Dynamic Revenue Analysis for California

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Executive Summary

In August, 1994 SB 1837 was enacted, requiring the Department of Finance to perform dynamic revenue analysis for proposed legislation having a revenue impact of ten million dollars or more. Preliminary research was conducted in Summer, 1995 and an appropriation was made in the 1995/96 budget, enabling a major research effort that began in September, 1995 to build an economic model of the State to assist with dynamic revenue analysis. This report documents the developmental work since September, 1995.

Computable General Equilibrium (CGE) models were chosen over other styles of models to represent explicitly the utility and profit maximizing behavior of households and firms and to explore the impact of dynamic responses of these agents. The Berkeley team specialized in a search of the literature and theory to maximize the use of California-based empirical estimates of theoretically sound functional forms. The Finance team specialized in government revenue and spending data, economic data and implementation of the theoretical design into the mathematical programming software. The result is a CGE model of California's economy that possesses a rich detail of industries, households and units of government and incorporates theoretically sound production, investment, consumption and trade relationships. Empirical estimation was not performed: the model's key parameters were imposed from published studies.

Sensitivity analysis has been performed to test the impact of these parameters. The results of this sensitivity analysis point to interesting properties of the model and its dependence upon a few key parameters—particularly those that affect trade. Notably:

- economic feedback results are significant for each of the three types of tax reduction examples investigated; and
- revenue feedback results are strongest for reductions in the Bank and Corporation Tax, weaker for Sales and Use Taxes and very slight for the California Personal Income Tax.

Preface

On August 30, 1994, the Governor of California, Pete Wilson, approved Senate Bill 1837. The text of SB1837 is reproduced below.

> The people of the State of California do enact as follows:
>
> SECTION 1. It is the intent of the Legislature in enacting this act to ensure that the Legislature and the Governor are presented with reliable information from the Legislative Analyst's office and the Department of Finance as to the probable behavioral responses of taxpayers, businesses, and other citizens to changes in state tax laws. Specifically, the Legislature intends that dynamic estimating techniques be used in estimating the state fiscal impact of proposals to change those laws, to the extent that data are available to permit estimates to be made in that manner.
>
> SECTION 2. Section 9143.5 is added to the Government Code, to read:
>
> 9143.5. (a) To the extent that any fiscal estimate prepared by the Legislative Analyst regarding the annual state budget involves one or more proposed changes in state tax law, the Legislative Analyst shall prepare the estimate, except where it is unreasonable to do so, on the basis of assumptions that estimate the probable behavioral responses of taxpayers, businesses, and other citizens to those proposed changes, and shall include in the fiscal estimate a statement identifying those assumptions. The requirement set forth in this section applies only to a proposed change in state tax law determined by the Legislative Analyst, pursuant to a static fiscal estimate, to have a fiscal impact in excess of ten million dollars ($10,000,000) in any one fiscal year.
>
> (b) This section shall remain in effect only until January 1, 2000, and as of that date is repealed, unless a later enacted statute, which is enacted before January 1, 2000, deletes or extends that date.
>
> SECTION 3. Section 13310 is added to the Government Code, to read:
>
> 13310. (a) To the extent that any fiscal estimate prepared by the Department of Finance regarding the annual state budget involves one or more proposed changes in state tax law, the department shall prepare the estimate, except where it is unreasonable to do so, on the basis of assumptions that estimate the probable behavioral responses of taxpayers, businesses, and other citizens to those proposed changes, and shall include in the fiscal estimate a statement identifying those assumptions. The requirement set forth in this section shall apply only to a proposed change in state tax law determined by the Department of Finance, pursuant to a static fiscal estimate, to have a fiscal impact in excess of ten million dollars ($10,000,000) in any one fiscal year.
>
> (b) This section shall remain in effect only until January 1, 2000, and as of that date is repealed, unless a later enacted statute, which is enacted before January 1, 2000, deletes or extends that date.

SB1837 was passed because the Legislature, the Governor, and a broad representation of governmental, academic and private economists felt that existing methods of evaluating tax changes ignored many of the rational responses of economic agents to those changes. Existing methods were believed to account for only the most direct responses and were termed "static."

An example of a purely static analysis is the prediction that a new tax of 10 percent on a product with $1,000,000 of sales would generate a $100,000 increase in revenue. A more extended analysis would predict a smaller revenue gain because the tax would lead consumers to buy less.

In dynamic revenue analysis, the exploration into economic behavior continues further through the economy. The behavioral changes of agents affect the decisions of other agents. Using our example, the introduction of the tax leads consumers to buy less of the taxed product. As a result, firms producing the taxed product produce less and employ fewer people. Those people who lose jobs have lower incomes and consume less, thereby reducing the demand for all goods. Firms with lower accounting profits would pay less corporate income tax. The laid-off employees not only do not pay taxes but may receive social benefits. The State loses tax revenue from these effects, and its expenditures increase. However, some or all of this may be offset by the State purchasing additional goods from its increased tax revenues. Further, effects are felt throughout the economy, some so subtle as to be extremely difficult to describe in an overview such as this. Keeping track of the incidence and distribution of these effects is so complicated that a computer model is essential.

In light of the requirements of SB1837, the Legislative Analyst's office (LAO) and the Department of Finance (DOF) began an examination of economic modeling techniques to perform dynamic revenue analysis. The LAO performed a survey of state governments in the United States and found that few had made any significant attempt at dynamic analysis. Of the few, Massachusetts had made the most progress in dynamic analysis. They employed external consultants who purchased an "off the shelf" regional model and used it to perform a set of dynamic analyses. It became apparent that the ultimate clients of this research were not satisfied with the results. State economists were not aware of all of the model's underlying assumptions and were unable to answer concerns raised about the results. There was a clearly expressed feeling that policy makers and advisors in that State's government were using a "black box" to evaluate policies, i.e., a model with properties that were not well known to the decision makers or their advisors.

Faced with this experience, DOF decided to conduct its analysis in a manner that would make assumptions transparent and be cost effective for the State. In order to make dynamic analysis part of the routine of DOF, rather than an ancillary obligation, DOF decided that much of the analysis would be carried out with a model run and interpreted by DOF economists. At this point it was still not clear what type of model should be used and how such a model could be constructed. The DOF commissioned a formal survey of the literature relevant to dynamic analysis to be conducted under the supervision of Dr. Peter Berck of the Department of Agricultural and Resource Economics, University of California at Berkeley. This study, completed in August, 1995 and reproduced in the appendices attached, recommended that computable general equilibrium models were the appropriate style of model and suggested an overall approach to building such a model for California. Further services of Dr. Berck, a post-doctoral fellow (Dr. Golan), and a graduate student (Mr. Dabalen) were contracted to assist DOF with building initial models during the Fall of 1995 and to enhance these through 1996.

Dr. Smith was employed by DOF, September 1, 1995, to guide the research under the supervision of Ted Gibson, Chief Economist. Mr. Barnhart was employed October 23, 1995, to perform the detailed analysis of government expenditure and other model elements.

The team has met very frequently since September, dividing tasks and appraising each others work. Insofar as the team members have specialized, the members at DOF have assumed responsibility for building the model and for California-specific data while the team members at Berkeley have been more concerned with determining functional form, theoretical economic issues, and non-California based parameter values.

There were four main tasks in building the California Dynamic Revenue Analysis Model (DRAM). The first task was to find data of both national and California-specific character. The resources of DOF were invaluable in providing data on California government and taxpayers. Data of a national character were either published, requiring extensive library research, or were commercially available. The second task was to define the aggregates to be used in the model. Aggregates were constructed in a way that captures and isolates most major taxpayers and government agencies while still providing a reasonably parsimonious model. The third task involved a detailed review of the literature on the functional forms and elasticities for the six primary behavioral equations in the model (consumption, production, trade, investment, labor supply, migration). At this stage, the functional forms for the model were established and adapted to the California situation. The majority of the remainder of this report is concerned with this step and with how each element in the model should be represented. The fourth task, model building, was performed concurrently with these data-finding and economic-evaluation activities. Model building is the process of reducing the substantive findings to an algebraic model that a computer can run. At present the model has 1,100 equations. The General Algebraic Modeling System (GAMS) makes it possible to code all of these equations with considerably less than 1,100 statements. The current version of the model allows comparisons of the current taxation system with an alternative system. It is fully “dynamic” in that most responses and feedback of an economic sort are accounted for. It currently supports only the comparison of long-run outcomes, i.e., outcomes after all migration and investment have taken place.

There is still considerable work to do on this program. Many of the relationships need to be derived from more California-specific data. Further sensitivity analysis will continue to reveal areas in which the model can be improved. The model will be made dynamic in the sense of showing the path by which long-run outcomes are achieved.

The contents of this report comprise an overview report on this research. The introduction provides an overview of the model and uses a minimum of technical language. The chapters require an introductory level of economics (and sometimes more) of the reader. Finally, the appendix setting out the model equations is accessible only to the technically proficient.

Where to Get More Information

To obtain further information, copies of this report, or electronic copies of the input files to run experiments with the model, please contact:

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California Department of Finance
915 L Street, 8th Floor
Sacramento, CA 95814
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e-mail: cf1.fibsmith@ts3.teale.ca.gov

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I. INTRODUCTION

Dynamic analysis of the effects of California taxation requires a comprehensive model of the California economy. The model needs to track income of individuals and firms since this is the basis for income taxation. It needs to track sales of goods and services since this is the basis of the sales, excise, and insurance taxes. But, to be dynamic, it needs to do more than that. It must account for the effects of taxation on the economy's use of labor and capital. A computable general equilibrium model (CGE) is a model that does all of these according to the basic economic principle that quantity supplied is equal to quantity demanded at a particular price. It is called "computable" because, rather than calculating algebraic solutions, a computer is used to find specific numeric solutions to questions posed to the model. It is called "general" because all markets and all income flows are included in the model. And it is called an "equilibrium" model because prices in the model adjust to make the demand for and supply of goods, services, and factors of production (labor and capital) equal. The California Dynamic Revenue Analysis Model (DRAM) is a CGE model for making dynamic revenue estimates.

The remainder of this introduction is a nontechnical description of DRAM. The general structure of this and most other CGE models and the availability of data for making a specifically California model are discussed in the first section. This is followed by a discussion of how the California model can be used. The introduction ends with a description of the remaining chapters of this report.

I.1. A DESCRIPTION OF CGE MODELS

A California CGE model is a description of the relationship among California producers, California households, California government, and the rest of the world. However, before the relationship between the different agents in the economy can be examined, the relevant agents for revenue analysis must be identified. The model cannot include an accounting of every individual producer, household, or government agency in the economy. To provide focus to the model, agents must be aggregated into sectors. This first step of model construction is described in the next section. This discussion is followed by a description of the key agents in the economy: agents and producers.

I.1.1. AGGREGATION

The DRAM, like all other empirical economic models, treats aggregates rather than individual agents. This is done both to provide focus for the analysis and contain the number of variables in the model. A correct aggregation or sectoring is an important element in the development of any CGE model because it determines the flows that the model will be able to trace explicitly. For the DRAM model, the California economy has been divided into 75 distinct sectors: 28 industrial sectors, two factor sectors (labor and capital), seven household sectors, one investment sector, 36 government sectors, and one sector that represents the rest of the world. The complete details of the sectoring are given in chapter II.

For the industrial sectoring, a grouping of firms, all of which make similar, though by no means identical, products is called a sector. Thus, all firms producing agricultural products are grouped together. The value of all California crops is added together, and this is the value of output for the agricultural sector. The total use of labor by the agricultural sector is added together, and this is the sector's labor usage. There are 27 other such industrial aggregates in the model. These represent the major industrial and commercial sectors of the California economy, though a few are designed to capture special tax situations. The most extreme example is the "Tobacco, Alcohol, and Horse Racing" sector. The output of this sector is much less than one percent of California's output, but it generates considerable revenue for the State.

Data for the industrial sectors originated with the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce, based on the Census of Business — a detailed survey of companies conducted in the United States every five years. In this survey, information is gathered about the purchases of intermediate goods, payments to factors (labor, capital, land and entrepreneurship), and taxes. Although the survey is quite extensive, it yields only enough detail to be able to make inferences about groups of firms at the national level. In addition, the most recent survey available was made in 1987. The conversion of national data to updated California data is accomplished by Impact Analysis for Planning (IMPLAN), a program which primarily utilizes state-level employment data to scale national-level industrial data down to the size of a state. To arrive at more current output levels, estimates were obtained from the Department of Finance's (DOF) econometric model of the state for an industrial breakdown fitting our model as closely as possible. These were combined with IMPLAN data to arrive at a reasonable approximation of 1995/96 expected economic conditions.

Like firms, households are also aggregated. California households were divided into categories based upon their income. There are seven such categories in the model, each one corresponding to a California Personal Income Tax marginal tax rate (0, 1, 2, 4, 6, 8, and 9.3 percent). Thus, the income from all households in the one-percent bracket is added together and becomes the income for the "one-percent" household. Similarly, all expenditure on agricultural goods for these households is added and becomes the expenditure of the one-percent household on agricultural goods. The total expenditure on agricultural goods is found by adding the expenditures of all households together. Data for income come from the Franchise Tax Board Personal Income Tax "sanitized" sample, while data on consumption by income come from a national survey.

The government sectors in DRAM are organized so that both government revenue flows and expenditure flows can be traced explicitly. The DRAM includes 36 government sectors: seven federal, 21 state, and eight local. Data for the government sectors come from published federal, state, and local government reports.

I.1.2. PRODUCERS AND HOUSEHOLDS

The beginning point for the description of the California economy and, hence, the California CGE model is the relationship of the two major types of agents: producers and households.

Producers, also known as firms, are represented in the model as aggregates or sectors, where each sector is treated as a representative firm. For instance, all of California's agricultural output is treated by the model as if it came from a single entity, the Agriculture sector. Each of these sectors or producers treats the prices that it sells its product (e.g., agricultural products) and the prices that it pays for its inputs (capital and labor, called "factors of production," and other inputs, called "intermediate goods") as fixed. This is the assumption of competition. The producers do not believe that their decisions have an effect on prices. Each producer is assumed to choose inputs and output to maximize profits. Inputs are labor, capital, and intermediate goods (outputs of other firms). Thus, the producer's supply of output is a function of price and the producer's demand for inputs is a function of price. More information on producers is provided in chapter IV.

Households make two types of decisions. They decide to buy goods and services. They decide to sell labor and capital services. They are assumed to make these decisions in the way that maximizes their happiness (called "utility" in the economics literature). Like the firms, they take the prices of the goods that they buy and the wage of the labor that they sell as fixed. Their supply of labor, as a function of the wage rate, is called the "labor-supply function." Their demand for goods or services, as a function of prices, is called, simply, the "demand function." In addition to their labor income, households receive dividends and interest from their stocks and bonds and other ownership interests in capital. A more detailed description of the demand for goods and services is given in chapter III while a more detailed description of the supply of labor is given in chapter VII.

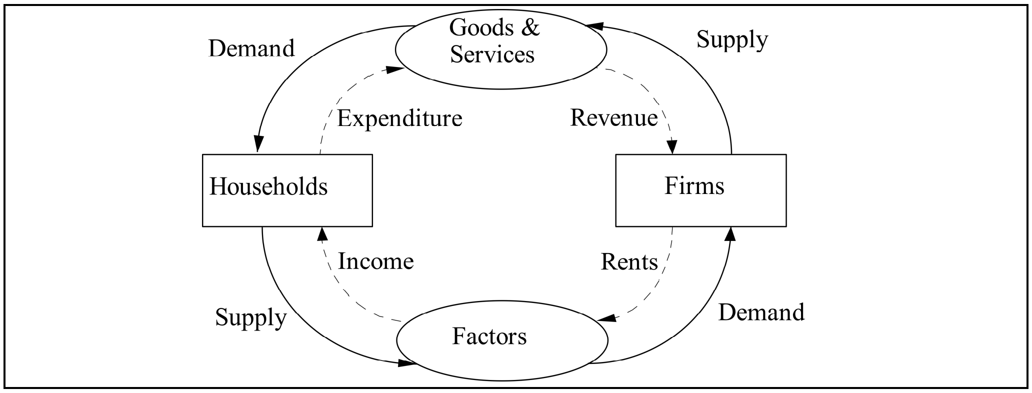
I.1.3. EQUILIBRIUM

So far, two types of agents have been described: firms and households. It remains to be explained how these agents relate. They relate through two types of markets: factor markets and goods-and-services markets. Firms sell goods and services to households on the goods-and-services markets. Households sell labor and capital services to firms on the factor markets. There is a price in each of these markets. There is a price for the output of each of the 28 sectors. There is a price for labor, called the "wage," and a price for capital services, called the "rental rate." Equilibrium in a market means that the quantity supplied (which is a function of price) is equal to the quantity demanded (which is also a function of price) in that market. Equilibrium in the factor markets for labor and capital and in the goods-and-services markets for goods and services defines a simple general equilibrium system. That is, there are 30 prices (the wage, the rental rate, and one for each of the 28 goods made by the 28 sectors) and these 30 prices have the property that they equate quantities supplied and demanded in all 30 markets. They are market-clearing prices.

These relationships are shown in more detail in the figure below, called a "circular-flow diagram." The outer set of flows, shown as solid lines, are the flows of "real" items, goods, services, labor, and capital. The inner set of flows, shown as broken lines, are the monetary flows. Thus, firms supply goods and services to the goods-and-services market in return for revenues that they receive from the goods-and-services markets. Firms demand capital and labor from the factor markets and in return pay wages and rents to the factor markets.

Households, the other type of agent in a simple model, buy, or in economic parlance, demand, goods and services from the goods-and-services markets and give up their expenditure as compensation. They sell capital and labor services on the factor markets and receive income in exchange.

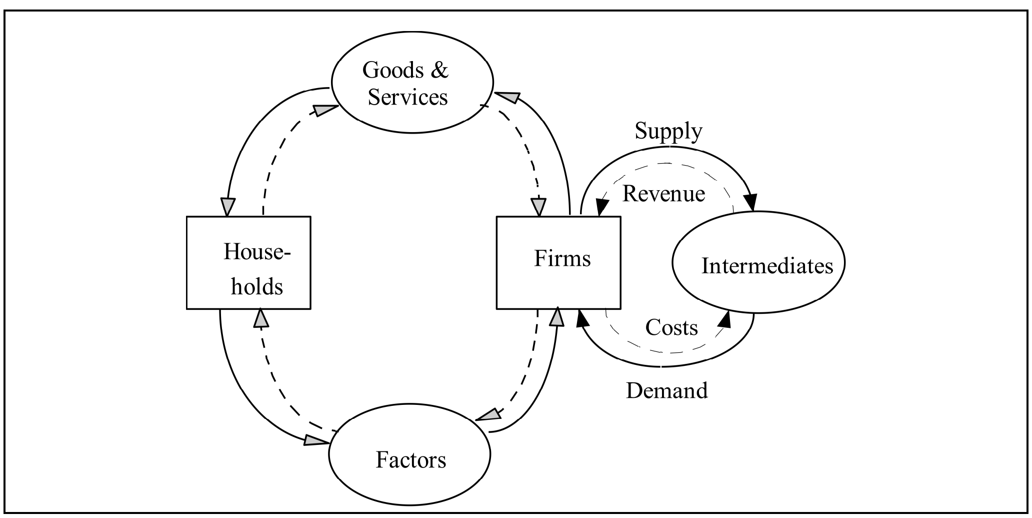
Figure I-1.The Basic Circular-Flow Diagram



I.1.4. INTERMEDIATE GOODS

The economy of California is far more complex than that shown in the figure above. There are not only final goods-and-services markets but also intermediate goods markets in which firms sell to firms. A typical example of this would be chemicals sold to agricultural firms. The final output of the chemical industry (perhaps fertilizer) is said to be an intermediate good in the agricultural industry. This type of market is demonstrated in the figure below. Here, part of the supply of a firm (chemical industry in the example) is not sold to households but rather to another firm in exchange for revenue. From the other firm's point of view, it buys an input to production from a firm rather than from a household. The expense of buying the input is a cost of production. Chapter IV contains the model specification for these types of transactions, which are based upon a national input-output (I-O) table.

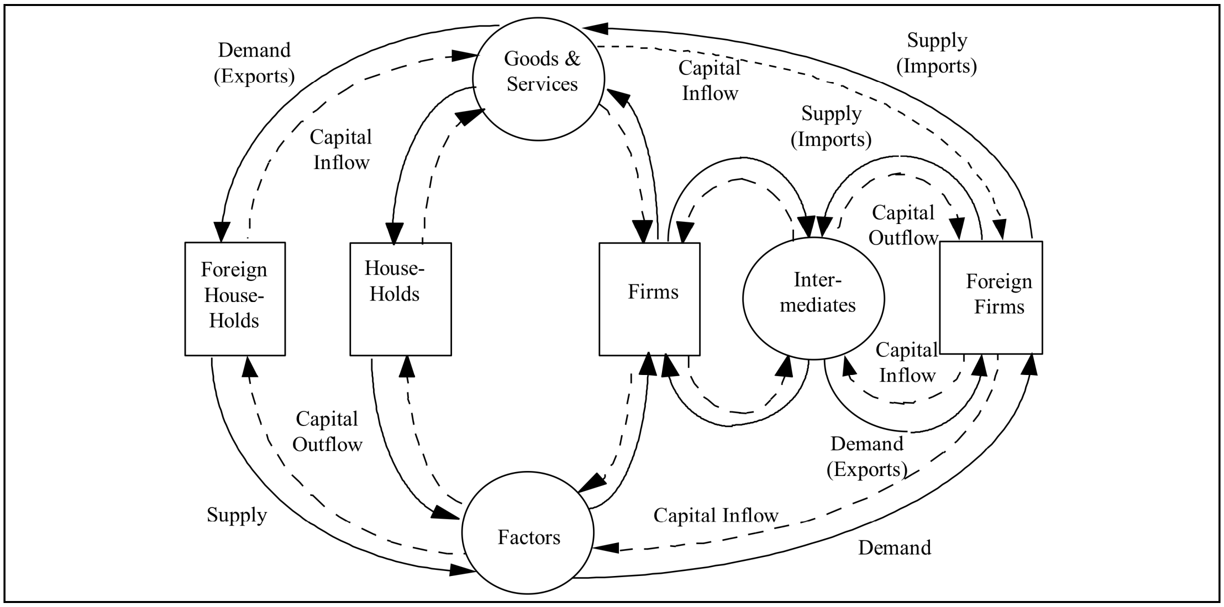
Figure I-2. The Circular-Flow Diagram with Intermediate Goods



I.1.5. REST OF THE WORLD

California is an open economy, which means that it trades goods, services, labor, and capital readily with neighboring states and countries. In this model, all agents outside California are modeled in one group called "Rest of World." No distinction is made between the rest of the US and foreign countries. California interacts with two types of agents: foreign consumers and foreign producers. Taking the producers first, the figure below shows that the producers sell goods on the (final) goods-and-services markets and on the intermediate markets, i.e., they sell goods to both households and firms. The model takes these goods as being imperfect substitutes for the goods made in California. Agricultural products from outside of California (e.g., feed grains, bananas) are taken as being close to, but not identical to, California-grown products (e.g., avocados, fresh chicken). The degree to which foreign and domestic goods substitute for each other is very important, and the evidence is described in chapter V. Foreign households buy California goods and services on the goods-and-services markets. They and foreign firms both can supply capital and labor to the California economy, and domestic migration patterns are described in chapter VIII.

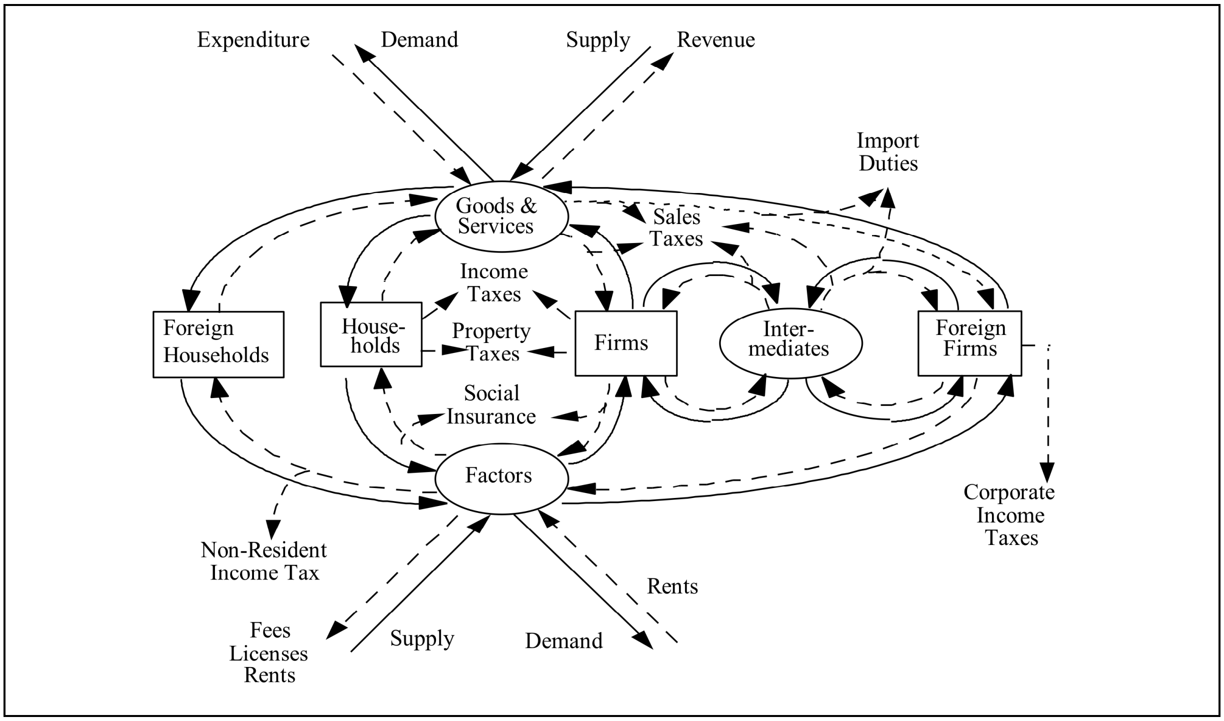
Figure I-3. The Circular-Flow Diagram with Intermediate Goods and Trade



I.1.6. GOVERNMENT

Finally, government is considered. Combining the taxing and spending effects of the three levels of government (federal, state, and local) gives the additional flows in the figure below. Beginning at the top, the figure shows that government buys goods and services and gives up expenditure. It supplies goods and services for which it may or may not receive revenue. Government also supplies factors of production, such as roads and education. The model does not currently include goods such as K-12 education as such goods are not always traded in organized markets. Government also makes transfers to households, which are not shown in the diagram. The middle section of the diagram shows the myriad of ways in which government raises revenue through taxation. Chapter II includes a detailed description of the government activities in the model.

