *The Structure of the Stockholm Economy (American Edition)*, Cornell University Press, Ithaca.

Barnard, J. R. (1967). *Design and Use of Social Accounting Systems in State Development Planning*, The University of Iowa, Bureau of Business and Economic Research, Iowa City.

Bourque, P. J., and Conway, R. S., Jr. (1977). *The 1972 Washington Input-Output Study*, University of Washington, Graduate School of Business Administration, Seattle.

Bourque, P. J., and others. (1967). *The Washington Economy and Input-Output Study*, University of Washington, Graduate School of Business Administration, Seattle.

Bowers, D. A., and Baird, R. N. (1971). *Elementary Mathematical Macroeconomics*, Printice-Hall, Inc., Englewood Cliffs.

Brucker, S. M., and Hastings, S. E. (1984). *An Interindustry Analysis of Delaware's Economy*, University of Delaware, Agricultural Experiment Station, Bulletin 452, Newark.

Carden, J. G. D., and Whittington, F. G. J. (1964). *Studies in the Economic Structure of the State of Mississippi*, Mississippi Industrial and Technological Research Commission, Jackson.

Case, K. E., and Fair, R. C. (1994). *Principles of Economics*, Prentice-Hall, Inc., Englewood Cliffs.

Chenery, H. B., and Clark, P. G. (1959). *Interindustry Economics*, John Wiley and Sons, New York.

DPA Group Inc., and Schaffer, W. (1989). *The Nova Scotia Input-Output System, 1984*, The DPA Group, Inc., Halifax.

Gamble, H. B., and Raphael, D. L. (1966). *A Microregional Analysis of Clinton County, Pennsylvania, Volume II*, The Pennsylvania State University, University Park.

Ghali, M. (1977). "Tourism and regional growth: An empirical study of the alternative growth paths for Hawaii." Studies in applied regional science, Martinus Nijhoff Social Sciences Division, Leiden.

Harmston, F. K. (1962). *A Study of the Resources, People, and Economy of Carbon County, Wyoming, 1962*, Wyoming Natural Resource Board, Cheyenne.

Hildebrand, G. H., and Mace, A., Jr. (1950). "The Employment Multiplier in an Expanding Industrial Market: Los Angeles County, 1940-47." *Review of Economics and Statistics*, XXXII, 241-249.

Hirsch, W. Z. (1959). "Interindustry Relations of a Metropolitan Area." *Review of Economics and Statistics*, 41, 360-369.

Isard, W., Choguill, C. L., Kissin, J., Seyfarth, R. H., and Tatlock, R. (1972). *Ecologic-Economic Analysis for Regional Development*, The Free Press, New York.

Isard, W. e. a. (1960). *Methods of Regional Analysis: an Introduction to Regional Science*, The M.I.T. Press, Cambridge, Massachusetts.

Jordan, P. G., and Polenske, K. R. (1988). "Multiplier Impacts of Fishing Activities in New England Nova Scotia." Input-Output Analysis: Current Developments, M. Ciaschini, ed., Chapman Hall, London, 326-366.

Kahn, R. F. (1931). "The Relation of Home Investment to Unemployment." *Economic Journal*, XLI, 173-198.

Keynes, J. M. (1936). *The General Theory of Employment, Interest, Money*, MacMillan, London.

Kogiku, K. C. (1968). *An Introduction to Macroeconomic Models*, McGraw-Hill Book Company, New York.

Krikelas, A. C. (1992). "Why Regions Grow: A Review of Research On the Economic Base Model." *Economic Review of the Federal Reserve Bank of Atlanta*, 16-29.

Lane, T. (1966). "The Urban Base Multiplier: An Evaluation of the State of the Art." *Land Economics*, 42, 339-347.

Leontief, W. (1953). "Interregional Theory." Studies in the Structure of the American Economy, W. L. a. others, ed., New York.

Levitt, K. (1975a). *Input-Output Study of the Atlantic Provinces, 1965. Vol. I: Structural Analysis Data Sources*, Statistics Canada, Input-Output Division, Ottawa.

Levitt, K. (1975b). *Input-Output Study of the Atlantic Provinces, 1965. Vol. I: Social Accounting Matrix Models*, Statistics Canada, Input-Output Division, Ottawa.

Metzler, L. A. (1950). "A Multiple-Region Theory of Income and trade." *Econometrica*, 18, 329- 354.

Miernyk, W. H. (1965). *The Elements of Input-Output Analysis*, Random House, New York.

Miernyk, W. H., Bonner, E. R., Chapman, J. H., Jr., and Shellhammer, K. (1967). *Impact of the Space Program on a Local Economy*, West Virginia University Library, Morgantown.

Miller, R. E., and Blair, P. D. (1985). *Input-Output Analysis: Foundations and Extensions*, Prentice-Hall, Inc., Englewood Cliffs, NJ.

Minnesota IMPLAN Group Inc. (1997). *IMPLAN Professional*, MIG, Inc., Stillwater, MN.

Miyazawa, K. (1976). *Input-Output Analysis and the Structure of Income Distribution*, Springer- Verlag, Berlin.

Moore, F. T. (1955). "Regional Economic Reaction Paths." *American Economic Review*, 45, 133- 148.

Moore, F. T., and Petersen, J. W. (1955). "Regional Analysis: An Interindustry Model of Utah." *Review of Economics and Statistics*, 37, 368-383.

Neal, F., and Shone, R. (1976). *Economic Model Building*, Macmillan Press Ltd, London.

Oser, J. (1963). *The Evolution of Economic Thought*, Harcourt, Brace and World, Inc., New York.

Polenske, K. R. (1980). *The U. S. Multiregional Input-Output Accounts and Model*, D.C. Heath and Company, Lexington, Massachusetts.

Pratt, R. T. (1968). "An Appraisal of the Minimum Requirements Technique." *Economic Geography*, XLIV, 117-124.

Richardson, H. W. (1969). *Regional Economics*, Praeger Publishers, Inc., New York.

Richardson, H. W. (1972). *Input-Output and Regional Economics*, Weidenfeld and Nicolson.

Schaffer, W. A. (1976). *On the use of input-output models for regional planning*, Martinus Nijhoff, Leiden.

Schaffer, W. A., and Chu, K. (1969). "Nonsurvey Techniques for Constructing Regional Interindustry Models." *Regional Science Association Papers*, 23, 83-101.

Schaffer, W. A., Joun, R. Y., and others. (1972). *Interindustry Study of the Hawaiian Economy*, Department of Planning and Economic Development, State of Hawaii, Honolulu.

Sirkin, G. (1959). "The Theory of the Regional Economic Base." *Review of Economics and Statistics*, 59, 426-429.

Smith, P., and Morrison, W. I. (1974). *Simulating the Urban Economy*, Pion Limited, London.

Tiebout, C. M. (1962). *The Community Economic Base Study*, Committee for Economic Development, New York.

Ullman, E. L., and Dacey, M. F. (1960). "The Minimum Requirements Approach to the Urban Economic Base." *Regional Science Association Papers*, 6, 175-194.

Wang, X. and Hofe, R. (2008). *Research methods in urban and regional planning.* Springer Science & Business Media.

Weiss, S. J., and Gooding, E. C. (1968). "Estimation of Differential Employment Multipliers in a Small Regional Economy." *Land Economics*, XLIV, 235-244.