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The Galveston Bay Area Economic Base

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October 1, 1970

Colonel Frank Bender, Director
Galveston Bay Study
Suite 702
3801 Kirby Drive
Houston, Texas 77006

Dear Colonel Bender

Submitted with this letter is a volume entitled "The Galveston Bay Area, Economic Base."

This report is a study of the socio-economic base and of the linkages that exist among the various industries that contribute to the dynamic economy of the Galveston Bay Study area. It is primarily a study of methodology used in arriving at the population forecast made for the area. Later, we shall submit a supplementary volume which contains additional supporting data for the forecast.

Sincerely yours

Stanley A. Arbingast

Stanley A. Arbingast
Director

SAA:jp

THE GALVESTON BAY AREA

ECONOMIC BASE

by

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FOREWORD

The area fronting on Galveston Bay is one of the most dynamic areas of industrial and population growth in the nation. The major growth factors have been the resources of the area and transportation facilities. Location midway between both coasts on the south central fringe of the nation with access to the shipping lanes of the warm Gulf, open to transportation to all parts of the world the year around, and to the major inland waterway networks of the nation is a marketing advantage *par excellence*. Even more important is the fact that the area is startlingly rich in the very minerals that are in greatest demand for use as raw materials by modern industry. Furthermore, some of these minerals occur in very fortunate proximity to each other. This means that assembly costs of raw materials used by many of the industries, especially the manufacture of chemicals, are low.

Population of the eight counties is now well over two million, an increase of over a half-million during the decade. Among the manufacturing industries in which the region ranks first in the nation are: petrochemicals, refined petroleum, and equipment used by the oil industry. It is also the major headquarters center for pipeline transmission and for several of the nation's leading oil companies. The ports of Houston and Galveston-Texas City rank in the country's top ten in tonnage handled. In addition to industrial research the area is important for research in aerospace and in medicine, and a significant concentration of scientists work in the area. The stability of the economy of the area is shown by its ability to remain highly viable during the current recession.

Although continued rapid growth of the Galveston Bay Area seems assured, certain socio-economic developments bear watching to see how they affect the region. Two of the developments which may affect the population forecast for the area are:

1. The decline in birth rate
2. The discovery of extensive new hydrocarbon sources in other sections of the continent, particularly on the North Slope.

Because of the long-range implications which may result from these developments and others, the forecast should be reexamined and updated periodically.

This study of linkages existing among industries is the result of extensive research on the economy of the Galveston Bay Area by members of the staffs of the Industrial Economics Research Division at Texas A&M University and the Bureau of Business Research at The University of Texas at Austin with major responsibility for coordination and writing assigned to Lamar Smith.

James R. Bradley

Stanley A. Arbingast

College Station and Austin

September 1, 1970

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THE GALVESTON BAY AREA

Introduction

The primary objectives of this study are to examine the recent history of the Galveston Bay Area (GBA) and to analyze the Area's growth prospects for the next fifty years. As defined here, the GBA consists of eight Texas counties covering an area of approximately 7,800 square miles and lying along the Texas Coast of the Gulf of Mexico. Located at the center of the Area, Harris County dominates the local economy and serves as a focal point for GBA social and economic activity. The other counties in the study area, all bordering on Harris County, are Brazoria, Chambers, Fort Bend, Galveston, Liberty, Montgomery, and Waller. Their relative locations are shown on the following map. This Area increasingly is coming to be viewed as a single unit, as shown by the fact that it is coterminous with the Houston-Galveston Area Council of Governments Region.

Total 1970 population in the Area exceeds two million. Houston, largest city in the GBA, is located at the geographic center of the Area, approximately fifty miles from the GBA boundaries. Other sizable cities in Harris County include Pasadena and Baytown. To the southeast, in Galveston County, are Galveston and Texas City. Freeport, south of Houston in Brazoria County, is the largest incorporated place in an industrialized area that has come to be known as Brazosport.

Transportation and natural resources are the chief growth factors in this Massachusetts-sized area. By the beginning of the Civil War, the Area had become the cotton trading center of the Gulf Coast. Brazos River steamboats, a developing railroad network, and ox-wagons traveling improved roads transported cotton from the fertile hinterland to the GBA. By 1900, Houston was the largest railroad center south of St. Louis. Galveston was initially the major Area port, but its decline began after the hurricane of 1900, the most devastating natural disaster in U.S. history. Begun in 1902, the Houston Ship Channel was opened to deep water vessels in 1914, and Houston gradually overtook Galveston as the primary port. Another boost to the Area's development as a transportation hub came in 1934 when the Intracoastal Canal system linked the GBA with the Mississippi River system.

Oil's influence on the Area began with the 1901 discovery of the Spindletop Field. Since that year the GBA has produced over three billion barrels of crude oil in addition to natural gas and natural gas liquids. Local salt domes, which hold most of the Area's oil and gas, are also a source of brine, salt, and sulfur. Magnesium chloride, bromine, and magnesium are produced from sea water on the GBA littoral. Other resources available in the GBA include lime from oyster shell, clay, sand, gravel, and forest products.

These natural resources along with the transportation facilities spurred the development of a vast complex of refining and chemical processing plants in the Area. Receiving its first major growth impetus during World War II, this complex, in turn,

supported the local development of numerous other industries: pipeline transportation, oil and gas research, and oil field tool manufacturing.[1] The metals industry became a major activity in the Area during World War II, as evidenced by the establishment of the Sheffield Steel Mill (now Armco's Houston Works). Transportation facilities and demand coming from the Area's resource-based petrochemical industry were major factors attracting this plant, the first fully integrated steel mill in the Southwest. Most other major GBA industries also have depended either directly or indirectly on the Area's natural resources and transportation facilities for their development.

Today Houston is the sixth largest incorporated city and the thirteenth largest Standard Metropolitan Statistical Area in the United States. In addition to the Port of Houston, which ranks third in the nation in total tonnage moved, the GBA has three other major ports: Texas City, Galveston, and Freeport. The Area contains the nation's largest complex of refining and chemical processing plants and serves as headquarters for much of the petroleum industry. In 1968 Houston's standing among all the nation's cities was fourth in building permit value, tenth in investment in new manufacturing facilities, fourteenth in industrial marketings, and sixteenth in value added by manufacturing.

This study is concerned mainly with the history of the GBA between 1940 and 1968, the period of its greatest economic growth. The local refining, chemical processing, and metals industries experienced their most rapid growth over this twenty-eight year span, and numerous other industries also were expanding rapidly (Table 1). Since economic base theory will be used as the theoretical framework for the upcoming historical analysis, it is desirable to discuss this theory.

Economic Base Theory

In spite of frequent criticism, economic base theory continues to serve as the organizing concept underlying most small-area economic analysis. Financial constraints and the paucity of available data are the most common justifications for not undertaking more sophisticated analyses. Yet if economic base studies are so full of problems as to render the results meaningless, then even their relatively low cost is not worth paying. A secondary objective of this report is to assess the value of economic base theory in light of its ability to contribute to an understanding of economic growth in a particular area.

The first problem an analyst encounters as he approaches the subject of regional development is to find conceptual tools which will enable him to organize and use the information available to him. Without such tools, he would be inundated with statistics and other facts to the extent that meaningful explanations and programs for action would never emerge.

Disregarding sociological, architectural, and other characteristics, one may view the limited geographic area through a functional relationship between dependent and independent economic variables. Economic base analysis uses producing units as its variables. The identifying attribute of producing units which are independent variables is that they sell their goods and services to nonresidents, thereby bringing new money into the study area. Producing units which are dependent variables sell to local customers.

[1] Chapter IV examines the local linkages of these refining and chemical processing industries.

FIGURE 1

GALVESTON BAY AREA

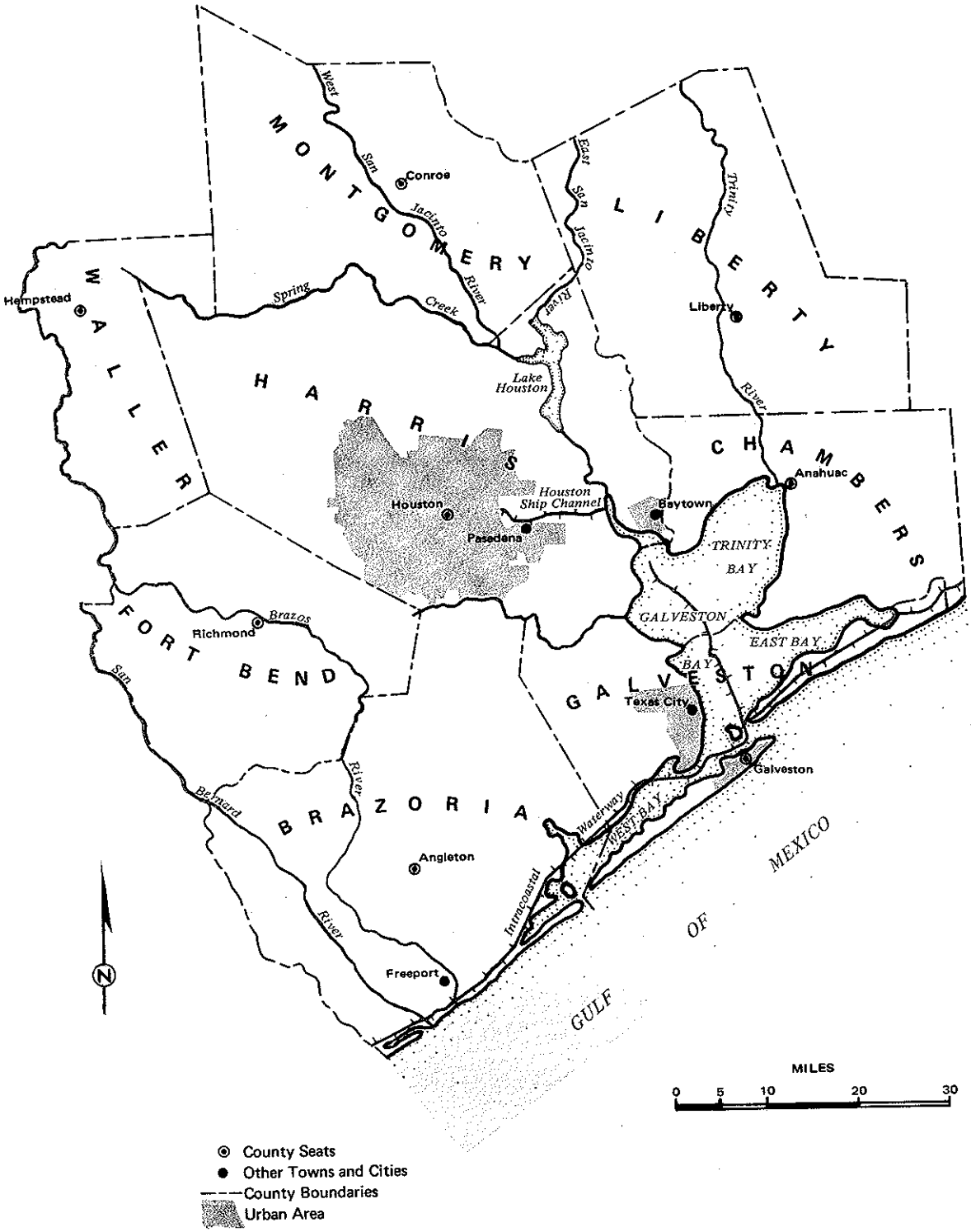

Table 1

EMPLOYMENT GROWTH IN SELECTED GALVESTON BAY AREA INDUSTRIES, 1940-1968

Industrial category	Percent increase
Mining	184
Contract construction	293
Manufacturing	186
Food and kindred products	105
Refining and chemical processing	167
Primary and fabricated metals	608
Machinery	191
Transportation, communication, and utilities	135
Trade	235
Finance, insurance, and real estate	261
Services	117

Source: U.S. Bureau of the Census.

Usual nomenclature labels producing units or industries treated as autonomous variables as: "base," "basic," "export," "primary." Others are known as "nonbasic," "service," "residentiary." Sometimes the theory in general is called "export base theory," and its application is called "multiplier analysis."

Base industries may be of many types. Manufacturers bring money into a region by selling their goods outside. The tourist industry brings people into the area to spend "foreign-earned" dollars. A renowned medical facility or educational institution may bring in outsiders who will spend for locally-produced services. An exogenous government (such as a Federal Government) facility will bring in tax dollars, some of them collected elsewhere.

In its most fundamental formulation, economic base analysis asserts that the cause of economic activity in most limited geographic areas lies in the existence of external demand for the goods or services which the area is particularly suited to produce. Growth of an area results from increase in external sales of its products. Thus, Houston's growth reflects the expanding demand for petroleum and its derivatives. Conversely, a declining demand for its exports causes a region to enter an economic slump or worse. West Virginia's poverty is graphic proof of the effect on a region of reduced demand for an essential export, such as coal.

To estimate the overall economic impact of a change in basic activity, planners, economists, businessmen and others use an "export multiplier," the value of which equals:

$$\frac{\text{absolute change in basic and service activity}^2}{\text{absolute change in basic activity}}$$

Assuming that the numerical value of this multiplier remains relatively constant over time, economic base theory is able to justify its emphasis on export activity. It should be noted, however, that, if the multiplier is subject to wide swings in its numerical value, then the multiplier joins export activity as a second variable determining changes in the level of economic activity.

Population projection is a common extension of economic activity estimates. Since population in small geographic areas is theorized to be highly correlated with employment, levels of economic activity usually are expressed in terms of employment when population projection is the ultimate objective. But, as will be seen presently, employment is only one among many possible units of measurement.

Economic base analysis furthermore theorizes that export activity is the key to changes in total activity because nonbasic industries exist to serve the needs of export industries either directly or indirectly. Direct service involves providing intermediate goods needed in the production of final export goods: components of the final product, electricity, etc. One example of indirect service would be fulfilling the needs of resident owners of factors of production used by basic industry: employees of basic industry need laundries, retail outlets, municipal government services. A second example of indirect service is supplying the needs of other service establishments and their employees.

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[2]It is important to distinguish this "export multiplier" from the "base-service ratio." The latter equals:

$$\frac{\text{service activity}}{\text{basic activity}}$$

Unit of Measurement[3]

Although theory can be couched in general terms such as "levels of economic activity," direct application necessitates using some unit of measurement to express these levels more precisely. Choice of the unit of measurement to be used has a widespread effect on the analysis as noted by Richard B. Andrews:

> . . . the way in which the base is measured has an important bearing on ultimate interpretations and applications of data collected. Moreover, measure is an inseparable part of the associated process of identification of the base.[4]

Employment

The most widely used unit of measurement is employment. As already noted, this measure appears to be the most meaningful when population projections are being sought. Employment data are relatively easy to obtain from employers, state employment commissions, the Department of Labor, and the Bureau of the Census.

Changes in basic economic activity, however, may not be fully or accurately reflected in employment figures. For example, employment figures cannot show wage rate changes in primary industries. A technological advance in a base industry may not lead to larger total employment. But if, as suggested by the presidential "guidelines," wage increases are related to productivity increases, wage payments may be expected to rise. Growing disposable income will lead to a positive shift in the demand for the output of service industries and a multiple increase in economic activity.

Employment figures give an approximation of the flow of exogenous money to only one of the factors of production, labor. But whenever base industry payments to residents for the use of their capital, land, or entrepreneurial ability climb, disposable income will rise, and economic activity will increase. Should payments to these factors of production change without a change in wages, employment figures may indicate a variation in the level of service activity without a corresponding change in the level of basic activity.

Closely allied with the problem of other factor payments is the problem arising from income derived from sources other than the sale of factors of production. Government transfer payments, gifts, and inheritances from exogenous sources are examples of these. For a community with a high concentration of elderly persons, an increase in social security payments will shift the demand for services up and and increase overall economic activity.

Nor can employment figures expressed as absolute numbers of workers take into account variation in time worked per employee. This problem can cause difficulties whenever overtime work or seasonal and part-time employment is prevalent. But this

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[3]The outline for this section comes from Richard B. Andrews, "Mechanics of the Urban Economic Base: The Problem of Base Measurement," Ralph W. Pfouts (ed.), *The Techniques of Urban Economic Analysis* (West Trenton, N.J.: Chandler-Davis Publishing Co., 1961), pp. 66-80. Also see Walter Isard, *Methods of Regional Analysis: an Introduction to Regional Science* (Cambridge, Mass.: The M.I.T. Press, 1960), pp. 194-95.

[4]Andrews, *op. cit.*, p. 66.

objection is not too serious, for it can be obviated by the relatively easy procedure of substituting man-hour figures for absolute number of employees.

Earnings or payrolls

The above discussion does not exhaust the list of problems encountered when employment is used as the unit of measurement. Other difficulties which will be listed later in conjunction with other units also may be relevant. One benefit of the discussion of problems with employment measures is the resulting suggestions of alternative units of measurement.

While the use of man-hours worked gets around problems of variations in number of hours worked per employee, the problem of differential wage rates remains. Use of total earnings solves both of these problems, but it too is limited to a single source of income. Lost in the transfer is the usefulness of employment changes in understanding variations in population.

A particular shortcoming of payroll measures, as well as employment measures, is that they fail to allow for the effects of changes in the distribution of income. An industry which automates and substitutes highly paid technical personnel for lower-paid manual laborers may not change its total payroll. Another industry might substitute highly paid engineers for other workers without changing total employment. If payroll measures were used in the first case, no change would appear in basic activity. The same would be true if employment measures were used in the second case.

Changes in income distribution affect personal consumption and saving patterns. The higher a person's income, the larger percentage of it he is likely to save. Of that part he does spend for consumption, more will tend to be spent outside the area where income is earned. Variations on total earnings such as median or average income have been suggested to lessen this problem.

Price changes present a difficulty in using payroll measurements over time which does not arise when employment measures are used. To make wages comparable, a price index must be used to deflate, and such indices are not usually available for small geographic areas.

Value of production and value added

A third unit of measurement may be obtained by subtracting the purchase price of all intermediate goods bought outside the region from the selling price of the goods and services produced by the base industries. To the difference must be added all payments originating outside the region which are made for use of factors of production but which do not represent the export of a good or service. Military base expenditures would fall into this latter group.

This unit of measurement is known as " value of production," and it is numerically equal to another known as "valued added." The latter, however, uses total local expenditures by the base industries to arrive at its total. The advantage of these measures over employment and payroll measures is that they take into account total factor payments made by basic industries.

Relative price movements as well as absolute variations in the price level present problems for both value added and value of production measurements. The latter is subject to problems of assigning value to the output of primary industries with products of intangible value, such as education. Since both measure a basic activity only in terms of the value of the product sold, they fail to account for government transfers, gifts, and inheritances from exogenous sources.