Figure I-4. The Complete Circular-Flow Diagram



I.2. REGIONAL AND NATIONAL MODEL DIFFERENCES

There have been hundreds of CGE models built and used for analyzing public policy at the national and international level. Regional, or sub-national, CGE models are very similar in design to national and international models, but exhibit major differences in several key assumptions. The seven most important differences between national and regional CGE models are discussed below.

The first, and maybe most important, difference is that regional CGE models do not require that regional savings equal regional investment. When Californians save more than California investors want to use, excess savings flow out of the state. When the converse is true, savings flow into the state. Rational economic agents would not accept less interest on their savings from California investors if higher interest rates were available in other states or countries. Conversely, rational investors in California would not pay higher interest for the use of Californian savings if other states or countries offered lower rates.

The second difference is that regional economies trade a larger share of their output. Therefore, trade is more important in regional models. Note that interstate trade is part of the Rest of World for California but ignored in national considerations of trade.

The third difference is that regional economies face larger and more volatile migration flows than nations. Regional and international migration to California is a major factor in the State's economy.

The fourth difference between national and regional CGE's is that regional economies have no control over monetary policy. The Federal Reserve is responsible for monetary policy and is a national institution.

The fifth difference is that in regional models taxes are interdependent through deductibility. Some local taxes are deductible from incomes subject to California Personal Income Taxes and Bank and

Corporation taxes. Some local and state taxes are deductible from incomes subject to Federal Personal Income Tax and may be eligible for deduction from corporate incomes for federal purposes. In DRAM, the personal tax deductibility is explicitly modeled. Since corporate deductibility is more uncertain and since the apportionment rules may reduce the connection to federal corporate taxes, corporate deductibility has not been included in DRAM.

Sixth, while good data for a CGE are hard to find at the national level, in many cases they are nonexistent for regional economies. The DRAM uses published economic and statistical literature to simulate much of the data important to our model. In some cases, such as labor supply, a wide variety of results is presented in the literature. This problem is addressed in three ways: (1) values are chosen so as to avoid the extremes, (2) the model is tested to determine the degree to which results are dependent upon our assumptions (this process is called "sensitivity analysis"), and (3) the use of published literature, especially of national results, has been minimized.

Seventh, the California CGE differs from a national CGE in that California faces a balanced-budget requirement. Even if this is ignored in the short run, bond markets tend to reflect this fact. When California issued bonds to cover short-term deficit spending in the early 1990s, bond ratings forced up the cost of borrowing. Ultimately, California would face unreasonable borrowing costs should it decide to maintain this level of borrowing.

I.3. OTHER CONSIDERATIONS AND MODEL BUILDING

The CGE models are not forecasting models; they are calibrated to reproduce a base year. In the case of DRAM, the model is constructed to exactly reproduce the economic conditions of Fiscal Year 1995/96. Of course, there are forecasting models. However, such models typically do not have the level of detail needed to examine dynamic tax effects. Given the paucity of California-specific data, it seems a better compromise to use a forecasting model, such as the one maintained by DOF, to set a base case and then use a policy model, such as DRAM, to find the differences from that case.

The DRAM model incorporates two assumptions that require some comment. It assumes competitive behavior in all private sectors. This is a good first approximation, particularly at the level of a sector. The alternative, oligopoly behavior, may well be present, but the degree of markup of price over marginal cost is not likely to be significant. The second assumption is that involuntary unemployment is constant. This is unlikely to be strictly true. The model has voluntary unemployment, which is agents deciding to work less when the wage is lower. This assumption is common to all equilibrium models. Technical issues of model closure are described in chapter IX.

Once the major agents in the economy have been identified and the relationship between these agents has been specified, the model can be built. In DRAM, the algebraic representation of the relationships between the agents in the California economy is achieved with General Algebraic Modeling System (GAMS). The model currently has 1,100 equations, exclusive of definitions and of the code to read in and organize the data. All of the model's equations and GAMS code are detailed in chapter X.

I.4.HOW THE MODEL CAN BE USED

When the final developmental details are complete, three streams of uses of the model appear evident:

1. The immediate goal of DOF fulfilling the requirements of SB1837 will be met. The DOF staff will use the model to assist in performing dynamic revenue analysis of legislation. The

model does not perform this analysis but will be a primary tool used to produce experimental results to supplement economic analyses of major legislation. The DOF plans to limit its efforts in 1996 to bills with $100 million or more impact until further model development occurs to improve the precision of the model. It is important to note that State revenues are on the order of $60 billion. The $100 million represents one part in 600 of the State's revenue—a very tiny percentage.

2. The DOF plans to use DRAM as the basis for further research by the University of California at Berkeley team members and other researchers in 1996. CGE models are particularly sensitive to the design of factor markets, and the team was forced to use national data from several years ago in the model. Current research to establish California consumption, labor supply, migration, investment, and production functions would enhance the model considerably.
3. Other state governments are in the midst of developing their own forms of dynamic revenue analyses—whether in response to legislated demands or expectation of the need for these analyses. The DOF will share its research with other states; in fact this process has already begun with Washington, Arizona, New Mexico, Oregon, and Ohio. The details of the DRAM model are available on request, and the DRAM team hopes to gain from the research of others and the insight of others reviewing their models.

I.5. DOCUMENT OUTLINE

The presentation of the California DRAM is organized to mirror the tasks involved with building the California CGE. In chapter II, the major agents in the economy are identified and aggregated into sectors. These aggregates are constructed to focus the model on the major industries, taxpayers, and government agencies in the California economy. At this stage, data sources corresponding to the model aggregation are also identified.

A detailed review of the literature on the six primary behavioral equations in the model is presented and the functional form and elasticities for each of these equations are established in chapters III through VIII. These behavioral equations form the links between the sectors in the model. Decisions regarding the functional form, elasticities, and variables for each equation determine the results of the model. The discussion of the behavioral equations is organized as follows. A review of the literature on the economic behavior of households with respect to consumption and savings decisions is presented in chapter III. The literature on the production decisions of firms is examined in chapter IV. The literature on international and interregional trade is reviewed in chapter V. Investment theory is discussed in chapter VI. The literature on regional labor-supply response to taxation and economic growth is examined in chapter VII, and the literature on migration and economic growth is examined in chapter VIII.

After establishing the sectors, data sources, and behavioral equations for the model, all that remains before the actual model can be built is a description of the model-closure rules. Closure rules are concerned with the mathematics of insuring that a solution exists to the 1,100 equations included in DRAM. The model closure is developed in chapter IX.

The mathematical notation for each equation in DRAM and the corresponding GAMS notation are described in chapter X. Chapter X is a technical description of the complete California Dynamic Revenue Analysis Model. Chapter XI presents some preliminary sensitivity analyses.

Appendices follow chapter XI. They include the original literature search by Dr. Berck and Mr. Dabalen in the Summer of 1995, explanations of notational methods used, lists of parameter and variable names used in the mathematical and software input files, and printed copies of the input files themselves.

II. DATA ORGANIZATION: SOCIAL ACCOUNTING MATRIX

The first step in constructing a CGE model is to organize the data. The traditional approach to data organization for a CGE model is to construct a Social Accounting Matrix (SAM). A SAM is a square matrix consisting of a row and column for each sector of the economy. Each entry in the matrix identifies an exchange of goods and services purchased by one sector from another sector or itself. The entries along a row in the SAM show each payment received by that particular sector. Summing the data across the row gives the total of payments made to that sector. The entries down a column in the SAM show the expenditures made by a particular sector. Summing the data down a column gives the total expenditures by sector.

For DRAM, the California economy has been divided into a SAM composed of 75 distinct sectors: 28 industrial sectors, two factor sectors (labor, capital), seven household sectors, one investment sector, 36 government sectors, and one sector which represents the rest of the world. The California SAM that was constructed for DRAM is presented in Appendix 1. The design of the sectoring is an important element in the development of any CGE, Social-Accounting or IO model because it determines the flows that the model will be able to trace explicitly. If the sectoring is done correctly, the major flows in the economy, both positive and negative, will be evident. If the sectoring is done incorrectly, the impact of policy will be blurred, with negative and positive flows occurring within a single sector. Without a correct sectoring, it would be difficult, if not impossible, to differentiate the distributive impact of government spending and taxation.

In the sections that follow, the criteria for the sectoring of the SAM are presented and each sector is described in detail. The data sources for each sector are also discussed. Industrial sectoring is examined in the first section. The two factor sectors in the model are discussed in the second section. The household sectoring is described in the third section. And the government sectoring is described in the fourth section.

II.1. CRITERIA FOR INDUSTRIAL SECTORING

Four criteria are considered in establishing the industrial sectoring for use in DRAM. First, the major industries in the economy in terms of employment, value of production, exports, and revenue are differentiated. Second, the major taxpayers in the economy are distinguished. Third, the distributive impact of government taxation and industrial-development policy are considered. Fourth, standard sectoring schemes, such as the Standard Industrial Classification (SIC) system, are followed when possible. Each of these criteria is examined in detail below. This discussion is followed by presentation of the industrial-sectoring scheme adopted for DRAM.

II.1.1. MAJOR CALIFORNIA INDUSTRIES

The first criterion considered when establishing the industrial sectoring is the importance of the industry in terms of its employment, value of production, exports, and revenue. Not only do these key industries capture the major flows in the economy but changes in these industries could trigger relatively large changes throughout the economy. The major California industries are outlined in the four tables following. Because the main source of data base used for the generation of the SAM is the 1992 IMPLAN, 1992 data are presented in all tables when possible.[1]

A ranking of major industries according to value of gross output is presented in the table below. This ranking in clearly reflects the observation that California, like the rest of the country, has become increasingly a service- and trade-oriented economy. The first manufacturing industry to make the list, Aerospace, enters in seventh place with a value of production barely 40 percent that of Business-Related Services.

Table II-1 Ten Largest Industries According to Value of Gross Output (in thousand $)

Industry	Gross Output
Business-Related Services*	$116,512
Retail Trade	95,308
Construction	89,479
Real Estate	75,260
Wholesale Trade	64,252
Health Services	63,157
Aerospace	47,223
Electronic Technology	44,898
Transportation	43,671
Food Processing	37,004

* Includes Business, Legal and Agricultural Services, Engineering and Management Consulting
Source: Ranking derived from Nov. 1995 update of 1992 IMPLAN.

The ranking of major industries according to the number of employees presented in the table below reproduces results similar to those in in the previous table; service and trade industries are the dominant employment sectors for the State. In 1992, Manufacturing supplied only 30 percent of the jobs that are found in the service and trade industries.

Table II-2. Wage and Salary Workers by Major Industry, 1992 (in thousands)

Industry	Number of workers
Services	3,426.3
Retail Trade	2,121.4
Government	2,095.6
Manufacturing	1,890.5
Finance, Insurance, Real Estate	791.9
Wholesale Trade	713.5
Transportation and Utilities	607.4
Construction	471.7
Agriculture*	351.6
Mining	35.4

*Includes Agricultural Services and Forestry and Fishing (not Veterinary, Other Animal, or Landscape and Horticultural Services).
Source: 1995 Economic Report of the Governor.

The table above can be further disaggregated to distinguish the major employers in Services and Manufacturing. This is done in the two succeeding tables.

[1] IMPLAN is a microcomputer-based system for constructing regional economic accounts and input-output tables. It is currently maintained by the U.S. Forest Service in Ft. Collins, Colorado, and the IMPLAN group at the University of Minnesota.

Table II-3. Wage and Salary Workers in Services (in thousands)

Industry	Number of workers 1993	1994	% change
Hotels and Motels	176.9	175.9	–0.6%
Personal Services	116.4	113.4	–2.6%
Business Services	755.5	798.6	5.7%
Auto and Other Repair	129.7	131.5	1.4%
Motion Pictures	130.7	140.9	7.8%
Recreation	163.4	171.3	4.8%
Health Services	825.4	832.8	0.9%
Legal Services	125.9	121.4	–3.6%
Private Education	166.4	170.3	2.4%
Private Social Services	208.8	216	3.4%
Membership Organizations	149.1	153.1	2.7%
Eng./Mgt. Consulting	383.4	393.4	2.6%
Other Services	130.8	130.2	–0.5%

Source: 1995 Economic Report of the Governor.

Employment in service industries for 1993 and 1994 is listed in the table above. Data for 1992 are not comparable to those for later years and were not included. The largest employers in the service industries for 1993–94 were Health Services, Business Services, and Engineering and Management Consultants. The fastest growing of the services in recent years have been Business-Related Services, Health Services, Motion Pictures, and Recreation Services. The service industry has been the largest employer in California since 1977. In 1992, the service industry employed 3,426,300 people — 1,304,900 more than the second largest employer, Retail. Services are the fastest growing segment of the California economy. Over 96 percent of the jobs added in 1994 were in service industries with three-quarters of these were in Business Services, Motion Pictures, and Engineering and Management Consultants. Contrary to popular belief, many service industries are high-wage industries, such as doctors, lawyers, engineers, computer programmers, architects, accountants, and motion picture production workers.

As shown in the table below, the largest employers in Manufacturing for 1992 were the two high-tech industries: Electronics and Aerospace. However, even when their employment is combined, these industries did not employ as many people as Health Services or Business Services.

Table II-4. Wage and Salary Workers in Manufacturing—Five Largest Employers, 1992 (in thousands)

Industry	Number of workers
Electronics	310.3
Computer and Office Equipment	95.1
Communications Equipment	30.1
Electronic Components	122.2
Lab. Measuring, Controlling Instruments	62.9
Aerospace	274.1
Aircraft and Parts	132.2
Missiles and Space Vehicles	57.9
Search and Navigation Instruments	84.0
Food and Kindred Products	182.6
Printing and Publishing	157.7
Apparel and Other Textile Products	139.9

Source: 1995 Economic Report of the Governor, California DOF.

The ten largest industries in terms of export earnings for 1992 are listed in the table below. The listing was compiled with updated 1992 IMPLAN data. It is important to distinguish the major export industries in the industrial sectoring because changes in these industries can have particularly large repercussions on the rest of the economy. Changes in export earnings are like exogenous shocks to the California domestic economy, entailing more than a redistribution of expenditure within the economy.

Table II-5. California's 10 Largest Export Industries, 1992 (in thousand $)

Industry	Export earnings
Business-Related Services*	39,671
Aerospace	36,436
Food Processing	21,469
Construction-Oriented Manufacturing	18,871
Entertainment	18,036
Electronic Technology	17,864
Paper and Publishing	13,649
Chemicals and Related	13,539
Wholesale Trade	13,472
Banking	13,375

*Includes Business, Legal and Agricultural Services, Engineering, Management Consulting.
Source: Ranking derived from updated (November, 1995) 1992 IMPLAN.

The rather surprising observation that Business-Related Services is the largest export industry is explained by the fact that Software Design and Publishing, Computer Systems Design, and Management and Technical Consulting are all included in Business-Related Services. Entertainment is a major export industry because it includes Motion Pictures.

II.1.2. MAJOR TAXPAYERS

The second criterion considered when establishing the industrial sectoring is the tax structure. A primary focus of the study is to ensure that the Legislature and the Governor are presented with reliable information as to the "probable behavioral responses of taxpayers, businesses, and other citizens to changes in state tax laws." In order to model explicitly taxpayer response to changes in state tax laws, DRAM must necessarily identify the major taxpayers in the State and the major corporate taxpayers are listed in the table following.

Table II-6. Firms Reporting Net Income Subject to State Taxation of $1 Billion or More, 1992 (in thousand $)

Industry	Net income subject to state taxation
Investment and Insurance Companies	5,320,185
Wholesale Trade	4,126,940
Banks and Savings and Loans	3,388,928
Retail Trade	3,341,524
Electric Machinery and Equipment	2,636,639
Communications	2,537,911
Electric, Gas, and Utilities	2,406,728
Business Services	2,091,496
Petroleum, Coal, and Rubber Products	1,761,465
Beverages	1,608,991
Real Estate	1,538,680
Chemicals and Allied Products	1,512,653
Construction	1,088,195

Source: Information reported in California Statistical Abstract, DOF, 1994.

II.1.3. DISTRIBUTIVE IMPACT

The third criterion considered when establishing the industrial sectoring is the distributive impact of government taxation and spending. In order to trace effectively the impacts of government spending and taxation on the distribution and incidence of production, income, spending and savings in the economy, it is important to establish an industrial sectoring that can be used to map the effects of government policy. The sectoring in DRAM distinguishes those industries that clearly stand to benefit from increased government spending from those industries that may incur negative repercussions from such spending.

As a first cut at differentiating the impacts of government policy, it is important to distinguish major taxpayers by size and by type of tax as was done in the previous section. Not only do the major taxpayers represent the primary source of funding for government spending but they also represent important variables in any industrial-development strategy. Targeted tax cuts or even general tax cuts to industry are primary tools in industrial-development incentive policy. The industrial sectoring must explicitly include the major taxpayers in order to trace the impact of such policies.

The industrial beneficiaries of government spending on infrastructure or education are difficult to isolate. Both theory and empirical observation suggest that the benefits of infrastructure and education are diffused throughout the economy. The direct beneficiaries of industrial-development spending are likely to be more narrowly delineated. A primary focus of many industrial-development strategies has been creating employment in wage-premium, high-export industries. Wage-premium jobs have a high salary to education ratio, and the earning effects of local employment are greater for new jobs in wage-premium industries. More jobs at higher wages provide the biggest "payoff" for employment-creation projects. Export industries are targeted because out-of-state earnings can have large economywide impacts.

California's largest wage-premium export industries are Aerospace, Motion Pictures, Engineering and Management Consulting, and Computer Software and Systems Development. Even if these industries are not specifically targeted by development incentives, they are important industries to track with the model. The economywide impact resulting from changes in these industries should be large because they are large employers paying high salaries, making large export earnings.

II.1.4.STANDARD INDUSTRIAL CLASSIFICATION

The fourth criterion considered when devising the industrial sectoring is comparability with other industrial classifications. When possible, the industry classifications used in DRAM are defined to coincide with industry classifications regularly used in the SIC, the most commonly used system for categorizing industries.

II.2. THE INDUSTRIAL SECTORS

The 28 non-governmental "industries" or industrial sectors are differentiated for inclusion in DRAM. The industries included in DRAM, along with their SIC codes and IMPLAN codes are presented in the table below. A description of each industry follows.

Table II-7. Industrial Sectoring and Codes

Sector	Name	SIC	Name	IMPLAN Sector
AGRIC	Agriculture	01	Crops	10-21,23
		02	Livestock	**1**-9
ENMIN	Energy Mining	12	Coal Mining	**37**
		13	Oil and Gas Mining	38-39

OTHPR	Other Primary	08 09 10 14	Forestry Fishing Metal Mining Nonmetallic Non-fuels Mining	**22,** 24 25 27-36 40-47
CONST	Construction	15 16 17	Building Construction Heavy Non-building Construction Special Trade Contractors	**48**-57 (not by SIC)
FOODS	Food Processing	20	Food and Kindred Products	**58**-90, 95-103
ALTOH	Tobacco	21	Tobacco, Alcohol, & Horse Racing	**91**-94,104-107, 487
APPAR	Apparel	23	Apparel	**124**-132
MFRCO	Construction-Oriented Manufacturing	24 25 32 34	Lumber and Wood Products Furniture and Fixtures Stone, Clay, Glass, & Concrete Fabricated Metals	**133**-147 148-160 230-253 273-306
PAPER	Paper, Printing & Publishing	26 27	Paper and Allied Products Printing and Publishing	**161**-173 174-185
CHEMS	Chemicals & Related	28 29 30	Chemicals and Allied Products Petroleum Related Rubber & Miscellaneous Plastics	**186**-209 211-214 215-220
PETRO	Petroleum Refining	291	Petroleum Refining	**210**
ELECT	Electronic Technology	357 366 367 382	Computers and Office Equipment Communications Equipment Electronic Components & Accessory Laboratory & Measuring Instrument	**339**-344 372-374 375-378 401-403
AEROS	Aerospace	372 376 381	Aircraft and Parts Guided Missiles & Space Vehicles Search, Detection, Navigation Equip	**389**-391 396 400
MOTOR	Motor Vehicles	371	Motor Vehicles	**384**-388,395,397
OTHMA	Other Manufacturing	22 31 33 35 36 37 38 39	Textile Mill Products Leather Primary Metals Machinery & Equipment Electronic Equipment Transportation Equipment Instruments Miscellaneous Manufacturing	**108**-123 221-229 254-272 307-338,345-354 355-371,379-383 384-388,392-395,397- 399 404-414, 415-432
TRANS	Transportation	40 41 42 44 45 46 47	Railroads Transit & Interurban Passenger Motor Freight Water Transportation Air Transportation Pipelines, except Natural Gas Transportation Services	**433** 434,510 435 436 437 438 439-440
COMMU	Communication	48	Communications	**441**-442
DRAM		SIC	codes	IMPLAN
UTILI	Utilities	49	Electric, Gas, and Sanitary Services	**443**-446,511,514
WHOLE	Wholesale Trade	50 51	Durable Goods Non-durable Goods	**447** (combined)
RETAI	Retail Trade	52 53 54 55 56 57 58 59	Building Materials General Merchandise Food Automotive & Gas Stations Apparel Home Furniture Eating & Drinking Miscellaneous Retail	**448** 449 450 451 452 453 454 455
BANKS	Banking	60 61	Depository Institutions Non-depository Credit Institutions	**456** 457
INSUR	Insurance Carriers	63	Insurance Carriers	**459**
REALE	Real Estate	65	Real Estate	**462**

OFIRE	Other Finance, Insurance, Real Estate	62 64 67	Security & Commodity Brokers Insurance Agents, Brokers, Services Holding and other Investment	460 **458** (457)
BSERV	Business Services	07 73 81 87	Agricultural Services Business Services Legal Services Engineering, Accounting, etc.	**26**-27 469-476 494 506-509
HEALT	Health Services	80	Health Services	**490**-493
ENTER	Entertainment	78 79	Motion Pictures Amusement & Recreation	**483** 484-486,488-489
OSERV	Other Services	70 72 75 76 82 83 84 86 88 89	Personal Services Hotels Automobile Services Miscellaneous Repair Services Educational Services Social Services Museums, Galleries, & Zoos Membership Organizations Private Households Miscellaneous Services	464-468 **463** 477-479 480-482 495-497 498-501 (502) 502-505 525-528 NA
FEDDE	Federal Defense	97	National Security & Int. Affairs	**519**
FEDNO	Federal Non-defense	43 91 92 93 94 95 96	U.S. Postal Service Executive, Legislative, General Justice, Public Order, & Safety Public Finance, Taxation, Monetary Admin. of Human Resource Policy Admin. of Env. Quality & Housing Admin. of Economic Programs	**513,** 515, 520, 521
	State (6 units)			**522** S&L Education
	Local (5 units)			**512** Oth. Local Ent. 521 S&L Non-Ed.
	Miscellaneous In IMPLAN, not in SIC		Non-comparable Imports Scrap Used and Secondhand Inventory Valuation Adjustment	516 517 518 528

II.2.1.AGRICULTURE

Agriculture includes four SIC categories: Crops, Horticultural Specialties, Greenhouse and Nursery Products, and Livestock. It does not include Agricultural Services. California is one of the largest and most diverse agricultural states in the nation. California farmers produce more than 250 crops, and California has led the nation in farm production and farm income for the past 45 consecutive years. On just three percent of U.S. farmland, California farmers produce more than half of the country's fruits, vegetables, and nuts. Total net income for California agriculture exceeded $7 billion in 1990, corresponding to an average of $82,710 per-farming operation or $228 per acre. In 1992 California farmers sold an estimated $18.1 billion of farm products and approximately 10 percent of all U.S. agricultural exports are shipped by California farmers (1994).