Physical production

Physical production presents yet another alternative unit of measurement, its chief merit being its ability to measure the effects of technological progress in manufacturing. But its prime shortcoming makes it virtually useless. This measure cannot distinguish quality or value differences among products: a fifty unit increase in automobile production is not differentiated from a fifty unit increase in pin production. Except for the difficulties with price indices, physical production is subject to most of the problems already listed in connection with other units of measurements.

Community income

The most comprehensive alternative unit of measurement is community income. Like value added and value of production, it includes all factor payments and is subject to problems arising from price movements. It is superior to value added and value of production, for it does include government transfers, gifts, and inheritances from exogenous sources.

In addition, community income is theoretically suited to take into account a problem which has not been mentioned heretofore. This difficulty which has come to be known as the "situs" problem, appears when a man works in one region but resides in another. Measures of factor payments would overstate disposable income in the region where the individual works and understate it where he lives.

Plan of Report

This report now proceeds in Chapter II, with a measurement of the GBA economic base over the period from 1940 to 1968. Chapter III outlines major theoretical shortcomings of economic base theory, and Chapters IV and V examine the degree to which these shortcomings hinder application of the theory to the study of GBA economic development betweeen 1940 and 1968.

If the Area's economic development conforms to economic base theory's version of the growth process, then an analysis of GBA growth should show that basic activity was the catalyst. In addition, service activity should tend toward being a relatively constant multiple of basic activity. Because the study area experienced sustained economic growth between 1940 and 1968, it should provide an excellent test case for economic base theory.

Drawing on historical data developed in previous chapters as well as on detailed industry analyses, Chapter VI will present projections of economic activity and population

in the GBA over the next half centry. The industry-by-industry analyses which underlie the projections of Chapter VI appear as appendix sections to this report. As each of the appendix sections was written by specialists on the industry under discussion, these sections are not intended to form a unified whole. Rather, each should be viewed as an interpretive discussion of the importance of a given industry group to the GBA.

Chapter II

THE GALVESTON BAY AREA'S EVOLVING ECONOMIC BASE, 1940-1968

Introduction

Analysts frequently must use indirect techniques to isolate the basic portion of an area's total economic activity. The cost of generating primary data is often prohibitive, and sometimes, especially in historical studies, primary data may not be available at any price. Furthermore, some firms may be unwilling to disclose information on their operations, or, as will be shown presently, direct sampling may lead to distortions of the data.

Several indirect techniques have been devised for estimating basic activity, but each has theoretical limitations. In selecting a technique to estimate basic activity, just as in choosing a unit of measurement, the analyst must weigh these limitations. Unless a suitable method for indirect measurement of basic activity is available, economic base theory is not a useful tool in small area analysis.

This chapter outlines three procedures for obtaining indirect estimates of the local economic base and applies them to the Galveston Bay Area (GBA). After evaluating each procedure, the chapter suggests a composite technique for measuring basic activity using a combination of these three procedures. Chapter I notes that employment is the most widely used unit of measurement and that employment data are relatively easy to obtain. Thus most of the calculations below make use of employment figures. Because the best historical data are available only for census years, 1940, 1950, and 1960 are used as base years. Also 1968 is used as a base year since it was the year in which the Bureau of Business Research, The University of Texas at Austin, and the Industrial Economics Research Division, Texas A&M University, undertook a direct measurement of the GBA economic base. At the end of the chapter, an attempt is made to calculate basic earnings in those years.

The Assumption Approach

Outline

The easiest to apply of the indirect measures is what is called here the "assumption approach." This method classifies each industry as being either basic or nonbasic according to what experience has shown its dominant characteristic to be. The extent to which the component parts are broken out of each major industry group depends on the needs of the particular study and the availability of data.

Dr. C. P. Blair uses a modified version of this technique in his study of the Dallas, Fort Worth, and Houston trading areas.[1] He assumes that all agriculture and mining and most manufacturing are basic. However, not all employees in food and kindred products plants and in printing and publishing establishments are considered basic.[2] Blair departs from a pure assumption approach by using concentration ratios to allocate service employment between the basic and nonbasic categories. The only other workers he considers to be basic are military personnel and their associated civilian employees.

Application

The results of applying the assumption approach to the GBA in the years 1940, 1950, 1960, and 1968 are shown in Table 2. Following Blair, all employment in agriculture and mining is treated as basic. In addition, all manufacturing employment is considered to be basic except for that in printing and publishing and one-half that in food and kindred products. Most workers in printing and publishing produce newspapers and other printed material for local consumption. Consequently they should be counted as service employees. Many employees in food and kindred products establishments work for bakers, soft drink bottlers, and others selling primarily to the local market. However, the GBA also has a large food processing industry selling in the export market. To take account of the dual nature of this segment of manufacturing, one-half of it is assumed to be basic. Finally, employees in federal and state public administration are added to the basic total because their incomes come from external sources.

This application of the assumption approach indicates that basic employment in the GBA increased from 81,203 in 1940, to 113,354 in 1950, to 145,562 in 1960, and to 207,122 in 1968. According to these figures, the base-service ratio was 2.5 in 1940, 4.2 in 1950, 3.0 in 1960, and 2.9 in 1968. This approach also gives a multiplier of between 1940 and 1950, of 5.1 between 1950 and 1960, and of 3.5 between 1960 and 1968.

Criticism

The assumption approach does not recognize any basic employment in such primarily nonbasic industries as contract construction; transportation, communication, and utilities; trade; finance, insurance, and real estate; and services. Yet many construction firms in the study area, such as Brown and Root and Warrior, bring revenue into the Area by doing work outside the eight counties. It can be argued that local construction firms are performing a basic activity when they build new plants or housing in the Area which is paid for with capital flows into the GBA. These investments bring into the study area external revenue, which is the identifying characteristic of basic activity.[3]

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[1]C. P. Blair, *Economic Growth Projections for the Dallas, Fort Worth, and Houston Trading Areas* (Austin, Texas: The Bureau of Business Research, The University of Texas at Austin, 1961), p. 11.

[2]Blair uses a company-by-company analysis to estimate basic employment in these industries.

[3]Frequently all local construction activity which is viewed as part of investment is considered basic by economic base studies because its levels are largely independent of existing level of total economic activity in a region.

Table 2

ESTIMATES OF BASIC EMPLOYMENT IN GALVESTON BAY AREA USING ASSUMPTION APPROACH, 1940-1968

Industrial category	1940	1950	1960	1968
Agriculture, forestry, and fisheries	24,297	16,659	13,863	4,840
Mining	9,974	12,361	16,639	28,280
Selected manufacturing[a]	44,432	80,866	110,954	131,913
Selected public administration[b]	2,500[c]	3,468	4,106	10,000[c]
Total	81,203	113,354	145,562	175,033

[a]All manufacturing is included here except "printing and publishing" and one-half of "food and kindred products."

[b]Only "federal public administration" and "state public administration" are included here.

[c]Estimated.

Sources: U.S. Bureau of the Census; Texas Employment Commission.

Many other examples are available of basic activity within these industry groups. Local transportation companies haul for nonresidents, local banks loan to nonresidents, and local insurance companies insure nonresidents. In addition, trade establishments such as retail stores and service establishments such as hotels attract business from tourists and other visitors to the study area. Local steel wholesalers serve much of the Southwest, as do other wholesalers.

On the other hand, this approach erroneously assumes that all agricultural and mining activity is basic. A large proportion of locally-produced dairy, poultry, fruit, vegetable, and horticultural products is consumed locally. Similarly, most of the sand, gravel, chemical and fertilizer minerals, clay, and oyster shell mined locally are sold to GBA consumers.[4]

The Location Quotient or Surplus Worker Technique

Outline

A second approach is the offspring of work by P. Sargent Florence, John M. Mattila, and Wilbur R. Thompson. Florence developed the location quotient to compare local concentration in an industry with that in a benchmark economy.[5] Mattila and Thompson developed the index of surplus workers to estimate the number of employees in an industry in excess of the number needed to satisfy local demand.[6] It is reasonable to assume that the extent to which an industry is concentrated locally and the number of "surplus" workers both indicate the proportion of basic activity in the industry. The estimates of basic activity appearing in Table 3 are made on this assumption.

Application

Table 3 compares the percentage distribution of employment among industries in the United States with that in the GBA for the years 1940, 1950, 1960, and 1968. Within each industry it is assumed that the "normal" number of employees would equal the total local employment times the percent of total U.S. employment in that industry during the year under consideration. If actual employment exceeds this measure of normal employment, the difference is considered to be a rough estimate of basic employment in the industry.[7]

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[4]Blair, *op. cit.*, pp. 89-92.

[5]P. Sargent Florence, W. G. Fritz, and R. C. Gilles, *Industrial Location and Natural Resources* (Washington, D.C.: United States National Resources Planning Board, 1943), p. 107.

[6]John M. Mattila and Wilbur R. Thompson, "The Measurement of the Economic Base of the Metropolitan Area," *Land Economics*, 31, No. 3 (August 1955), 218-219.

[7]Similar calculations were made using Texas as the benchmark economy, but in no industry group did the results appear to be superior to those in Table 3.

Table 3

ESTIMATES OF BASIC EMPLOYMENT IN GALVESTON BAY AREA USING LOCATION QUOTIENT OR SURPLUS WORKER TECHNIQUE, 1940-1968

Industrial category	1940 United States Percent distribution	1940 Galveston Bay Area Normal number	1940 Galveston Bay Area Actual number	1940 Galveston Bay Area Actual over normal	1950 United States Percent distribution	1950 Galveston Bay Area Normal number	1950 Galveston Bay Area Actual number	1950 Galveston Bay Area Actual over normal
Agriculture, forestry, and fisheries	18.9	53,863	24,297	–	12.4	52,074	16,659	–
Mining	2.0	5,700	9,974	4,274	1.6	6,719	12,361	5,642
Contract construction	4.6	13,109	19,539	6,430	6.1	25,617	40,998	15,381
Manufacturing	23.7	67,542	51,624	–	26.0	109,188	90,746	–
Transportation, communication, and utilities	6.9	19,664	30,777	11,113	7.9	33,176	45,201	12,025
Trade	16.6	47,308	58,075	10,767	18.7	78,531	92,308	13,777
Finance, insurance, and real estate	3.3	9,405	11,229	1,824	3.4	14,278	17,581	3,303
Services	19.3	55,002	68,576[1]	13,574	17.9	75,172	86,848	11,676
Public administration	3.1	8,835	7,309	–	4.5	18,898	11,820	–
Industry not reported	1.6	4,560	3,587	–	1.5	6,299	5,431	–
Total	100.0	284,987	284,987	47,982	100.0	419,953	419,953	61,804
	1960				1968			
Agriculture, forestry, and fisheries	6.7	39,177	13,863	–	5.4	43,203	4,840	–
Mining	1.0	5,847	16,639	10,792	0.9	7,200	28,280	21,080
Contract construction	5.9	34,499	44,103	9,604	4.6	36,802	76,865	40,063
Manufacturing	27.1	158,462	124,053	–	28.0	224,015	147,715	–
Transportation, communication, and utilities	7.0	40,931	53,531	12,600	6.2	49,603	72,310	22,707
Trade	18.2	106,421	123,070	16,649	20.0	160,010	194,595	34,585
Finance, insurance, and real estate	4.2	24,559	27,989	3,430	4.8	38,402	40,525	2,123
Services	20.9	122,209	132,137	9,928	21.7	173,611	185,337[2]	11,726
Public administration	5.0	29,237	17,119	–	8.5	68,004	49,585[3]	–
Industry not reported	4.0	23,389	32,227	8,838	–	–	–	–
Total	100.0	584,731	584,731	71,841	100.0	800,052	800,052	132,284

Notes: Columns may not add precisely because of rounding. Percentage distribution of 1968 total U.S. employment estimated from various sources.

[1]Does not include employment in educational services.

[2]Differs from figure in Table 5 because estimated employment in public educational services is included here.

[3]Differs from figure in Table 5 for government employment because estimated employment in public educational services is not included here.

Sources: U.S. Bureau of the Census; U.S. Department of Labor; Texas Employment Commission.

This method indicates that basic employment in the GBA increased from 47,982 in 1940, to 61,804 in 1950, to 71,841 in 1960, and to 132,284 in 1968. According to these figures, the base-service ratio was 4.9 in 1940, 5.8 in 1950, 7.1 in 1960, and 5.0 in 1968. These figures also give a multiplier of 9.8 between 1940 and 1950, 16.4 between 1950 and 1960, and 3.6 between 1960 and 1968.

Criticism

Because the location quotient or surplus worker technique incorporates large rural areas in its base to determine the "normal" employment distribution, this method is not well suited to estimating basic employment in agriculture for an urban area. Using the United States as the benchmark economy, this method derives a "normal" employment in agriculture which exceeds the actual number for each year considered in this study. But in fact, the GBA long has been an exporter of rice, cotton, beef, and other agricultural products.

Nor is the location quotient or surplus worker technique suitable for measuring basic employment in manufacturing. It erroneously assumes that if a product is both manufactured and consumed locally, then the locally produced items must be the ones that are being consumed locally. In reality any area is likely to produce one brand of a product for export while it imports another brand of the same product.

When all manufacturing employment is aggregated into a single industry group, this technique is particularly unreliable in estimating basic manufacturing employment in an area whose manufacturing is highly specialized, as is the GBA petrochemical industry. Even if there were no other manufacturing in the Area, this technique would make it appear that the Area was only slightly below the national norm for percent of workers in manufacturing. Even more misleading, the location quotient or surplus worker technique would indicate that the GBA had no basic employment in manufacturing under such conditions.

The Minimum Requirements Technique

Outline

Edward L. Ullman and Michael F. Dacey have developed a technique for estimating basic employment in urban areas using a benchmark based on urban data from the 1940 and 1950 Censuses.[8] They choose numerous cities at random and group them into various size classifications. Within each size classification, Ullman and Dacey find the fourteen cities with the smallest percent of their total employment in fourteen industry groups. This minimum percent is assumed to be the minimum required for survival by a city in the given size group.

[8]Edward L. Ullman and Michael F. Dacey, "The Minimum Requirements Approach to the Urban Economic Base," *Papers and Proceedings of the Regional Science Association*, 6 (1960), 174-94.

From these calculations, Ullman and Dacey develop linear regression equations which estimate the minimum employment requirement in each of fourteen industries after taking into account the urban area's population.[9] It is important to note that their calculations indicate that the base-service ratio tends to vary directly with city size. The equations all have the form:

$$Y = a + b \log X$$

"Y" is the minimum employment requirement expressed as a percent, "X" is the urban area's population, and "a" and "b" are the following parameters:

Industry type	a	b
Agriculture and related activities	-0.73888	0.28766
Mining	not computed, minimum requirement is 0.0%	
Construction	-1.95250	1.12851
Durable manufacturing	-3.55865	1.10865
Nondurable manufacturing	-5.57221	1.72703
Transportation and related activities	-0.43408	0.87031
Wholesale trade	-1.45025	0.63809
Retail trade	8.22845	0.97674
Finance	-0.35947	0.43173
Business, repair services	-0.43254	0.41521
Personal services	0.65422	0.56129
Entertainment	-0.39717	0.19992
Professional services	-2.48673	1.69448
Public administration	-1.94562	0.79043

To estimate basic employment, one compares the minimum requirement with actual employment. If the actual exceeds the minimum, the difference is the estimate of basic employment.

Application

Table 4 presents the results of these calculations for the GBA. This table differs somewhat from the Ullman and Dacey format, for their division of employment into fourteen industries has been reduced to the nine industries used by this study in previous calculations.

According to the results obtained by using the minimum requirements technique, basic employment in the GBA increased from 130,462 in 1940, to 184,216 in 1950, to 221,181 in 1960, and to 349,349 in 1968. These figures give a base-service ratio of 1.2 in 1940, of 1.3 in 1950, of 1.6 in 1960, and of 1.3 in 1968. They also indicate a multiplier of 2.5 between 1940 and 1950, of 4.5 between 1950 and 1960, and of 1.7 between 1960 and 1968.

[9] *Ibid*, p. 182.

Table 4

ESTIMATES OF BASIC EMPLOYMENT IN GALVESTON BAY AREA USING MINIMUM REQUIREMENTS TECHNIQUE 1940-1968

Industrial category	1940 Minimum requirement (percent)[1]	1940 Minimum requirement	1940 Actual number	1940 Actual over minimum	1950 Minimum requirement (percent)[1]	1950 Minimum requirement	1950 Actual number	1950 Actual over minimum
Agriculture, forestry, and fisheries	0.9	2,703	24,297	21,594	1.0	4,180	16,659	12,479
Mining	0.0	0	9,974	9,974	0.0	0	12,361	12,361
Contract construction	4.7	13,303	19,539	6,236	4.9	20,372	40,998	20,626
Manufacturing	7.5	21,388	51,624	30,236	8.0	33,448	90,746	57,298
Transportation, communication, and utilities	4.7	13,314	30,777	17,463	4.8	20,211	45,201	24,990
Trade	16.2	46,315	58,075	11,760	16.5	69,349	92,308	22,959
Finance, insurance, and real estate	2.2	6,194	11,229	5,035	2.2	9,421	17,581	8,160
Services	14.2	40,412	68,576[1]	28,164	14.7	61,505	86,848	25,343
Public administration	2.7	7,670	7,309	–	2.8	11,841	11,820	–
Total				130,462				184,216
	1960 Minimum requirement (percent)[1]	1960 Minimum requirement	1960 Actual number	1960 Actual over minimum	1968 Minimum requirement (percent)[1]	1968 Minimum requirement	1968 Actual number	1968 Actual over minimum
Agriculture, forestry, and fisheries	1.0	6,106	13,863	7,757	1.1	8,444	4,840	–
Mining	0.0	0	16,639	16,639	0.0	0	28,280	28,280
Contract construction	5.0	29,488	44,103	14,615	5.2	40,556	76,865	36,309
Manufacturing	8.4	49,394	124,053	74,659	8.8	68,743	147,715	78,972
Transportation, communication, and utilities	5.0	29,008	53,531	24,523	5.1	39,691	72,310	32,619
Trade	16.8	98,167	123,070	24,903	17.0	133,180	194,595	61,415
Finance, insurance, and real estate	2.3	13,547	27,989	14,442	2.4	18,557	40,525	21,968
Services	14.1	88,494	132,137	43,643	15.4	121,268	185,337[2]	64,069
Public administration	3.0	17,274	17,119	–	3.0	23,868	49,585[3]	25,717
Total				221,181				349,349

Note: Minimum requirement expressed as a percent of the labor force does not correspond precisely with minimum requirement expressed as an absolute number because of rounding.

[1]Does not include employment in educational services.

[2]Differs from figure in Table 5 because estimated employment in public educational services is included here.

[3]Differs from figure in Table 5 for government employment because estimated employment in public educational services is not included here.

Sources: Ullman and Dacey, "The Minimum Requirements Approach to the Urban Economic Base," *Papers and Proceedings of the Regional Science Association*, VI (1960); U.S. Bureau of the Census; U.S. Department of Labor; Texas Employment Commission.

Criticism

The minimum requirements technique, after assuming that an urban area has no minimum requirement for employment in mining, concludes that all employment in mining is basic. In the above criticism of the assumption approach, it has already been pointed out that this is not the case in the GBA.

Nor does the minimum requirements technique provide a theoretically satisfactory estimate of basic employment in manufacturing, for it is subject to the same two weaknesses as the location quotient or surplus worker technique. Both techniques implicitly assume that urban areas do not export a product and import it at the same time. Both also implicitly assume that all manufacturing will be for the local market until total employment in manufacturing passes some critical minimum level.

The Composite Technique

Outline

As shown above, each of the three techniques discussed thus far has serious shortcomings when estimating basic employment in certain industries. Fortunately, however, not all of the approaches have debilitating problems with the same industries. Classifying employment by the same nine industry groups already identified, this section estimates basic employment in each industry by using that technique which appears most reliable for it.

Relevant theoretical considerations already are listed, along with some unique characteristics of the GBA which affect the choice of techniques. This section looks at one additional factor in evaluating the various approaches: the correspondence between 1968 estimates of basic employment from each technique and those from a mail survey conducted by the Bureau of Business Research, The University of Texas at Austin, and the Industrial Economics Research Division, Texas A&M University.

This study attempted to secure primary data on the economic base of the GBA. A questionnaire (Figure 2) was sent to each firm in a random sample drawn by the Texas Employment Commission. The questionnaire asked each sample firm to estimate the percentage of its sales made to customers located outside the GBA. Basic employment was estimated in accordance with the proportion of industry revenues coming from outside the Area. The only exception was in the case of public administration, where independent estimates were made. Table 5 presents the results of the mail survey.

Application

As already noted, the assumption approach leads to an estimate of basic employment in agriculture in the GBA which is too large to be realistic. At the other extreme, the location quotient or surplus worker technique, because it includes too much rural area in its base, gives an estimate which is unrealistically small. Although the estimate

Table 5

ESTIMATES OF BASIC AND DEPENDENT EMPLOYMENT IN GALVESTON BAY AREA AS DETERMINED BY MAIL SURVEY, 1968

Industrial category	Total employment[a] 1968	Basic employment[b] 1968	Basic income[c] (dollars) 1968	Percent of all basic income 1968	Dependent workers supported by basic workers[d] 1968	Ratio: dependent to basic 1968
Agriculture, forestry, and fisheries	4,840	527[e]	2,620,244	0.12	595.1	1.13
Mining	28,280	17,712[e]	170,690,544	8.16	40,465.1	2.28
Contract construction	76,865	20,451	152,462,205	7.29	36.150.8	1.77
Manufacturing	147,715	99,179	775,106,612	37.06	183,779.1	1.85
Transportation	52,092	29,738	159,246,990	7.61	37,737.7	1.27
Communication and utilities	20,218	12,188	89,435,544	4.27	21,174.8	1.74
Wholesale trade	62,223	23,775	180,642,450	8.63	42,795.8	1.80
Retail trade	132,372	13,300	55,820,100	2.66	13,190.8	0.99
Finance, insurance, and real estate	40,525	11,560	72,943,600	3.48	17,257.2	1.49
Services	148,537	38,766	196,166,893	9.38	46,515.0	1.20
Lodging	12,586	10,344	30,711,336	1.46	7,240.1	0.70
Personal services	17,644	120	445,080	0.02	99.2	0.83
Business and repair services	31,648	11,614	58,882,980	2.81	13,934.7	1.20
Professional and related services	79,145	15,833	102,819,502	4.91	24,348.5	1.54
Recreation	7,514	855	3,307,995	0.15	743.8	0.87
Government	86,385	36,960	236,066,640	11.28	55,937.1	1.51
Federal	20,485	20,485	162,835,265	7.78	38,580.7	1.88
State and local	65,900	16,475	73,231,375	3.50	17,356.4	1.05
Total	800,052	304,156	2,091,201,822	99.94	495,598.5	1.63

[a]Estimated from Texas Employment Commission figures.

[b]Based mainly on proportion of industry revenues from outside the Area as determined by survey.

[c]Basic employment times industry's average yearly wages per basic employee.

[d]Total dependent (nonbasic) employment allocated according to percentage distribution in preceding column.

[e]Basic employment is surprisingly low because a large part of output is sold to other industries in the Area for additional processing before export.

Figure 2

GALVESTON BAY AREA ECONOMIC STUDY

CONFIDENTIAL QUESTIONNAIRE

Please return this entire sheet in the enclosed reply envelope.

BUREAU OF BUSINESS RESEARCH
THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS 78712

INDUSTRIAL ECONOMICS RESEARCH DIVISION
TEXAS A&M UNIVERSITY
COLLEGE STATION,TEXAS 77843

NOTE: Rough estimates will be acceptable for all of the following questions. Of course, the name of your organization will not be published in connection with these data, and the information you send us will remain confidential in our files.

1. How many persons are employed in the establishment to which this questionnaire is addressed? (Please include managers, part-timers, and all others.) . . . . . _____

2. About how many employees do you expect to have five years from now? (Please make your best estimate. If you cannot foresee any change, enter your present employment.) . . . . . _____

3. About what percentage of the total goods or services you provide go to customers who are located *outside* the Galveston Bay Area? (The Galveston Bay Area is defined to include the counties of Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller.) (Include goods and services provided to visitors to the area as being to customers located outside the area.) . . . . . _____%

4. About what percentages of the total goods or services you provide go to business and government customers located *within* the Galveston Bay Area who are in the following industry groups?

   (a) Gas, oil, and other mineral producers . . . . . _____%
   (b) Petroleum refineries and chemicals manufacturers . . . . . _____%
   (c) Oil-field machinery and equipment manufacturers . . . . . _____%
   (d) Primary metals and fabricated metal products manufacturers . . . . . _____%
   (e) Food processors and beverage manufacturers . . . . . _____%
   (f) Government space programs and private aerospace companies . . . . . _____%
   (g) Transportation companies and services (including rail, ship, air, highway, urban transit, and pipeline) . . . . . _____%
   (h) Tourist-type trades and services (including all eating and drinking places, service stations, hotels and motels, and amusement and recreation places) . . . . . _____%
   (i) Any other major industry to which you provide sizeable amounts of goods or services within the Galveston Bay Area. Name of industry: _____ . . . . . _____%

5. If you would care to make any confidential comments on the back of this sheet on particular needs or problems of the area, or about developments that are likely to have a highly stimulating effect on the area's growth, they would be of substantial value in this survey.

THIS INFORMATION IS CONFIDENTIAL.

given by the minimum requirements technique is zero for 1968, this method yields figures for earlier years which appear to be the most reasonable. Consequently, in spite of the fact that some 1968 basic employment in agriculture is omitted, the composite technique uses the estimates provided by the minimum requirements technique for basic employment in agriculture. A possible explanation of the method's failure to find any basic employment in 1968 is that the linear regression equations used are based on out-of-date figures from the 1940 and 1950 Censuses.

This chapter also shows that it is unrealistic to assume that all mining in the GBA is basic. But this is the conclusion of both the assumption approach and the minimum requirements technique. Estimates from the location quotient or surplus worker technique for 1968 are slightly higher than those given by the mail survey, perhaps because mining companies sell some of their output to local refiners and chemical processors for processing before export. Since the mail questionnaire asked the mining companies only for the location of their customers, employees producing this intermediate product would not be counted as basic. But even the slightest allowance for including the producers of some intermediate products in basic employment (to be discussed below) would surely result in counting these mining employees as basic. Thus the estimates given by the location quotient or surplus worker technique may be more realistic than those from the mail survey, and the composite technique uses this approach to estimate basic employment in mining.

The assumption approach is rejected as a technique for measuring basic employment in construction because it considers all construction employment to be nonbasic. Estimates from the minimum requirements technique and from the location quotient or surplus worker technique both are much higher than results of the mail survey. But the wording of the questionnaire led respondents not to count local construction paid for with external capital as basic activity. Since this also represents a flow of purchasing power into the economy, it fits the definition of basic activity. Chapter IV explains the composite technique's use of the location quotient or surplus worker technique instead of the minimum requirements technique.

The location quotient, surplus worker, and the minimum requirements techniques have already been criticized as measurements of basic employment in manufacturing. They implicitly assume that urban areas do not export a product and import it at the same time and that all manufacturing will be for the local market until total employment in manufacturing passes a critical minimum level. As a result, the location quotient or surplus worker technique comes to the absurd conclusion that there was not any GBA basic employment in manufacturing in any of the study years. Somewhat better estimates come from the minimum requirements technique, but they also appear to be far too low.
too low.

For 1968, the minimum requirements technique's estimate of basic manufacturing employment is only 79.6 percent of the estimate coming from the mail survey. At the same time, theoretical considerations make it appear likely that the mail survey figure is too small itself. It has already been pointed out, with regard to mining, that the mail survey tended to underestimate basic employment by not counting closely linked producers of intermediate products. Thus a local producer of chemicals was not considered basic when its output was sold to another local plant even if the second plant sold only on the export market.[10]

[10]See Chapters III and IV.

The assumption approach is not subject to these difficulties when estimating basic employment in manufacturing. At the same time, this technique is able to count any manufacturing activity as service whenever experience shows this to be its dominant characteristic. For these reasons, the assumption approach appears to give the best estimates of basic employment in manufacturing.

Alternatively, the assumption approach is not useful for estimating basic employment in transportation, communication, and utilities, for it erroneously assumes that there is no basic employment in this industry group. The minimum requirements technique consistently gives a higher estimate of basic employment in this industry group than the location quotient or surplus worker technique. Since the former comes closest in its 1968 estimate to the results from the mail survey, the composite technique uses the minimum requirements approach to estimate basic employment in transportation, communication, and utilities.

Similar considerations dictate the use of the location quotient or surplus worker technique to estimate basic employment in trade. This technique's estimates for 1968 are much closer to those from the mail survey than are those from the minimum requirements technique. The assumption approach is rejected because it does not put any of the trade employment into the basic category.

The assumption approach also can be eliminated as a means of measuring basic employment in finance, insurance, and real estate because of its failure to count any of the employment as basic. The location quotient or surplus worker technique gives a somewhat closer approximation to the results of the 1968 mail survey than does the minimum requirements technique. However, the location quotient or surplus worker technique gives a 1968 estimate below that of the mail survey, and there are reasons to suspect that the mail survey elicited responses which underestimate basic employment. A local real estate company's sale to the local office of a national company would be a basic activity if payment were made with imported funds. Since the real estate company would not be likely to know the source of the funds, it would probably classify the sale as nonbasic. The same could be true of a "local" sale by an insurance company. For this reason, the composite technique uses the higher estimates of the minimum requirements technique to approximate basic employment in finance, insurance, and real estate.

Estimates of basic employment in services made by the minimum requirements technique come closer to the results of the 1968 mail survey than comparable estimates by the other two indirect methods. The assumption approach unrealistically assumes that there is no basic employment in services.[11] Estimates from the minimum requirements technique are somewhat higher than those from the mail survey. Again, however, it is to be expected that the mail questionnaire generated estimates of basic employment in services which are too low. Often the service establishments sell to nonresident businessmen, tourists, and other visitors. In many of these cases, the service firm will probably not know that it is selling to nonresidents. Estimates from the location quotient or surplus worker technique are, like those from the assumption approach, lower than the results of the mail survey for 1968 and therefore appear unreliable.

[11] It is possible to separate components of the services total as being export-oriented in much the same way as nonbasic components of manufacturing are isolated. "Lodging" is the most obviously export-oriented component of services. Still, the minimum requirements technique comes closer to the results of the mail questionnaire.

Finally, the composite technique uses the assumption approach to estimate basic employment in public administration. Since this sector of the economy makes few if any sales, the mail questionnaire is not useful in surveying its basic employment. In the composite table, federal and state public administration is considered to be basic, for the workers are paid by external entities.

Table 6 presents the estimates of basic employment in the GBA using the composite technique. The following is a review of the methods used in the composite technique to estimate basic employment in the various industries:

Industry	Technique
1. Agriculture	Minimum requirements
2. Mining	Location quotient or surplus worker
3. Contract construction	Location quotient or surplus worker
4. Manufacturing	Assumption
5. Transportation, communication, and utilities	Minimum requirements
6. Trade	Location quotient or surplus worker
7. Finance, insurance, and real estate	Minimum requirements
8. Services	Minimum requirements
9. Public administration	Assumption

The composite technique measures basic employment in the GBA as having been 140,659 in 1940, 190,106 in 1950, 242,470 in 1960, and 356,297 in 1968. According to these figures, the base-service ratio was 1.0 in 1940, 1.2 in 1950, 1.4 in 1960, and 1.2 in 1968. These figures also give a multiplier of 2.7 between 1940 and 1950, 3.1 between 1950 and 1960, and 1.9 between 1960 and 1968.

Estimating Basic Earnings

The problem

As illustrated by the discussion in Chapter I, all of the alternative units of measurement for economic activity are subject to varying degrees of criticism. One of the major criticisms of economic base studies using employment as the unit of measurement is that they fail to allow for differences in earnings per worker among industries. The problem is that an increase in basic employment of one low-paid farm laborer does not have as large an impact on the local economy as an increase in basic employment of one highly-paid scientist. Data recently made available by the U.S. Bureau of the Census on earnings by broad industrial sector make it possible to tackle this problem.

Application

Total study area earnings were $400,516,000 in 1940, $1,607,163,000 in 1950, $2,960,269,000 in 1959, and $5,839,113,000 in 1968. Because earnings data are not available for 1960, this analysis uses 1959 as a study year and assumes that the ratio between basic and total employment in each industrial sector was the same in 1959 as in 1960. The total of earnings in each study year shown in Table 7 is less than total earnings in that year because the table omits Waller County earnings in mining as well as the relatively

Table 6

ESTIMATES OF BASIC EMPLOYMENT IN GALVESTON BAY AREA USING COMPOSITE TECHNIQUE, 1940-1968

Industrial category	1940	1950	1960	1968
Agriculture, forestry, and fisheries	21,594	12,479	7,757	0
Mining	4,274	5,642	10,792	21,080
Contract construction	6,430	15,381	9,604	40,063
Manufacturing	44,432	80,866	110,954	131,913
Transportation, communication, and utilities	17,463	24,990	24,523	32,619
Trade	10,767	13,777	16,649	34,585
Finance, insurance, and real estate	5,035	8,160	14,442	21,968
Services	28,164	25,343	43,643	64,069
Public administration	2,500	3,468	4,106	10,000
Total	140,659	190,106	242,470	356,297

Table 7

EARNINGS BY BROAD INDUSTRIAL SECTOR IN GALVESTON BAY AREA, 1940-1968

(In thousands of dollars)

Industrial category	1940	1950	1959	1968
Agriculture, forestry, and fisheries	12,190[1]	33,926[1]	32,242[1]	39,517[1]
Mining	54,482[2]	171,941[2]	248,037[2]	297,655[2]
Contract construction	27,734	153,716	197,540	597,365
Manufacturing	75,216	339,270	735,146	1,411,624
Transportation, communication, and utilities	59,802	180,670	319,399	513,155
Trade	98,166	342,251	604,145	1,180,689
Finance, insurance, and real estate	26,175	90,522	176,737	343,723
Services	51,088	186,544	395,490	929,722
Public administration	34,748[3]	104,089[3]	245,360[3]	512,981[3]

[1]Total farm earnings.

[2]Does not include Waller County.

[3]Total government earnings.

Source: U.S. Bureau of the Census.

small amount of earnings which the Census Bureau does not allocate to an industrial sector.

Table 8 estimates basic earnings by assuming that in each industry the percent of total earnings which is basic is equal to the percent of total employment which is basic. This technique indicates that basic earnings in the GBA were $204,780,000 in 1940, $741,650,000 in 1950, $1,387,756,000 in 1959, and $2,846,760,000 in 1968. The ratio of nonbasic earnings to basic earnings was 1.0 in 1940, 1.2 in 1950, 1.1 in 1959, and 1.1 in 1968. Using the Houston consumer price indexes (1957-59=100) for the base years from the Bureau of Labor Statistics to make the figures comparable, the adjusted total income figures become $817,379,000 in 1940, $1,875,336,000 in 1950, $2,928,060,000 in 1959, and $5,219,086,000 in 1968. The adjusted basic income figures are $419,918,000 in 1940, $865,403,000 in 1950, $1,372,657 in 1959, and $2,396,262,000 in 1968. These adjusted income figures give an income multiplier of 2.4 between 1940 and 1950, 2.1 between 1950 and 1959, and 2.2 between 1959 and 1968.

Conclusions

Chapter I points out that economic base theory can justify its emphasis on export activity only after implicitly assuming that the numerical value of the base multiplier remains relatively constant over time. When using employment as the unit of measurement and the assumption approach to estimate basic activity, the value of the multiplier ranges from 4.2 to 7.3 over the periods 1940 to 1950, 1950 to 1960, and 1960 to 1968. Moreover, the assumption approach has serious theoretical shortcomings, and the results in 1968 differ significantly from those of a mail survey of the GBA.

Two other approaches, the location quotient or surplus worker technique and the minimum requirements technique, do not suffer from all of the same theoretical limitations, but over the same time spans, the location quotient or surplus worker technique gives base multipliers ranging in value from 3.6 to 16.4 Although the swings in value are not as extreme as those coming from the location quotient or surplus worker technique, the minimum requirements technique does give base multiplier values ranging from 1.7 to 4.5. The variations in both cases are large enough to impair seriously the usefulness of economic base theory. In addition, both techniques have theoretical limitations which, although different from those affecting the assumption approach, are at least as serious. Finally, both techniques resemble the assumption approach in giving estimates of basic employment which differ significantly from those of the 1968 mail survey.

The description of the composite technique for indirectly estimating basic activity indicates that the three preceding techniques do not have debilitating theoretical problems with the same industries. Consequently a superior technique can be developed by combining the three preceding techniques. Basic activity in each industry is measured by that technique which is best suited to the situation. Although the results of this approach differ from those obtained by the mail survey, theoretical considerations indicate that the composite estimates are even more reliable than those from the mail survey.