Direct employment in agricultural production (not including Agricultural Services) was 225,700 in 1992, falling to 215.6 by 1994. Gross agricultural production for 1992 (IMPLAN data) was valued at approximately $19 billion. Total value added was approximately $12.5 billion with employee compensation estimated at approximately $2.5 billion.

II.2.2. ENERGY MINING

Energy Mining in California includes oil and natural-gas extraction. Energy Mining is the largest mining industry in the State, accounting for three-quarters of all employment in mining. California ranks fourth in the nation in oil production though California production only meets about 50 percent of the State's oil demand and 65 percent of the State's natural gas demand. In 1994, California produced about 15 percent of the nation's domestic crude oil, 344 million barrels. At the beginning of 1994, California oil reserves were estimated at 4.0 billion barrels. Crude-oil production in the State includes onshore sources (82 percent), federal offshore sources (12 percent), and State waters (6 percent). Most California oil is heavy and has a high sulfur content, making it expensive to refine. Recent weak market prices have reinforced the long-term decline in California oil production. In 1992, approximately 27,000 people were employed in Energy Mining in California. By 1993, this number had dropped to approximately 24,000. In 1992, the Energy Mining industry was valued at $6.5 billion (IMPLAN). Value added was estimated at $4.3 billion and employee compensation at $1 billion.

II.2.3. OTHER PRIMARY

Other Primary includes four SIC categories: Fishing, Hunting and Trapping, Forestry, and Metal Nonmetallic and Non-fuels Mining. Together, the 1992 output of these three industries was valued at $2.6 billion and they employed approximately 17,000 workers (IMPLAN, 1992).

Fishing and Hunting and Trapping are the smallest of the industries included in the Other Primary grouping. As an industry, Fishing and Hunting and Trapping employed less than 1,000 people in 1992 and represents a very minor industry in California.

The Forestry Industry classification includes two IMPLAN categories: Forest Products (IMPLAN sector 22) and Forestry Products (IMPLAN sector 24). The IMPLAN database documentation manual distinguishes the two sectors according to commodity output orientation. Forest Products primarily comprises stumpage, pulp wood, fuel wood, Christmas trees, and fence posts (commodity output is secondary). Forestry Products primarily consists of establishments engaged in the operation of timber tracts, tree farms, and forest nurseries as well as activities including reforestation and the growing of Christmas trees (IMPLAN, 1993). All other horticultural specialties are included in agriculture. Other Horticultural Services are included in Agricultural Services. From 1988 to 1992, lumber production in California fell from 5.5 billion board feet to four billion board feet (a fall in production of 18 percent). Harvest levels on both national forests and private lands have been declining and will probably continue to do so as a result of environmental regulations, endangered species acts, and declining number of trees available for harvest. Despite declining harvest levels, California is among the top three lumber producing states in the nation. As an industry, Forestry is assessed a special tax called the Timber Yield Tax, and this tax will be tracked through the Other Primary sector.

In California, non-energy mining principally includes gold and building materials. Industrial minerals account for 85 percent of the total value of non-energy mining in the State, and metals account for 15 percent. California ranks second among the states in non-energy mining. California is the sole producer in the nation of boron and tungsten and is the nation's largest producer of sand, gravel, Portland cement, diatomite, rare earth concentrates, natural sodium sulfate, and asbestos. California is the nation's second largest producer of gold. Non-energy Mining in California has been fairly stable for the past few years; since 1992, approximately 8,000 wage and salary workers have been employed.

II.2.4. CONSTRUCTION

Construction includes three SIC categories: Building Construction, Heavy Non-building Construction, and Special Trade Contractors. Commercial, industrial, and residential building all serve as indicators of the strength of the economy. Construction, particularly Building Construction, is firmly tied to the rest of the economy; the link between the creation of new jobs and the demand for new housing is well documented as is the link between economic growth and the demand for commercial and industrial space. Heavy construction, primarily public works and utilities, is less sensitive to business cycles but will be one of the first sectors to react to changes in government spending on infrastructure.

Construction employment in California rose in 1994 for the first time since 1989. Nearly 20,000 jobs were added in 1994, for a 4.4 percent annual increase. This upturn reflects an increase in home-building and public-works construction. In 1992, Construction had the 13th largest income subject to state corporate taxes.

II.2.5. FOOD PROCESSING

Food Processing includes those industries that are engaged in the processing of all food and kindred products. Food Processing is the State's largest non-durable goods manufacturing industry. In 1992, Food Processing supplied approximately 182,600 jobs, which represents a high for the industry for the 1984–1994 time period. In 1992, Food Processing was the third largest employer in the State. Employment in the industry has been falling at a rate of 1.6 percent since 1992 for a total of 177,600 employed in 1994. About 75 percent of Food Processing involves production for the local market, such as bakeries, dairies, and bottlers. Nevertheless, the 1992 IMPLAN ranks Food Processing as the second largest export industry for the State in 1992. The 1992 IMPLAN estimates industry output at $37 billion (tenth largest in the State for 1992), value added at $12 billion, and employee compensation at approximately $6 billion. Food Processing was not among the 12 largest corporate taxpayers for 1992.

II.2.6. TOBACCO, ALCOHOL, AND HORSE RACING

Though Tobacco, Alcohol, and Horse Racing production represents minor economic activity in California, they are differentiated as a separate sector because of the special taxes that are applied to these products. The 1992 IMPLAN estimates the value of production for these combined industries at $5 billion, approximately .39 percent of the State's total gross domestic product (GDP). Employment is estimated at roughly 25,000 workers. Taxes levied on these industries generated almost 2.1 percent of California's tax revenue (1.9 percent in 1994). In DRAM, taxes on these three industries are accounted through this one combined sector.

II.2.7. APPAREL

The Apparel industry is one of the State's largest manufacturing employers. In 1992, the industry supplied 139,900 wage and salary jobs and was the fifth largest manufacturing employer. Employment in the apparel industry has been increasing since 1985 and realized a 4.3 percent increase in 1993–94. Almost 70 percent of the industry's employment is concentrated in misses' outerwear. The 1992 IMPLAN estimates industry output at $10.5 billion, value added at $4.5 billion, and employee compensation at $3.0 billion. Not only is Apparel a large sector but it also has been one in which shifting trade patterns threaten to remove many California jobs. Industries that operate "at the margin" in the face of imports are of particular interest when modeling regional tax policy.

II.2.8. CONSTRUCTION-ORIENTED MANUFACTURING

Construction-Oriented Manufacturing includes four SIC categories: Lumber and Wood Products; Furniture and Fixtures; Stone, Clay, Glass, and Concrete; and Fabricated Metals. The strength of Construction-Oriented Manufacturing is directly linked with that of the primary construction sector. Improvements in construction activity signal growth in employment in lumber, stone-clay-glass, furniture, and fabricated metals. Recent growth in California construction activity has translated into an upward trend in employment in Construction-Oriented Manufacturing. This sector employed 256,100 people in 1992. The 1992 IMPLAN estimates industry output at $31 billion, value added at $14 billion, and employee compensation at $9 billion. Construction-Oriented Manufacturing was also the fourth largest export industry in the State in 1992.

II.2.9. PAPER, PRINTING, AND PUBLISHING

In 1992, Paper Products supplied 39,700 jobs while printing and publishing supplied 157,700. In 1992, the printing and publishing sector was the fourth largest manufacturing employer. Both Paper and Printing are primarily population serving industries that grow or contract in response to changes in the State's population, nevertheless, Paper and Publishing was the seventh largest export industry in the State for 1992. The 1992 IMPLAN estimates industry output at $25.5 billion, value added at $12.5 billion, and employee compensation at $7.7 billion.

II.2.10.CHEMICALS AND RELATED PRODUCTS

Chemicals and Related Products includes Chemicals and Allied Products (such as industrial inorganic chemicals, plastics, drugs, soaps, paints, and agricultural chemicals), Petroleum and Coal Products (other than petroleum refining), and Rubber and Miscellaneous Plastics Products (such as tires and footwear). Employment in Chemicals and Related Products has been fairly stable; in 1992 employment was 144,900 and slightly declined to 144,200 in 1994. The 1992 IMPLAN estimates industry output at $28.7 billion, value added at $12 billion, and employee compensation at $6 billion. In terms of the value of output, Chemicals and Related Products was ranked 18th in 1992 but, in terms of reported taxable income, this industry was ranked 12th. Sales of Chemicals and Related Products were just about equally split between the California domestic market and exports, and this industry was rated 10th for export earnings in 1992.

II.2.11. PETROLEUM REFINING

California depends on petroleum for 50 percent of its energy needs, and virtually all of the petroleum products consumed in California are refined in California. During the last 10 years, petroleum consumption in the State has increased 0.4 percent per year but is expected to increase more slowly as more fuel-efficient, less-polluting vehicles replace older models (use of motor gasoline accounts for approximately 60 percent of the State's petroleum consumption). Employment in the California Petroleum Refining industry has been steadily decreasing for at least the last decade. In 1984, there were 25,700 wage and salary workers in this industry, 22,300 in 1992, and 18,700 in 1994. The 1992 IMPLAN estimates industry output at $26.4 billion, value added at $5.5 billion, and employee compensation at $1.7 billion. In DRAM, California's fuel tax will be accounted for through the Petroleum Refining industry.

II.2.12. ELECTRONIC TECHNOLOGY

The Electronic Technology classification delineates the primary high-tech electronic industries. These include four SIC categories: Computers and Office Equipment, Communications Equipment, Electronic Components and Accessories, and Laboratory and Measuring Instruments. The last several years have seen strong increases in the demand and production of computers and electronic components. However, in recent years, the strong performance of the industry has not been matched by increases in industry employment in California. Increased sales of the past few years have been largely fueled by falling prices and increasing efficiencies within the industry. Electronic Technology employment has declined steadily from 1984 to 1994. In 1988, employment in Electronic Technology was 344,600 wage and salary jobs. By 1992, this was 310,300, and by 1994 this had fallen to 293,400. Recently there has been some increase in Electronic Technology employment. In March, 1995, employment was up 2.8 percent from the previous year. Electronic Technology remains the largest manufacturing employer in the State.

The 1992 IMPLAN estimates industry output at $45 billion, value added at $22 billion, and employee compensation at $15 billion. In terms of the value of gross output, Electronic Technology was the 11th largest industry in the State in 1992. This industry also supplies a large number of wage-premium jobs and approximately 40 percent of industry production is exported out of California. The 1992 IMPLAN ranks Electronic Technology as the sixth largest export industry for 1992.

II.2.13. AEROSPACE

The Aerospace category represents the second largest high-tech industry in California. It includes three SIC categories: Aircraft and Parts; Guided Missiles and Space Vehicles; and Search, Detection, and Navigation Equipment. Like Electronic Technology, the Aerospace industry has a large number of wage-premium jobs, and exports from Aerospace are even larger than for Electronic Technology. Approximately 76 percent of Aerospace production is sold outside of the State, and it was ranked second in the State for export earnings in 1992. The 1992 IMPLAN estimates industry output at $47.2 billion, value added at $21.5 billion, and employee compensation at $16 billion. In terms of value of gross output, Aerospace was ranked 10th in the State in 1992.

Peak employment in the Aerospace industry was reached in 1988 with over 380,000 jobs. Since then, employment in Aerospace has declined sharply. By 1995, employment had dropped by over 50 percent of the 1988 level. There is some hope that the worst of the job hemorrhaging in Aerospace is over. By early 1995, the average monthly job loss for the industry, which peaked at 5,000 to 6,000 jobs in the first half of 1993, had slowed to 1,000 jobs per month. However, with continued cuts in federal military spending and the shift away from the advanced technology systems in which California specializes, the outlook is for continued decline in Aerospace employment for the next several years.

II.2.14. MOTOR VEHICLES

Motor Vehicles was delineated as a separate industry in the original industrial sectoring in order to account for motor-vehicle fees and registration. During the course of development of DRAM, it became apparent that having a separate sector for motor vehicles was not essential due to its decline in share of industrial output in California and the decision to exclude consideration of most stocks in the model. In future enhancements of DRAM, this sector will be considered for merging with Other Manufacturing. In 1992, value added for Motor Vehicles was approximately $3 billion and employees compensation was approximately $1 billion.

II.2.15. OTHER MANUFACTURING

The Other Manufacturing industry includes seven SIC categories: Textile Mill Products, Leather, Primary Metals, Machinery and Equipment, Transportation Equipment, Instruments, and

Miscellaneous Manufacturing. The 1992 IMPLAN estimates the value of industry output at $60.7 billion, value added at $24 billion, and employee compensation at $16.9 billion (these figures include motor vehicles).

II.2.16. TRANSPORTATION

The Transportation industry includes six SIC categories: Railroads, Transit and Interurban Passenger Busses, Motor Freight, Water Transportation, Pipelines (except natural gas), and Transportation Services. Employment in the industry has been declining for the last few years. In 1992, approximately 450,000 people were employed in Transportation. In 1994, jobs in trucking increased by three percent, but airlines and utilities continued to lose employment. The general decline in employment in the industry has been attributed to restructuring of the air industry (triggered by the success of low-cost/low-fare carriers), and to a more competitive regulatory environment. The 1992 IMPLAN estimates industry output at $43.6 billion, value added at $22.8 billion, and employee compensation at $15.7 billion.

II.2.17. COMMUNICATIONS

Employment in the Communications industry was approximately 153,000 wage and salary employees in 1992. Employment in the industry declined by 2.3 percent in 1993 and then remained unchanged in 1994. Growth within the industry has been led by the cellular communication industry. The 1992 IMPLAN estimates industry output at $20 billion, value added at $14.3 billion, and employee compensation at $7 billion. In terms of the value of gross output for 1992, Communications ranked 21st in the State but generated the sixth largest reported taxable income.

II.2.18. UTILITIES

The Utility industry includes Electric, Gas, and Sanitary Services. In 1992, employment in the industry was 88,500 salary and wage employees. From 1992 to date, employment in the Utility industry has been falling—a trend that is expected to continue as large utilities make cuts in their work force. The 1992 IMPLAN estimates industry output at $28.7 billion, value added at $13.7 billion, and employee compensation at $4.8 billion. In terms of the value of gross output for 1992, Utilities ranked 19th in the State but generated the seventh largest reported taxable income.

II.2.19. WHOLESALE TRADE

Employment in Wholesale Trade rose by 1.4 percent in 1994 after three years of decline. In 1992, the number of jobs in Wholesale Trade was 713,500 and, by 1994, this number had fallen to 696,300. Despite the decline in employment in the industry, Wholesale Trade continues to be the sixth largest major-industry employer. The 1992 IMPLAN estimates industry output at $64 billion, value added at $48 billion, and employee compensation at $30.4 billion. In terms of the value of gross output for 1992, Wholesale Trade ranked seventh in the State and reported the second highest net income subject to state corporate taxation. Wholesale Trade was also ranked as the ninth largest export industry for 1992.

II.2.20. RETAIL TRADE

The Retail Trade category includes Building Materials, General Merchandise, Food, Automotive and Gas Stations, Apparel, Home Furniture, Eating and Drinking Establishments, and Miscellaneous Retail. Retail Trade is the second largest employer in California. As a major industry grouping, Retail Trade surpassed Manufacturing in 1987 as the second largest employer in the state (after Services). From 1990 to 1994, Retail Trade employment declined from 2,223,800 to 2,125,000. In

1992, employment for the industry was approximately 2,121,400. Retail sales increased by 6.1 percent in 1994, and it is expected that sales should continue to improve, bringing employment with them. Overall taxable sales are expected to rise by four percent in 1995 and 6.5 percent in 1996. The 1992 IMPLAN estimates Retail Trade output at $95.3 billion, value added at $70 billion, and employee compensation at $43 billion. In terms of the value of gross output for 1992, Wholesale Trade ranked second in the State and reported the fourth highest net income subject to state corporate taxation.

II.2.21. BANKING

The Banking industry is composed of depository institutions and non-depository credit institutions. As a whole, Banking has recently experienced large job losses due to mergers, consolidations, automation, and cost-cutting measures. From 1992 to 1993, employment in Banking dropped from 374,500 jobs to 368,100, a 1.7 percent drop. This drop is part of the long-term decline in Banking employment that began with the recession in 1989 and has continued to date (March, 1995, reports).

Like manufacturing industries, Banking is subject to Bank and Corporation taxes and, in 1992, Banking reported the third highest income subject to state franchise taxes. For the same year, the value of gross output in Banking was the tenth largest in the State. The 1992 IMPLAN estimates industry output at $34.8 billion, value added at $16.5 billion, and employee compensation at $13.9 billion.

II.2.22. INSURANCE CARRIERS

This industrial section includes carriers of insurance of all types, including reinsurance. As specified in the SIC codes, agents and brokers dealing in insurance and organizations rendering services to insurance carriers or to policyholders are not included in the Insurance Carriers category (see Other). Insurance employment was 227,300 wage and salary employees in 1992. The Insurance industry experienced large losses in California in 1992 leading to job losses in the industry though 1995. This drop was probably part of the long-term decline experienced by the finance sector since 1989. The 1992 IMPLAN estimates industry output at $24 billion, value added at $8.4 billion, and employee compensation at $7.4 billion. Insurance is taxed separately from Banks and Corporations and, in 1992, the insurance gross premium tax accounted for 2.26 percent of the total State budget (1.8 percent in 1994).

II.2.23. REAL ESTATE

As specified in the SIC Manual (1994), the Real Estate industry includes real estate operators, owners and lessors of real property, buyers, sellers, developers, agents, and brokers. Like other members of the financial sector, Real Estate began to experience a decline in employment after a pre-recession peak in 1989. Unlike the other financial sector members, real estate had a slight increase in employment in 1994 (1 percent). In 1992, employment in Real Estate was 192,500 and, in 1994, it was 190,700. The reason for the upturn in Real Estate was the long awaited increase in residential sales in 1993–1994. This increase indicates that low interest rates and population growth in California were finally complemented by an increase in employment and income. The 1992 IMPLAN estimates industry output at $75.3 billion, value added at $55.5 billion, and employee compensation at $5.5 billion. In terms of the value of gross output for 1992, Real Estate ranked fourth in the State and reported the 11th highest net income subject to state corporate taxation.

II.2.24. OTHER FINANCE, INSURANCE, AND REAL ESTATE

The Other Finance industry includes three major groups: (1) establishments engaged in the underwriting, purchase, sale, or brokerage of securities and other financial contracts on their own account or for the account of others and exchanges, exchange clearinghouses, and other services allied with the exchange of securities and commodities; (2) establishments, agents, and brokers dealing in insurance and organizations offering services to insurance companies and policyholders; and (3) investment trusts, investment companies, holding companies, and miscellaneous investment offices (classifications according to SIC Manual, 1989). The 1992 IMPLAN estimates that this sector generated a gross output of $16.3 billion in 1992 and employed approximately 193,000 people.

II.2.25. BUSINESS-RELATED SERVICES

Business-Related Services include four SIC categories: Agricultural Services, Business Services, Legal Services, and Engineering and Accounting Services. So defined, Business-Related Services was the largest service employer and the largest single industry in terms of value of gross output for 1992. The recent growth in Business Services has been slanted toward growth in temporary employment agencies and toward the practice of employee "leasing" through business-service firms. The 1992 IMPLAN estimates that Business-Related Services supplied approximately two million wage and salary jobs in 1992 and produced an output valued at approximately $116.5 billion, a value added of approximately $81.6 billion, and an employee compensation of approximately $53 billion. Business Services reported the eighth highest net income subject to state corporate taxation in 1992.

II.2.26. HEALTH SERVICES

Health Services is the second largest employer of the service industries. However, since 1992, Health Services has had an employment growth rate of less than one percent. In 1992, 820,200 wage and salary workers were employed in Health Services. By 1994, this number had risen only to 832,800. Slow employment growth in the industry is attributed to cost-containment efforts throughout the industry. The 1992 IMPLAN estimates Health Services output at $63.2 billion, value added at $49 billion, and employee compensation at $33.4 billion. In terms of the value of gross output for 1992, Health Services ranked eighth in the State, but did not rank in the top 12 corporate taxpayers for 1992.

II.2.27. ENTERTAINMENT SERVICES

Entertainment Services includes two SIC categories: Motion Pictures and Amusement and Recreation. From 1992 to 1993, these two industries had the highest employment growth rates for the entire service industry. In one year Motion Picture employment grew by 12.0 percent and Amusement and Recreation employment grew by 3.9 percent. From 1993 to 1994 these industries again posted the highest rates of growth. In this year, Motion Picture employment grew by 7.8 percent and Amusement and Recreation employment grew by 4.8 percent. Despite the high rates of employment growth, Entertainment Services are still a relatively small employer, employing only 312,200 wage and salary workers in 1992. Nevertheless, the fact that average salaries in Motion Pictures are among the highest in the State and that the industry's export earnings are high in proportion to total output warrant creating a separate industry for DRAM. The 1992 IMPLAN estimates Entertainment Services output at $34.6 billion, value added at $20.5 billion, and employee compensation at $11.6 billion. Entertainment Services was the fifth largest industry in terms of export earning for 1992 (IMPLAN 1992).

II.2.28. OTHER SERVICES

Other Services include Personal Services, Hotels, Automobile Services, Miscellaneous Repair Services, Educational Services (non-governmental), Social Services, Museums, Galleries, Zoos, Membership Organizations, Private Households, and Miscellaneous Services. The 1992 IMPLAN estimates Other Services output at $68.5 billion, value added at $36.8 billion, and employee compensation at $25 billion.

II.3. THE FACTOR SECTORS

A factor of production is a stock that generates a flow of services used in the production of goods and services. In a SAM, value added is distributed through the factors of production to household owners of factors. Factor markets define many of the results of a CGE model and its ability to reflect reaction to policy change. The two factors of production have been sectored out for DRAM: Labor and all other factors aggregated into "Capital."

The IMPLAN's 1992 value-added data formed the starting point for distributing factor payments. Additional information on the levels of factor payments are taken from personal income data used by DOF in its econometric simulation model. These data come from ES202 data collected from payroll records. The industrial aggregation for factor payments in these data is much greater than for DRAM, so IMPLAN shares for these larger aggregations are used to distribute labor and capital payments across DRAM's sectors.

In DRAM, the total value added allocated to Labor is $480.919 billion and to Capital, $204.249 billion.

II.4. THE HOUSEHOLD SECTORS

Households have a number of functions in the economy: they receive income from value added; they consume goods and services and save and invest; and they pay taxes. In the sectoring of households for the SAM, each of these functions must be represented. However, because Senate Bill 1837 specifies that a complete dynamic analysis must examine taxpayers' behavioral response to changes in taxes, the primary criterion for household sectoring is household tax status. For DRAM, seven household sectors are delineated. These sectors correspond to the seven marginal tax brackets specified in the California tax code for 1996.

Sectoring of households according to their primary wage earner's marginal tax bracket not only distinguishes the households for tax purposes but it also results in a grouping of households according to income levels. A grouping of households by income allows the modeler to distinguish consumption and income patterns between income levels. The household sectoring was accomplished using the Franchise Tax Board stratified sample data to obtain the distribution of wages and other income by marginal tax rate for California Personal Income Tax data for 1993. This information was used to produce a percentage distribution of factor payments generated by industrial and government sectors to the seven household groups. IMPLAN uses Consumer Expenditure Survey data to obtain consumption distribution percentages for triciles of household incomes. These patterns of expenditure were applied to the seven household groups by assigning the lowest two to IMPLAN's first tricile, the middle three to IMPLAN's second, and the remaining two to IMPLAN's highest tricile. Each of the seven household sectors are discussed in detail below. The sectors are delineated by marginal tax rate so that sector "9.3 MT" delineates the household group subject to a marginal tax rate of 9.3.

II.4.1. 9.3MT HOUSEHOLDS

These are the highest taxable income earners in California and span a group of households from $80,000 taxable income to the highest income group in Franchise Tax Board's (FTB) "stratified" sample who average about $10 million of taxable income (this last group has a lower bound of $5 million). About 12 percent of California's working households are in this group, they earn about 43 percent of incomes in California and pay almost 70 percent of the California Personal Income Tax revenues.

For this household sector, income is derived from wages, returns to capital, land and entrepreneurship, and modest pension and other incomes. These households are the focus of much of the California government's interest in tax reduction policy because it is believed that these households dominate the entrepreneurial activities of the State.

II.4.2. 8.0MT HOUSEHOLDS

This group spans households who averaged about $65,000 gross income in FTB's stratified sample. About four percent of California's working households fall into this group. They earn over seven percent of incomes in California and pay six percent of the California Personal Income Tax revenues. While less a focus of the California government's interventionist policies, these households are believed to be substantial contributors to the entrepreneurial activities of the State.

II.4.3. 6.0MT HOUSEHOLDS

This group spans households who averaged about $50,000 of gross income in FTB's stratified sample. About 15 percent of working households in California fall into this group. They earn 20 percent of incomes in California and pay 14 percent of the California Personal Income Tax revenues.

II.4.4. 4.0MT HOUSEHOLDS

This group spans households who averaged about $34,000 gross income in FTB's stratified sample. About 13 percent of working households in our model are in this group. They earn 12 percent of incomes in California and pay six percent of the California Personal Income Tax revenues.

II.4.5. 2.0MT HOUSEHOLDS

This group spans households who averaged about $20,000 gross income in FTB's stratified sample. About 24 percent of working households in California fall into this group. They earn less than about 13 percent of incomes in California and pay less than four percent of the California Personal Income Tax revenues.