While the composite technique is theoretically superior to the other techniques, it does give multipliers with a fairly wide range: 1.9 to 3.1. By changing the unit of measurement from employment to earnings, this range becomes 2.1 to 2.4. The latter unit

Table 8

ESTIMATES OF BASIC EMPLOYMENT AND EARNINGS IN GALVESTON BAY AREA USING COMPOSITE TECHNIQUE TO ESTIMATE BASIC EMPLOYMENT 1940-1968

Industrial category	1940 Employment Total	1940 Employment Basic	1940 Employment Basic (percent)	1940 Earnings Total (thousands of dollars)	1940 Earnings Basic (thousands of dollars)	1950 Employment Total	1950 Employment Basic	1950 Employment Basic (percent)	1950 Earnings Total (thousands of dollars)	1950 Earnings Basic (thousands of dollars)
Agriculture, forestry, and fisheries	24,297	21,594	88.9	12,190[1]	10,837	16,659	12,479	74.9	33,926[1]	25,411
Mining	9,974	4,274	42.9	54,482[2]	23,373	12,361	5,642	45.6	171,941[2]	78,405
Contract construction	19,539	6,430	32.9	27,734	9,124	40,998	15,381	37.5	153,716	57,644
Manufacturing	51,624	44,432	86.1	75,227	64,770	90,746	80,866	89.1	339,296	302,313
Transportation, communication, and utilities	30,777	17,463	56.7	59,802	33,908	45,201	24,990	55.3	180,670	99,911
Trade	58,075	10,767	18.5	98,166	18,161	92,308	13,777	14.9	342,251	50,995
Finance, insurance, and real estate	11,229	5,035	44.8	26,175	11,726	17,581	8,160	46.4	90,522	42,002
Services	68,576[3]	28,164	41.1	51,088	20,997	86,848	25,343	29.2	186,544	54,471
Public administration	7,309	2,500	34.2	34,748[4]	11,884	11,820	3,468	29.3	104,089[4]	30,498
Total					204,780					741,650

Industrial category	1959 Employment Total	1959 Employment Basic (a)	1959 Employment Basic (percent)	1959 Earnings Total (thousands of dollars)	1959 Earnings Basic (thousands of dollars)	1968 Employment Total	1968 Employment Basic	1968 Employment Basic (percent)	1968 Earnings Total (thousands of dollars)	1968 Earnings Basic (thousands of dollars)
Agriculture, forestry, and fisheries	13,863	7,757	56.0	32,242[1]	18,056	4,840	0	–	39,517[1]	0
Mining	16,639	10,792	64.9	248,037[2]	160,976	28,280	21,080	74.5	297,655[2]	221,753
Contract construction	44,103	9,604	21.8	197,540	43,064	76,865	40,063	52.1	597,365	311,227
Manufacturing	124,053	110,954	89.4	735,146	657,221	147,715	131,913	89.3	1,411,624	1,260,580
Transportation, communication, and utilities	53,531	24,523	45.8	319,399	146,285	72,310	32,619	45.1	513,155	231,433
Trade	123,070	16,649	13.5	604,145	81,560	194,595	34,585	17.8	1,180,689	210,163
Finance, insurance, and real estate	27,989	14,442	51.6	176,737	91,196	40,525	21,968	54.2	343,723	186,298
Services	132,137	43,643	33.0	395,490	130,512	185,337[5]	64,069	34.6	929,722	321,684
Public administration	17,119	4,106	24.0	245,360[4]	58,886	49,585	10,000	20.2	512,981[4]	103,622
Total					1,387,756					2,846,760

[1]Total farm earnings.
[2]Does not include Waller County.
[3]Does not include employment in educational services.
[4]Total government earnings.
[5]Differs from figure in Table 5 because estimated employment in public educational services is included here.
[6]Differs from figure in Table 5 for government employment because estimated employment in public educational services is not included here.
[a]Employment figures used are those for 1960.

of measurement, while not the ideal, is more desirable than employment because it takes into consideration differences in earnings per worker among industries. The remaining variations in multiplier values may be at least partially explained by the shortcomings of earnings as a unit of measurement.[12] Chapters III and IV develop other possible explanations of this fluctuation.[13] Still, a range of multiplier values of only 2.1 to 2.4 indicates that economic base theory is applicable in the GBA and it appears to justify the theory's emphasis on basic employment when analyzing economic development in the Area.

[12]See Chapter I.

[13]The relatively crude techniques used to measure historical basic employment, even though they represent the best approaches available, quite probably exaggerate the variation of multiplier.

Chapter III

THEORETICAL SHORTCOMINGS OF ECONOMIC BASE THEORY

Introduction

Chapter II focuses on the problems arising when one attempts to measure the changing economic base of a particular area. But, except for brief mention of such problems as those arising from the existence of linkages, Chapter II does not deal with the more theoretical difficulties affecting economic base theory. The present chapter examines these conceptual problems.

Many of the journal articles examining these shortcomings of economic base theory are collected in a book edited by Ralph W. Pfouts.[1] The articles in that book together with the observations made by Walter Isard in his work on regional science[2] effectively summarize the thinking on the subject up to the beginning of the present decade. This chapter will examine some of the articles in the Pfouts book, many of Isard's comments, and a few of the journal articles on base theory appearing since the publication of those two books.

As the preceding statement implies, the present chapter does not attempt to catalog all of the difficulties which analysts have encountered with economic base theory, for there are far too many of them. Instead, an attempt is made to pick out for treatment some of those most relevant to a study of the Galveston Bay Area. Nor does this chapter relate the particular issues raised to the study area. The following is a theoretical discussion only, but it serves as a prelude to Chapter IV, which examines the importance of these problems to an understanding of the GBA economic history.

Linkages

Described as a "fundamental" difficulty by Isard,[3] one aspect of the problem of linkages arises because exporters differ in the percent of their inputs which they buy locally. The most common way of identifying basic employment is to determine whether it produces goods or services for export. This conceptual scheme would not classify as basic an industry producing an intermediate good to be sold to a local exporter. Richard B. Andrews illustrates the resulting dilemma with the example of a town having a maker of starters who

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[1] Ralph W. Pfouts (ed.), *The Techniques of Urban Economic Analyses* (West Trenton, N.J.: Chandler-Davis Publishing Co., 1961).

[2] Walter Isard, *Methods of Regional Analysis: an Introduction to Regional Science* (Cambridge, Mass.: The M.I.T. Press, 1960).

[3] *Ibid.*, p. 197.

sells to a local exporter of automobiles.[4] Intuitively it seems that if the automobile manufacturer is classified as a basic activity, then the maker of starters should be basic also, even though he sells his output locally. If the two industries were to merge, the resulting whole would be classified as entirely basic.[5]

But if the producer of starters is counted as part of basic activity, it becomes very difficult to reestablish a division between basic and nonbasic employment. Once the door has been opened and one producer of intermediate goods has been admitted to the basic category, it is hard to justify the exclusion of another. According to this broad definition of basic industry, for example, it seems that the local utility companies should be viewed as basic enterprises to the extent that they sell to local exporters such as the automobile manufacturer. Likewise local stenographic services and laundries would appear to be basic when they sell to basic establishments.

If local suppliers of intermediate goods to exporters are considered basic, the logic being used also would seem to justify counting as basic those workers producing the intermediate goods to be sold to other producers of intermediate goods who, in turn, sell to local exporters. Thus, part of the local natural gas distributor's labor force should be included in basic employment if the electric utility uses gas to generate the electricity sold to the automobile manufacturer. If the exporter's labor force is viewed as an intermediate product, then local grocery stores, barbers, and others selling to that labor force logically would appear to be partially basic establishments.[6]

The trouble is that, the larger the basic employment category is allowed to become, the less useful is economic base theory in explaining growth. The theory's value lies in its ability to pinpoint a rather easily identifiable variable which can be used to explain much of a small area's economic development. If all of the indirect contributors to the production of export goods are included in basic employment, the task of identifying all these linked activities becomes so formidable as to reduce greatly the theory's appeal.

But failure to allow for any producers of intermediate goods within the basic category has undesirable consequences for the application of base theory which are at least as serious. Under this condition, only workers producing goods and services to be sold directly in the export market fall into the basic classification. Without an allowance for linkages to local producers of intermediate goods, an examination of economic growth over a period of time in a region with several exporters will be likely to give wide variations in the base multiplier as exports increase first in industries with many local linkages and then in industries with few local linkages.[7] These large swings in the value of the multiplier, by making the overall impact of a change in basic activity difficult to predict, also would reduce significantly the usefulness of the theory in analyzing regional growth.

Somewhere between these two extremes the economist must make a somewhat arbitrary decision on how much of the linked employment to put in the basic category. The quality of the particular study depends heavily on how good this decision is.

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[4]Richard B. Andrews, "Mechanics of the Urban Economic Base: Special Problems of Base Identification," Pfouts, *op. cit.*, pp. 111-15.

[5]This problem is clearly stated again in Hans Blumenfeld, "The Economic Base of the Metropolis," Pfouts, *op. cit.*, pp. 248-49, 256-58.

[6]For a similar treatment of this subject see Isard, *op. cit.*, p. 197.

[7]For a discussion of this problem in terms of base-service ratios see James Gillies and William Grigsby, "Classification Errors in Base-Ratio Analysis," Pfouts, *op. cit.*, pp. 223-25.

Another equally critical aspect of the linkages problem arises from the ability of the producers of intermediate goods themselves to act as an independent source of economic growth.[8] Reminiscent of the old dictum that "a penny saved is a penny earned," it is true that an urban area may grow as the result of the local establishment of a firm to produce previously imported inputs for a local exporter, just as well as through the establishment of a new export firm. Since it is a key assumption of economic base theory that all nonbasic activity is linked to basic activity, it is valid, within the context of the theory, to view any increase in residentiary activity not directly associated with a particular increase in basic activity as an autonomous increase in the size of local linkages. Thus the size of local linkages becomes a second independent variable in economic base theory determining the level of economic activity.

The extent of local linkages tends to vary directly with the geographic size of the study area. Transfer costs are a prime factor in explaining this relationship; as the geographic area under study grows, transportation charges make it increasingly expensive to import inputs.[9] Expanding the boundaries of the study area is also likely to bring into it some previously external input suppliers.

A consequence of the relationship between linkages and geographic size is that, as the area under study grows in size, export base theory becomes increasingly less relevant.[10] As extreme cases which are useful in illustrating this phenomenon, Hans Blumenfeld contrasts a copper mining village with the entire United States.[11] Economic growth in the village may be dependent largely on its ability to expand exports, but this is certainly not true of the United States where exports equal only about 5 percent of gross national product. The ultimate example is the world itself from which there are no exports. Generally speaking, the larger the area under consideration, the better able are its inhabitants to survive and grow by trading among themselves or "taking in each other's washing."

Population is another determinant of the extent of local linkages. Economies of scale are a prime factor in explaining this relationship, for population growth pushes local demand past successive "critical minima" for economic production of goods and services locally.[12] Agglomeration economies reinforce this relationship.

A third aspect of the linkages problem for economic base theory appears when some economists suggest that the availability of local linkages, rather than the level of exports, is the most crucial independent variable determining the level of local economic activity. Assuming this point of view, Hans Blumenfeld argues that the local availability of specialized services, or the external economies, in urban areas enable export establishments to develop. As demands change, export industries change, but the new industries will locate where the services are available. To support this contention Blumenfeld notes that during the last 100 years no town which has achieved a population of 500,000 or more has subsequently fallen below that level.[13]

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[8] A partial development of this idea appears in Blumenfeld, *op. cit.*, pp. 253-54.

[9] Charles T. Stewart, Jr., "Economic Base Dynamics," *Land Economics*, 35, No. 4 (November 1959), 327-28.

[10] See Charles M. Tiebout, "The Urban Economic Base Reconsidered," in Pfouts, *op. cit.*, p. 287.

[11] Blumenfeld, *op. cit.*, pp. 237-39, 262-63.

[12] Stewart, *op. cit.*, pp. 327-28. See also Isard, *op. cit.*, p. 200.

[13] Blumenfeld, *op. cit.*, pp. 276-77.

Thus it is apparent that linkages create problems for economic base theory in at least three ways. First, they make it hard to decide what should be included in the basic activity category. Second, linkages often act as independent variables in their own right. Third, some analysts even believe that export sales are essentially a variable dependent on the availability of local linkages.[14]

Explicit identification of these linkages is the major advantage of input-output studies over economic base studies, but input-output tables also are a great deal more expensive. Whereas export sales usually can be estimated from a mail survey of local firms, the necessary questionnaire for a reasonably thorough input-output study is so detailed that a personal interview must be conducted to fill it out. Even when funds are available for personal interviewing, researchers often find firms reluctant to release detailed figures on their purchases and sales. Cooperation also may be expensive for the firm. Since the required information is not usually a part of the firm's records, the firm may likely have to compile it from accounts receivable and accounts payable records. Finally, while there are methods of estimating historical basic employment, it is virtually impossible to estimate historical input-output coefficients from secondary data.

Characteristics of the Population

Richard B. Andrews is one of several economists who recognizes that sociological characteristics may have a profound influence on the area's base-service ratios and export multipliers. According to Andrews, an area's particular sociological makeup depends largely on the type of labor force demanded by the local basic industries. To illustrate, he contrasts Washington, D.C., with Scranton, Pennsylvania. The basic government industry in Washington needs a large number of female clerical workers, but Scranton's basic mining industry requires a predominantly male labor force. Washington's female basic workers, like women everywhere, spend a large part of their income on locally produced services, giving the town a high base-service ratio. Contrastingly, Scranton's male basic workers do not spend as much of their income on local services, and the city has a lower base-service ratio.[15]

Sex and other sociological characteristics present problems for economic base theory, for they represent additional variables which may affect export multipliers and base-service ratios. This is especially true if, as is often assumed by economic base theory, increased exports create new jobs in basic industry which are filled by in-migrants. The relevant multiplier for estimating the total increase in employment may be strongly influenced by the sex and other sociological characteristics of these migrants.[16]

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[14]For a critical discussion of economic base theory's use of forward linkages which assume population to be a relatively constant multiple of total employment see Charles E. Ferguson, "Statics, Dynamics, and the Economic Base," Pfouts, *op. cit.*, pp. 334-35.

[15]Richard B. Andrews, "Mechanics of the Urban Economic Base: The Concept of Base Ratios," Pfouts, *op. cit.*, pp. 143-44.

[16]This is also explained in Ferguson, *op. cit.*, pp. 335-36.

The population's average propensity to save also may affect local export multipliers and base-service ratios. Part of the income stream finds its way into savings, which may or may not be invested locally. Often it is the local banks, savings and loan associations, insurance companies, and other corporations which make the investment decisions. External investment drains money from the local economy, just as does the purchase of imported goods or services.[17]

Per capita income is particularly important in determining the influence of savings flows on local development. Persons with low incomes generally have proportionately higher propensities to consume than those with large incomes. Consequently a community with a low per capita income, even if it has a large population, probably will not generate enough savings to represent a potentially significant drain on its balance of payments. If an area has high per capita income, there must be sufficient competitive investment opportunities within the area for locally generated savings or a serious drain may result.

The marginal propensity to save is normally higher than the average propensity to save when per capita income is rising. If per capita income rises as a result of increased exports, the higher marginal propensity to save pulls up the average propensity to save of basic employees. With more basic income going into savings, it becomes more likely that external investments will put downward pressure on local export multipliers and base-service ratios. This, of course, assumes that the marginal propensity to invest externally is higher than the marginal propensity to consume imported goods and services.

Patterns of consumption also change in response to rising per capita incomes. One tendency is for consumers to demand greater diversity within each class of goods and services purchased, which leads to more imports. Pushing in the opposite direction on export multipliers is the tendency for consumers to spend an increasing proportion of their incomes on services and a decreasing proportion on manufactured goods. Since a greater percentage of services than of manufactures is produced locally, this tendency drives upward the export multipliers and base-service ratios. Because these two tendencies are in opposition, the net impact of rising per capita incomes is indeterminate.[18]

Sociological characteristics such as sexual composition and economic characteristics such as per capita income are only representative of a wide range of population characteristics which can affect export multipliers and base-service ratios. Among other characteristics, the distribution of income will influence consumption and bring consequences similar to those described already in conjunction with per capita income.[19] There also appears to be a correlation between a city's age and its demand for services. As a city grows older, its inhabitants often evidence an increasing interest in recreational and other public services.[20]

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[17]See Ralph W. Pfouts and Erle T. Curtis, "Limitations of the Economic Base Analysis," Pfouts, *op. cit.*, pp. 320-21.

[18]Stewart, *op. cit.*, pp. 328-31.

[19]Richard B. Andrews, "Urban Economics: An Appraisal of Progress," *Land Economics*, 37, No. 3 (August 1961), 221-22.

[20]Andrews, "Concept of Base Ratios," pp. 145-46.

Supply Factors

Economic base theory explains growth primarily in terms of a growing external demand for the study area's exports, but local supply considerations may be equally crucial. These latter "permissive factors" determine whether an area can take advantage of an increase in external demand, the "implemental factor."[21] An area will not be able to reap the benefits of a growing demand for a natural resource which is mined locally if the local source is nearly depleted. Human resources and capital accumulation raise similar considerations. Unless an area already possesses excess qualified workers and industrial plants, it may not be able to increase production quickly when external demand rises for a locally manufactured good. The necessity for new workers to immigrate to the area or for existing manpower to be trained and for new facilities to be built will delay the anticipated expansion of local economic activity.

Technological changes also may be viewed as supply factors which affect a region's response to external demand. In some industries, producers located close to raw materials or other productive factors are able to capture a larger share of the existing market as a result of improvements in transportation or production technology.[22] Thus, in addition to determining a region's ability to benefit from an increase in the external demand for its exports, supply factors may also enable a region to increase its exports without an accompanying increase in aggregate demand for the product. The reverse, of course, is also true. Even if total external demand for a product remains unchanged, a region may find its exports of the good declining as a result of technological changes making local manufacturers less competitive.

These supply factors which are largely overlooked by economic base theory are the central concern of comparative cost, production, and location theories.[23] The problem created for economic base theory by its failure to give adequate attention to supply factors does not center on the relationship between basic and total economic activity. Rather, the problem is that economic base theory is not able to explain fully why changes in export activity occur.

Additional Autonomous Variables

Numerous independent variables other than export sales already have been mentioned–linkages, sexual composition of the population, per capita income, tastes, resources, and technology. Without any increase or decrease in export sales, changes can occur in these other variables and lead to a change in the overall level of local economic activity.

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[21]Theodore Lane, "The Urban Base Multiplier: An Evaluation of the State of the Art," *Land Economics,* 42, No. 3 (August 1966), 342-46.

[22]Isard, *op. cit.,* p. 200.

[23]The shortcomings of economic base theory in comparison with these other theories are outlined in Morgan D. Thomas, "The Export Base and Development Stages Theories of Regional Economic Growth: An Appraisal," *Land Economics,* 40, No. 4 (November 1964), 427-31.

Consumer investments in housing, business investments in plant and equipment, and government expenditures are additional variables affecting the level of economic activity which do not always depend on the current level of export sales.[24] The housing industry in the short run is highly dependent on "interest rates, down payment requirements, in-and-out migration, and building regulations."[25] Profit expectations, themselves dependent on more than just export sales and the level of income, are a prime determinant of short-run business investment.[26] Both types of investment often reflect a flow of external funds into the area, for investment money is highly mobile. But this influx of new money into the community is not directly tied to any tangible or intangible export. Similarly, government expenditures in the short run depend heavily on interest rates and political considerations.[27] If these expenditures are made by external governments or are paid for by local government borrowing, they too reflect a flow of funds into the region unrelated to a change in exports.

Summary

The theoretical shortcomings of economic base theory which have been listed fall into two convenient groups: those limiting the theory's ability to forecast the overall impact of a given change in basic activity and those limiting the theory's ability to explain thoroughly all sources of change in economic activity. Some problems associated with the existence of linkages and with changing characteristics of the population belong in the first group. As an example this chapter illustrates how failure to take account of linkages may result in wide swings in the value of the base multiplier. In addition, the chapter shows how changing sociological and economic characteristics of the population can affect the value of the multiplier.

Other problems associated with the existence of linkages fall into the second group. Linkages may act as independent variables themselves or serve to attract new basic enterprises. Supply factors are sources of change, for they determine a region's response to external demand conditions. Finally, additional autonomous variables such as investment and government expenditures can be the catalysts of change.

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[24]The failure of base theory to incorporate these other independent variables from Keynesian income theory is noted in Tiebout, *op. cit.*, p. 285.

[25]Se-Hark Park, "The Economic Base Identification: An Appraisal," *Land Economics,* 41, No. 4 (November 1965), 384.

[26]*Ibid.* See also Isard, *op. cit.*, p. 211.

[27]Park, *op. cit., p. 384.*

CHAPTER IV

LINKAGES IN THE GALVESTON BAY AREA

Introduction

Although the development of the Galveston Bay Area (GBA) conforms quite closely to the economic base theory version of the growth process, its history also provides many examples of the difficulties for economic base theory raised by the existence of linkages. First mentioned in Chapter II as a relevant consideration in estimating basic employment, the problems arising out of the existence of linkages are outlined more fully in Chapter III. To recapitulate, linkages raise questions about exactly what constitutes basic employment. In addition, they provide a potentially independent source of growth. Finally, some observers feel it is more realistic to view linkages as the independent variable determining the level of export sales.

This chapter deals with only the first of these three aspects of the linkages problem: the questions raised about what to include in basic employment. The approach involves measuring some of the most direct linkages of the GBA's largest export industries in 1968. Lack of data precludes making historical estimates of these linkages just as it renders hopeless the task of constructing detailed historical input-output tables. Other aspects of the linkages problem and supply considerations are discussed in Chapter V.

Direct Linkages

Question 4 from the questionnaire sent out by the Bureau of Business Research, The University of Texas at Austin, and the Industrial Economics Research Division, Texas A&M University (Figure 2) provides useful information on some of the most direct linkages between major GBA export industries and other local establishments. The meaning attached here to the term "direct linkages" is essentially the same as that given to "direct service" in Chapter I. Direct linkages exist between a basic industry and its suppliers of intermediate goods needed in the production of final export goods--components of the final product, electricity, and the like. On the other hand, indirect linkages exist between a basic industry and firms selling to its labor force and between a basic industry and firms selling to producers of intermediate goods for the basic industry.

Rather than attempting to measure the direct local linkages of all the GBA basic industries, the questionnaire asked only for information on these linkages to industry groups which ex ante expectations indicated would be the major exporters. Questionnaire results confirmed that these "industry groups" were major exporters (Table 9).[1]

[1]Throughout this chapter, the term "industry groups" refers to those groups listed in Table 9.

Table 9

BASIC EMPLOYMENT AS A PERCENT OF TOTAL EMPLOYMENT IN SELECTED INDUSTRY GROUPS, GALVESTON BAY AREA, 1968

Industry group	Percent
a. Gas, oil, and other mineral producers	62.63
b. Petroleum refineries and chemicals manufacturers	82.94
c. Oil-field machinery and equipment manufacturers	94.14[1]
d. Primary metals and fabricated metal products manufacturers	69.55
e. Food processors and beverage manufacturers	52.54
f. Government space programs and private aerospace companies	100.00[2]
g. Transportation companies and services (including rail, ship, air, highway, urban transit, and pipeline)	57.09
h. Tourist-type trades and services (including all eating and drinking places, service stations, hotels and motels, and amusement and recreation places)	49.91

[1]Calculated from a separate expansion of questionnaire responses in this segment of the non-electrical machinery manufacturing industry.

[2]All National Aeronautics and Space Administration and related employment assumed to be producing for the nation as a whole, an external market.

The first step in processing the data obtained on direct linkages was to convert the percentages requested by Question 4 into employment figures. This was done on each questionnaire separately. In many cases, the sum of the percentages supplied in Questions 3 and 4 exceeded 100 percent, and, when this occurred, an attempt was made to adjust the figures in light of the respondent's apparent misunderstanding of the questions. All employment figures were rounded off to the nearest whole numbers.

Next, the questionnaires were grouped into approximately the same "industrial categories," as used in Table 10, the only difference being that manufacturing was broken down into all of the 2-digit standard industrial classification (SIC) components.[2] Within each "industrial category," the sample employment figures coming from responses to Question 4 were summed to find total sample employment producing goods and services sold locally to customers in each of the "industry groups." During this process, some questionnaires were not included because their data clearly was erroneous. Total sample employment in each "industrial category" also was found.

By dividing total sample employment in each "industrial category" into total sample employment in that "industrial category" producing goods and services sold locally to customers in each of the "industry groups," it was possible to calculate the percent of total sample employment in each "industrial category" producing goods and services sold locally to customers in each of the "industry groups" (Table 10). In this step, calculations were made for each 2-digit SIC component of the manufacturing group rather than for the industry as a whole.[3]

After assuming that the percentages calculated in the foregoing step were representative of all establishments in each "industrial category," it was possible to calculate total employment in each "industrial category" selling locally to each "industry group" of Question 4. This was done merely by multiplying these percentages by total 1968 employment in each of the "industrial categories" (Table 11). From the twenty-one 2-digit SIC components used in calculating percentages and employment in manufacturing, Tables 10 and 11, as well as the upcoming Table 12, record only the five most important components in the GBA.

Several general shortcomings exist in the figures in Tables 10 and 11. First, as noted above, the Texas Employment Commission (TEC) drew the sample to which questionnaires were mailed, and the TEC classifies each establishment in only one SIC group. Even though this is supposed to be the major area of the firm's activity, many companies operate in several industries. By classifying each returned questionnaire in a single SIC group, some employment of multi-industry firms was included which did not belong in that SIC group. In extreme cases, this caused the figures to indicate a nonexistent link between a particular industrial category and one of the industry groups listed in Question 4. A closely associated problem arose from the fact that the TEC apparently misclassified some of the sample firms.

Another source of error in the figures came from incorrect answers to Question 4. Numerous respondents seem to have misread the question and to have interpreted it as asking what percent of their customers worked for the listed "industry groups." This

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[2]Throughout this chapter, the term "industrial categories" refers to those categories listed vertically in Table 10.

[3]The percentages shown in Table 11 for the manufacturing industry as a whole were calculated after estimating total manufacturing employment in each 2-digit SIC category selling locally to each of the given "industrial groups."

Table 10

ESTIMATES OF PERCENT OF GALVESTON BAY AREA EMPLOYMENT IN BROAD INDUSTRIAL CATEGORIES SELLING TO MAJOR LOCAL EXPORTERS, 1968

Industrial category	Group a (percent)	Group b (percent)	Group c (percent)	Group d (percent)	Group e (percent)	Group f (percent)	Group g (percent)	Group h (percent)
Agriculture, forestry, and fisheries	0.00	0.00	0.00	0.00	2.17	0.00	0.54	0.18
Mining	9.63	21.46	0.30	0.33	0.00	0.03	0.51	0.13
Contract construction	5.32	30.45	0.63	0.95	0.76	8.18	1.06	1.79
Manufacturing	1.73	8.40	1.49	2.70	2.67	0.47	1.22	1.12
Chemical and allied products	0.90	8.84	0.27	0.28	0.23	0.33	0.23	0.49
Petroleum refining	0.36	13.42	0.03	0.01	0.00	0.00	0.34	3.41
Primary metal industries	1.76	1.69	6.98	22.56	0.00	0.17	3.47	0.00
Fabricated metal products	2.76	24.13	1.09	3.80	10.76	0.66	1.07	0.25
Machinery, except electrical	3.25	4.77	1.58	0.32	0.02	0.70	0.87	0.20
Transportation	1.35	5.09	0.69	0.74	1.18	0.94	4.28	0.58
Communication and utilities	4.46	6.07	2.48	4.57	3.25	3.45	4.81	3.42
Wholesale trade	5.07	6.08	2.13	2.22	0.58	10.72	1.93	2.04
Retail trade	4.04	2.95	1.63	1.52	1.42	1.30	2.05	4.20
Finance, insurance, and real estate	3.94	4.13	2.19	3.58	2.06	0.51	1.61	3.14
Services	6.88	11.40	1.95	3.40	1.76	4.87	2.75	3.09

Note: Industry groups are identified in Table 9.

Source: Total sample employment in each "industrial category" divided into total sample employment in that "industrial category" producing goods and services sold locally to customers in each of the "industry groups."

Table 11

ESTIMATES OF GALVESTON BAY AREA EMPLOYMENT IN BROAD INDUSTRIAL CATEGORIES SELLING TO MAJOR LOCAL EXPORTERS, 1968

Industrial category	Group a	Group b	Group c	Group d	Group e	Group f	Group g	Group h
Agriculture, forestry, and fisheries	0	0	0	0	105	0	26	9
Mining	2,723	6,069	85	93	0	8	144	37
Contract construction	4,089	23,405	484	730	584	6,288	815	1,376
Manufacturing	2,556	12,408	2,202	3,987	3,942	700	1,795	1,654
Chemical and allied products	246	2,420	74	77	63	90	63	134
Petroleum refining	48	1,804	4	1	0	0	46	458
Primary metal industries	160	154	635	2,052	0	15	316	0
Fabricated metal products	529	4,628	209	729	2,064	127	378	48
Machinery, except electrical	761	1,117	371	76	4	164	203	46
Transportation	703	2,651	359	385	615	490	2,230	302
Communication and utilities	902	1,227	501	924	657	698	972	691
Wholesale trade	3,155	3,783	1,325	1,381	361	6,670	1,201	1,269
Retail trade	5,348	3,905	2,158	2,012	1,880	1,721	2,714	5,560
Finance, insurance, and real estate	1,597	1,674	887	1,451	835	207	652	1,281
Services	10,219	16,933	2,896	5,050	2,614	7,234	4,085	4,590
Total	31,292	72,055	10,897	16,013	11,593	24,016	14,634	16,769

Note: Industry groups are identified in Table 9.

mistake was made most often by firms in the retail trade and service industries. Other establishments read Question 4 as asking for which of the listed groups they operated in.

Not all the employment listed in Table 11 can be viewed as closely linked to basic activity, or what might be called "secondary-basic," because not all of the sales made by the industry groups listed in Question 4 were to nonresidents. Only that portion of the employment listed in Table 11 was "secondary-basic" which made intermediate goods and services used in the production of basic goods and services. To estimate "secondary-basic" employment, it was assumed that the percentage of purchased intermediate goods used in production of exports by each industry equalled the percentage of that industry's total production which was basic. "Secondary-basic" employment was calculated by multiplying the employment totals from Table 11 by the relevant percentages from Table 9 (Table 12).

The "secondary-basic" employment in Table 12 is that which has "direct linkages" to basic employment, except in the case of "group f" (government space programs and private aerospace companies).[4] The wording of the questionnaire led the private aerospace companies and those firms selling to the private aerospace companies both to indicate in Question 4 that they were selling to "group f." Consequently employment in both types of firms is included in the "secondary-basic" total for "group f." But if the private aerospace companies are treated as selling to the government space programs rather than being basic themselves, then the firms selling to the private aerospace companies do not fit the definition of "secondary-basic" activity. Either the private aerospace companies' employment must be moved to the basic employment classification, or the employment in firms selling to private aerospace companies must be subtracted from the "secondary-basic" total selling to "group f."

According to estimates from the National Aeronautics and Space Administration (NASA), private aerospace companies in the GBA employed about 6,000 persons in 1968. If those workers are considered part of basic employment, total "secondary-basic" employment becomes 141,837, not 147,837 as shown in Table 12. Since the TEC lists those firms in the wholesale trade classification, total "secondary basic" employment in this "industry group" falls from 15,513 to 9,513. In addition, total "secondary-basic" employment producing for sale to "group f" drops to 18,016 from 24,016.

"Secondary-Basic" Employment and the Composite Technique for Estimating Basic Employment

In developing the composite technique for estimating basic employment, Chapter II repeatedly criticizes the results of the mail survey for not including in the total basic activity what this chapter calls "secondary-basic" employment.[5] The following discussion assesses the implications for the composite technique inherent in these estimates of "secondary-basic" activity. Throughout the remainder of the chapter, the term "primary-basic" employment is used to describe employment producing goods and services for sale directly to nonresidents. Table 13 sums "primary-basic" and "secondary-basic" employment in each "industrial category" to obtain total basic employment.

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[4]The "government space programs" were the operations of the National Aeronautical and Space Administration's Manned Spacecraft Center. Virtually all of the private aerospace companies in the GBA were there to serve the needs of this government installation.

[5]As will be seen further along, Chapter II treats contract construction differently.

Table 12

ESTIMATES OF GALVESTON BAY AREA SECONDARY-BASIC EMPLOYMENT IN BROAD INDUSTRIAL CATEGORIES SELLING TO MAJOR LOCAL EXPORTERS, 1968

Industrial category	Group a	Group b	Group c	Group d	Group e	Group f	Group g	Group h	Total
Agriculture, forestry, and fisheries	0	0	0	0	55	0	15	4	74
Mining	1,705	5,055	80	65	0	8	82	18	7,013
Contract construction	2,561	19,494	456	508	307	6,288	465	687	30,766
Manufacturing	1,601	10,335	2,073	2,773	2,071	700	1,025	826	21,404
Chemical and allied products	154	2,016	70	54	33	90	36	67	2,520
Petroleum refining	30	1,503	4	1	0	0	26	229	1,793
Primary metal industries	100	128	597	1,427	0	15	180	0	2,447
Fabricated metal products	331	3,855	197	507	1,084	127	216	24	6,341
Machinery, except electrical	477	930	349	53	2	164	116	23	2,114
Transportation	440	2,208	338	268	323	490	1,273	151	5,491
Communication and utilities	565	1,022	472	643	345	698	555	345	4,645
Wholesale trade	1,976	3,151	1,247	960	190	6,670	686	633	15,513
Retail trade	3,349	3,252	2,032	1,399	988	1,721	1,549	2,775	17,065
Finance, insurance, and real estate	1,000	1,394	835	1,009	439	207	372	639	5,895
Services	6,400	14,103	2,726	3,512	1,373	7,234	2,332	2,291	39,971
Total	19,597	60,014	10,259	11,137	6,091	24,016	8,354	8,369	147,837

Note: Industry groups are identified in Table 9.

Table 13

ESTIMATES OF GALVESTON BAY AREA PRIMARY-BASIC AND SECONDARY-BASIC EMPLOYMENT IN BROAD INDUSTRIAL CATEGORIES, 1968

Industrial category	Primary-basic employment	Secondary-basic employment	Total basic employment
Agriculture, forestry, and fisheries	527	74	601
Mining	17,712	7,013	24,725
Contract construction	20,451	30,766	51,217
Manufacturing	99,179	21,404	120,583
Chemical and allied products	22,956	2,520	25,476
Petroleum refining	10,895	1,793	12,688
Primary metal industries	5,466	2,447	7,913
Fabricated metal products	10,773	6,341	17,114
Machinery, except electrical	19,516	2,114	21,630
Transportation	29,739	5,491	35,229
Communication and utilities	12,188	4,645	16,833
Wholesale trade	23,775	15,513	39,288
Retail trade	13,300	17,065	30,365
Finance, insurance, and real estate	11,560	5,895	17,455
Services	38,766	39,971	78,737

Extractive industries

In developing the composite technique to estimate basic employment, Chapter II uses the minimum requirements technique to calculate basic employment in agriculture, forestry, and fisheries, even though this technique finds no 1968 basic employment in the industry. Table 12 shows that, while about 55 employees in the industry were producing intermediate-export goods for sale to food processors and beverage manufacturers, there was very little "secondary-basic" employment in the industry. This finding supports the choice of the zero estimate from the minimum requirements technique over the 4,840 basic employment estimate from the assumption approach in 1968.[6]

The estimates of "secondary-basic" employment in mining also support the choice of the location quotient or surplus worker technique, used by the composite technique, as the best indirect method for measuring basic employment in mining. Summing questionnaire results on "primary-basic" and "secondary-basic" employment in mining gives an estimate of total basic employment which exceeds the composite technique's estimate by about 3,600 workers. But although the minimum requirements technique and assumption approach get higher figures by counting all mining employment as basic, it has already been argued that it is unrealistic to assume that all mining employment is basic.

Table 12 indicates that most of the mining industry's "secondary-basic" employment was producing goods and services for sale to the local petroleum refineries and chemicals manufacturers. Chapter V outlines the many linkages between these two industries. It appears that a large segment of "secondary-basic" employment in the mining industry was producing goods and services for sale to local gas, oil, and other mineral producers. This reflects the facts that the *SIC Manual* classifies producers of oil and gas field services in the mining industry, that the GBA was a major center for the production of these services, and that they were in demand by the large local mining industry.

Contract construction

The composite technique also used the location quotient or surplus worker technique to measure basic employment in contract construction. That procedure is justified by the fact that this technique's 1968 estimates of basic employment in contract construction are closer to the sum of "primary-basic" and "secondary-basic" employment shown in Table 12 than are the estimates of either of the other indirect techniques.

Nevertheless the estimates in Table 12 do not include all employment in contract construction supported by capital flows into the GBA. Chapter II argues that this category constitutes basic activity. On the other hand, "secondary-basic" employment figures do include activity which likely is producing intermediate products for future, rather than current, export activity. The construction of a new plant may take several years, and it seems more reasonable to count the construction workers as contributing to the ultimate exports of the new plant than to count them as part of basic activity before the plant starts

[6]Knowledge that the GBA historically has been an exporter of agricultural, forestry, and fishery products eliminates basic employment estimates from the location quotient or surplus worker technique which showed no basic employment in this industry group in any of the years.

operating. That position, however, is counterbalanced somewhat by the fact that the "secondary-basic" employment figures do not include previous construction workers who built the plants operating in 1968.