II.4.6. 1.0MT HOUSEHOLDS

This group spans households who averaged just over $7,000 in FTB's stratified sample. Just over 30 percent of households in the model fall into this group. They earn about six percent of incomes in California and pay less than one percent of the California Personal Income Tax revenues.

It is interesting to note that, on average (in 1993), households in this group pay about $15 in personal income taxes.

II.4.7. 0.0MT HOUSEHOLDS

This group includes working households who earn no taxable income (i.e., deductions exceed incomes) and many of the households who receive incomes without participating in the labor market.

II.5. THE INVESTMENT SECTOR

Investment in economic theory is a purchase of goods and services augmenting the capital stock. Capital stocks by industry are imputed for DRAM by assuming that the economy was initially in equilibrium and by using IMPLAN's estimates of payments to capital and published values for average rates of return by industry. Assuming a three percent depreciation rate, a gross investment value by destination of investment for the 28 industrial sectors of DRAM is imputed.

These estimates of imputed gross investment are combined with an industry share matrix calculated from the most current (1982) BEA matrix of capital purchases by source and destination for the United States. Combining the share matrix, which identifies how a dollar of gross investment made by an industry is distributed across the source industries, with the imputed gross investment estimates resulted in a matrix of investment demand by source.

A series of assumptions are incorporated in the DRAM investment calculations. To the extent that the economy is not in equilibrium in the base year, the levels of investment will be misrepresented. To the extent that the distribution of investment sources has changed since 1982, further misrepresentation is introduced. However, the gains from reflecting with precision how an investment decision in one sector results in investment demand in other sectors would appear to outweigh these potential sources of error.

The investment estimates used in DRAM favorably compare with other estimates of investment demand in California. For DRAM, investment demand from the construction sector is estimated at about $28 billion. The IMPLAN's value for this is $53 billion. Estimates from the BEA place the total output of the Construction industry in California just over $30 billion. Clearly, the method used for DRAM delivers a more realistic investment demand value for this major source of investment demand.

II.6. THE GOVERNMENT SECTORS

The primary purpose of DRAM is to analyze the dynamics of California state revenue. However, DRAM must account for government expenditure in order to trace any feedback effect to state revenue from changing demand for goods, services, and factors as expenditure changes. Further, some elements of government are mandated to change their expenditures as their revenue changes (such as Cal Trans) and the State's distribution of expenditure changes as its General-Fund revenues change (Proposition 98).

As a result of these considerations, government sectors must be organized so that both revenue flows and expenditure flows can be traced explicitly. The major government revenues are taxes, sales of services, and intergovernmental transfers. The major government expenditures are the purchase of goods and services, transfer payments to households, and intergovernmental transfers. Federal, state, and local governments all engage in revenue collection and expenditure, and all three levels of government are represented in DRAM. California state government revenue and taxation receive the greatest scrutiny while federal and local governments are held primarily exogenous to the model.

For DRAM, 36 government sectors representing federal, state, and local governments have been created. This sectoring allows the modeler to trace explicitly the major government expenditure and revenue flows. A description of the criteria and sectoring for each level of government follows.

II.6.1. FEDERAL-GOVERNMENT SECTORING

In order to model the federal government for the purposes of DRAM, seven federal government sectors are created: five to account for federal government revenue flows and two to account for federal government expenditure flows. The primary sources of revenue for the federal government are summarized in the following table.

Table II-8. Federal Government Revenue (in million $)

	1990	1991	1992	1993	1994 Est.
Personal Income	466,684	467,827	475,964	509,680	549,901
Corporation Income	93,507	98,086	100,270	117,520	130,719
Social Insurance	380,047	396,016	413,689	428,300	461,923
Excise Taxes-Federal Use	15,591	18,275	21,836	24,522	28,672
Excise Taxes-Trust Funds	19,754	24,127	23,733	23,535	25,878
Estate and Gift Taxes	11,500	11,138	11,143	12,577	12,749
Customs Duties	16,707	15,949	17,359	18,802	19,198
Federal Reserve Deposits	24,319	19,158	22,920	14,908	15,847
Total	1,031,321	1,054,272	1,090,453	1,153,535	1,249,071

Source: U.S. Bureau of the Census, 1994, Table 505, p. 331.

Federal government expenditure is divided into two sectors to separate the pattern of defense expenditures (goods and service acquisition from particular sectors and rental of labor) from the rest of the federal government's expenditures in California (transfer payments to individuals, intergovernmental transfer payments, purchases of goods and services, and factor rentals).

Note that most elements of the federal government are exogenous to DRAM. Taxation rates, purchases of goods and services, and rental of factors are fixed in real terms, though nominal expenditures are allowed to change in response to prices. Transfer payments to individuals (Social Security and federal pensions) are fixed in per-household nominal terms with the number of households receiving these a fixed fraction of non-working households derived from analysis of tax sample data. The federal government sectors are described in detail below.

SOCIAL SECURITY (USSOC)

This is the social-security component of federal revenues. The primary source of payments made by industries, households, and other governments to USSOC is DOF personal income data estimates. The primary source of the distribution of payments from USSOC is FTB's stratified tax sample for 1993.

PERSONAL INCOME TAX (USPIT)

This is the personal income tax component of federal revenues. Data for federal personal income taxes are from Internal Revenue Service (IRS) data stratified by FTB staff and made available to DOF. These data are allocated according to DRAM's household types. Discrepancies between federal and state tax tables are accommodated by applying an overall correcting constant to each household type's tax calculation to return estimates of actual taxes received. It is important to note that the model explicitly accounts the deductibility of state and local taxes from federal incomes subject to taxes. The FTB-supplied average rates of itemizing deductions are used for each household type.

CORPORATION TAX (USCOR)

This is the corporation tax component of federal revenues. The California Statistical Abstract (1995) provides data concerning federal returns from California. This source reveals income tax data for

1994 federal fiscal year and is updated to the current year of the model. Industry aggregation of these data is accomplished with summary data supplied by the FTB.

DUTIES (USDUT)

This is the import duty tax component of federal revenues. Import and export data for regional economies are quite poor in detail. One major problem with the data is the lack of ability to distinguish which items are simply passing through the state en route to a final destination. The latest data currently available are from the 1992 IMPLAN. This data is problematic due to the level of aggregation and requires much refinement (albeit imperfect). Import duty estimates in total are updated and distributed by category of good or service using IMPLAN import data.

MISCELLANEOUS (USMSC)

This is the miscellaneous tax component of federal revenues. All other federal taxes are grouped into the miscellaneous component. Of this aggregation, excise taxes on tobacco, alcohol, and liquid fuels are the major taxes. Excise taxes on liquid fuels are assigned to the industrial sectors PETRO and ALTOH. The remainder are distributed across the rest of the industrial sectors by their percentage share of domestic demand.

FEDERAL NONDEFENSE SPENDING (FEDNO)

This sector accounts for federal non-defense spending and receives its income from USPIT, USCOR, and USMSC. Its expenditures are of two kinds: purchases of goods and services combined with rentals of factors and intergovernmental transfers to FEDDE (defense spending), California expenditure units, and local expenditure units. Patterns of expenditures shown in IMPLAN data are applied to updated expenditure totals to arrive at the first kind of expenditure. Published summaries of local government revenue and expenditure combined with the State's budget summary identifies the destination of all but FEDDE transfers. The FEDDE transfers are made equal to FEDDE expenditures.

While not fully implemented at the federal level, it is assumed that all intergovernmental transfers from the federal government to California and local governments are "block grants." Given the indirect relationship between liquid fuels taxes and transfers for transportation and the thrust at the federal level to turn all health and human services into block grants, this seems a reasonable assumption. In making this assumption, any connection between economic activity in California and federal grants to California and local governments is ignored.

FEDERAL DEFENSE SPENDING (FEDDE)

This sector accounts for federal defense spending. Shares of defense spending by industrial sector and factor are taken from IMPLAN and applied to published estimates of defense spending in California. An intergovernmental transfer from FEDNO to FEDDE is established to equal the total of expenditures.

II.6.2. STATE GOVERNMENT SECTORING

In order to model the California State government for the purposes of DRAM, 21 state government sectors are created: 15 to account for government revenue flows and six to account for government expenditure flows.

Table II-9. California Government Revenue Budgets, 1995-96 (in million $)

	General fund	Special fund	Total
Alcoholic Beverage Tax and Fees	266	0	266
Bank and Corporation (Income) Taxes	5,680	1	5,681
Cigarette Tax	166	478	644
Horse Racing (Pari-mutuel) License Fees	69	38	106
Estate, Inheritance and Gift Tax	543	0	543
Insurance Gross Premium Tax	1,139	0	1,139
Trailer Coach License (In Lieu) Fees	36	0	36
Motor Vehicle License (In Lieu) Fees	0	3,258	3,258
Motor Vehicle Fuel Tax (Gasoline)	0	2,448	2,448
Motor Vehicle Fuel Tax (Diesel)	0	360	360
Motor Vehicle Registration	0	1,607	1,607
Personal Income Tax	20,220	0	20,220
Retail Sales and Use Tax-Realignment	0	1,593	1,593
Retail Sales and Use Taxes	15,545	169	15,714
Regulatory Taxes and Licenses	114	1,637	1,751
Revenue from Local Agencies	308	169	477
Services to the Public	42	842	883
Use of Property and Money	373	179	552
Miscellaneous	198	245	442
Total	44,698	13,023	57,722

Sources: California State Budget Summary, DOF, 1996-97, Schedule 8.

State revenues are collected into three types of funds: the General Fund, Special Funds, and Non-governmental Funds. The General Fund is the largest government accounting unit. Most taxes and fees that are collected without a specific expenditure allocation are deposited into the General Fund. Revenue collected from special taxes, fees, or revenue designated to a specific expenditure destination are collected through Special Funds. Non-governmental funds are managed by the State of California but are off-budget items. Two non-governmental funds (unemployment/disability insurance and workers' compensation) are explicitly modeled in DRAM. State revenues are also augmented by federal funds. These are a source of income for California but are counted as inter-government transfers. All California state government revenue details are extracted from the California State Budget Summary, DOF, 1995–96, Schedules 8 and 2.

The units for California revenue and expenditure are best summarized in table form, with the first table identifying the sources of revenues and the second, how expenditures are grouped in DRAM.

Table II-10. California Revenue-Receiving Units in DRAM

DRAM sector	Name	Major revenue source(s)
CAENE	Energy Mining	State Land Royalties Rental of State Property Federal Land Royalties
CAOPR	Other Primary	State Land Royalties Rental of State Property Federal Land Royalties
CAINS	Insurance Tax	Insurance Gross Premiums Tax
CAMVS	Motor Vehicles	Trailer Coach License (In Lieu) Fees Motor-Vehicle License (In Lieu) Fees Motor-Vehicle Registration
CAGAS	Gasoline (Includes Special Fuels)	Motor-Vehicle Fuel Tax (Gas) Motor-Vehicle Fuel Tax (Diesel)
CALSU	Sales & Use Tax	Retail Sales and Use Taxes Retail Sales and Use Tax-Realignment
CABAC	Bank & Corporation	Bank & Corporation (Income) Tax
CAUDI	Unemployment Insurance	Compensation Insurance Fund
CALWC	Disability Insurance	Unemployment Compensation Disability Fund
CAPIT	Personal Income	Personal Income Tax
CASUF	California State University Fees	California State University Fees
CAINH	Inheritance	Inheritance Tax
CASIN	Alcohol, Tobacco & Horse Racing	Excise Tax on Beer and Wine Excise Tax on Distilled Spirits Cigarette Tax Horse Racing Revenues Liquor License Fees
CAMSC	Miscellaneous	Remaining Revenue
CALGF	General Fund	Other State Revenue Units Investment

Source: Governor's Budget Summary, Fiscal Year 1994-95.

Table II-11. California Expenditure Units in DRAM

Model Sector	Major departments	Major sources of revenue	Expenditure
CATRA	Cal Trans, CHP	Highway Users Taxes Motor-Vehicle Fees	Engineering Services Construction Transfers to Local Gov'ts
CACOR	Youth and Adult Correction Agency	General Tax Revenue	Labor Goods & Services
CAK14	Education	General Tax Revenue	Transfers to Local Gov'ts
CAOED	Higher Education	General Tax Revenue	Labor Goods & Services
CAHAW	Health and Welfare	General Tax Revenue Transfers from USA	Transfers to Households and Local Gov'ts
CAOTH	Legislative, Judicial, Executive, State and Consumer Services, Business, Housing, Trade and Commerce, Resources, General Government	General Tax Revenue Special Funds subvened to Local Governments	Rental of Factors Goods & Services Transfers to Local Gov'ts

Source: Governor's Budget Summary, Fiscal Year 1994-95.

One revenue account, CALGF, deserves special mention. This account receives transfers from revenue units according to proportions reported in the Budget Summary. It transfers its revenues to expenditure units according to three guiding principles. The first is the application of Proposition 98 in either its Test 2 or Test 3 forms. When Test 2 is applied, a transfer from CALGF to LOK14 education is made in amounts proportionate to previous transfers updated by changes in average daily attendance and per-capita personal income. Test 3 mandates a transfer in proportion to changes in average daily attendance and per-capita General-Fund revenues. Without belaboring the details of Proposition 98, the choice of Test 2 or 3 is more of a public choice decision than an economic one. The DRAM accounts for these flows and can accommodate either decision.

For each expenditure unit, published summaries of expenditures are consulted to obtain the most precise distribution of these expenditures across DRAM's industry, factor, and household sectors. Where published data are inadequate in disaggregating expenditures (particularly in the area of purchases of goods and services other than Construction), IMPLAN shares of expenditures for appropriate governmental units are used.

II.6.3. LOCAL GOVERNMENT SECTORING

Because local governments are exogenous to our model, their level of detail in DRAM is minimized. As with federal units, the major sources of local revenue and expenditures from published reports (relying generally on the series of *Financial Transactions Concerning...* annual reports issued by the Controller's Office for Cities, Counties and other local governmental units) are identified. The local revenue sources fall into four categories: property taxes, fees, miscellaneous revenues, and intergovernmental transfers from the federal government and California. The sectoring of local government revenue agencies reflects these sources. Local government expenditure agencies are sectored according to expenditure on transportation, corrections and legal affairs, education, health and welfare, etc. A description of each of the local government sectors is given below.

LOCAL PROPERTY TAX (LOPRP)

Many local entities, such as counties, cities, and special districts, have the legal authority to levy taxes on certain real property. With the advent of tax reform in the 1970s (such as Proposition 13), these revenues have fallen to about a quarter of local government revenues. For Fiscal Year 1995–96, these revenues are estimated at approximately $19 billion.

Given more developmental time for DRAM, the value of property stock in the model by industry and household would have been included. Thus, the relationship between economic activity and local government revenues could have been reflected more closely. However, since the taxed value of property has a limited relationship to market prices and since no data appear to exist to properly identify the value of real estate by industry or household type, the overall level of property tax revenue by all local governments is identified and treated as a per-working household tax and as an excise tax on business. The per-household rate is set proportionate to incomes in the base data but not allowed to vary in the model from these levels. This design merits further work in future enhancements of DRAM. The excise tax is distributed by domestic demand in the model, excluding industries not subject to the property tax.

LOCAL FEES (LOFEE)

In response to Proposition 13, many governments have raised fees to maintain revenues. In fact, they raise about $1.50 in fees for each $1.00 in property taxes (a total of almost $28 billion for 1995–96). Some of the new fees are collected from services rendered that may have been provided previously from property tax revenues, such as garbage collection and recycling programs. Additionally, as land prices have increased developer's fees have risen in response to demand for infrastructure, such as roads and utility hookups. Fees have grown to be the second largest share of local revenues, second only to intergovernmental transfers. Unfortunately, there is little in the way of sectoral breakdown of the sources of these revenues. In DRAM, one-half of the fee amount is collected as an excise tax on industry sales as and the other half as a per-household tax proportionate to initial income levels.

LOCAL MISCELLANEOUS (LOMSC)

Local governments operate some utilities at a profit, generate profits from other business-type activities, and have other minor sources of income. While not a major source of local governmental revenues (about $2.5 billion), these are included as a separate "taxing" authority of local governments. These are distributed across industrial sectors and households in the same manner as LOFEE.

LOCAL TRANSPORATION (LOTRA)

Transportation is a key element of expenditure at the local level. Major sources of the total revenue of over $8 billion are the share of liquid fuels taxes and motor vehicle fees collected by California and remitted for local transportation spending (about $3 billion) and federal transportation-based intergovernmental transfers (about $.5 billion). Other sources of revenue account for only about one-half of the revenue for transportation. Expenditures are distributed using IMPLAN shares for State and Local Non-education where published expenditure data do not distribute these according to DRAM's sectoring.

LOCAL CORRECTIONS (LOCOR)

Local Corrections, including courts, are established to reflect the State's pattern of expenditures. Local corrections expenditures total just over $2 billion and are distributed using IMPLAN shares for State and Local Non-education.

LOCAL KINDERGARTEN THROUGH 14 (LOK14)

The LOK14 expenditures total over $37 billion. Approximately one-half of these expenditures are funded by California intergovernmental transfers that are guided by Proposition 98. The remainder of revenues is from local property taxes and other local revenues. About eighty percent of expenditures are in the form of labor costs, with the remainder distributed using IMPLAN's shares for State and Local Education.

LOCAL HEALTH AND WELFARE (LOHAW)

Local spending for Health and Welfare totals over $25 billion. Almost 60 percent of this is for transfer payments to households, 95 percent of which is financed by transfers from the federal government and California (50 percent and 45 percent shares, respectively). The remaining 40 percent of LOHAW expenditures covers a variety of programs, with spending on health care predominating. Expenditures are distributed using IMPLAN State and local Non-education shares.

LOCAL OTHER (LOOTH)

The remainder of local governments is aggregated into this local Other grouping. Policing, Fire, Utilities, Refuse and Parks and Recreation form the majority of this sector. Revenue and expenditure not specifically allocated to other local governments and identified in published reports is allocated to LOOTH. Expenditures of $50 billion exceeds income by about $7 billion. It is assumed that this deficit highlights the total of errors that accumulated while assembling data from disparate sources and that local government revenue and expense are roughly in balance. In future enhancements to DRAM, this issue will be explored further to minimize this apparent error or to find support for the deficit identified. Expenditures are allocated to factors and sectors using IMPLAN's State and Local Non-education shares.

II.7. THE REST OF WORLD SECTOR

California has a large, complex economy that maintains trading relationships with other regional economies in the United States and other countries. In DRAM economic activity outside of California is modeled as a single economic unit. Thus, a household in Ohio buying California's oranges is as foreign as a firm in Osaka buying circuit boards built in San Jose. It is assumed that, like in California, households and firms outside California maximize utility and profits. California exports to Ohio or Osaka compete with local production in those economies and with goods and services produced elsewhere in the world.

Finding reliable data for these exports and for imports from the rest of the United States or the rest of the world is not possible. Foreign trade statistics are notoriously weak. Exports from Pacific ports in California are only partially documented as to their original sources, and transshipments through California for export are frequently identified as exports from California. Imports arriving in California's ports are documented even more poorly as to their final destination. Trade between California and the rest of the United States attracts no usable documentation for trade analysis purposes. With the advent of the North American Free Trade Agreement (NAFTA), the already limited documentation of trade between California and two of its three largest bilateral trade partners (Mexico and Canada) is deteriorating.

Faced with weak and unreliable data, DRAM relies on IMPLAN as the primary source for trade data. The IMPLAN contains estimates of interstate and international trade by 528 sectors. These sectors are aggregated into DRAM's 28 industry sectors. Completion of DRAM's SAM involved ad-hoc balancing or the payments to and from the 28 industry sectors using import and export values. Trade equals production minus consumption.

The levels of imports and exports are singularly the weakest and least supportable data of DRAM. Nevertheless, trade levels in the solution to experiments conducted with DRAM evolve in the direction of relative price changes, thus capturing the direction of an experiment's effects on the economy.

II.8.REFERENCES

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III. HOUSEHOLD DEMAND FOR GOODS AND SERVICES

Consumers' choices of what goods and services to buy is the province of the theory of demand. The theory assumes that consumers maximize their utility (sense of well-being) subject to the constraint that they do not spend more money than they have. In its purest form, demand theory assumes that consumers have preferences over all goods and services that they will ever consume. In application, demand theory considers all preferences over current goods and services. This chapter is focused on the choice of current-period goods and services as a function of current-period, personal-consumption expenditure (after-tax, after-savings income) and prices.

The choice to work or consume leisure is not covered in this chapter (see the chapter on labor supply and migration).

The pure theory of demand and common sense both place restrictions on the demand function. First, demand functions must add up. That is, total expenditure on goods and services must equal total income less taxes less savings. Second, an equal percentage increase in income and prices should have no effect on what is purchased. That is, if the prices of all goods and services and income doubled, the quantities demanded should not change. Third, less of a good or service should be demanded if its price rises. While this is intuitive, theory does not demand it and empirical research reveals goods that are price insensitive. Finally, theory asserts that the substitution matrix is symmetric. This is a technical requirement that will not be of concern in this chapter.

Common functional forms used in demand analysis are presented in the next section of this chapter. The forms are presented in order of increasing flexibility, except for the last two that are equally flexible. This issue of flexibility is how much theory is imposed by the choice of form and how much can be tested for later. The more flexible forms have received the greatest recent empirical attention so that they are the ones for which estimates of demand equations for American consumers have been prepared.

III.1. FUNCTIONAL FORMS IN DEMAND

III.1.1. COBB-DOUGLAS

A representative household consumes I types of goods and services. The quantity consumed is called a "consumption bundle," and it is denoted by the vector $\mathbf{c} = (c_1 ... c_I)$. The prices of these goods are the vector $\mathbf{p} = (p_1 ... p_I)$. The consumer's income is y. The level of happiness or utility that the consumer receives from bundle c is $U(\mathbf{c})$. The consumer is assumed to choose his consumption bundle to maximize utility, $U(\mathbf{c})$, subject to the budget constraint, $y = \mathbf{p} \cdot \mathbf{c}$. (The term "$\mathbf{p} \cdot \mathbf{c}$" is an inner product, and it is just the sum of each element of the list of prices, p_i, times each element of the list of consumption amounts, c_i.) The solution to the constrained optimization problem is the set of demand equations, $\mathbf{c}(y,\mathbf{p})$, where consumption is a function of income and prices. If the utility function is Cobb-Douglas, then the demand equations are of the following form

$$\text{(III-1)} \qquad x_i = \lambda_i \frac{I}{p_i}$$

where λ_i is a parameter to be estimated and has the interpretation that it is the share of income expended on good i. This is the simplest of demand functions. The functional form, itself, imposes all of the theoretical desiderata, but it also greatly constrains how consumption can be modeled. The two greatest constraints are the constancy of own-price elasticities across all levels of consumption and the constancy of the share of household expenditure on each good.

Despite these theoretical restrictions, the Cobb-Douglas form is the easiest form to estimate from existing California data and it is the form implemented in the initial versions of DRAM.

III.1.2. LINEAR EXPENDITURE SYSTEM (LES)

The first generalization of the Cobb-Douglas system is the LES system. Letting **m** be the bundle of goods that will be consumed at income $\mathbf{p} \cdot \mathbf{m}$ (called a "subsistence bundle"), the formula for demand is

$$x_i = m_i + \lambda_i \frac{I - \mathbf{p} \cdot \mathbf{m}}{p_i} \qquad \text{(III-2)}$$

The share parameters (λ_i) and the subsistence bundle quantities (m_i) are the parameters to be estimated. This form is a generalization of Cobb-Douglas because additional income need not increase the consumption of every good proportionately. However, this form still imposes the other desiderata of economic theory and so is not general enough to test that theory.

III.1.3. CONSTANT ELASTICITY OF SUBSTITUTION (CES)

The structure of a CES demand can be written as

$$x_i = \frac{\beta_i^{\sigma} p_i^{1-\sigma}}{\sum_{j=1}^{N} \beta_j^{\sigma} p_j^{1-\sigma}} \frac{I}{p_i} \qquad \text{(III-3)}$$

The new notation in this equation is the β_is, which are parameters, and the σ, which is related to the elasticity of substitution. As a functional form for demand, CES is less restrictive than Cobb-Douglas, but is still too restrictive for modern work on the theory of demand Evans (1994).

III.1.4. TRANSLOG

The Translog (or the transcendental logarithmic indirect utility function) is free from the more restrictive assumptions embodied in Cobb-Douglas, LES, and CES functions. While having desirable generality for modern work, it leads to difficult nonlinear estimation and so has been largely passed over in favor of the almost ideal demand system (AIDS) function.

III.1.5. ALMOST IDEAL DEMAND SYSTEM

This system is both flexible and easy to estimate. The AIDS model gives an arbitrary second-order approximation to any demand system. Deaton and Muellbauer (1980) show that it satisfies the axioms of choice, aggregates over consumers without a need to assume parallel Engel curves, and has a functional form consistent with known household budget data. In addition, it is simple to estimate and it can be used to test whether or not demand functions have the desirable properties of homogeneity and symmetry.

DERIVATION OF AIDS

The beginning point for the AIDS model is the expenditure function, $e(u,\mathbf{p})$—the least amount of money needed to reach utility level u when prices are **p**.