Manufacturing

Chapter II judges the assumption approach to be the best indirect measure of basic employment in manufacturing even though the approach gives an estimate of 1968 basic employment in the industry which exceeds by over 33,000 workers the questionnaire results for "primary-basic" employment. The chapter justifies this choice by arguing that manufacturers of intermediate products for exporters should be included in basic activity. When "secondary-basic" employment as estimated from the questionnaire results is added to "primary-basic" employment in manufacturing, the 1968 total is very close to the 1968 basic employment estimate by the assumption approach: 120,583 versus 131,913. Thus, estimates of "secondary-basic" employment also support the choice of the assumption approach for estimating basic employment in manufacturing.

Five of the twenty-one 2-digit SIC components comprising the manufacturing industry accounted for over 70 percent of this 1968 "secondary-basic" employment serving major export "industry groups" in the GBA. These five components were chemical and allied products; petroleum refining; primary metal industries; fabricated metal products; and machinery, except electrical. Chapter V examines the linkages within the chemical, petrochemical, and refining industries.

The 1968 estimates of "secondary-basic" employment in GBA primary metal industries indicate that their major local market was the fabricated metal products industry. Exclusive of machinery producers, establishments in the fabricated metal products industry made most of their local sales to petroleum refineries and chemical manufacturers (valves and pipe fittings, pressure vessels, process towers and columns, tanks, and the like) and to food processors (metal cans). Finally, makers of nonelectrical machinery sold locally primarily to refineries and chemical manufacturers (various types of machinery including pumps and compressors) and to gas, oil, and other mineral producers (offshore drilling platforms, wellheads, bits, swivels).[7] Although the questionnaire did not ask for linkages to the construction industry, all of these metals industries had large sales to local construction firms.

Other industries

The 1968 estimates of "secondary-basic" employment shown in Table 13 fail to indicate that the composite technique described in Chapter II uses the wrong indirect method for estimating basic employment in any of the remaining industrial categories. While Table 13 separates transportation from communication and utilities, the composite technique combines these industries and uses the minimum requirements technique to estimate basic employment in all of them. The estimate of total basic employment in the three industries derived by the minimum requirements technique is the closest of the three indirect estimates to the sum of "primary-basic" and "secondary-basic" employment shown in Table 13.

[7]See Table 12 for estimates of these linkages in terms of employment.

The three remaining private "industrial categories" resemble agriculture, forestry, and fisheries in that they made most of their 1968 sales to local residents. These industries are trade; finance, insurance, and real estate; and services. Still, each of the industries did have some basic employment, and this consideration leads to the rejection of the assumption approach in favor of another technique as the best method for estimating basic employment in them. In the latter two (finance, insurance, and real estate and services) the minimum requirements technique gives a 1968 basic employment figure closer to the total of "primary-basic" plus "secondary-basic" as shown by the questionnaire than the location quotient technique.

On the other hand, the minimum requirements technique gives a basic employment estimate in retail and wholesale trade (treated as a single industry in Chapter II) closer to the Table 13 estimate of total basic employment in these industries than the figure used in the composite technique. Earlier in this chapter, it is noted that many of the firms in the retail trade industry answered Question 4 in terms of what "industry groups" their customers worked for. This misunderstanding of the questionnaire tended to make the Table 13 estimates of "secondary-basic" employment in trade too high. In light of this consideration, it again appears that the composite technique uses the best indirect method for estimating basic employment.

Industry Multipliers

It is apparent in Table 12 that the GBA's major export industries differed considerably in the extent of their local linkages in 1968. As explained in Chapter III, these differences would lead to variations in the impact on the local economy of a one-unit increase in "primary-basic" activity depending on the local linkages of the industry in which the increase occurred. Figures obtained by the mail questionnaire make it possible to derive rough industry multipliers for the "industry groups" listed in Question 4.

Table 14 lists these "industry groups" as well as estimates of both "primary-basic" and "secondary-basic" employment in each.[8] While the "primary-basic" employment estimates are derived from various sources, the "secondary-basic" employment totals (except for the figure for "group f") come directly from Table 12. From this table the estimate of "secondary-basic" employment in "group f" (government space programs and private aerospace companies) is reduced in Table 14 by 6,000 workers, the approximate number of GBA aerospace company employees in 1968, because these employees are included in the "primary-basic" total for this "industry group."[9]

Dividing "primary-basic" employment into "secondary-basic" employment in each "industry group" yields the ratio between the two types of employment shown in Table 14. If it is assumed that this ratio remains a constant, the ratio becomes the "secondary-basic" employment multiplier. For example, assuming the ratio is a constant, Table 14 indicates that for each increase in basic employment of one worker in "group a" "secondary-basic" employment in "group a" will increase by 1.1 workers.

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[8]Table 14 calculates "secondary-basic" employment by summing the columns in Table 12. In Table 13, "secondary-basic" employment equals the sum of the rows in Table 12.

[9]See the above discussion of theoretical difficulties raised for this "industry group" by the wording of the questionnaire.

Table 14

PRIMARY-BASIC EMPLOYMENT MULTIPLIERS IN SELECTED GALVESTON BAY AREA INDUSTRY GROUPS, 1968

Industry group	Primary-basic employment[1]	Secondary-basic employment	Total basic employment	Number of secondary-basic employees per primary-basic employee[2]	Primary-basic employment multiplier[3]
a. Gas, oil, and other mineral producers	17,712	19,597	37,309	1.1	3.8
b. Petroleum refineries and chemicals manufacturers	33,851	60,014	93,865	1.8	5.0
c. Oil-field machinery and equipment manufacturers	14,116[4]	10,259	24,375	0.7	3.1
d. Primary metals and fabricated metal products manufacturers	16,239	11,137	27,376	0.7	3.1
e. Food processors and beverage manufacturers	7,699	6,091	13,790	0.8	3.2
f. Government space programs and private aerospace companies	10,600[5]	18,016[6]	28,616	1.7	4.9
g. Transportation companies and services (including rail, ship, air, highway, urban transit, and pipeline)	29,738	8,354	38,092	0.3	2.3
h. Tourist-type trades and services (including all eating and drinking places, service stations, hotels and motels, and amusement and recreation places)	27,060[7]	8,369	34,429	0.3	2.3

[1]This is the same as what is called "basic employment" in previous chapters.

[2]Secondary-basic employment divided by primary-basic employment.

[3]One plus number of secondary-basic employees per primary-basic employee times the overall multiplier for economy.

[4]Calculated by a separate expansion of questionnaire responses in this segment of the nonelectrical machinery manufacturing industry.

[5]Estimated from National Aeronautics and Space Administration data.

[6]Estimated 6,000 aerospace company employees subtracted from total secondary-basic employment in this industry group, as calculated in Table 4.4, because these aerospace company employees already are included in primary-basic employment.

[7]Estimated from an expansion of Texas Employment Commission data.

If "secondary-basic" employment is included in total basic employment, total basic employment for 1968 in the GBA becomes 451,993, as measured by the questionnaire.[10] This leaves a total of 348,059 nonbasic employees and a base-service ratio of 0.8 for the economy as a whole. If it also is assumed that this ratio is a constant, then this ratio plus one becomes the service employment multiplier. For each unitary increase in total basic employment, service employment must increase by 0.8 workers.

Given that the base-service ratio for the economy is constant, then the ratio of total employment to total basic employment must remain constant. This ratio is the overall multiplier for the economy, and it is used to calculate the total increase in employment resulting from each unitary increase in basic employment.

The "primary-basic" employment multiplier in 1968 for each "industry group" listed in Table 14 equals one plus the number of "secondary-basic" employees per "primary-basic" employee in the given industry times the overall multiplier for the economy as a whole. While Chapter II shows it is unrealistic to assume that the above ratios will remain constant, input-output analysis must make similar assumptions, and most economists still judge input-output analysis to be a valuable tool. In any case, these industry multipliers are superior to a single employment multiplier for the entire economy because they make an attempt to take account of variations in local linkages among export "industry groups."

[10]The Table 5 estimate of 1968 "primary-basic" employment plus the Table 14 estimate of "secondary-basic" employment.

Chapter V

OTHER THEORETICAL SHORTCOMINGS AND THE GALVESTON BAY AREA

Introduction

While Chapter IV explores one of the theoretical shortcomings arising for economic base theory from the existence of linkages in the Galveston Bay Area (GBA), it does not address three other sources of theoretical difficulties outlined in Chapter III. These additional sources are changing population characteristics, supply considerations, and independent variables other than export sales. Each of these sources is really a group of numerous factors affecting economic growth. This chapter assesses the relevance to an understanding of the economic development of the GBA between 1940 and 1968 of some examples drawn from each group.

Characteristics of the Population

The sexual composition of the population is one of the variables affecting base-service ratios which is examined in Chapter III. One argument is that, since women tend to spend a larger proportion of their income on locally produced goods and services than do men, then areas with heavy concentrations of females in their population will have higher base-service ratios than areas with light concentrations of females. It would follow that, as the percent of females in a given region's population increased, so too would the percent of that area's employment engaged in nonbasic activity.

Females gradually moved from the minority to the majority in the population of the GBA over the period from 1940 to 1960. As shown in Table 15, females constituted 49.7 percent of the total population in 1940, 50.1 percent in 1950, and 50.7 percent in 1960. Their increasing importance in the employed labor force over the period was somewhat more impressive, and this increase is a better measure of their control over purchasing power in the Area. Again referring to Table 15, the female proportion of total employment rose from 25.8 percent in 1940 to 28.0 percent in 1950 and to 31.7 percent in 1960.

As females gradually increased their proportion of the GBA population and employment, according to this theory, a greater percent of total Area consumption should be of locally produced goods and services, and the base multiplier should increase in value. Using the composite technique to estimate basic activity and employment as the unit of measurement, Chapter II finds the Area's multiplier increasing from 2.7 between 1940 and 1950 to 3.1 between 1950 and 1960. While the rise in the female proportion of Area employment and population appears to be too small to explain the total increase in the value of the multiplier, it seems that it may have been a contributing factor.

Table 15

FEMALE POPULATION AND EMPLOYMENT, GALVESTON BAY AREA, 1940-1960

Year and classification	Eight-county total
1940	
Total population	735,553
Female population	365,367
Total employment	284,987
Female employment	73,602
1950	
Total population	1,068,437
Female population	536,004
Total employment	419,953
Female employment	117,378
1960	
Total population	1,581,137
Female population	801,538
Total employment	584,731
Female employment	185,265

Source: U.S. Bureau of the Census.

On the other hand, when Chapter II uses the composite technique to estimate basic activity but substitutes earnings as the unit of measurement, the resulting multiplier decreases in value from 2.4 between 1940 and 1950 to 2.1 between 1950 and 1959. This, however, appears to be the result of the fact that earnings rose much more rapidly in basic than in nonbasic industry. While yearly earnings per worker in manufacturing rose $4,469. over the period, those in services rose only $2,248. Thus although total employment in nonbasic activity was rising faster than that in basic activity, total earnings of basic workers were rising faster than those of nonbasic workers. This relationship is not inconsistent with the proposition that expenditures on locally produced goods and services were rising faster than total Area consumption expenditures.

Chapter II presents the argument that an increasing female proportion of total employment reflects an increasing demand for female workers by basic industry. Table 16 presents an attempt to test this hypothesis. The table calculates basic employment as a percent of total employment in each industry group. It then assumes that, within each industry group, the percent of female employment which is basic equals the percent of total employment which is basic. Given this assumption, total female basic employment can be calculated. According to these figures, the proportion of basic employment which was female increased from 20.9 percent in 1940 to 21.3 percent in 1950. Continuing the upward trend after 1950, the proportion rose to 25.2 percent in 1960.

Apparently basic industry employment of females increased continually between 1940 and 1960. This gradually rising proportion of basic employment which was made of females could help explain the rising demand for locally produced goods and services discussed above. But this test does not establish as a fact that basic industry actually preferred more female workers after 1940 and that female immigration occurred as a result of the needs of basic industry. It may have been that, as more married women sought jobs and females became a larger part of the available labor force, basic industry hired women because the supply of men was insufficient. In a rapidly growing area such as the GBA, this is particularly likely to be the case.

A second characteristic of the population which Chapter III discusses as possibly having some influence on base multipliers and base-service ratios is per capita income. As developed above, the argument is that rising per capita incomes create more savings and that these savings are a potentially significant source for an outward flow of funds. If these funds flow out into external investments, then the multiplier and base-service ratio will tend to decline.

Estimates of per capita income can be obtained by dividing personal income estimates from the Office of Business Economics by population estimates. This procedure gives the following approximations of per capita income in the GBA: $727 in 1940, $1,802 in 1950, and $2,244 in 1960.[1] Savings certainly increased in the GBA along with per capita incomes. And, even though rapid growth in the Area created many investment opportunities, a significant portion of these savings probably was invested outside the eight counties. As noted in Chapter III, these external investments by individuals, banks, savings and loans, insurance companies, and other organizations drained the GBA of purchasing power just as if the money had been spent on imports.

[1] In calculating the 1960 per capita income figure, a 1959 estimate of personal income is used.

Table 16

ESTIMATES OF FEMALE BASIC EMPLOYMENT, GALVESTON BAY AREA, 1940-1960

Industrial category	1940			1950			1960		
	Basic as percent of total	Total female[1]	Basic female	Basic as percent of total	Total female[1]	Basic female	Basic as percent of total	Total female[1]	Basic female
Agriculture, forestry, and fisheries	88.9	1,396	1,241	74.9	1,224	917	56.0	1,345	753
Mining and contract construction	36.3	776	282	39.4	2,404	947	336	4,992	1,677
Manufacturing	86.1	5,155	4,438	89.1	12,800	11,405	89.4	16,228	14,508
Transportation, communication, and utilities	56.7	2,452	1,390	55.3	6,382	3,529	45.8	8,785	4,024
Trade	18.5	15,895	2,941	14.9	33,181	4,944	13.5	45,290	6,114
Finance, insurance, and real estate	44.8	3,681	1,649	46.4	7,684	3,565	51.6	13,475	6,953
Services	41.1	41,684	17,132	29.1	49,319	14,352	33.0	79,121	26,110
Public administration	34.2	1,005	344	29.3	2,563	751	24.0	4,115	988
Total			29,417			40,410			61,127

[1]The total of this column does not equal total female employment in the given year, for it does not include employment in the Census classification called "industry not reported."

Source: U.S. Bureau of the Census.

Supply Factors

Chapter III finds another source of theoretical difficulty for economic base theory in its failure to pay adequate attention to supply factors and their crucial importance to growth. These "permissive factors" determine a region's response to external demands, and they range from input availability to technology. They are the focal points of comparative cost, production, and location theories.

Availability of natural resources

In the GBA, there has been no more important factor behind the growth of the giant chemical, petrochemical, and refining industries than the availability of essential natural resources. This eight-county study area is the center of the world's largest concentration of these industries. It contains nearly 80 percent of the nation's chemical production facilities, accounts for at least 40 percent of every basic petrochemical produced in the United States, and manufactures nearly 600 chemical products. The rapid increase in world demand for these products after 1940 was not a sufficient explanation of the growth of this industrial complex in the GBA. Equal attention must be given to the Area's local abundance of all the major natural resource inputs needed by these chemical, petrochemical, and refining industries.

Foremost among these natural resources was crude oil, which has been produced in the study area since 1902, with over 300 oil fields having been discovered within the eight counties. Evidence that the Area possessed an abundant supply of crude oil throughout the period under study in this report comes from the fact that all of the Area's 16 "giant" oil fields, those estimated to have recoverable reserves of over 100 million barrels, were discovered before 1940. In addition to these local supplies, GBA plants were able to draw on crude oil supplies from throughout the rest of Texas and the Gulf Coast.

While they have only recently become a prime feedstock for the chemical plants, natural gas and natural gas liquids were abundant throughout the period under study. Katy Field in Waller County is the nation's third largest natural gas field. The Katy, Old Ocean, and Chocolate Bayou fields each contained over one trillion cubic feet of gas, and they all were discovered before 1940. In addition, the Area also was able to draw on the hinterland's supplies of natural gas and natural gas liquids.

Sulfur is another essential mineral for chemical processing plants. The Texas and Louisiana coasts, where sulfur is found in large salt domes, are the major sources of sulfur in the U.S. A relatively small amount of sulfur was recovered from sour gas produced by petroleum refineries. Most of this sulfur, in the GBA as elsewhere, was used to make sulfuric acid, an essential ingredient in the manufacture of fertilizers and industrial chemicals.

Water, a fourth resource needed by chemical, petrochemical and refining industries, also is available in large quantities in the GBA. Over the study period, the production and refining of crude oil required large amounts of seawater, and both of these activities as well as chemical processing used substantial supplies of fresh water. Refineries alone consume an average of 30 gallons of water for each barrel of crude oil processed. The above industries made additional use of water in the Frasch process of sulfur production and for transportation. During the development of these industries, the Gulf of Mexico was a ready source of seawater; the Trinity, San Jacinto, and Brazos rivers supplied surface water; and a large aquifer underlying much of the GBA supplied ground water.

Other locally available minerals needed by the chemical, petrochemical, and refining industries in their development were lime, salt, magnesium compounds, and bromine. Lime was available from oyster shell in Galveston Bay, and this reef shell also was used to produce soda ash. Local salt domes provided a virtually unlimited supply of salt, and seawater was a source of magnesium compounds and bromine.

Transportation

A second vital "permissive factor" in the economic development of the GBA between 1940 and 1968 was the outstanding transportation resources of the Area. These were partly gifts of nature—rivers and harbors—and partly the product of human effort. Among the latter, the pipeline network which grew during the study period was an instrumental factor in the building of the chemical, petrochemical, and refining industries. It was primarily these pipelines which gave the Area access to the crude oil, natural gas, and natural gas liquids of the hinterland as well as access to markets. By 1968 forty crude-oil pipelines and twenty-nine product pipelines served the GBA.

In the development of the Area's primary metals industry, these transportation resources again provided access to essential natural resources as illustrated by Armco's Houston Works. This plant's blast furnace and open-hearth and electric furnaces used iron ore which came by ship from Labrador. Barges and railroads brought coal from Alabama, Oklahoma, and West Virginia. Railroads also brought limestone from Central Texas quarries and, along with highway transportation, brought iron and steel scrap from nearby areas. Finally pipelines brought oil and gas for fuel. Thus, although the GBA lacked many of the natural resources and other inputs required for primary metals industry, the Area's transportation resources enabled it to overcome these deficiencies.

In addition to the already mentioned pipeline network, the transportation resources of the Area included four deep water ports: Houston, Galveston, Texas City, and Freeport. The Intracoastal Canal provided protected access by water for barge movements. Six major rail systems, highways, and airlines also served the Area's transportation needs.

Technology

A given area's comparative advantage in producing any product depends heavily on the value placed on that area's assets by current production methods. As noted in Chapter III, technological changes may occur which increase the value of being close to the market or, alternatively, increase the value of being near the source of raw materials. These technological changes constitute a third supply factor which may affect economic development.