The AIDS expenditure function is

$$\ln e(u,\mathbf{p}) = \alpha_o + \sum_k \alpha_o \ln p_k + \tfrac{1}{2}\sum_k \sum_j \gamma^*_{ij} \ln p_k \ln p_j + u\beta_o \prod_k p_k^{\beta_k} \quad \text{(III-4)}$$

Note that the α, β, and $\gamma*$ are parameters.

The demand functions, stated in share of expenditure form, are derived using the fact that the derivative of an expenditure function is Hicksian demand. Differentiating these equations with respect to p_i yields the share equations:

$$\frac{\partial \log e(u,\mathbf{p})}{\partial \log p_i} = \frac{\partial e(u,\mathbf{p}).p_i}{\partial p_i .e(u,\mathbf{p})} = \frac{p_i c_i}{e(u,\mathbf{p})} = S_i \quad \text{(III-5)}$$

where S_i is the share of good i in total expenditure e. Since

$$\frac{\partial \log e(u,\mathbf{p})}{\partial \log p_i} = \alpha_i + \sum_k \lambda_{ij} \log p_j + \beta_o \beta_i u \prod_k p_k^{\beta_k} \quad \text{(III-6)}$$

$$\lambda_{ij} = \tfrac{1}{2}\left(\gamma^*_{ij} + \gamma^*_{ji}\right) \quad \text{(III-7)}$$

Combining these gives Hicksian demand (demand in terms of utility rather than income).

$$c_i = \frac{e(u,\mathbf{p})}{p_i}\left(\alpha_i + \sum_k \lambda_{ij} \log p_j + \beta_o \beta_i u \prod_k p_k^{\beta_k}\right) \quad \text{(III-8)}$$

The inversion of the expenditure function to solve u for income and the fact that income is equal to expenditures gives

$$\ln y = \alpha_o + \sum_k \alpha_k \ln p_k + \tfrac{1}{2}\sum_k \sum_j \gamma^*_{ij} \ln p_k \ln p_j + u\beta_o \beta_i \prod_k p_k^{\beta_k} \quad \text{(III-9)}$$

$$u = \frac{\log y}{\beta_o \prod_k p_k^{\beta_k}} - \frac{\alpha_o + \sum_k \alpha_k \ln p_k + \tfrac{1}{2}\sum_k \sum_j \gamma^*_{ij} \ln p_k \ln p_j}{\beta_o \prod_k p_k^{\beta_k}} \quad \text{(III-10)}$$

Substitution of u into the share equations allows the expenditure shares to be written as a function of income and all prices. Recall that this is also the equation that is usually estimated.

$$\begin{aligned} S_i &= \alpha_i + \sum_j \lambda_{ij} \ln p_j \\ &+ \beta_o \beta_i \prod_k p_k^{\beta_k}\left(\frac{\ln y}{\beta_o \prod_k p_k^{\beta_k}} - \frac{\alpha_o + \sum_k \alpha_k \ln p_k + \tfrac{1}{2}\sum_k \sum_j \gamma^*_{ij} \ln p_k \ln p_j}{\beta_o \prod_k p_k^{\beta_k}}\right) \end{aligned} \quad \text{(III-11)}$$

This simplifies to

(III-12) $$S_i = \alpha_i + \sum_k \lambda_{ij} \ln p_j + \beta_i \ln\left(\frac{y}{P}\right)$$

Here, p is a price index of the form

(III-13) $$\ln P = \alpha_o + \sum_k \alpha_k \ln p_k + \tfrac{1}{2}\sum_k \sum_j \gamma^*_{ij} \ln p_k \ln p_j$$

For estimation purposes, it is often easier to work with a simpler, linearized AIDS model. The linear AIDS model is the share equation and a linear in logs price index

(III-14) $$\ln P = \sum_k S_k \ln p_k$$

In the linear AIDS system, the cross-price elasticities of demand are

(III-15) $$\varepsilon_{ij} = \frac{\lambda_{ij}}{S_i} - \frac{\beta_i S_j}{S_i}$$

ESTIMATION OF AIDS

A large number of authors have used national data on expenditure shares to estimate the AIDS system. Deaton and Muellbauer (1980) use British data to test properties of demand functions. Blanciforti, Green, and King (1986) use American data for much the same purpose, though they have a much greater interest in the resulting demand for food.

The linear AIDS form is the most easily estimated of the general functional forms. The current version of DRAM does not use it because of the mismatch between the sectors in the empirical studies that estimated AIDS and the sectors in DRAM.

III.2. ELASTICITIES OF SUBSTITUTION IN CONSUMPTION

The most comprehensive study of consumer behavior in the United States are performed by Houthakker and Taylor (1970). They estimated demand equations for 82 commodities using a dynamic econometric model and private consumption expenditure data collected by the Department of Commerce and contained in the *Survey of Current Business*. For each of the 82 commodities, Houthakker and Taylor (1970) calculated short- and long-run elasticities at means with respect to price and total expenditures. Although this study is unparalleled in its comprehensiveness, cross-price elasticities between commodities are omitted from the estimates. Moreover, it has become outdated in its industry classification.

Most of the studies on consumer demand, since Houthakker and Taylor’s (1970) study, use fewer commodities. Deaton (1981) estimated an LES for 11 commodities using British data for the period 1954–1974. The 11 commodities include housing, food, clothing, fuel, drink, tobacco, transport/communication, services, and other goods. The results show that only housing and food and housing and transport/communication have cross-price elasticities that are significant. The own-price elasticities range from 0.04 to 0.420.

Barnett (1981) used a household model to estimate demand equations for four commodities: perishables, semi-durables, durables, and services. The data are for United States (1890–1955), and the model used is Constant Slutsky Elasticity. Except for cross-price elasticity between durables and perishables, the other cross-price elasticities are small. In addition to being highly aggregated and, therefore, less useful for our California model, the symmetry conditions usually imposed on the Slutsky matrix is violated. Barnett later imposes the symmetry requirement and most cross-price elasticities disappear.

The estimated elasticities of demand, the estimated own-price elasticity by industry, data used, and sources for a large number of demand studies are shown in the table below. The majority of these studies did not estimate demand systems for more than a single commodity, so there is very little information on cross-price elasticities between sectoral goods. In the few cases in which there are cross-price elasticities, they are typically of a commodity within the same industry.

Table III-1 Demand Elasticities

Industrial sectors	Own-price elasticities	Data sources	Source
Agriculture			
Meat	–0.38 to –0.81	USDA (1948–1972)	Manser(1976)
Produce	–0.16 to –0.42		
Cereals	–0.06 to –1.18		
Other food	–0.45 to –0.94		
Food processing	See Table III-3	U.S. (1957–1975)	Pagoulatos/Sorenson (1986)
Chemicals, petroleum, coal, rubber, and plastic	–0.11	U.S. (1929–1973)	Danielsen/DeLorme (1975/76)
Transportation	–0.54	Canadian (1979)	Oum (1989))
Communications	–0.712 to –1.72	U.S. (1964–1974)	Rea/Lage (1978)
Electric, gas, and sanitary	–0.36	U.S. (1950–1987)	Chang/Hsing (1991)
services	–0.13		
	–0.32		
	–0.65	Arkansas (1957–86)	Suwanakul/Nunthirapakorn (1991)
	–0.35	U.S. (1978–1979)	Garbacz/Roth (1983)
	–0.1 (short-run)	U.S. (28 SMSA)	Quigley/Rubinfeld (1989)
	–0.7 (long-run)		
	–0.03	U.S. (Wisconsin data)	Caves/Christensen/Herriges (1987)
Gasoline	–0.13	cross-country	Dahl (1982)
Water	–1.6	U.S. (Texas)	Hewitt/Hanemann (1995)
Wholesale trade	–1.1	U.S. (autos)	Gallasch (1984)
Retail trade	–1	U.S. (autos)	Gallasch (1984)
Banking			
Insurance	–0.26 to –0.50	U.S. (1953–1979)	Babbel (1985)
Real estate	–0.44 to –0.51	UK (time-series/ cross-section)	Rosenthal (1989)
Health services	–0.6	U.S.	Marquis/Phelps (1987)
	–0.6	U.S.	Welch (1986)
Educational services	–1.3	U.S. (1958–1982)	Kim (1988)
Government services			
Education	–1.29	U.S. (38 municipal)	Perkins (1977)
Infrastructure	–0.31	U.S. (38 municipal)	Perkins (1977)
Public order	–0.74	U.S. (38 municipal)	Perkins (1977)

There are extensive estimates for agricultural commodities (see, for instance, Pagoulatos and Sorensen, 1986). Perkins provides the most comprehensive estimate of demand for government services. His elasticity and cross-elasticity estimates are shown in the table below.

Table III-2. Elasticities of Cross Elasticities of Demand for Government Services

Public Good	Gen. Admin	Police	Fire	Health	Sani-tation	High-ways	Schools	Librar-ies	Parks/ rec.	Water	Income
Gen.	–0.51										0.40
Admin	(1.1)										(1.0)
Police		–0.74	1.37							0.10	0.21
		(1.5)	(2.8)							(2.4)	(1.2)
Fire		1.07	–0.89						–3.2	1.79	0.17
		(0.6)	(0.5)						(0.9)	(0.2)	(0.9)
Health				–4.07	0.91					0.33	0.67
				(1.4)	(0.1)					(1.8)	(0.9)
Sani-				11.43	22.14					–22.9	0.15
tation				(2.4)	(2.1)					(2.1)	(0.1)
High-						–0.31					0.78
ways						91.6)					(2.6)
Schools							–1.29	–0.03			1.02
							(7.6)	(0.1)			(4.5)
Librar-							0.78	1.19	0.90		0.51
ies							(1.4)	(2.5)	(0.6)		(0.9)
Parks/				–0.29				1.57	1.97		0.66
rec.				(0.3)				(4.4)	(2.5)		(1.8)
Water			–3.5	21.2	4.9					–13.3	0.39
			(1.3)	(3.8)	(0.5)					(1.0)	(0.3)

Note: The numbers in parenthesis are t-statistics.

Contained in the table above are own- and cross-price elasticities of a relatively recent comprehensive study (Blanciforti, et al., 1986). It is also one of the few studies that used AIDS—one of the flexible demand functions mentioned above. The results attached here are for their linear approximate static model. The model imposes homogeneity but not symmetry. Not surprisingly, all own-price elasticities are negative and income elasticities are mostly positive. The cross-price elasticities show the change in the budget share of commodity i if the price of commodity j changes by a percentage point. For example, the value in row one, column seven, can be read as the percentage decrease in the budget share allocated to housing following a percent increase in the price of food. In practice, some of these numbers should be close to zero.

Table III-3. AIDS Demand, Constant Income Elasticity, Demand-Elasticity, Cross-Elasticity Estimates

Commodity	Constant	Income elasticity	Food	Alcohol/ tobacco	Clothing	Housing
Food	1.25	0.33	–0.51	–0.19	0.11	–0.03
Alcohol/tobacco	0.37	2.93	0.15	–0.25	–0.05	–0.29
Clothing	0.16	0.55	0.36	0.41	–0.38	0.06
Housing	0.92	1.07	–0.53	–0.46	–0.81	–0.39
Utilities	0.14	0.52	–0.08	–0.71	–0.03	0.23
Transportation	0.41	0.16	0.64	–0.02	0.96	–0.03
Medical care	0.19	1.81	–0.68	0.10	–0.67	–0.33
Durable goods	–2.86	1.69	–0.35	0.58	0.53	0.76
Other nondurable	–0.14	–0.23	0.32	0.24	–0.19	–0.69
Other services	0.26	1.59	–0.02	–0.27	–0.05	–0.64
Other misc.	0.31	–0.24	0.03	0.12	–0.27	–0.11

Commodity	Util.	Transp.	Medical care	Durable goods	Other nondurable	Other services	Other misc.
Food	–0.30	0.33	0.48	–0.24	0.36	–0.35	–0.12
Alcohol/tobacco	0.19	–0.35	0.18	0.61	–0.78	–0.05	0.38
Clothing	0.37	–0.81	0.23	0.03	–0.26	–0.53	–0.40
Housing	–0.55	0.51	0.16	–0.46	0.15	0.84	1.17
Utilities	–0.67	0.09	0.19	–0.64	0.72	0.24	0.01
Transportation	0.53	–0.47	0.57	0.48	–0.51	1.06	0.68
Medical care	–0.13	–0.01	–0.70	–0.83	0.44	0.82	1.18
Durable goods	1.07	–0.80	–1.90	–0.04	–0.14	–1.40	–1.97
Other nondur.	–0.15	–0.29	0.57	0.80	–1.21	0.47	–0.10
Other services	–0.08	–0.13	0.50	0.44	–0.06	–0.28	–0.27
Other misc.	–0.87	0.71	0.27	0.08	0.08	–0.43	0.03

III.3. HOUSEHOLD SAVINGS

The prevailing theory of savings is the permanent-income hypothesis. The theory asserts that savings and consumption decisions are made with respect to the income that agents believe they will make during their entire life. Savings is a way of ensuring that there are no times when personal-consumption expenditure is greatly lower than it was at other times. The implication of this hypothesis for a CGE model is that, in a multiple period model, personal-consumption expenditure should be growing at a slow but steady pace across time. An older and largely empirical tradition asserts that savings is a fixed fraction of income or of current and lagged income. This could be implemented by employing a demand system without the property that each additional dollar earned is an additional dollar spent. Thus, savings would become savings in the base period plus the change in after-tax income less the change in consumption.

Each form of savings behavior is found in published CGE literature. Most modelers represent savings as either the residual of after-tax income less consumption or as a fixed share of after-tax income. A few use forms of a permanent-income hypothesis. This last group faces clear empirical evidence that the savings behavior of households does not support a constant inter-temporal substitution rate between consumption today and consumption tomorrow. They have been forced to adopt ad-hoc estimates of changing inter-temporal substitution rates to avoid predicting high rates of household savings at ages when the empirical evidence is overpoweringly opposed to these predictions.

In a regional model, unlike a national model, savings need not equal investment. In a national model, it is likely that a substantial fraction of any increased savings will translate into increased national investment. Lack of information about foreign firms and exchange-rate risk makes this rational behavior. In a regional model, however, increased regional savings need not translate into increased regional investment. There is one currency and ready access to firm specific information in the United States, so capital markets in the United States are at the national level. Thus, additional California savings are spread over the whole nation, and increasingly over the entire world. This difference between regional and national models should cause a lesser dynamic effect for a tax change in a region.

III.4. HOUSEHOLD EQUATIONS IN DRAM

Review of the theoretical literature on household consumption reveals AIDS consumption functions as the clear theoretical choice. However, no usable estimates of elasticities or forms corresponding to the aggregation of households and goods in DRAM are available. As an interim solution, Cobb-Douglas consumption functions are implemented in DRAM. Unitary income and own-price elasticities of demand are used to ensure homogeneity. The own-price elasticity in DRAM appears to be a reasonable general approximation of published estimates.

For the savings equations, DRAM incorporates the assumption of savings as the residual of after-tax income less consumption. To model savings as a fixed share of after-tax income ignores the permanent-income theory entirely and imposes a distribution of the remaining share of income across goods. Thus, goods and services markets are forced to absorb additional income. To model households as following the permanent-income hypothesis faithfully would require substantial complications in modeling, such as the introduction of age groups. Thus, the 'savings as residual' equations in DRAM follow the older and largely empirical tradition of savings models. Given that savings are essentially a leakage in a model of a regional economy, rather than an engine that drives investment, the choice of savings function may be rendered substantively less important than in a model of an isolated national economy.

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IV. PRODUCER BEHAVIOR

Firms pay for inputs including renting labor and capital, and purchasing raw materials and the outputs of other firms. They use these inputs to make an output which they sell. In this chapter, the behavioral and technical assumptions needed for a theory of firm behavior are described, a review of empirical findings on firm behavior is provided, and the model of a firm used in the CGE model is described.

IV.1. BEHAVIORAL ASSUMPTIONS

Firms are assumed to be price takers and profit maximizing agents. Profits are a firm's revenues less the firm's costs. Therefore, a profit-maximizing firm is one that maximizes the return to the firm's owners. When the firm operates in more than one time period, the generalization of profit-maximizing is maximizing stock-market value. The alternative paradigms to profit maximization include maximizing the return to management, rather than shareholders, or maximizing sales. These views are not generally accepted and are not pursued here.

Price-taking behavior means that the firm does not believe that its output decisions affect the price at which the good is sold. The firm takes prices as given. This is clearly an approximation to real firm behavior. The other extreme form of assumption is monopoly. In a monopoly there is only one firm, and that firm knows exactly what the relationship is between price and the quantity that it sells. When it decides to produce more, it knows that price will go down. Industrial structures between these two extremes are oligopolies. At the sectoral level used in a CGE model, price-taking behavior is a reasonable approximation. Sectors are much bigger than industries so, even if there were monopoly power in, say, sparkling bottled water, it would be submerged in a much bigger aggregate of processed food. Another reason for assuming that price-taking behavior is a close enough approximation for modeling is that the measured markup of price over marginal cost in American industry tends to be small. That is, even where there is less-than-perfect competition, industries tend to operate close to the competitive output rule of price is equal to marginal cost.

IV.2. THE PURE THEORY OF PROFIT MAXIMIZING

Given price-taking, profit-maximizing behavior, and a model of the physical production process, it is possible to derive a model of firm outputs and input decisions. The model requires some terminology and definitions:

p = Price of output.

y = Quantity of output.

$\mathbf{w}$ = Price vector of n input prices, $(w_1...w_n)$.

$\mathbf{x}$ = Vector of n physical input quantities used in production, $(x_1...x_n)$.

$f(\mathbf{x})$ = Production function—quantity of output as a function of the quantities of inputs.

$C(y,\mathbf{w})$ = Cost function—minimum amount of money needed to purchase inputs at input prices, $\mathbf{w}$, that will produce output y.

$x_i(y,\mathbf{w})$ = Conditional-factor demand—quantity of input i used at factor prices, $\mathbf{w}$, when y units of output are made in a least-cost fashion.

$y(p,w)$ = Supply curve—profit-maximizing quantity of output at output price, p, and input prices, **w**.

$\pi(p,w)$ = Profit function—the maximum profit when input prices are **w** and output price is p.

$x_i(p,w)$ = Unconditional-factor demand—quantity of input i used to make maximum profits when input prices are **w** and output price is p.

The usual derivation of the rules for profit maximization proceeds from the cost function to the profit function. The cost function is defined formally as

$$\text{(IV-1)} \qquad c(y,\mathbf{w}) = \min_{\mathbf{x}}(\mathbf{x}\cdot\mathbf{w}) \quad \text{such that } y = f(\mathbf{x})$$

The value of **x** that minimizes costs is conditional-factor demand. The profit function is

$$\text{(IV-2)} \qquad \pi(p,\mathbf{w}) = \max_y \, p\cdot y - c(y,\mathbf{w})$$

The calculus condition for this maximum is the familiar rule that price equals marginal cost. The value of y that maximizes profits is supply.

While this progression of definitions seems natural (starting with the physical description of production, f(**x**), and using the calculus to find c(y,**w**) and π(p,**w**)), starting with c(y,**w**) could be done just as easily. In that case, the second equation should be used to find the profit function. Then, by the following two theorems, factor demands will be found. The derivative of the profit function, with respect to an input price, is a factor demand and, with respect to an output price, is the supply function. The derivative of a cost function with respect to an input price is a conditional-factor demand.

Production functions are often classified based on the amount that one input can substitute for another in production. The technical measure is called the "elasticity of substitution." In general, elasticity is defined as the percentage of change of quantity divided by the percentage rate of change of price. In the case of substitution of factors, it is the percentage rate of change of the ratio of two inputs divided by the percentage rate of change of their relative prices. Formally, the elasticity of substitution of input i for input j is

$$\text{(IV-3)} \qquad \sigma = \frac{\partial \ln\left(\frac{x_i}{x_j}\right)}{\partial \ln\left(\frac{w_i}{w_j}\right)}$$

The functional forms that may be chosen by an applied general-equilibrium modeler include four types: Cobb-Douglas, CES, and Leontief production functions and Translog cost function. A discussion is presented about each and the input-demand equations or cost shares that result from each choice, along with a brief discussion of the advantages and disadvantages of each form—from the perspective of CGE modeling. However, these results are summarized in the table below.

Table IV-1. Production Functions

General Form	Advantages	Limitations
Cobb-Douglas	All data are available from a single I-O table.	Inputs are highly substitutable for each other.
Leontief	All data are available from a single I-O table.	Inputs are not substitutable for each other at all.
CES	Most data are available from a single I-O table. Can represent substitution between inputs more realistically.	Must build a complex "nest" of CES functions to have different rates of substitution if more than two inputs. Conflicting empirical evidence for rates of substitution.
Translog	Full modeling of substitution or complementarity between inputs.	Only estimable for highly aggregate models.
Hybrid CES/Leontief	Full accounting for intermediates with no substitution among them. Substitution between labor and capital of arbitrary degree. Data requirements same as CES.	No substitution between intermediates. No substitution between capital and intermediates.

IV.3.FUNCTIONAL FORMS

IV.3.1.COBB-DOUGLAS PRODUCTION FUNCTIONS

The Cobb-Douglas production function is

(IV-4) $$y = A \prod_{i=1,n} x_i^{\alpha_i}$$

In this formulation, A is a scalar for productivity (at the current level of technology) and α_i is a parameter for each factor used. The sum of α_i is the scale parameter, s.

Define the cost share of a factor as $S_i = x_i\, w_i/c(y,\mathbf{w})$. In a Cobb-Douglas function, $S_i = \alpha_i$. This provides a simple method of estimation of these functions. To compute the cost shares, use the I-O table entries. With constant returns to scale, s = 1, py = c(y,**w**), so the conditional-factor demands also have the expression

(IV-5) $$x_i = \frac{py\alpha_i}{w_i}$$

The elasticity of substitution is known to be one.

This result highlights the assumption behind the use of Cobb-Douglas production functions: Inputs are very good substitutes for each other. However, this functional form is attractive for one major reason. The only parameters required for highly disaggregated production functions are contained in a single I-O table. The shares of production are the exponents (α) in the equations above.

Technological progress is relatively simple to embody in a Cobb-Douglas production function. It is just an increase in the scale factor (A) in the production function. There is no simple way to model biased progress (e.g., progress that makes labor and not capital more productive) with this function.

IV.3.2.CES

Faced with empirical evidence that the elasticity of substitution is not one, Arrow et al. (1961) developed the CES function

$$y = A\left[\sum\left(\alpha_i x_i\right)^{\rho}\right]^{\frac{1}{\rho}} \tag{IV-6}$$

where the α_i are parameters related to share, A is the scale parameter, and ρ is a parameter related to the elasticity of substitution. Let $r = \rho/(\rho - 1)$. The share of total cost of the i^{th} input is

$$S_i = \frac{\left(\frac{x_i}{\alpha_i}\right)^r}{\sum\left(\frac{x_i}{\alpha_i}\right)^r} \tag{IV-7}$$

and the elasticity of substitution is

$$\sigma = \frac{1}{1+\rho} \tag{IV-8}$$

There are a great many results available for the CES function and for its generalizations, including the functional forms for the factor demands, conditional-factor demands, and cost function. The simple CES shown above is a homogenous of degree one function (i.e., it has constant returns to scale). To produce a function that has decreasing returns, add a constant inside of the summation. An estimate of the elasticity of substitution and factor shares is all that is needed to produce an estimate of a CES system. Thus, CES has one additional parameter to estimate than does Cobb-Douglas.

IV.3.3.TRANSLOG FUNCTION

The Translog cost function approximates an arbitrary cost structure and, as explained above, an arbitrary production structure. It does not impose theoretical requirements of symmetry of cross elasticities so that it can be used to test these assumptions. The ability to test assumptions of theory, rather than convenience in estimation, is the chief reason for the recent popularity of this functional form. The Translog cost function yields nice functional forms for factor demands while the Translog production function does not. This is the reason for starting with the cost rather than production function. The Translog cost function is

$$\begin{aligned}\ln C = \ln\alpha_i + \alpha_y \ln y + \sum_i \alpha_i \ln w_i + \tfrac{1}{2}\beta_{yy}\left(\ln y\right)^2 + \tfrac{1}{2}\sum_i\sum_j \beta_{ij}\ln w_i \ln w_j \\ + \sum_i \beta_{iy}\ln y \ln w_i\end{aligned} \tag{IV-9}$$

Differentiating this equation with respect to the log of the price of one input (w_i) yields the cost share for this input (S_i):

$$S_i = \alpha_i + \sum_j \beta_{ij}\ln w_j + \beta_{iy}\ln y \tag{IV-10}$$

The elasticity of substitution is

$$\sigma_{ij} \equiv \left(1 + \frac{\beta_{ij}}{S_i S_j}\right) \tag{IV-11}$$

IV.3.4.LEONTIEF PRODUCTION FUNCTION

The Leontief production function has a required amount of each input per unit of output. There is no substitutability of inputs. The production function is

$$(\text{IV-12}) \qquad y = \min\left(\frac{x_1}{\alpha_1},\cdots,\frac{x_n}{\alpha_n}\right)$$

The cost share of the i[th] factor is

$$(\text{IV-13}) \qquad S_i = \frac{\alpha_i w_i}{\sum_j \alpha_j w_j}$$

The elasticity of substitution is zero. Again, only factor shares are needed to estimate this function.