At about the same point in history as this study picks up the story of the GBA, changes in the technology of oil refining along with changes in the industry's market structure were altering the relative values placed on different locational factors by refiners. Because before the 1940's a large proportion of refinery output had no known economic value, a refinery's marketable products weighed considerably less than its crude oil inputs. Consequently refineries located near sources of crude to minimize transportation costs. Supporting this locational characteristic was the lack of markets large enough to absorb the entire output of refineries operating at a scale which minimized average total costs. Under

these conditions the natural and transportation resources of the GBA made it a profitable location for refineries.

During and shortly after World War II, production technology developed new uses for previously discarded by-products of refining, thereby reducing the weight-loss in crude processing. Since it was considerably cheaper to ship crude oil than it was to ship a great variety of finished products, market locations became more attractive. At about the same time, regional markets for petroleum products were growing large enough to consume the entire output of refineries operating at maximum efficiency.

As a result of this transition of refining from a resource-oriented to a market-oriented industry, the GBA lost some of its attraction for refiners based on the local availability of resources. But in the 1940's, the petrochemical complex in the Area was providing a rapidly growing market for the output of local refineries, and this demand led to the continued expansion of refineries in the study area.

Had it not been for the new local market created by the developing petrochemical industry, these technological changes, even without the complementary effects of the market changes, surely would have resulted in at least a slowing of the growth of GBA refining activity. This example illustrates the perils to an understanding of economic development inherent in an approach which concentrates exclusively on changes in external demand. Chapter III points out that technological changes in production processes also may lead to increases in an area's export sales independently of any change in aggregate external demand.

Availability of locally made inputs

Addressing the issue of what is the most meaningful definition of basic employment, Chapter IV attempts to measure some of the more direct linkages between GBA exporters and local producers of their intermediate products. Another important consideration regarding the local availability of these intermediate products is that they may act as catalysts of export sales and growth. New export establishments may come to an area to be near a source of these intermediate products.

In addition, growth in an area may be the result of an increase in local production of intermediate goods for local exporters. This is the second aspect of the linkages problem raised in Chapter III. The third aspect is that some observers feel, since many exporters are completely dependent on the local availability of intermediate products, that it is more meaningful to view the extent of these linkages as the independent variable determining the level of export sales.

The history of the development of the chemical, petrochemical, and refining industries in the GBA also provides illustrations of these factors in economic growth. The above discussion of changing locational patterns in the refining industry points out that refineries grew in the GBA during and after the 1940's in order to supply intermediate products to the developing petrochemical complex. This is a classic example of economic growth resulting from an increase in local production of intermediate goods for local exporters.

It is also true that many plants in these industries, whose markets lay outside the GBA, came to the study area to take advantage of the ready availability of intermediate chemical products. The pipeline network mentioned in the previous discussion of transportation resources played a key role in enhancing this availability. By the end of the

study period, this network had grown to over 1,000 miles of pipeline connecting 10 upper Texas Gulf Coast refineries, 69 chemical plants, 5 gasoline processing plants, and 8 salt domes from Beaumont to Victoria. The fact that most sales of chemicals and petrochemicals were to other manufacturers of these products also reflects the highly interdependent nature of these industries.

Thus, in the GBA, while the level of intermediate production of petrochemical and other chemical products depended on the level of exports by establishments using these inputs, the level of exports also depended on the local availability of petrochemical and other chemical products. There is no unequivocal answer to the question of which was the dependent and which was the independent variable.

Other Independent Variables

Among other variables which are largely independent of the current level of export sales, Chapter III lists consumer investments in housing and business investments in plant and equipment The chapter also points out that both types of investment often reflect a flow of external funds into the area. But historical statistics are not available for the GBA on the value of local purchases of goods and services for investment purposes which were paid for with external capital. If these estimates were available, they should be added to total basic activity, for these external funds also have a multiplied impact on the local economy.

Nevertheless, new investment in an area would soon dry up if that area were not economically healthy. If, as asserted by economic base theory, the economic health of an area depends primarily on the level of its exports, then investment also depends indirectly on the level of exports. This is most evident in consumer investment in housing. Without incomes deriving either directly or indirectly from export sales, consumers would be unable to make house payments and support the local housing industry.

The situation with business investment is not as direct as the one with consumer investment. Instead of depending so closely on current exports, business investment depends more on potential exports. As long as demand continued to grow for chemical products and interest rates were low enough to make investment profitable, new chemical processing plants continued to be built. They were built in the GBA because the area maintained its comparative advantage in the production of chemicals for export. Thus, once again, it was the export base which was the prime determinant of local business investment in the long run.

Chapter VI

SUMMARY AND PROJECTIONS

Economic Base Analysis

The examination of economic base theory and its relevance to the recent economic history of the Galveston Bay Area (GBA) leads to the conclusion that the theory should be used as a framework for analysis rather than as a mechanical tool. Each step in the application of economic base theory requires judgment, but the ease with which the theory can be expanded to include diverse new variables gives it value as a framework for analysis. The results achieved when using the theory in this role appear to justify the relatively low cost of generating the required data inputs.

One factor weighing against a mechanical approach to the application of the theory is the absence of a single unit of measurement which works best in all situations. When choosing a unit of measurement, the analyst must consider its comprehensiveness, comparability if used in a time series, and availability. Chapter I shows that income is the most comprehensive unit of measurement, but this unit runs into problems with price level changes when used in a time series. In addition, data on income are not readily available. On the other hand, employment figures are easy to compile and do not depend on price levels; but they measure only one of the factors of production.

Nor is there a single indirect technique which gives the best estimates of basic employment in all industries. The choice of techniques depends on the unique characteristics of the study area as well as on theoretical considerations. Thus, the choice of the assumption approach to measure basic employment in manufacturing rests partly on the prior knowledge that this industry has long had extensive internal linkages in the GBA. The choice also rests partly on the theoretical considerations that both of the alternative indirect techniques implicitly assume that urban areas do not export a product and import it at the same time and that all manufacturing will be for the local market until total activity in manufacturing exceeds a critical minimum level.

On the positive side, economic base theory provides a useful classification system for data on economic activity by viewing all economic activity as either basic on nonbasic. This system has value because, as shown in Chapter II, the ratio between these two types of economic activity exhibits a certain amount of stability. This limited variation also justifies the effort required to develop basic activity multipliers.

Chapter III develops four major areas of theoretical shortcomings for economic base theory: linkages, characteristics of the population, supply factors, and additional autonomous variables. In its most fundamental formulation, economic base theory tends to overlook these factors. The first of them, linkages, raises questions about exactly what should be included in basic employment, provides a potentially independent source of growth, and sometimes seems to be the major independent variable determining the level of export sales. Population characteristics, such as the local ratio of males to females and per

capita income, influence base-service ratios and export multipliers. Supply factors determine how a region responds to the existence of an external demand for its exports. Finally, numerous other autonomous variables in addition to basic activity may cause changes in the level of total economic activity.

But in discussing how these factors in the GBA have affected the extent of basic activity as well as its measurement and the size of basic activity multipliers, Chapters IV and V also are showing how economic base theory can be adapted to take account of these factors. Chapter IV examines the "direct linkages" of major GBA export "industry groups" and develops the concept of "secondary-basic" employment to take account of them. This expansion of the traditional economic base theory definition of basic employment enables the theory to incorporate this factor in its representation of the economic development process and makes possible the development of rough industry multipliers.

In Chapter V the treatment of population characteristics and the extent of local linkages shows that these variables can be incorporated into economic base theory by treating them as determinants of the size of basic activity multipliers. Supply factors, in turn, may be viewed as determinants of basic activity. Finally, Chapter III shows that investment also acts as an independent variable, and Chapter V demonstrates that most investment, like "secondary-basic" activity, can be fitted into the economic base concept of development as a component of basic activity.

This versatility means that, while fundamental economic base theory is valuable in organizing data and getting an initial grip on the economic development process, the theory does not limit the scope of subsequent investigation. These attributes are highly desirable in a framework for analysis.

Projections

Because of these considerations, the following summary of projections of economic activity in the GBA are organized along the lines of the economic base framework. Employment is used as the unit of measurement because it facilitates relating the projections to the foregoing historical analysis and because, as noted in Chapter I, employment appears to be the most meaningful measure when population projections are being sought.

The first major input to the following projections of economic activity is the study of the evolving GBA economic base between 1940 and 1968 (Chapter II). Table 17 converts the estimates of basic employment from Table 6 into compound annual growth rates over the three historical periods covered in Chapter II.

Detailed analyses of local industries, population, labor force, and geography comprise the second major input to the projections of economic activity in the GBA. These analyses, made by specialists on the subjects, comprise the appendix sections to this report. While their orientation is toward an assessment of past and probable future trends rather than toward an evaluation of the impact of these trends on the economic base of the GBA, Chapters IV and V illustrate the way in which these trends are incorporated into the economic base framework in making projections.

Assumptions about the future course of the national economy form the third major input to the projections of economic activity in the GBA. Knowledge of local conditions alone is not sufficient as a basis for predictions of economic development, especially in an

Table 17

GALVESTON BAY AREA BASIC EMPLOYMENT
GROWTH RATES, 1940-1968

Industrial category	1940-1950	1950-1960	1960-1968
Agriculture, forestry, and fisheries	– 5.3	– 4.6	– 67.4
Mining and manufacturing	5.9	3.5	2.9
Construction	9.1	– 4.6	19.5
Transportation and utilities	3.7	– 0.2	3.6
Trade	2.5	1.9	9.6
Finance, insurance, and real estate	4.9	5.9	5.4
Services	– 1.1	5.6	3.9
Government	3.3	1.7	11.8

area as small as the GBA. Economic base theory explains growth in terms of export sales, and assumptions must be made about the future course of the national economy in order to forecast GBA export sales.

It is assumed that major wars will be averted. It is also assumed that through judicious use of monetary and fiscal policies the federal government will be able to bring inflation under control, to avoid severe recessions, and to foster an annual growth rate of production of around 3.5 percent. Although output per man-hour rose at an average rate of 3.6 percent a year during the 1960's, this growth should slow somewhat as the United States shifts from a manufacturing to a service economy. It is also assumed that automation, management efficiency, personal income, and employment will continue their rapid increases, that the labor force will become better educated, and that the workweek will decline gradually.

Numerous groups recently have been engaged in examining the prospects for the national economy over the next several decades. In addition to being representative of most current thinking, the most comprehensive and useful specific forecasts of national economic development are those by Herman Kahn and Anthony J. Wiener in their book *The Year 2000.*[1] Their projections of employment increases are expressed in Table 18 as compound growth rates. Except for agriculture, the Kahn and Wiener predictions are assumed to reflect changes in national patterns of demand and productivity which will influence the GBA economy.

To put these national economic projections in perspective, it is necessary to look at the recent economic history of both the nation and the GBA. Historical employment totals for the United States and the GBA, using the same industrial groupings as Kahn and Wiener, are shown in Table 19. These totals for the United States are converted into compound growth rates in Table 20, and the same is done for GBA totals in Table 21.

Labor force

As unemployment in the GBA is currently at a very low level, any large-scale increases in the demand for workers will have to be supplied either through increased participation in the labor force by the population or through immigration. Since virtually all qualified males already have jobs, most increases in participation in the labor force by the population will have to be the result of more females seeking employment. Chapter V shows that this has been occurring in recent years, and it also argues that this trend puts upward pressure on the base multiplier. Workers immigrating to the study area to fill new jobs should tend to be the type in demand by local industry; otherwise they may not be able to find employment. The appendix sections to this report conclude that prospective growth of basic industries in the GBA should be primarily in those industries which will require well-educated or highly skilled employees who will be able to command relatively high wages and salaries. This will cause per capita income to rise and, as shown in Chapter III, may put downward pressure on the base multiplier.

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[1]Herman Kahn and Anthony J. Wiener, *The Year 2000* (New York: The Macmillan Company, 1967).

Table 18

PROJECTED U.S. TOTAL EMPLOYMENT GROWTH RATES, 1965-2000

Industrial category	1965-1985	1985-2000
Agriculture	—	—
Mining and manufacturing	0.8	0.8
Construction	2.2	1.9
Transportation and utilities	1.1	1.1
Trade	3.4	2.5
Finance and real estate	2.2	1.7
Services	4.7	2.9
Government	1.0	1.2

Source: Herman Kahn and Anthony J. Wiener. *The Year 2000.* New York: The Macmillan Company, 1967. p. 176.

Table 19

UNITED STATES AND GALVESTON BAY AREA TOTAL EMPLOYMENT, 1940-1968

Industrial category	United States (millions)				Galveston Bay Area			
	1940	1950	1960	1968	1940	1950	1960	1968[a]
Mining and manufacturing	13.5	15.1	17.1	20.4	61,598	103,107	140,692	175,995
Construction	2.3	3.3	3.6	3.4	19,539	40,998	44,103	76,865
Transportation and utilities	3.5	4.3	4.3	4.4	30,777	45,201	53,531	72,310
Trade	8.5	10.2	11.1	14.1	58,075	92,308	123,070	194,595
Finance, insurance, and real estate	1.7	1.9	2.6	3.4	11,229	17,581	27,989	40,525
Services	8.0	7.8	9.6	10.7	68,576	73,373	103,613	148,537
Government	3.4	4.4	6.2	11.8	–	25,295	45,643	86,385

[a]Primary estimates except for government employment, which represents the Texas Employment Commission estimate for the Houston and Galveston-Texas City SMSA's.

Source: U.S. Bureau of the Census, except as otherwise noted.

Table 20

U.S. TOTAL EMPLOYMENT GROWTH RATES
1940-1968

Industrial category	1940-1950	1950-1960	1960-1968
Agriculture, forestry, and fisheries	– 1.9	– 4.8	n.a.
Mining and manufacturing	1.0	1.3	2.2
Construction	3.7	0.9	– 0.7
Transportation and utilities	2.1	0.0	0.3
Trade	1.8	0.9	3.0
Finance, insurance, and real estate	1.1	3.2	3.4
Services	– 0.3	2.1	1.4
Government	2.6	3.5	8.4

n.a. Not available.
Source: U.S. Bureau of the Census.

Table 21

GALVESTON BAY AREA TOTAL EMPLOYMENT GROWTH RATES, 1940-1968

Industrial category	1940-1950	1950-1960	1960-1968
Agriculture, forestry, and fisheries	– 3.9	– 1.7	– 12.4
Mining and manufacturing	5.3	3.2	2.8
Construction	7.7	0.7	7.2
Transportation and utilities	3.9	1.7	3.8
Trade	4.8	2.9	5.9
Finance, insurance, and real estate	4.6	4.8	4.7
Services	0.7	3.5	4.6
Government	–	6.1	8.3

Source: U.S. Bureau of the Census.

Summary of basic and total employment changes

Using annual compound percentage growth rates of basic employment for the periods under analysis, Table 22 summarizes this report's projections of basic employment. The first step in estimating future overall basic employment was to project changes in that component producing goods and services to be sold to nonresidents. Figures for this part of overall basic employment, known as "primary-basic," were derived by combining anticipated external demand conditions with local supply factors. "Secondary-basic" employment constitutes the second component of projected overall basic employment, and the figures for "primary-basic" employment were inflated to reflect direct local linkages of GBA exporters over the study years.[2] Finally, to arrive at projections of total basic employment, the sum of "primary-basic" and "secondary-basic" employment was inflated to take account of additional autonomous variables likely to bring new money into the Area: consumer investments in housing, business investment in plant and equipment, and external-government expenditures.[3]

Table 22 indicates that basic employment in the GBA will increase rapidly in the immediate future but that the growth rate will decline in the long run. Several considerations underlie this profile. External demand for Area exports should expand quickly in the next twenty years, but beyond that sources of demand are difficult to pinpoint. Also, as total basic employment grows, it will take ever-larger absolute increases in basic employment each year just to maintain a constant growth rate. Current developments point toward greatly increased linkages in the next decade or two between exporters and local producers of their intermediate goods, with linkages themselves acting as an independent variable.[4] But there will be a gradual reduction in opportunities for the production of new types of intermediate products as the list of those already available locally grows. The falling growth rate for these components of basic employment, in turn, should lead to a leveling off of the flow of external funds into the GBA for investment purposes.

Table 23 presents this study's conclusions regarding the overall growth rate of employment in each of the eight industry groups after the addition of nonbasic employment to the estimates of total basic employment underlying Table 22. Instead of summing total basic employment and then using a single export multiplier to relate total basic employment to total employment, this study allocates service employment among the industry groups of Table 23, for it is felt that this detail provides valuable insights into the probable character of GBA growth.

Agriculture, forestry, and fisheries

A comparison of Tables 20 and 21 reveals that the trend of GBA employment in agriculture, forestry, and fisheries has conformed to the national decline in employment in this industry group since 1940. When Table 17 is set against Table 21, it is apparent that

[2]See Chapters III and IV.

[3]See Chapters III and V.

[4]See Chapter III.

Table 22

PROJECTED GALVESTON BAY AREA BASIC EMPLOYMENT GROWTH RATES, 1968-2020

Industrial category	1968-1990	1990-2000	2000-2020
Agriculture, forestry, and fisheries	0.0	0.0	0.0
Mining and manufacturing	2.2	1.9	1.4
Construction	3.7	2.9	2.5
Transportation and utilities	1.1	1.0	1.0
Trade	3.7	2.7	2.3
Finance, insurance, and real estate	3.0	2.8	2.1
Services	4.6	3.0	2.7
Government	0.5	0.5	0.5

Table 23

PROJECTED GALVESTON BAY AREA TOTAL EMPLOYMENT GROWTH RATES, 1968-2020

Industrial category	1968-1990	1990-2000	2000-2020
Agriculture, forestry, and fisheries	− 1.2	− 1.0	− 1.0
Mining and manufacturing	1.7	1.8	1.4
Construction	3.5	2.7	2.3
Transportation and utilities	1.4	1.3	1.3
Trade	3.9	2.9	2.4
Finance, insurance, and real estate	2.8	2.7	1.9
Services	4.9	3.2	2.9
Government	0.9	0.9	0.9

basic employment in the industry group has been declining even more rapidly than total employment. The appendix sections to this report conclude that employment in agriculture, forestry, and fisheries should continue to decline over the next fifty years in the GBA but at a lower rate of decrease than in recent years. The decline in agriculture and forestry will result primarily from urbanization, which is removing land from agricultural use, and also from conversion of land to recreational uses. Cotton and sorghum cultivation should experience moderate declines, while truck and greenhouse farming should continue to expand. Such increases in land-intensive farming will tend to stabilize agricultural employment, though it will still decline. The fishing industry will be affected by human alteration of the physical structure of Galveston Bay and other bays and lagoons which form the Galveston Bay estuarine system.