IV.3.5.NESTED CES AND LEONTIEF

The data available to estimate a state's CGE consist of an I-O table compiled every five years and more frequent updates at the national level. Given these data limitations and a need for computational simplicity, the following is assumed:

1. Intermediate goods are used in fixed proportion to output.
2. Capital and labor (and eventually education and infrastructure) form an aggregate good called "value added," which is also used in fixed proportion to output. Capital and labor form value added by means of a CES process.

The nested production function does not impose an elasticity of substitution between labor and capital, but it makes an extreme assumption of intermediate goods of zero substitution. The production function is

$$(\text{IV-14}) \qquad y = \min\left\{\left[(x_1\alpha_1)^\rho + (x_2\alpha_2)^\rho\right]^{1/\rho},\frac{x_3}{\alpha_3},\ldots,\frac{x_n}{\alpha_n}\right\}$$

The first input is capital, and the second is labor. Inputs 3 through n are intermediate goods, the outputs from other sectors, imports, or raw materials. Again, let r = ρ/(ρ - 1). The cost function is

$$(\text{IV-15}) \qquad c(y,\mathbf{w}) = \left\{\left[\left(\frac{w_1}{\alpha_1}\right)^r + \left(\frac{w_2}{\alpha_2}\right)^r\right]^{\frac{1}{r}} + \alpha_3 w_3 + \ldots + \alpha_n w_n\right\} y$$

Define the cost of materials, $cv = \alpha_3 w_3 + \ldots \alpha_n w_n$. Now, the share of the i^{th} material in materials cost is given by the previous share equation (IV-13) while the share of labor or capital in non-material costs is given by equation (IV-7).

IV.4.ESTIMATES OF ELASTICITIES OF SUBSTITUTION

A great many studies have been done to estimate the elasticity of substitution between capital and labor for manufacturing. These studies give answers, in general, near one. Fewer studies have been done for other elasticities of substitution, and the tendency in these studies is to find minimal substitutability.

IV.4.1.CAPITAL AND LABOR IN MANUFACTURING

There exists some general agreement that capital and labor are substitutes. Summarized in the table below are the findings of five studies by Griliches (1967), Dhrymes and Zarembka (1970), Zarembka (1970), Fishelson (1979), and Moroney (1972).

Table IV-2. Elasticity of Substitution between Labor and Capital

	Study				
Industry	Griliches	Dhrymes	Zarembka	Fishelson	Moroney
Food	0.98	0.822	1.009	0.967	0.538
Textile	0.938	0.9675	0.909	0.973	0.69
Apparel	1.055	1.214	0.861	0.928	0.759
Lumber	1.069	0.875		0.958	0.825
Furniture	1.039	1.173	1.074	0.838	0.621
Paper	1.667	1.432	0.724	0.999	1.276
Printing	0.827	0.998		0.945	0.737
Chemicals	0.714	0.8697	0.923	0.851	0.764
Petroleum		0.8915	0.312	0.851	0.445
Rubber and plastics	1.281	1.5625		0.955	0.772
Leather	0.839	0.8573		0.953	0.775
Stone, clay, and glass	0.908	1.027	0.644	0.984	0.982
Primary metals	1.407	0.7654	1.809	0.948	0.601
Fabricated metals	0.849	0.557	0.673	0.927	0.593
Machinery	1.24	0.7468	1.132	0.606	0.15
Electrical machinery	0.662	0.5915	0.212	0.98	0.552
Transportation equipment	0.961	1.242	1.467	0.955	0.692
Instruments	0.752			0.851	0.554

Griliches (1967) did one of the early estimates of the elasticities of substitution for two-digit industries in the United States. He used the 1958 data from the census of manufactures. Most of the elasticities are close to unity. Except for the paper industry, with an elasticity estimate of 1.667, and primary metals, with an estimate of 1.40, the remainder of the estimated values fall in the interval between 0.62 and 1.24. Griliches admits that only one of the 18 estimated elasticities is statistically significant from one.

Dhrymes and Zarembka (1970) is a study of two-digit U.S. manufacturing industries, using census of manufactures data for 1957. The elasticities of substitution between capital and labor range from 0.36 in nonelectrical machinery to 1.15 in pulp and paper products. As in other studies, the results show that most of the elasticities are close to unity. The industries where the labor and capital substitution elasticity is close to one are pulp and paper (1.15); textile mill products (0.81); chemicals and products (0.9); and stone, clay, and glass (0.96). Those with elasticities in the lower range are nonelectrical machinery (0.36), transportation equipment (0.68), and lumber (0.63). The results for all of the industries included in the study are reported in column three of the table above.

Zarembka (1970) estimates the elasticity of substitution for 13 two-digit industries for which at least 15 observations were available in 1957–58. As in the estimates reported by Griliches (1967), the elasticity estimates are all near unity. Using the results based on the 1958 data, furniture, primary metals, non-electrical machinery, and transport equipment had elasticity estimates above unity. Those with elasticities less than 0.8 were paper; petroleum; stone, clay, and glass; fabricated metals;

and electrical machinery. The results, for the 1958 estimates, are shown in column four of the table above.

The estimation of capital and labor substitution elasticities follows a standard procedure. It is assumed that a firm minimizes the costs of its inputs (capital and labor) given that it wants to produce a target level of output. Then, the ratio is regressed of wage to cost of capital on the ratio of capital to labor that is obtained from the first-order condition. The elasticity of substitution is the coefficient of the ratio of wage to cost of capital. The ratio of the first-order conditions (capital-labor ratio) is sufficient to undertake estimation. This strategy was followed by Moroney (1972) using 18 two-digit industry data for the United States for 1957. The results are in the last column of the table above. The substitution elasticity for the paper industry is the only one that is above unity. Only two other industries (lumber and stone, clay, and glass) have estimates closer to one. The remainder of the industries have below-unit elasticity estimates.

Fishelson's (1979) study used the first-order conditions from a profit-maximizing firm rather than the more common procedure used in Moroney and many other studies. Instead of estimating the ratio of first-order conditions for labor and capital, as is commonly done when cost minimization is assumed, Fishelson carried out a joint estimation of first-order conditions for labor and capital. The results are in column five of the table above. Notice that most of the estimates are close to unity. What is remarkable is that nearly all of the industries have about the same elasticity of substitution between labor and capital.

IV.4.2.OTHER FACTORS

Two other inputs that are often studied are energy and materials. In a sample of five studies, three, Berndt and Wood (1975), Hudson and Jorgenson (1974), and Field and Grebenstein (1980), found that capital and energy are complements. Chung (1987) found the two inputs to be substitutes. In the same studies, Berndt and Wood, Hudson and Jorgenson, and Chung concluded that labor and energy are substitutes. None of the studies found energy and labor to be complements. Two of the studies, Chung and Berndt and Wood found capital and materials and labor and materials to be substitutes. Hazilla and Kopp (1984) reported mixed results.

IV.4.3.NONMANUFACTURING

Huckins (1989) estimated a log-linear function where capital to labor ratios used in municipal governments were hypothesized to depend on the price of labor relative to the price of capital. The short-run elasticity of substitution between capital and labor for 46 cities in the United States with populations exceeding 300,000 by 1970 was found to be 0.114.

IV.5.CONCLUSION: DRAM

The functional form chosen for DRAM was CES for factors and fixed-shares for intermediates. The elasticities of substitution between labor and capital were chosen to represent a middle ground of the elasticity estimates found in the established literature. Factor elasticities just below 1.0 were chosen for all industries. The elasticity of substitution between other inputs was set at zero.

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V. TRADE

V.1.INTRODUCTION

This chapter deals with how foreign trade is incorporated in CGE's. Theoretical trade models focus on the determinants of the direction and composition of trade. Section two begins with a discussion on pure theory in which the conclusions of four schools of thought regarding how and why nations trade are summarized. In section three the implementation of trade theory in CGE models is presented. A brief discussion of the empirical literature including a review of elasticity estimates is presented in section four. The available trade data for implementing the California model are described in section five, and conclusions follow.

V.2.PURE THEORY

Nations trade for many reasons, and many generations of economic theorists have tried to isolate those factors that matter most in determining the direction and magnitude of trade. In pursuit of this goal, economists have found it useful to create idealized worlds. The simplified world from which these theorists draw their conclusions may not resemble the real world closely. Nonetheless, it serves the useful purpose of identifying those variables that would remain crucial even if the world became more complex.

Older theories traced the emergence of trade between countries to differences in relative costs of production. Differences in cost arise either because a country has an abundance of a factor of production relative to its trading partner or because the quality of one or more of its factors is higher. More recent theories suggest that differences in cost may not matter as much as production technologies and the preferences of the consumers. The reasoning is as follows. If consumers prefer a variety of products and firms have increasing returns-to-scale technologies (i.e., they can more than double their output if they double their inputs), then trade between two countries that have identical costs can still occur and be beneficial as long as they produce differentiated products. The next four sections elaborate these ideas more fully in discussions of classical, neoclassical, new, and Armington trade theories.

V.2.1.CLASSICAL TRADE THEORY

According to classical theorists, countries trade because they have a comparative advantage in producing a commodity. For a country to have a comparative advantage in production, it must be able to produce that commodity more cheaply than its trading partners, where cost is measured in terms of opportunity costs. If a country is maximizing its output, the opportunity cost of producing another unit of one good is the foregone production of another good. One trading partner may have absolute advantage (i.e., be the low cost producer of all goods where cost is measured in money or another "absolute" measure). However, no country could be the lowest cost producer of all goods where cost is measured by opportunity cost. Countries may find that opportunity costs permit advantageous trade to both countries even in the presence of absolute advantage.

In classical trade theory, cost advantage arises from endowments that are peculiar to that country's factors of production. For instance, the factors may be of higher quality or perhaps they are in plentiful supplies. Whatever the reason, it is important that the country produces the commodity cheaper than any other country with which it trade. To make this conclusion very transparent, consider the following world.

There are two countries in the world, California and the rest of the world. Each country produces two commodities, manufactures and agriculture, using only one input, labor. Labor in each country is mobile within sectors but not across borders. A worker in California's manufacturing sector can switch to work in agriculture without any relocation costs, and vice versa, but California labor cannot work in the rest of the world. The production of each commodity in each country has constant returns to scale. This means that the sector can double its output if it doubles its input. Finally, there is perfect competition in commodity trade; there are no transport costs, tariffs, or barriers of any sort.

In this simple world, the pre-trade price ratio in each country is determined entirely by output per unit input. To make this sharper, imagine that California has a fixed supply of labor. All labor can be employed in manufacturing or in agriculture, in which case output is a certain maximum of manufactures or agriculture. Alternatively, let only a fraction of available labor be employed in each sector. In the latter case, California must sacrifice some manufactures in order to get more of agriculture. The price ratio reflects this trade-off. The price at which manufactures trade for agriculture is equal to the number of agriculture units produced per worker for every unit of manufactures given up per worker. This is true whether there are 50 or 100 workers. So neither demand nor the level of supply of the factor influences the price ratio; only proportions matter.

In each country, the cost of shifting labor from manufacturing to agriculture is a constant. However, these constant cost ratios differ between countries and they are the basis for comparative advantage of nations. Since only labor is used in production, the central argument of classical trade theory boils down to comparative advantage are due to differences in labor productivity (Bhagwati, 1964, Chipman, 1965).

The pattern of exports or imports is determined by relative factor productivity. Suppose manufacturing in California produces a_1 units of manufactures per worker and California agriculture produces a_2 units per worker. Furthermore, imagine that manufacturing in the rest of the world produces b_1 units of manufactures and their agriculture produce b_2 units of agriculture. Then, California will export manufactures and import agriculture if $(a1 \div a2) > (b1 \div b2)$, that is, if California's productivity in manufacturing relative to agriculture is higher than rest of the world productivity in manufacturing relative to agriculture.

While theories of comparative advantage are straightforward in a world of two commodities and two countries, indeterminate results arise when more commodities are added or when the number of trading partners increases. The major contribution of this theory is to introduce analytical methods into trade theory not to endure as a generalized explanation for trade.

V.2.2.NEOCLASSICAL TRADE THEORY

The important lesson from neoclassical theory is that commodity trade can substitute for lack of trade in factors of production. In other words, observed restrictions on the movement of factors of production, such as labor and capital, across borders will not prevent efficient trade from being conducted between countries if there are no restrictions on commodity trade. Efficiency in trade describes a situation where the commodities that are traded are those that are produced in the least costly way by each country.

The simplest neoclassical model begins with the assumption of two countries and two commodities. Two inputs, say, capital and labor, are used in production. The quality of land and capital are considered identical in both countries. However, sectors in a country use factors at different levels of intensities. For instance, manufacturing in California may use more capital than does agriculture. It also assumes that marginal productivity of a factor diminishes when more of it is used. That is, as one increases the units of labor in manufacturing while holding capital constant, total output in manufacturing increases at a decreasing rate. The model also assumes that both commodities are produced in each country. As in the classical model, factor mobility is absent between countries and the production technology for each commodity is characterized by constant returns to scale (Samuelson, 1949).

In such a world, when each country tries to produce the maximum amount of manufactures and agriculture obtainable from its factor endowments, pure competition will lead to the equalization of domestic relative factor prices in manufacturing and agriculture. In other words, the ratio of the price of labor to that of capital in manufacturing is equal to the ratio of the price of labor to the price of capital in agriculture. Relative factor prices are determined by factor productivity. So marginal productivity across sectors will also be equal.

If the same price ratio is obtained in a domestic economy for the two commodities, there is nothing to prevent it from happening between the two countries. Competitive free trade will push countries to allocate resources efficiently, or in a manner that will bring about uniform factor price ratios, which are equal to commodity price ratios, in both countries. The fact that international factor and commodity prices become equalized despite an initial assumption of international factor immobility is the foundation for the suggestion that commodity trade substitutes for lack of trade in factors (Mundell, 1957). Complete specialization of any of the countries in one of the commodities occurs in this world only if the factor-use intensities are extreme.

Because the classical and neoclassical trade models are simplifications, many of their features are often violated in the real world. Goods do not move without transport costs, production technologies across countries are not necessarily identical, and qualities of inputs differ significantly. Furthermore, the technologies need not exhibit constant returns. Finally, the trading environment is rarely characterized by perfect competition. In recent trade models, some of these real-world observations are taken into account.

V.2.3.NEW TRADE THEORY

The insight from new trade theory is that two-way trade in like products (such as models of cars or TV sets) can still take place even when countries do not have comparative advantage in the production of these goods. Two-way trade in like products could arise because consumers prefer product variety and because firms have economies of scale.

The main difference between new trade theories and traditional theories lies in their assumptions about market institutions and production technologies. The new theories assume that the market has many firms with the ability to influence price unlike firms in a perfectly competitive market. These firms are able to set the price of a unit of their output above what it cost them to produce it because their product is slightly different from their closest competitors. As for technology, the firms are assumed to enjoy increasing returns. Most of the other assumptions are similar to the previous models.

There are two countries, and one factor of production, say, labor. The countries have the same technology of production and the same utility function. Consumers in each country consume all the different varieties of goods produced in both countries. The elasticity of demand for a product increases if its price increases. This means that a producer cannot continue to increase the price of the product without losing larger market share. Labor does not move across borders, and transport costs are zero (Krugman, 1979).

Since the countries are identical (they have the same tastes and technology), then wage rates and commodity price in both countries should be the same. Therefore, there is no apparent advantage to trade. However, trade does occur because the size of the market increases when borders open. Faced with a larger market, profit-maximizing firms will tend to expand, driving up output and wages. At the same time, product variety goes up in each country. Workers can use additional income from increases in their wages to buy more variety. Since consumers in each country get utility from all product varieties, trade increases consumer welfare. Thus, according to this model, the increased volume of trade is due to economies of scale enjoyed by firms and consumer preference for more variety. What the model cannot predict is which commodities will be exported and which ones imported by a country.

V.2.4.ARMINGTON MODEL

The Armington model is a parsimonious model that shares some elements of both neoclassical and new trade models. The main assertion is that the products imported by Californians from the rest of the world are considered to be imperfect substitutes for products made by California. Two commodities, say, imports and domestic goods, are imperfect substitutes if a one percent change in the relative price of imports to price of domestic goods, results in other than a one percent change in the demand for domestic goods. If the price of imports relative to the price of similar goods in the domestic economy goes up, California consumers will adjust by demanding more domestic products.

On one hand, the Armington model resembles the new trade models in postulating that consumers get utility from consuming a variety of products. On the other hand, it is in the neoclassical tradition in that goods are produced by firms enjoying constant returns to scale who face perfect competition in trade.

V.2.5.LESSONS FROM TRADE THEORY

To summarize, there are three lessons from pure theory. First, countries trade because they have different technologies of production stemming from differences in factor endowments. Factor endowments are the basis for differences in costs and, therefore, beneficial trade. Second, lack of trade in factors of production need not create distortions in trade patterns if there exists free trade in commodities. The invisible hand of the market will force nations to allocate resources internally in a way that reproduces the pattern of trade that would prevail if there were no restrictions on factor mobility. Finally, even if countries do not have comparative advantage in costs of production, beneficial two-way trade is possible if consumers prefer a larger choice (product variety) and firms have economies of scale.

Implementing theoretical ideas in a model designed to evaluate quantitative gains from trade is not always a smooth transition. In practice, choices need to be made about which functional forms retain essential elements of theory.

V.3.FUNCTIONAL FORMS IN TRADE

A variety of functional forms are used to track expenditure on domestic output and imports from different sources by industry. In general, these models assume that national expenditure is determined through a two-stage budgeting process. In the first stage, total expenditure is allocated between the types of goods in the model. A share of total expenditure is set aside for food, pharmaceuticals, cars, electronics, etc. In the second-stage, expenditure for each good is apportioned between imports and domestic goods.

The specification of the first stage preferences is discussed in detail in the chapter on household behavior. The most common style for modeling the second stage is the CES form (Armington, 1970) although utility functions of the type used by Dixit and Stiglitz (1977) for monopolistic competition models and AIDS have been suggested.

Early CGE models assumed a particular kind of trade model. Nations or firms were presumed to trade in homogeneous goods. Accordingly, domestic consumers made no distinctions between domestic cars and those from the rest of the world. The homogeneity of products implied that traded goods had the same price if there were no transport costs or tariffs. When small relative price changes occurred, rational consumers switched all of their consumption to the low-priced good. Because large swings in demand to the low-price source have been observed rarely, these models were abandoned.

To avoid the problem posed by perfect substitutability between domestic and foreign goods based on the assumption of homogeneity of traded products, and maintain perfect competition in trade, modelers adopted ad-hoc formulations reflecting gradual adjustments in trade toward lower priced sources. While these formulations mirrored observed trade patterns, Armington (1969) took these modelers to task for the lack of explicit economic theory underlying their models. He introduced a simple innovation. His goal was to identify the simplest functional form based upon explicit assumptions about economic behavior that would allow economic modelers to reflect observed patterns of trade. The innovation was to choose a CES preference function in which goods were identified by source of production and consumers did not view the goods from external sources to be perfect substitutes for domestic goods. The model has remained the most popular in applied CGE models, and a first-order condition of utility maximization of the Armington formulation has been implemented in DRAM.

V.3.1.IMPORTS

NESTED CONSTANT ELASTICITY OF SUBSTITUTION

In some models the fact that some consumers may prefer German cars to Korean cars is taken into account. The basic idea is to think of all cars not made in California for the domestic market as an aggregate import good from n different sources, M, that substitutes imperfectly for domestic production, D. The standard way to express this in a Constant Elasticity of Substitution (CES) function is

(V-1)
$$
\begin{aligned}
&U = U(\mathbf{q})\\
&q = \left(\beta_m M^{\delta} + \beta_d D^{\delta}\right)^{\frac{1}{\delta}}\\
&M(m_1,\ldots,m_n) = \left(\alpha_1 m_1^{\rho} + \ldots + \alpha_n m_n^{\rho}\right)^{\frac{1}{\rho}}
\end{aligned}
$$

The first equation indicates that consumers gain a portion of their overall utility from consuming each good (**q** is a vector of quantities). Each of these goods is a composite of the aggregate import and domestic goods, as expressed in the second equation. Subscripts could have been added to each variable and parameter in the second and third equation for the type of good. They have been omitted for clarity. The third equation shows how foreign-sourced goods are aggregated into a representative import, m. This particular specification of second-stage budgeting is often referred to as nested CES form, both in the second and third equations. In addition to the parameters β_m, β_d, and all of the α_is, these equations contain two elasticities of substitution. The first, $\omega = [\ 1 \div (\ 1 - \delta\ )\ ]$, captures the elasticity of substitution between aggregate imports and domestic production. Because consumers have different preferences over imported goods, $\sigma = [\ 1 \div (\ 1 - \rho\ )\ ]$ is used as a parameter to account for consumer discrimination between different foreign goods. It denotes elasticity of substitution between, for example, German cars and Korean cars. If the consumer maximizes utility subject to the budget constraint, one gets a set of demand functions which, when expressed in share form, reduce to

$$\text{(V-2)} \qquad S_i(p_1, p_2, \ldots, p_I) = \frac{p_i x_i(p_1, \ldots, p_I, y)}{y} = \frac{\alpha_i^{\sigma} p_i^{1-\sigma}}{\sum_{i=1}^{I} \alpha_i^{\sigma} p_i^{1-\sigma}}$$

where y denotes income. The share equations make it clear that the demand for a good is a function of its own price, the prices of competing goods, and income.

This kind of utility function is useful when there is interest in preferential trade because it distinguishes commodities by source. The California model treats the rest of the United States and the rest of the world as equal trading partners. For that reason, a non-nested CES function is used, meaning that the third type of equation above is omitted.

NON-NESTED CONSTANT ELASTICITY OF SUBSTITUTION

The utility function of a California consumer can be expressed as a CES function of an aggregate import, M, and an aggregate domestic good, D. In this variant, imported goods from different parts of the world are aggregated into a single good for each sector (as are domestic goods). The utility function is

$$\text{(V-3)} \qquad Q_i = \alpha_i \left[\beta_i M_i^{\left(\frac{\sigma_i - 1}{\sigma_i}\right)} + (1 - \beta_i) D_i^{\left(\frac{\sigma_i - 1}{\sigma_i}\right)} \right]^{\left(\frac{\sigma_i}{\sigma_i - 1}\right)}$$

For notation, Q_i is the utility derived from consumption of goods in sector i, α_i and β_i are parameters, and σ_i is the elasticity of substitution between imports and domestic goods in that sector. Suppose that the prices of the aggregate import and domestic goods in the sector are $P_{i,m}$ and $P_{i,d}$, respectively. The standard procedure where a consumer maximizes utility subject to a budget constraint yields import demand per unit of domestic demand as a function of relative prices,

$$\text{(V-4)} \qquad \frac{M_i}{D_i} = \left[\left(\frac{\beta_i}{1 - \beta_i} \right) \frac{P_{i,d}}{P_{i,m}} \right]^{\sigma_i}$$

The elasticities of substitution are industry specific and have been estimated econometrically. Most applied CGE models use the share equations implied by the optimal conditions (refer to equation above). These import-share functions not only contain all of the information necessary to implement theoretically consistent trade equations but also at low computational costs.

There are four variables that affect the import-share equation: the initial level of import share, the price of imports (which is taken to be the same as the world price), import price relative to domestic price in each sector, and the elasticity of substitution between imports and domestic goods. The functional form chosen to identify domestic and import shares is simply

$$(\text{V-5}) \qquad d_i = \bar{d}_i \left(\frac{P_{i,w}}{P_{i,d}} \right)^{\sigma_m}$$

In this equation, $P_{i,w}$, $P_{i,d}$ are world and domestic prices, respectively. The d_i is domestic share of demand for sector i goods, the sector's initial share is $\bar{d}_i$, and own-price elasticity of domestic share in California is denoted by σ_m. Given the domestic share, the share of imports, m_i, for the sector becomes

$$(\text{V-6}) \qquad m_i = (1\text{-}d_i)\, D_i$$

where D_i is total domestic demand for sector i, that is, the sum of import- and domestic-good consumption.

These simple functional forms state that the share of imports adjusts in each sector towards the lower cost source, which is the same idea conveyed by the equation above. The quantity of imports changes due to two forces. First, as total domestic demand grows, perhaps due to increases in California incomes, imports increase according to their share of total domestic demand. Second, as relative prices (domestic relative to world prices) increase, domestic goods become more expensive than imports. This forces Californians to decrease their domestic-good consumption and increase their purchase of imports, thereby increasing the share of imports.

V.3.2.EXPORTS

Turning to exports, the rest of the world consumers are treated as California consumers are treated; they maximize a utility function that contains California exports and the rest of the world goods. The consumers have a ceiling on their budget, and they go about allocating it across the domestic goods from each industry and corresponding competing imports from California. They make these decisions in two stages, much like California consumers.

It is assumed that California, compared to the rest of the world, is a small open economy. That is, California is not large enough to influence the world price of exports of any one good. It may be the case that California can and does affect the world price of some narrowly defined goods, such as almonds. However, the goods produced by California sectors are so aggregated in DRAM that the "small open economy" assumption seems appropriate. Continuing with the CES functional form, and assuming that foreign consumers do what all rational consumers are expected to do (make the best decisions given the information available to them), their demand for California exports, in shares, can be derived to be

$$(\text{V-7}) \qquad e_i = \bar{e}_i \left(\frac{p_w}{p_d} \right)^{\sigma_e}$$

where e_i represents the share of California exports in sector i with an initial value of $\bar{e}_i$, σ_e is the own-price elasticity of export supply for California exports, and p_d, p_w are domestic and world prices of California exports, respectively.