Although Chapter II concedes that there was some basic employment in this industry group, Table 6 indicates that there was no local basic employment during 1968 in agriculture, forestry, and fisheries. However, as explained in Chapter II, the minimum requirements technique which gives the zero estimate of basic employment still appears to be the best indirect technique for estimating basic employment in the industry group. Since the appendix sections of this report indicate that there should be no aggregate increases in basic employment in this industry over the next fifty years and since the benchmark figures for 1968 basic employment used by this study show zero basic employment, Table 22 projects no change in basic employment in the industry. Negative growth rates for total employment in agriculture, forestry, and fisheries over the entire projection period, shown in Table 23, reflect the conclusion, indicated in the appendix sections, that employment in this industry group should continue to decline although at a rate considerably slower than that experienced since 1940.

Mining and manufacturing

The preceding tables indicate that GBA employment in mining and manufacturing has been growing more rapidly than employment in these industries for the nation as a whole during most of the years since 1940. The fact that the basic employment component of total local employment in the industries has tended to grow faster than total local employment in mining and manufacturing means that the industries have become increasingly export oriented. Particular interest attaches to the years between 1960 and 1968 because during these years the total local employment growth rate fell below the nation's growth rate in the industries, and the GBA's basic employment growth rate fell to a level equal to the growth rate of total local employment in the industries.

One of the major conclusions of the appendix sections to this report is that refining, inorganic chemical, and petrochemical industries will be among the leaders of a rapidly expanding manufacturing complex in the GBA over the next fifty years.[5] This prediction assumes that the Area will continue to enjoy relatively cheap availability of many chemical and petrochemical inputs, with crude oil increasingly coming from offshore wells or from foreign sources.[6] Local mining firms should prosper from this demand for inputs as well as

[5]See Chapter V for a resume of the historical importance of supply factors and of technological changes in production techniques to these industries in the GBA.

[6]Evidence continues to accumulate indicating that offshore operations will provide a vast new supply of oil. In particular, see Frank J. Gardner, "Huge Offshore Growth Set for 1970's," *Oil and Gas Journal*, 68, No. 11 (March 16, 1970), 123-135.

from export sales. It also is assumed that since the GBA firms in these industries are among the largest in the world; they will be able to afford extensive research and development activities and can keep unit production costs at a minimum. A third assumption is that more efficient transport should lessen the Area's current disadvantage of being distant from major U.S. market areas. Finally, it is assumed that local markets from other firms in these industries as well as local consumer markets and national markets for these products will expand rapidly.

Export sales by mining industries as well as by refining, chemical, and petrochemical industries will have exceptionally large impacts on the local economy because these industries have large "primary-basic" employment multipliers (Table 14). The "primary-basic" employment multiplier for gas, oil, and mineral producers is about 3.8, and the "primary-basic" employment multiplier for petroleum refineries and chemicals manufacturers is about 5.0. Both industries purchase large amounts of intermediate products locally. As a result, their growth will be accompanied by growth throughout much of the rest of the local economy.

Primary and fabricated metals manufacturing industries also should be in the forefront of the anticipated rapid expansion of the GBA manufacturing complex. The locational advantage of metal-using plants in the Area should improve with the growth of local primary metal producers. Additionally, developments in the oilfield equipment industry will favor large-scale producers. Since the GBA is the home of the world's largest manufacturers of oilfield equipment, this segment of the industry should experience additional increases in its comparative advantage. Otherwise, relative national and regional supply conditions may show little change. Increasing demand within the Gulf Southwest, however, should stimulate rapid expansion in these industries.

Manufacturers of primary metals and fabricated metal products have a moderately large "primary-basic" employment multiplier (Table 14). The value of this multiplier is 3.1 both for the oilfield machinery and equipment manufacturers and for producers of primary metals and fabricated metal products. Thus the primary and fabricated metal products industries are major consumers of locally made intermediate products.

Food and kindred products manufacturing also is expected to grow rapidly in the GBA over the next fifty years. Underlying this growth will be the expanding regional market, relatively inexpensive transportation, and easy access to raw materials. Since the food group has a "primary-basic" employment multiplier of 3.2 (Table 14), its exports also will have a substantial impact on the local economy.

The production of paper and allied products should expand for several reasons. The Area will have a large demand for such products; it is adjacent to fibrous raw materials from the East Texas Piney Woods region and should have an adequate supply of water. Also the Area will have an abundant supply of low-cost fuel in natural gas. Printing and publishing should grow primarily to serve the needs of local industry and residents. Additional growth can be expected, too, in stone, clay, and glass manufacturing and in transportation equipment manufacturing.

On the other hand, apparel and related products manufacturing probably will continue to decline. The Area is well removed from wholesale clothing markets and lacks the requisite supply of low-cost unskilled or semiskilled labor. The latter factor also will militate against the growth of textile mill products manufacturing.

On balance, the appendix sections to this report indicate that external demand should grow rapidly over the coming years for many of the mining and manufacturing industries already well established in the GBA, and comparative cost considerations lead to

the conclusion that local firms should prosper as a result. In addition, prospects appear favorable for the appearance of new exports ranging from electronic components to oceanographic research tools. Such developments as these will lead to considerable growth in the "primary-basic" component of total basic employment.

Also contributing to the high growth rate forecast for basic employment is the tendency of local exporters to buy large quantities of their intermediate products from GBA mining and manufacturing firms. Chapter IV argues that the resulting "secondary-basic" employment should be included in total basic employment, and the projections of Table 22 are based on this approach. Table 12 estimates that in 1968 over 28,000 "secondary-basic" employees in mining and manufacturing were producing intermediate goods to be used in the production of exports by the eight "industry groups" under study. The appendix sections to this report indicate that these local direct linkages should continue to grow over the next half century.

The probable continued development of the GBA as an office metropolis constitutes a third factor underlying the projections of basic employment in mining and manufacturing shown in Table 22. National firms in these industries recently have been moving more of their administrative operations into the study area, the most notable cases being Humble Oil and Refining Company, Tenneco, and Shell Oil Company. Executives of these and other firms are well satisfied with the GBA as an administrative center largely because their employees enjoy living in an area with a mild climate and extensive recreational facilities and with a relatively low cost of living. The growing number of administrative offices will create a demand large enough to justify local provision of more support activities such as legal and financial services. These in turn will serve to attract more administrative installations. Such considerations as these indicate that the GBA will experience very rapid expansion in its role as an administrative center for American industry.

While a growing local market will stimulate increased production for sale to Area residents, the growth prospects for this component of the total output of mining and manufacturing firms are not as good as for exports. Consequently the growth rate for basic employment (Table 22) should once again exceed that for total employment (Table 23) in GBA mining and manufacturing over this study's projection period. Thus the industries will continue to become more export oriented. Because the industries in which the GBA enjoys its largest comparative advantages are forecasted to be the industries which will experience some of the highest growth rates over the next fifty years, the GBA growth rate should be considerably faster than that expected in the nation as a whole for employment in mining and manufacturing (Table 18).

Construction

The composite technique for estimating basic employment, developed in Chapter II, uses the location quotient or surplus worker technique to measure basic employment in contract construction because, as explained in Chapter IV, this indirect technique yields estimates closest to the 1968 mail survey figures for total basic employment. However, these estimates admittedly do not include construction activity supported by capital flows into the GBA.[7] In developing the Table 22 projections of basic employment changes in

[7]See Chapter II for criticism of the assumption approach.

construction, an attempt was made to correct this deficiency of the composite technique and include all anticipated employment which will be supported by capital flows into the Area: construction workers selling their services directly to nonresidents, those producing intermediate products for local exporters, and those building locally but being paid with funds coming from outside the GBA.

Looking at the first of these three components of basic employment in construction, local construction firms should continue to expand their operations outside the GBA. The study area already contains headquarters for many of the Southwest's largest and most experienced general contractors, and the rapid economic development expected throughout much of the Southwest will generate a growing demand for their services. In addition, as evidenced by the recent M. W. Kellogg Company announcement of plans to move its home offices to Houston, the Area is continuing to become even more of a world headquarters for firms specializing in building plants for the refining and chemical processing industries.

The rapid expansion of Area exports forecasted by this report will require the erection of large amounts of new plant capacity. The second component of anticipated basic employment increases in construction arises from the decision to treat this output of new plants as an intermediate product in the production of exports and to treat the workers who will build the new facilities as part of "secondary-basic" employment. Table 12 estimates that in 1968 there was a total of more than 30,000 such "secondary-basic" employees in contract construction building intermediate products for the eight GBA "industry groups" judged to be the major exporters.

A third component of basic employment in construction overlaps the second somewhat. Construction workers who are viewed as part of basic employment because they produce intermediate products for exporters often may be viewed as basic for another reason; they may be paid with money coming from outside the study area. Chapter III notes that this is a common characteristic of the construction of buildings for business and also of the construction of housing for consumers. It is the conclusion of this study that the rapid economic growth of the GBA over the study period will entail business investments in plants and consumer investments in housing which will be too large to be financed through locally generated savings. The high mobility of capital makes it likely that funds will come from external sources. Consequently this third component also points toward rapid increases in basic employment in construction.

Overall employment in construction is not expected to grow quite as rapidly as the basic component. This relationship between the relative growth rates existed in the GBA between 1940 and 1950 and again between 1960 and 1968, the periods of the Area's most rapid growth.[8] The tendency for external capital to flow into construction in an area experiencing rapid economic development is a likely explanation for the historical relationship between these growth rates and is the major factor accounting for the disparity between projected basic and total employment growth rates. While there is virtually no limit to the quantity of external funds which can flow into an area to support basic activity in construction, the growth rate of the nonbasic component is limited by the ability of the local level of income to generate savings.

[8]See Tables 17 and 21.

Transportation and utilities

The transportation and utilities industries in the GBA will expand to meet the needs of the growing local economy. The better their services, the more industry they will attract to the Area. With low-cost natural gas and gas-based energy sources, local utilities should be particularly successful in attracting new industry. External sales by transportation companies will have a strong impact on the Area economy, for this industry has a "primary-basic" employment multiplier of about 2.3 (Table 14).

A comparison of Tables 17 and 21 reveals that total local employment in transportation and utilities consistently has grown faster than basic employment in the same industries since 1940. As the importance of the GBA as a manufacturing center increasingly has overshadowed its importance as a transportation center, the Area's transportation industry has grown more in response to the needs of local industry than in response to the needs of external industry.[9] The result has been a higher growth rate for service employment than for basic employment in transportation. At the same time, the GBA has been growing faster than its hinterland, the major external market for GBA utilities. As a consequence, nonbasic employment in the utilities has grown faster than basic employment. Both of these trends should continue over the projection period of this report and cause total employment in transportation and utilities to grow faster than its basic segment.

Trade and services

Although the trade and service industries are treated separately in the tables in this chapter, it is appropriate to discuss them in conjunction for they respond to many of the same influences. Over the period from 1940 to 1968 both industries saw their basic employment growth rates overtake their relatively high total employment growth rates.[10] These extremely high growth rates for basic employment were partly the result of increased visitation in the GBA by nonresidents and the consequent increased sales to visitors. Expanding business activity drew more businessmen to the Area, outstanding meeting and exhibit facilities combined with rapidly improving hotel and motel accommodations drew more conventions, and the recreational resources drew a growing number of vacationers. Table 14 estimates that the "primary-basic" employment multiplier for tourist-oriented trade and services was 2.3 in 1968, which indicates that sales to visitors by these industries have considerable impact on the local economy.

Direct linkages to GBA exporters also were a key factor underlying the rapid basic-employment increases in trade and services. These industries were a major source of intermediate goods and services used in the production of the rapidly rising volume of Area exports. An indication of the trade and services industries' importance as suppliers of intermediate goods and services appears in Table 12. Out of the 1968 total of 147,837 "secondary-basic" employees making intermediate products for export by the eight selected "industry groups," nearly 50 percent worked for the trade and service industries.

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[9]See Chapter V for a discussion of GBA transportation resources as a "permissive factor" in the Area's economic growth.

[10]See Tables 17 and 21.

As shown in this chapter and in the appendix sections, the "industry groups" listed in Table 12 all show extremely good prospects for future growth of their export sales. The "primary-basic" employment multipliers for these "industry groups" in Table 14 highlight the probability that increases in basic employment in these "industry groups" will be accompanied by large increases in "secondary-basic" employment. The 1968 distribution of "secondary-basic" employment shown in Table 12 suggests that approximately one-half these increases in "secondary-basic" employment will occur in the trade and services industries.[11]

The likelihood of the continued growth of the GBA as an administrative center for American industry will lead to large increases in "secondary-basic" employment in services, for these administrative operations will require a wide range of locally produced services. Such services constitute an intermediate component in the production of the export service, administration. Other available evidence also indicates that basic employment in trade and services should continue to grow rapidly in the GBA over the projection period. The factors listed above in explanation of past increases in visitation to the Area by nonresidents should continue to be important in the future. Finally, improved transportation facilities and an expanding regional market should lead to more exports by Area wholesalers.[12]

A comparison of Table 22 and Table 23 points to the conclusion that nonbasic employment should once again grow faster than basic employment in the GBA trade and service industries. Although the factors listed above will lead to large increases in basic employment, changes in local market conditions should cause even more rapid increases in nonbasic employment. As outlined in this chapter, the appendix sections to this report conclude that basic employment will grow rapidly throughout much of the GBA economy, and, largely because this growth will be concentrated in high-wage industries, per capita income will swell. Both of these developments will cause large increases in the local demand for the output of GBA trade and service industries, and this demand will be supplemented by increased sales to other local producers selling within the study area. Employment in services should grow faster than that in trade because as per capita income rises consumers tend to increase their purchases of services faster than their purchases of consumer goods.

Finance, insurance, and real estate

Finance, insurance, and real estate also are service activities which sell primarily to local industry and residents and depend on the overall expansion of the local economy for their growth. However, banks and savings and loan associations have key roles in retaining funds within the Area, and banking is becoming an increasingly important source of external funds through the export of banking services and through the attraction of deposits from nonresidents. Good prospects for economic growth in the study area presage moderate

[11]While it appears that "secondary-basic" employment will have the largest impact on total basic employment in the trade and services industries, similar considerations underlie the Table 22 projections of basic employment in other industries. As indicated in Table 13, "secondary-basic" employment also should be particularly important in determining total basic employment in contract construction, manufacturing, and mining.

[12]As noted in Chapter IV, this study treats local private aerospace companies' employees as part of basic employment in the wholesale trade industry. The following discussion of government employment outlines this study's assumptions about the prospects for this segment of basic employment in wholesale trade.

increases of activity in finance, insurance, and real estate. As growth of local financial institutions enables them to increase the range of their services and as the GBA increasingly becomes the regional financial center, these institutions should become even more important as a source of external funds.

Government

Local residents who work for external governments constitute basic employment in government, for they are paid out of tax revenue collected mostly from outside the Area.[13] Recent rapid increases in this component of total GBA employment in government have been largely the result of the establishment of the Manned Spacecraft Center. While it appears unlikely that the Center will continue to be expanded at anything like the rate of recent years, the nation's space program should gradually expand over the years even though there may be temporary absolute reductions in spending. As a result, it will be necessary to enlarge the command capabilities of the GBA installation. The private aerospace companies, in turn, should respond by continuing to grow locally but at a greatly reduced rate. Whatever employment increases do occur in government space programs and private aerospace companies may be expected to have very large impacts on the local economy because these activities have a "primary-basic" employment multiplier of about 4.9 (Table 14).

Other federal and state activity also should grow as the scope of administrative functions expands and as the growth of the GBA creates a need for more administrators in both levels of government. Nonbasic employment, however, should grow faster than basic, for it has been the experience of most urban areas that the need for local government services (e.g., education, law enforcement, transportation) has grown faster than the need for external government services. The quality of these government services, especially education, will be a prime determinant of the GBA's attractiveness to new industry.

Multipliers and base-service ratios

Tables 24 and 25 convert the growth rates of Tables 22 and 23, respectively, into absolute employment numbers in the reference years of 1990, 2000, and 2020. These latter figures indicate that the multiplier will increase slowly in the coming years: from 2.4 between 1968 and 1990, to 2.5 between 1990 and 2000, to 2.6 between 2000 and 2020. This will be the result primarily of the GBA's gradually becoming more self-sufficient as it grows in size.

Population

In order to convert employment figures into population figures for the forecast years, it is necessary to project the population/labor-force ratio. This ratio was 2.7 in 1960,

[13]See Chapter II for discussion of additional autonomous variables.

Table 24

GALVESTON BAY AREA BASIC EMPLOYMENT, 1968, PROJECTED TO 1990, 2000, AND 2020

(Thousands)

Industrial category	1968	1990	2000	2020
Agriculture, forestry, and fisheries	0	0	0	0
Mining and manufacturing	153.0	246.9	298.0	393.6
Construction	40.1	89.1	118.6	194.3
Transportation and utilities	32.6	41.5	45.8	55.9
Trade	34.6	76.9	100.4	158.3
Finance, insurance, and real estate	22.0	42.1	55.5	82.4
Services	64.1	172.3	231.6	394.5
Government	10.0	11.2	11.7	13.0
Total	356.4	680.0	861.6	1,292.0

Table 25

GALVESTON BAY AREA EMPLOYMENT, 1968,
PROJECTED TO 1990, 2000, AND 2020

(Thousands)

Industrial category	1968	1990	2000	2020
Agriculture, forestry, and fisheries	4.8	3.7	3.3	2.7
Mining and manufacturing	161.0	254.0	303.3	399.7
Construction	76.9	163.6	213.2	336.3
Transportation and utilities	72.3	98.2	111.8	144.6
Trade	194.6	451.1	600.1	964.5
Finance, insurance, and real estate	40.5	74.4	96.9	141.4
Services	148.5	425.4	582.9	1,032.5
Government	86.4	105.2	115.1	134.5
Total	785.0	1,575.6	2,026.6	3,156.2

the most recent year for which figures are available. The trend toward more years of formal education and entry into the labor force at an older age, earlier retirement, and other influences will tend to push this ratio up in the future. At the same time, increasing labor force participation among married women, the continuing migration of young workers into the area, and other factors will put downward pressure on the ratio. Current and foreseeable conditions indicate that the ratio will hold constant at approximately 2.7. When the constant 2.7 population/labor-force ratio is combined with the employment forecasts, the resultant population estimates are 4,254,100 in 1990, 5,471,800 in 2000, and 8,521,700 in 2020, as shown in Table 26.

Table 26

GALVESTON BAY AREA TOTAL EMPLOYMENT AND POPULATION, SELECTED YEARS 1960-1968, AND PROJECTED TO 2020

(Thousands)

Category	1960	1966	1968	1990	2000	2020
Total employment	584.7*	n.a.	785.0	1,575.6	2,026.6	3,156.2
Population/labor force	2.7	—	—	2.7	2.7	2.7
Population	1,581.1*	1,930.1*	n.a.	4,254.1	5,471.8	8,521.7

n.a. Not available.
* U.S. Bureau of the Census.

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