In some CGE models, a distinction is made between goods (often of a different quality) produced for the export market and those made for the domestic market. This distinction is particularly popular among scholars who do CGE models of developing-country economies. In order to implement this notion, a Constant Elasticity of Transformation (CET) function is employed, where domestic output is composed of imperfectly substitutable domestic consumption and exports.

The California model makes no such behavioral assumptions for California firms. They are assumed to produce a homogeneous quality good that they sell to both domestic and foreign consumers. How much they sell in each market is determined by California price relative to the world price and by elasticity of substitution between California exports and the rest of the world domestic goods. Since producing different quality products for different markets is ignored, accounting for total domestic production, x_i^d, is straightforward: It is the sum of exports plus the share of California output consumed in total California consumption, i.e.,

(V-8) $$x_i^d = e_i + d_i D_i$$

V.3.3.SOME UNRESOLVED ISSUES IN ARMINGTON MODELS

Notwithstanding its popularity, there are some contestable assumptions in Armington models. First, domestic and imported goods are only substitutes for each other, never complements. There is little or no empirical evidence available to support the contention that goods are only substitutes in consumption.

Second, shipments to California from the rest of the United States are treated as perfect substitutes for international imports. Even if a set of "nested" CES functions are included to first aggregate goods of a type from non-California United States with those from the rest of the world, goods from all sources can only be represented as substitutes, never complements. There is no preferential trade.

Third, demand for intermediate goods is seldom included in this type of sophisticated analysis. Intermediate demand is usually simply assigned by fixed shares between domestic and imported sources.

Fourth, little attention is given to developing empirical support for the parameters (i.e., substitution elasticities) of these functions. The CGE researchers generally "calibrate" their model to replicate a given year's known levels of imports, by guessing the correct import or export elasticities, and proceed to predict the future based on these imposed, in contrast to econometrically estimated, numbers.

Fifth, these functional forms collapse when the domestic share is zero, that is, a sector has no domestic production. In a large and diversified economy, such as that of California, finding a sector with zero output would require disaggregating the economy beyond the availability of current data. However, when domestic shares become small, these functions become very unstable.

V.3.4.COMPETING FUNCTIONAL FORMS

MONOPOLISTIC COMPETITION MODELS

Recent CGE models that have modeled the foreign sector to include theoretical insights of new trade theories use a utility function that is a blend of Armington-type CES and Cobb-Douglas (Willenbockel, 1994).

(V-9) $$U = \prod_{i \in I} \upsilon_i^{\varepsilon_i}$$

where i denotes a product category, say, cars, and ε_i is the share of that product category in total consumption. Accounting rules require that all the shares add up to one. The υ_i is a CES function of an aggregate import good and an aggregate domestic good, just like the Armington function discussed above. To make transparent the notion that within the same product category i there are distinct models (both domestic and imported), the υ_i function is written more explicitly in two steps. In the first,

$$\text{(V-10)} \qquad \upsilon_i = \left[\beta_i M_i^{\left(\frac{\sigma_i - 1}{\sigma_i}\right)} + (1-\beta_i) D_i^{\left(\frac{\sigma_i - 1}{\sigma_i}\right)}\right]^{\left(\frac{\sigma_i}{\sigma_i - 1}\right)}$$

where M_i and D_i represent aggregate import and domestic good for sector i. Again, if cars were a sector, M_i would be imported cars and D_i would be domestic cars, both defined as distinct goods. In the second step, the equation for distinct models in a product category takes the form

$$\text{(V-11)} \qquad \upsilon_i = \left[n_i m_i D_i^{\left(\frac{\sigma_i - 1}{\sigma_i}\right)} + n_i(RW) m_i(RW) M_i^{\left(\frac{\sigma_i - 1}{\sigma_i}\right)}\right]^{\left(\frac{\sigma_i}{\sigma_i - 1}\right)}$$

Here, $n_i(RW)m_i(RW)$ is the number of distinct models from the rest of the world imported in product category i. To make the idea concrete, and continuing with the example of cars, $n_i(RW)m_i(RW)$ includes all the different types of cars (henceforth models) such as Toyota, Mercedes, Nissan, etc. For notational conformity, M_i and D_i still denote imports and domestic goods, respectively, but, at this stage, they represent firm-specific imports (e.g., Toyota) and domestic (e.g., Ford) goods in sector i. The demand for domestic products that are consistent with this kind of utility function are

$$\text{(V-12)} \qquad D_i = \Theta_i^{\sigma_i - 1} p_i^{-\sigma_i} \varepsilon_i Y$$

while the import demand becomes

$$\text{(V-13)} \qquad M_i = \Theta_i^{\sigma_i - 1} q_i^{-\sigma_i} \varepsilon_i Y$$

In both equations Y is total income, p_i is the price of domestic model i, q_i is the price of an imported model i, and Θ_i is the consumer price index that is an average of all import and domestic models' prices in sector i. Written exactly,

$$\text{(V-14)} \qquad \Theta_i = \left[n_i m_i p_i^{1-\sigma_i} + n_i(RW) m_i(RW) q_i^{1-\sigma_i}\right]^{\left(\frac{1}{1-\sigma_i}\right)}$$

The new trade theory models, such as the monopolistic competition models, are theoretically appealing. They can explain two-way trade in similar products, which is pervasive in modern industrial economies. Unfortunately, they are difficult to implement in a CGE model because they require data on market structure (monopolistic, perfect competition, etc.) and trade data at a level of disaggregation that is not easy to obtain. Furthermore, there is no consensus yet of a unified general theory of trade under imperfect competition and economies of scale. Mostly, what is known as new trade theory is a collection of special cases. Additionally, as Francois and Shiells (1994) observe, Armington and monopolistic competition models with differentiated products are equivalent if there is free entry and exit and the variety of foreign and domestic products does not change in equilibrium. For these reasons, a monopolistic competition model is not used in DRAM.

V.4.ESTIMATES FROM THE LITERATURE

V.4.1.IMPORT ELASTICITIES

Import-price elasticities estimated for the United States vary widely across sectors and no consistently observable sectoral patterns emerge. Stone's (1979) estimates range from 0.02 for organic chemicals to 3.49 for metal products. In addition, Stone's estimates show that metals, office machines, inorganic chemicals, and dyeing, tanning and coloring all have elasticity estimates above two while Kreinin (1973) finds few sectors with estimates greater than one.

The most recent and comprehensive estimates of the elasticities of substitution between imports and domestic goods for United States manufacturing and mining sectors are calculated by Reinert and Roland-Holst (1992). They estimate the Armington model for 163 mining and manufacturing sectors. About two-thirds of the estimated elasticities are positive and statistically significant. Among the significant two-thirds, the values ranged from a low of 0.13 for chocolate and confectionery products to a high of 3.49 for wine, brandy, and brandy spirits. Processed food sectors had a range of 0.13 to 1.88 while electrical equipment and electronics ranged from 0.36 to 2.65. A sample of these estimates are contained in the first numerical column of the table following. Reported in the other two numerical columns are other recent elasticity estimates (Shiells, 1993), using both non-nested and nested types of the Armington model for U.S. imports from Canada and Mexico for a selection of sectors that Reinert and Roland-Holst studied.

Table V-1. Estimated Import Elasticities of Substitution for the United States

Sector	(Reinert and Roland-Holst)	Nonnested CES (Shiells/Reinert)	Nested CES (Shiells/Reinert)
Iron and ferroalloy ores mining	1.22		2.97
Clay, ceramic, and nonmetallic min.			0.04
Malt and malt beverage	0.02	0.17	0.60
Distilled liquor	0.15	0.26	0.12
Sawmills	0.58	0.74	0.84
Wood preserving/particle board	0.49	1.09	1.17
Paper mills (excl. building paper)	0.97	1.02	1.02
Building paper and board mills	0.97		1.13
Industrial inorganic/organic chemicals.	0.48	0.89	0.90
Synthetic rubber	0.87	0.88	0.67
Tires and inner tubes	0.02	0.80	0.21
Hydraulic cement	1.09	0.98	0.36
Ceramic plumbing and electrical supply	0.84	0.98	0.97
Primary copper	0.91	0.14	-0.10
Primary lead, zinc, and nonfer. metals		0.10	1.0
Primary aluminum		1.49	1.60
Metal barrels, drums, and pails	1.03	1.02	1.00
Farm and garden machinery/equipment	1.06		1.39
Transformers, switch gear, and switchboards	0.20	0.68	0.77
Electrical lamps, lighting, and wiring	0.82		1.01
Electrical equipment and supplies	0.36	0.98	1.02
Motor vehicles, parts, and accessories	1.16		1.00

Source: Reinert and Roland-Host (1992) and Shiells and Reinert (1993).

In addition to Reinert and Roland-Holst and Shiells and Reinert studies, estimated elasticities of imports for United States are available from studies designed to analyze the gains from NAFTA. The elasticities reported in the table below correspond to σ in the Armington model. It is the percent change in the ratio of imports (from Canada and Mexico) to U.S. domestic-goods consumption, due to a one percent change in the relative price of U.S. domestic goods to price of imports. Most of the industries seem to have an elasticity around one, except for agriculture, electricity, construction, commerce, transport and communications, and finance, insurance, and real estate, which have elasticities closer to 1.5. The least-traded goods seem to be beverages and apparel, with estimates of 0.326 and 0.479, respectively.

Table V-2. Elasticities of Substitution: U.S. Domestic Goods and Imports from Canada and Mexico

Agriculture	1.50
Mining	1.062
Petroleum	0.660
Food processing	0.889
Beverages	0.326
Tobacco	1.008
Textiles	0.918
Apparel	0.479
Leather	1.007
Paper	0.967
Chemical	0.903
Rubber	1.026
Nonmetal mineral products	1.152
Iron and steel	0.931
Nonferrous metals	0.825
Wood metal products	0.888
Non-electrical machinery	1.012
Electrical machinery	1.035
Transport equipment	0.982
Other manufacturing	0.550
Construction	1.500
Electricity	1.500
Commerce	1.500
Transport and communication	1.500
Finance, insurance, and real estate	1.500
Other services	1.500

Source: Roland-Holst, Reinert, and Shiells (1994).

V.4.2.EXPORT ELASTICITIES

The export elasticities that are available from the literature are scant and old. Stone (1979) did one of the more comprehensive studies. He used U.S. semiannual data for the period 1963–1972. In 14 of the 34 sectors studied, export elasticities were around one. The sectors with the highest elasticities were aluminum and its products, and paper manufacturing, with estimates of 4.09 and 4.01, respectively. The lowest estimate was recorded for toys and sporting goods.

The other studies that were done about this time estimated a single aggregate export elasticity number. All of these studies were done for a single manufacturing sector. They include Clark (1974), who found an elasticity of 0.91; Kwack (1972), who estimated an elasticity of 0.71; and Houthaker and Magee (1969), who estimate a value of 1.20.

For more recent work, NAFTA studies provide some reasonable estimates. In a world of few nations, three in the case of North America, the import elasticities of one can be considered to be export elasticities of the other. Roland-Holst, Reinert, and Shiells (1994) report the Armington elasticities of import demand for Mexico and Canada. Because these imports are exclusively from the United States, the Canadian and Mexican demand for U.S.-source imports can be considered as demand for U.S. exports. Actual estimates are reported in columns two and three of the table below.

Three observations stand out in this table. First, the export elasticities for U.S. goods to Canada are slightly higher than those to Mexico. The highest export elasticities are in agriculture and service industries. Second, these estimates are on the low end of what would be the true export elasticities. This is because the United States trades simultaneously with its NAFTA partners and with Europe and Asia so that the magnitude of price sensitivity of its exports cannot be captured accurately by estimates from North American trade flows alone. Third, in the case of California, these estimates are lower bounds as California's exports also compete with goods from the rest of the U.S.

Table V-3. Export Elasticities for U.S. Goods

Sector	Canada	Mexico
Agriculture	1.50	2.250
Mining	1.062	0.781
Petroleum	0.660	0.580
Food processing	0.889	1.007
Beverages	0.326	0.726
Tobacco	1.008	1.008
Textiles	0.918	1.022
Apparel	0.479	0.802
Leather	1.007	1.066
Paper	0.967	0.734
Chemical	0.903	0.702
Rubber	1.026	0.763
Nonmetal mineral products	1.152	0.826
Iron and steel	0.931	0.716
Nonferrous metals	0.825	0.663
Wood metal products	0.888	0.594
Nonelectrical machinery	1.012	0.694
Electrical machinery	1.035	0.705
Transport equipment	0.982	0.679
Other manufacturing	0.550	0.463
Construction	1.500	1.20
Electricity	1.500	1.20
Commerce	1.500	1.20
Transport and communication	1.500	1.20
Finance, insurance, and real estate	1.500	1.20
Other services	1.500	1.20

Source: Roland-Holst, Reinert, and Shiells (1994).

V.5.CONCLUSION

To evaluate the impact of trade on the California economy, the share equation from Armington's CES is chosen for DRAM. Reliable trade data at the state level are not available nor are trade elasticities for states. The elasticities used for California import demand and export supply in DRAM were chosen to represent the middle ground of published estimates obtained from the most recent studies available. All of these studies use U.S. data. The assumption is that California's trade patterns mimic U.S. trade and that true parameters for California resemble those of U.S. At worst, the U.S. estimates are lower bounds for California because there is good reason to believe that a region's goods are more price sensitive than those of a nation. For DRAM, import and export elasticities are set at 1.5 and 1.65, respectively, except for less traded goods such as most services, which have elasticities set at 0.5 and 0.65.

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VI. INVESTMENT

In this chapter the choice of investment equation is explained. There are four main approaches to modeling investment, but for reasons of data availability, only two of those approaches can be implemented in a regional model. The chosen approach, Engle's relative rates of return approach, has both theoretical and practical advantages. The advantages include sensitivity to tax policy and ease of computation. This chapter is organized into three major parts: (1) Investment theory, explaining the four major theories of investment (2) Regional investment, explaining the changes to the theory needed for a regional model and giving prime examples of the estimation of these models, and (3) Conclusions, explaining the selected model and proposed parameter values.

VI.1.INVESTMENT THEORY AND SOME NATIONAL ESTIMATES

There are four main theories of investment: (1) the q-theory of Tobin, (2) the accelerator model, (3) the replacement cost theory of Jorgenson, and (4) the cost of adjustment or Euler equation theory. These four theories, focusing on the model of Jorgenson, which is most applicable to a CGE framework, are discussed in this section. Both the q-theory and the replacement cost model have versions that account for the effects of tax policy. The tax adjustments for the replacement cost model are discussed in detail.

VI.1.1.Q-THEORY OF INVESTMENT

The q-theory asserts that investment is a function of the ratio of the market value of the firm to its replacement value (Tobin, 1969). This ratio is called q and when it is corrected for the effects of taxation, it is called Q (Schaller, 1990, Summers, 1981). The market value of a firm is its stock market value plus the value of its debt. The replacement value of a firm's capital stock is the estimated value of replacing all the equipment, structures, and inventories owned by the firm. Replacement value is reported by the firm to the Securities and Exchange Commission. Investment is a function of Q and possibly Q from past years.

From the point of view of theory, Q-based models are appealing because they imply profit-maximizing behavior and they are forward looking. The market value of the firm is the stock markets' expectations of the present value of what the firm's capital stock can earn. The replacement value is an estimate of what that capital stock cost to make. If the returns are greater than the cost of making capital, adding capital (also called investment), is the profitable option. Firms invest when a dollar's worth of investment is expected to yield more than a dollar, so Q-theory incorporates profit maximization. The model is forward looking because the stock market value of the firm is investors' beliefs about the firm's future earnings.

The difficulty with a regional implementation of Q-based investment is that firms do business across several states and their equity and debt is only valued in a national market. Since there is a lack of a good region-based estimate of equity, there is no way to implement a Q-theory of investment model in a model such as DRAM for California.

VI.1.2.ACCELERATOR MODEL

The second national model that has been used in investment studies is the accelerator model. In an accelerator model, investment is dependent upon past values of the capital stock and past values of output (or value added). The logic of the model is that sectors that have output growth will invest. These models are simple to estimate on a regional basis, but they have little use for policy analysis.

In the model, the effects of all policies (including taxes and interest rates) are subsumed in past output. Since the model is silent about how policy variables affect output, it is silent about how they affect investment. Therefore, these models are not suitable for tax policy analysis.

VI.1.3.COST OF CAPITAL MODEL

The cost of capital model ((Jorgenson and Siebert, 1968, Jorgenson and Stephenson, 1967) is an empirical application of the standard microeconomic rule that factors of production are employed until the point where their marginal value product equals their cost. This section has four parts: (1) the pure neoclassical theory of investment; (2) benefits from investing one more unit of capital, marginal-value product; (3) costs of investment, which include taxes and interest; and (4) how the ratio of marginal-value product to cost influences investment over time.

PURE THEORY

The pure theory of investment assumes a representative firm that maximizes the present value of profits. The firm takes the rate of return that it could earn after tax from investing in an alternative to its own activities, such as buying a bond, as a given constant, r. The value of the firm's output, net of material costs, is p Q, which is taken as a function of labor and capital. At any given instant in time, the firm has revenues net labor (L at wage s) and investment costs (I at price q).

Now, net revenues, R, are

$$R = (pQ - sL - qI) \qquad \text{(VI-1)}$$

The firm pays taxes in amount D. Taxes are determined by the corporate tax rate, u, and the income subject to corporate tax. The income which is subject to corporate tax is value added (pQ–sL–qI) less interest payments less depreciation. The firm makes payments to holders of debt and to holders of an equity interest. The fraction of debt in the sum of debt plus equity is w. Thus, wK is the amount of capital financed with debt and wqK is its value. Given that debt instruments pay r percent interest, the interest payments are rqwK. The depreciation rate is δ, and the fraction of depreciation that is deductible from income is v. Thus income, for tax purposes is decreased by vδqK, as a depreciation allowance. In the expression below, the sub expression in brackets is income for tax purposes and D is the total tax bill per unit time.

$$D = u(pQ - sL - v\delta qK - wrqK) \qquad \text{(VI-2)}$$

A firm that maximizes the present value of its profit stream would maximize

$$\begin{aligned} V &= \int_0^\infty e^{-rt}(R - D)dt \\ &= \int_0^\infty e^{-rt}\left\{pQ - sL - qI - \left[u(pQ - sL - v\delta qK - wrqK)\right]\right\}dt \end{aligned} \qquad \text{(VI-3)}$$

The firm maximizes this value subject to an investment constraint. The investment constraint is that the change in capital stock is investment less depreciation. The solution to this problem in a steady state (defined to be a condition when all variables grow at a constant rate) is given by Jorgenson (Jorgenson and Stephenson, 1967):

$$qr + q\delta = \left[(1-u)p\frac{\partial Q}{\partial K} + u(v\delta q + wrq)\right] \qquad \text{(VI-4)}$$

The left-hand side of (VI-4) consists of the costs of investing a unit of capital, namely, the interest and depreciation costs. It is equal (in steady state) to the right-hand side, which is the after-tax, marginal-value product of capital. The after-tax, marginal-value product has three parts. The first part is what the firm would get if it paid taxes on all of its marginal-value product. The other two terms, in braces, adjust for the depreciation and interest-deduction allowances.

Instead of stating (VI-4) in after-tax terms, Jorgenson states it in pretax terms. This yields

(VI-5) $$\frac{p\frac{\partial Q}{\partial K}}{c} = 1$$

where c is

(VI-6) $$c = q\left(\frac{1 - uv}{1 - u}\delta + \frac{1 - uw}{1 - u}r\right)$$

Equations (VI-5) and (VI-6) give the condition for equilibrium in the investment market, at least in theory. The remainder of this section includes the way in which these formulas are implemented and how out-of-equilibrium (non-steady-state) conditions are handled.

MARGINAL-VALUE PRODUCT OF CAPITAL

The number of additional dollars, per unit time, earned by investing in one extra unit of capital is called the marginal value product of capital. It is composed of the product of the price of output, p, and the marginal physical product of capital, Q/K, the amount of extra product produced by adding one unit of capital. This quantity is not observable. What can be observed is value added, and what could be estimated is a production function.

Jorgenson's choice is to assume that the production function has a multiplicative functional form (called Cobb-Douglas) so that the marginal product of capital is simply proportional to output. Thus, Jorgenson uses pQ as his measure of marginal-value product. (The constant of proportionality is subsumed in his regression technique and need not be of any concern.)

COST OF CAPITAL

The price of capital services, c, depends on (1) the price-of-investment goods, q; (2) the rate of return; (3) the rate of depreciation; (4) the rate of growth of the price-of-investment goods, and (5) the tax structure.

Here, r stands for the opportunity cost of capital. It is a harmonic weighted mean of the earnings per share for all manufacturing firms and the long bond yield. The weighting is done by using the share of the subject sectors' debt in its capital structure. The ratio of earnings to price of a share and the value of outstanding shares is reported by Standard and Poor. The value of debt, like the value of equity, is an estimate and is reported by Standard and Poor. The value of debt for a sector is the ratio of the sector's net monetary interest to the bond yield for all manufacturing firms. This gives all the pieces needed to calculate r.

Here, the method of calculating a sector of the economy's corporate tax rate, u (corporate tax payments divided by corporate profits before taxes), w; the fraction of total cost of capital that is interest, δ; the depreciation rate; and v, the part of depreciation allowed for tax purposes, will not be of any concern.

NON STEADY STATE INVESTMENT

In reality, the marginal value product of capital and the cost of capital are not equal. Although explicit assumptions about speed of adjustment to equilibrium can be provided, Jorgenson's frank empirical approach has as much to recommend it. The empirical approach is simply that investment net of depreciation, N, is a function of present and past values of the ratio of marginal value product to cost. The higher the ratio the higher is net investment.

The way Jorgenson implements this is extremely technical, but of great interest because of its implications for timing. An unfortunate amount of terminology is in order. First, let the ratio of marginal value product to cost be Y_t where the t is time. Now let $L^n Y_t$ be Y_{t-n}. L is called a lag operator. Define $\phi(L)$ and $\Phi(L)$ to be polynomials in the lag operator, e.g. $L^2 + 4L$. The model is $N_t = (\phi(L)/\Phi(L))\ Y_t$. The model is estimated by choosing a degree for each of the two polynomials. The import of this procedure is that current net investment will depend upon past values of the ratio of marginal value product to cost of capital. In Jorgenson's actual estimated models, very little of the effect of an increased Y is seen within the first year. Thus the estimated model essentially rules out dynamic effects through capital happening within the year a tax cut is made.

RESULTS

The tables of coefficients from the empirical model allow calculation of the elasticity of investment net of depreciation with an additional assumption on the size of the capital share parameter. Jorgenson and Stephenson (1967) present estimates for this parameter, which they characterize as unrealistically small. The elasticity calculations presented in the table below assume the conventional wisdom estimate for this parameter of one-third. The stated elasticities are the total across several years. For all the industry groups included in the study, investment multipliers did not last longer than six quarters. For all manufacturing, a one percent increase in the ratio of value added to cost of capital induces a 0.42 percent increase in net investment (investment net of depreciation). But this 0.42 percent increase is realized over six quarters. For total manufacturing, 0.0381 of the effect happens in the first two quarters of the first year, 0.1589 in the third and fourth quarters of the first year, and 0.2305 in the first two quarters of the second year.

In a recent study, Oliner, Rudebusch, and Sichel (1995) examine the ability of all the national investment models reviewed in this chapter to forecast investment in producer durables and nonresidential structures for the manufacturing sector in the United States. The variant of Jorgenson's model that they used for their work is very close to that of Jorgenson and Stephenson (1967) except for the following. Net investment is not lagged, and the lags estimated for value added to cost of capital ratio are longer. In addition, their data run from the first quarter of 1952 to the fourth quarter of 1992 and is normalized by capital stock in each period. Save for these differences, the models are identical and therefore comparable. These authors found that full realization of investment response to a tax cut takes eleven (11) quarters.

Table VI-1: Total Elasticities of Investment with Respect to PQ/c

Sector	Elasticity
Total Manufacturing	0.42
Total Durables	0.0782
Primary iron and Steel	0.1549
Primary Nonferrous Metal	0.0001
Electrical Machinery and Equipment	0.0352
Machinery, Except Electrical	0.0025
Motor Vehicles and Equipment	0.2930
Transportation Equipment excluding Motor Vehicles	0.0071
Stone, Clay and Glass	0.0404
Other Durables	0.0016
Total Non-durables	1.4815
Food and Beverages	0.0261
Textile Mill Products	0.0083
Paper and Allied Products	0.2430
Chemicals and Allied Products	13.184
Petroleum and Coal Products	-0.1414
Rubber Products	0.0226
Other Non-durables	0.0014

VI.1.4.COST OF ADJUSTMENT THEORY

The cost of capital theory of Jorgenson has no explanation, other than empirical, of when investment will happen. As theory, it simply states that the capital stock will adjust until no more profits can be made. The cost of adjustment approach provides a theoretical justification for slow adjustment of capital stock. It is simply assumed that the more one tries to invest per time period the more expensive investment will be. This simple artifice causes a present value of profit maximizing firm to spread its desired investment over many time periods. The path of investment can be derived by explicitly writing out the model. The procedure assumes that firms maximize the present value of their profits (after tax). The prices of capital goods rise as investment rises. Capital is increased by investment and decreased by depreciation. The first order conditions for a maximum in this model are called Euler equations and so this is also called the Euler "Euler equation theory." Empirical tests (Oliner, et al., 1995) show this model to be vastly inferior to the first three models described.

VI.1.5.RESULTS FROM INVESTMENT EQUATIONS USED IN MACRO MODELS

In addition to the investment models discussed above, there are many other investment equations that are often used to predict effects of investment flows from policy changes. These models are usually part of large scale macroeconometric models. Six such models are used to predict investment response to tax incentives. They include Bureau of Economic Analysis (BEA) model, Chase, DRI, Michigan, MPS, and Wharton. In the next few paragraphs, a brief description is given of each of these equations and then predictions are reported for investment response following a tax policy change.

The BEA investment equations depend on the ratio of price of output to rental price of capital. The ratio is adjusted for by price elasticity of demand for capital. Tax changes affect investment through their effect on the rental price of capital. Other variables that can be added to the definition of rental price of capital include expected inflation, expected interest rate, and dividend to price ratio. The model predicts moderate tax effects on investment.

Chase equations specify a function for new factory orders. According to the model, new orders are a linear function of consumer non-durable expenditures, a price index, housing starts, the rate of capacity utilization, level of defense and space output, and relevant tax parameters. Because the model is linear, tax variables can be assessed independent of their impact on other variables.

The DRI model is the one closest to the cost of capital model of Jorgenson. In this equation, investment is made to depend on the ratio of value added to cost of capital and/or its past values. Also included in the equation are the ratio of interest payments to gross cash flow, producer's capital stock, expected rate of capacity utilization, output-supply shocks, and even a dummy variable for the Vietnam War period. Because variations in gross cash flow are expected to follow cyclical variations in profits, this investment equation predicts large tax effects to the extent that taxes influence cash flow.

What is referred to as the Michigan investment equation is, by and large, several equations. There are three separate investment equations for production, agriculture, and other equipment, and another for structures. Each of the equipment investment equations is slightly different from the other two. The production equipment investment equation is a function of change in output, wage to capital rental price ratio, and lagged investment expenditures on producers' structures and production equipment. The equation for equipment in agriculture is a function of all the variables in production equipment function except lagged investment in structures and production. It then includes agriculture's lagged producers' equipment expenditures and changes in farm income relative to nonfarm income. Other equipment has added terms of inflation and strikes by autoworkers. The investment equation for structures is a function of ratio of wage to rental price of capital, lagged output, and lagged investment expenditures on producers' structures. The tax parameters do not enter into the latter equation at all. In the investment equations for equipment, tax policy impact is felt through tax effects on rental price of capital.

The MPS equipment investment equation , like the Chase investment equation, attempts to predict new orders for producers' durables. Equipment investment is a function of the ratio of output price to cost of capital, changes in lagged output, investment tax credit, price controls, and unfilled orders for producers' durables. The investment model for structures depends on output price to rental price of capital ratio, and capital stock for structures.

Finally, in the Wharton model, non-agricultural industry investment equations depend on current output, one- to two-quarter expected investments, and current capital stock. Rental price of capital is also an important determinant of investment. Rental prices of capital are, in turn, functions of industry income tax structure.

Having reviewed the nature of these models, albeit briefly, it is possible to look at their predictive ability. Chirinko and Eisner (1983) report that the investment equations yield radically different results for simple policy changes. Their policy experiment involved doubling the investment tax credit. For instance, suppose that the investment tax credit prior to the policy change was 10 percent. Now imagine that the policy is changed in such a way that the investment tax credit is doubled, then the new investment tax credit is 20 percent. Imagine furthermore that the change in tax credit was effected at the beginning of, say, 1973.

By the end of the fifth year (i.e., end of 1977), following the one-time change in investment tax credit, the change in investment as a percent of the 1973 investment levels that were calculated for each of the equations are:

Table VI-2 One-time Change in Investment as a Percentage of 1973 Investment Levels

Model	Equipment Investment	Structures Investment
BEA	9.8	3.5
Chase	4.7	3.4
DRI	14.2	6.3
Michigan	1.5	0.0
MPS-A	15.1	5.7
MPS-B	15.1	5.7
Wharton	4.9	5.0

As the table shows, the results range from a small change of 1.5 percent in equipment investment from the Michigan model to a high of 15.1 percent predicted by MPS. In structures, the responses are not as dramatic. The Michigan model still predicts the smallest change, but the highest prediction by DRI is 6.3 percent.

VI.2.REGIONAL INVESTMENT MODELS

There is reason to believe that regional investment is more volatile than national investment. For that reason alone, it is worthwhile to identify the factors that distinguish regional investment from national. The difficulty inherent in regional estimation of investment is that data on capital by region are sparse. An underlying problem is that whatever investment firms report generally includes their investment in several regions.

VI.2.1.THEORY

In theory, regional investment models differ from national models in that they account for location-based or regional advantages. These include labor quality and costs, capital costs, other input supplies, land prices, local taxes, agglomeration, amenities, etc. Models may choose to consider one or more of these advantages.

The models that distinguish regions according to their cost-of-capital advantages are Jorgensonian in flavor. Like their national counterpart, they argue that investment responds to rates of return to capital. Unlike the national version, they consider relative rates of return to be more important. In other words, firms are said to care more about rates of return in a state relative to other competing states than to a state versus the market as a whole. The major addition one needs for a California model is to calculate u as the Federal plus State tax rate, taking due account of deductibility of state income tax from Federal.

For non-Cobb Douglas production functions, such as the CES production functions proposed for the California model, one just uses the marginal product of capital instead of the proxy, value added.

VI.2.2.PRACTICE

Among the regional models reviewed below, Engle's on Massachusetts, Lin's on Arkansas, and Crow's Northeast are based on Jorgenson-type relative rates of return. The rest, Bell's on Massachusetts and Glickman's on Philadelphia are simple versions of the accelerator.

None of the models incorporate taxes in their estimations. Tax policy analysis cannot be done using the accelerator model because the model makes investment dependent on output and lagged capital stock variables such as cost of capital. The models based on Jorgenson's cost of capital model can, in principal, take tax analysis into consideration. But in none of these models was that done.

MASSACHUSETTS (ENGLE)

Engle's (Engle, 1974) investment equation for Massachusetts, I^m, is a function of rates of return to Massachusetts, r^m, and average rate of return in U.S., r^*. When data are available, this variable is the rate of return of the state with the highest return. It is the opportunity cost of capital elsewhere. The other variable upon which investment in a state depends is U.S. investment, I^{us}.

$$\text{(VI-7)} \qquad I^m = \beta_0 + \beta_1\left(\frac{r^m}{r^*}\right) + \beta_2 I^{us}$$

Engle used Massachusetts' profit rate data where the profit rate is calculated as the difference between value added and wage bill for Massachusetts. This information is available from the census of manufactures. The estimation was done for four aggregate industries: nondurables 1 (textile, apparel, leather), nondurables 2 (printing, processed foods), durables 1 (electronics, machinery, technology), and durables 2 (primary, fabricated metals). The elasticity estimates for the four industries are 0.64, 1.57, 0.80, and 1.5, respectively.

ARKANSAS (LIN)

Lin (Lin, 1985) made use of Arkansas profits and capital stocks to calculate the rates of return for several sectors in that state. The investment function that Lin worked with is linear in logarithms.

$$\text{(VI-8)} \qquad \ln\ I_t = b_o + b_1\ \ln\ I_t^{US} + \tfrac{1}{3}\ b_2\ \ln\left(R_g + R_{t-1} + R_{t-2}\right) + e_t$$

where I is regional investment for Arkansas, I_t^{us} is investment in the United States in time t, and R is relative rate of return to Arkansas by sector. The model posits that both current and past periods' rates of return affect investment. In this particular model, consideration is given to rates of return in the past two years.

Although rate of return is emphasized in the study, it is not clear how it is measured. It is not, in general, simple to calculate rate of return. And it is especially difficult with what is available as regional data. Lin estimates the rate of return in Arkansas as the ratio of sectoral profits in Arkansas to sectoral capital stocks. Arkansas' profits are estimated from a national model. The method used first estimates a regression of profits on net value added using national data. Net value added is gross value of output less wages. To estimate regional profits, Lin uses the coefficient from the regression using the national data to construct profits for Arkansas.

The cost of capital is estimated by subtracting depreciation from investment using historical Arkansas data for investment and then multiplying the difference with inflation-adjusted investment prices used by Bureau of Labor Statistics. Where Arkansas' historical data do not exist, the cost of capital is constructed by assuming that, for each sector, Arkansas' share of national value added is proportional to the share of that sector's investment.

The data for Arkansas' investment is obtained from the *Annual Survey of Manufactures* and *Census of Manufactures.* Profits for the United States are obtained from National Income and Products Account. The regional profits are calculated from the national profits.

In terms of elasticity of investment with respect to rates of return, Lin's results are given the table below. The interpretation is that a one percent change in the rate of return (e.g., from 10 percent to 10.1 percent) would increase investment by .31 percent (i.e., .0031) for the food sector. One-third of the increase would come in each of the current year, next year, and third year. The estimates are notable for the large and negative estimates for apparel and paper. These results are simply too counterintuitive to be believed. The largest positive elasticity is for electrical machinery at just below two.

Table VI-3. Elasticity of Investment with Respect to Rates of Return for Arkansas (Lin)

Sector	Elasticity
Food	0.31
Textiles	0.76
Apparel	-3.07
Furniture and Fixture	0.36
Paper	-1.77
Printing and Publishing	-0.05
Chemicals	1.07
Petroleum and Coal	-0.31
Stone, Clay and Glass	0.71
Primary Metals	1.31
Fabricated Metals	0.34
Non-electrical Machinery	1.58
Electrical Machinery	1.82
Transportation Equipment	1.33

MASSACHUSETTS (BELL)

Another study using Massachusetts data is conducted by Bell (1967). The investment equation used by Bell is a log-linear function of regional output and the level of technology. Regional output in this study relies heavily on exports. It is exports, the author argues, that lead to expansive (growth-inducing) economic activities. Regional income is measured as export income “received.” The model also allows investment to depend on past values of capital stock. The reason is that new structures, funding arrangements, etc., take time. In addition, entrepreneurs may be reluctant to make a complete adjustment until demand conditions show some persistent pattern.

Bell uses regional capital stock for manufacturing since no such data exist for non-manufacturing. Capital stock is computed as net book value of assets. The estimated elasticity for export income is 0.939 while, for lagged capital stock, it is –1.023.

NORTHEAST CORRIDOR (CROW)

The regional investment model for the northeast proposed by Crow (Crow, 1973) is embedded in a larger regional macroeconometric model. He models nonresidential fixed investment, FIXD, as a function of lagged total gross private product less private wage bill, $PRIV_{t-1}$. The exact equation is

$$(\text{VI-9}) \qquad FIXD = \beta_0 + \beta_1 PRIV_{t-1} + D1 + u_t$$

where D1 is a dummy variable for observations in the northeast.

Investment is in current dollars as is total wage bill. The model is not, strictly speaking, designed to predict investment flows. Profits appear in the model in order to help forecast how firms finance investment. Investment in fact is not the primary focus of the model. Rather, it is regional econometric forecasting. Crow estimates a coefficient of 0.203 for lagged private profits. Since the mean values of profits are not reported in the paper, one cannot readily compute the response of investment to profits (i.e., elasticities) at their mean values cannot readily be computed.

PHILADELPHIA (GLICKMAN)

The investment equation for Philadelphia is also embedded in a larger regional forecasting model. Data were available for manufacturing sectors only. The investment equation proposed by Glickman (Glickman, 1971) is more like the national accelerator model. In Glickman's model, investment is a function of past values of investment, capital stock, and output. Making current investment decisions depend on past values of output, investment, and capital stock ignores important ways in which current policy announcements induce future behavioral adjustments by economic agents.

The estimated coefficients for K_{t-1}, Q_t, and I_{t-1} are –0.123, 0.224, and 0.958, respectively. Again, these are not elasticities but merely level changes.

CONTIGUOUS STATES OF THE UNITED STATES (RICKMAN)

Rickman, Shao, and Treyz (Rickman, et al., 1993) is an attempt to predict nonresidential investment in structures for each of the states in the United States. Investment is described by a stock adjustment process, meaning that the level of investment is a function of the gap between desired capital, K^*, and actual capital stock, K. The proportion of actual capital added each year toward achieving the target level of desired capital is called "adjustment" and, in the model, is denoted α. The idea is that all the desired level of investment capital cannot be installed at once. There are many reasons why this happens. Among them is the difficulty of the firm to raise enough money to fund all its capital investment needs and the fact that time to build physical structures can be long. The model also includes depreciation, d.

According to the model, the region's desired stock of nonresidential capital depends on that region's share of employment (AE), labor costs (ARW), and capital costs (ARC). The variables AE, ARW, and ARC are aggregated by industry. Then they are weighted by industry size and capital intensity of the industry. Formally:

$$K^*_{t,r} = \gamma_r \left[\left(\frac{ARW_{t,r}}{ARW_{t,u}} \right) \Big/ \left(\frac{ARC_{t,r}}{ARC_{t,u}} \right) \right] \left(\frac{AE_{t,r}}{AE_{t,u}} \right) K^*_{t,u} \qquad \text{(VI-10)}$$

The subscripts t and u denote region and U.S. respectively. The numerator of the term in brackets is a region's labor cost per sector weighted by industry size relative to the national wage costs by sector, also weighted by industry size. The denominator of the term in brackets is a region's share of capital costs by sector weighted for industry size, compared to the U.S. costs of capital by sector weighted by industry size. The term in parentheses is regional share of employment relative to the national, both variables appropriately weighted for industry size.

Desired capital is unobservable. To avoid that problem, the equation above is usually transformed into an investment equation, which takes the form,

$$
(\text{VI-11}) \qquad I_{t,r} = \alpha_r \left[\begin{array}{l} \gamma_r \left[\left(\dfrac{ARW_{t,r}}{ARW_{t,u}} \right) \Big/ \left(\dfrac{ARC_{t,r}}{ARC_{t,u}} \right) \right] \left(\dfrac{AE_{t,r}}{AE_{t,u}} \right) \cdot \left[\dfrac{I}{\alpha_u + (1 - d_t) K_{t-1,u}} \right] \\ -K_o \prod_{i=1}^{t} (1 - d_i) - \sum_{i=1}^{t-1} I_{i,r} \prod_{j=i+1}^{t} (1 - d_j) \end{array} \right]
$$

The investment data for each state are not reported and so had to be constructed from observable U.S. investment levels. The parameters were estimated using non-linear least squares. The overall speed of adjustment for non-residential investment was estimated at 0.27.

VI.3.CONCLUSION

By way of summary, four theories of investment flows at the national level were reviewed. Three of the four were also found to have regional counterparts. The latter differ from the former in the data that they use and the specific regional variables they consider important in a firm's investment decisions. Of the three regional modeling approaches considered in this chapter, the q-theory is the most theoretically appealing because it assumes forward-looking behavior for firms. In practice, however, it is difficult to implement because data on replacement cost of capital for firms is difficult to obtain. In addition, stock-market values of firms at the regional level do not exist. The accelerator model rests on shaky theoretical grounds. However, the main reason that it was not chosen is that tax policy, which is the main focus for DRAM, is precluded by this theory. Another difficulty is that data on capital stock series are unavailable and often poorly measured.

Engle's model is chosen for DRAM for California because it has solid theoretical grounding and is simple to implement. The functional form used for implementation is a Cobb-Douglas variant of the cost-of-capital model discussed above:

$$
(\text{VI-12}) \qquad \ln I^c = \beta_0 + \beta_1 \ln\left(\frac{r^c}{r^{us}} \right) + \varepsilon_t
$$

where I is the rate of investment; B_0 is an estimated parameter; r is the tax-adjusted rate of return; the subscripts, c, and us, refer to California and the United States, respectively; and B_1, the coefficient of r, is the elasticity. More explicitly, B_1 is the percentage change in investment flow into California following a one percent increase in rates of return in California relative to United States. The increase in the rate of return is presumed to be due to tax policy change.

Reliable estimates of the elasticity of investment with respect to rates of return are difficult to find because, as mentioned earlier, good data on regional investment are difficult to find. Nonetheless, Engle's estimates are reasonable. In addition, Massachusetts and California are states that may rank about the same among investors. The estimates implied by the Jorgenson and Stephenson model for the whole of the United States are measured with some error but not serious enough to render them useless. In addition, they are based on aggregate data of national investment. The latter is not as volatile as investment in a state. For DRAM, elasticity of investment with respect to rate of return (B_1) is set at 1.5. This appears to be a reasonable extrapolation from the estimates reported by Engle and Jorgenson and Stephenson.

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VII. LABOR SUPPLY

The ability of policy makers to influence economic growth critically depends on the responsiveness of labor supply to economic incentives. In addition, the ultimate impact of economic growth on government revenues primarily depends on the impact such programs have on the tax base via the labor-force response. In this chapter the literature on domestic labor supply responsiveness to changes in taxes and changes job availability is examined. (The responsiveness of migration to economic incentives is examined in chapter VIII.) For thorough reviews of the literature on labor supply and taxation, see Hausman (1985), Pencavel (1986), MaCurdy *et al*. (1990), and Heckman (1993). Bartik (1991) presents an exhaustive review of the literature on labor supply responsiveness to regional job expansion. Moffit (1992) thoroughly reviews the literature on the incentive effects of the U.S. welfare system.

VII.1. LABOR SUPPLY, WAGES AND TAXATION

Two opposing effects occur as a result of a reduction in income tax. First, leisure becomes more expensive. With the rise in real wages, every leisure hour represents a higher amount of foregone wages. As a result, the typical worker might choose to substitute more work hours for leisure hours (the substitution effect). The second effect reflects the fact that, with higher real wages, workers become richer and can therefore afford to purchase more leisure, even if it is more expensive (the income effect). The magnitude and relative strength of these two opposing effects is important for two reasons. First, the deadweight loss to society of the tax system depends on the magnitude of the two effects; large offsetting income and substitution effects could result in large welfare losses (Hausman, 1985, MaCurdy et al, 1990). Second, the relative strength of these two effects determines whether or not a reduction in taxes would reduce hours of work (backward-bending labor supply curve) or lead to an increase in hours of work, maybe even to the extent that government revenue would actually increase (supply-side argument).

Discussion of the relative weight of the substitution and income effects in determining the direction of the labor supply response to a change in income tax has generated a large theoretical literature but little consensus (for example, Bohanon, et al., 1986, Gwartney and Stroup, 1983, Rosen, 1980, Wilde, et al., 1984). The many complexities and distortions inherent in most tax systems dims the outlook for anything but a loose consensus in the theoretical literature. In the introduction to his exhaustive review of the literature on labor supply and taxation, Hausman (1985) observes that progressive income taxation results in a convex, nonlinear budget set that requires modification of standard micro-theory for theoretical analysis. The addition of other provisions of the tax code, such as the earned income credit, the standard deduction and Federal Insurance Contributions Act (FICA), and transfers such as Aid to Families with Dependent Children (AFDC), create nonconvexities in the budget set that prohibit general conclusions about labor supply and income taxation. Hausman concludes that

> Little definite knowledge can be gained by a theoretical analysis of the effect of taxation. In fact, we cannot usually tell whether an increase in tax rates will increase or decrease hours worked. Nor can we decide how an increase in exemptions or other similar changes will affect hours worked. Thus, only empirical investigation can determine the sign and magnitude of the effect of taxation. (p. 214)

Review of the empirical literature on labor supply response to changes in income taxation again reveals a large literature with surprisingly little consensus, particularly in the early literature. Not only is there little consensus, but what consensus does exist is often disguised by a nonconformity in reporting. This characteristic of the literature is not so much a result of sloppy research as it is a result of the nature of the investigation. As observed by Hausman (1985), elasticity measures, the traditional sensitivity measures, are often not accurate in assessing the effect of taxation on labor supply. Hausman presents a number of reasons for this conclusion. First, the nonlinear, nonconvex character of the budget sets under investigation can lead to large changes in labor supply as a result of small changes in taxes. In such a case, elasticity measures are meaningless. Second, at zero hours, the utility function of anyone not currently in the labor force is not tangent with a budget set and, as a result, small changes in taxes will not affect most nonworkers. Because approximately 40 percent of all women are not labor-force participants, the fact that nonworkers do not enter into elasticity calculations could prove very distorting. Third, when taxes are changed, both the change in after-tax wages and in nonwage incomes must be considered. Problems associated with the first reason are decreased to some extent with aggregation; however, the last two problems remain.

Another source of confusion in the labor supply literature springs from the fact that labor was not disaggregated in the early analysis. One observation that clearly arises in the recent literature is that the labor supply response to tax changes of different income groups, and prime-age males, female heads of households, and married females, are all different. Failure to account for this observation in general studies of labor supply response has led to conflicting results.

Another note of caution regarding the empirical literature on labor supply response is sounded by Heckman (1993) in his review of the literature. Heckman cites two studies conducted by the Survey of Research Center of the University of Michigan (Juster and Stafford, 1991) that provide evidence regarding bias in the Current Population Survey (CPS). These studies produce evidence that the CPS has failed to register a secular trend toward reduced working hours by males and has exaggerated evidence concerning declining real wages. Because the CPS is the data source for the majority of the studies on labor supply, these studies are also open to bias.

The next section reviews the empirical evidence on the general characteristics of labor supply. All results should be interpreted in light of the provisos offered above.

VII.1.1. GENERAL LABOR SUPPLY CHARACTERISTICS

The first set of results shed light on the general characteristics of the male labor supply curve. The results of five studies investigating the characteristics of the labor supply curve with taxation are summarized in the following table.

Table VII-1. Prime-Age Male Labor Supply Results

Authors	Wage elasticity	Income elasticity
Wales/Woodland (1979)	0.09	–0.11
Ashworth/Ulph (1981)	–0.13	–0.05
Hausman (1981)	0.00	–0.17
Hausman (1983)	0.08	–0.04
Hausman/Rudd (1984)	–0.03	–0.10

Source: Hausman (1985).

The results of the studies summarized in this table suggest a labor supply elasticity with respect to wages that is close to zero (these results are much closer to zero than is typically found in labor supply studies that ignore taxes) and a negative income elasticity (implying that leisure is a normal good).

Table VII-2. Married-Women Labor Supply Results

Authors	Wage elasticity	Income elasticity
Ashworth/Ulph (1981)	0.19	–0.14
Hausman (1981)	0.91	–0.50
Nakamura/Nakamura (1981), United States	–0.16	–0.05
Nakamura/Nakamura (1981), Canada	–0.3	–0.19
Rosen (1976)	2.3	–0.42
Hausman/Rudd (1984)	0.76	–0.36

Source: Hausman (1985).

The results of five studies investigating the labor supply behavior of married women where taxation is included are presented in the table above. As shown in the table, the elasticity measures calculated by the five studies vary widely. Hausman (1985) concludes that the Nakamura and Nakamura (1981) results cannot be supported and should be disregarded. Once this is done, the general finding is that married women's estimated uncompensated wage elasticity is positive and sizable, meaning that the overall effect of an income-tax increase would be a decrease in wives' labor supply. Like men, married women exhibit a negative income elasticity.

Though the general direction of labor supply responsiveness exhibited by men and married women is similar, the magnitude of the elasticities of married women is much larger than those for men. Two observations help to explain the different characteristics of men's versus married women's labor supply curves. First, the labor supply decision of married women might be a conditional decision. More generally, the labor supply decision of spouses might be interconnected. Many models explicitly or implicitly assume that household income is exogenous to wives' labor supply decision (Mroz, 1987). However, Hausman and Rudd (1984) fail to reject a joint household model of labor supply and it is reasonable to expect that the leisure hours of husbands and wives might be complements or substitutes.

Another explanation for the difference between men and married women's labor supply is the observation that women enter or exit the work force to adjust family income. Mroz (1987), Triest (1990), and Heckman (1993) all find that labor-participation decisions of married females are more elastic to changes in taxes than decisions regarding hours of work. In addition, there appears to be an important asymmetry to women's labor supply elasticities. As observed by Eissa (1995), reductions in marginal tax rates induce women to enter the work force, but increases in marginal tax rates do not induce them to exit at the same rate. Mroz (1987) finds that, once in the labor force, female participants are likely to remain in the labor force.

The observation that women's labor supply response might be more elastic, due to the fact that they enter (and to a lesser extent exit) the labor force more readily than men or female heads of households, is an important result for the literature as a whole. In his review of the literature, Heckman (1993) states that a major lesson of the past 20 years of labor supply research is that "the strongest empirical effects of wages and nonlabor income on labor supply are to be found at the extensive margin—at the margin of entry and exit—where the elasticities are definitely not zero." For those who are already working, Heckman revises George Stigler's dictum that all elasticities are one in absolute value. Heckman states that a dictum nearer the truth is that elasticities are closer to zero than one for hours-of-work equations estimated for those who are already working.

The empirical evidence on labor supply response to tax changes are reviewed in the next three sections. Different income groups, as well as prime-age males, female heads of households, and married females, will each be considered individually.

VII.1.2. MIDDLE-INCOME LABOR SUPPLY RESPONSE TO TAXATION

Two studies that explicitly examine the effect of taxes on prime-age male labor supply for different levels of wage earners are summarized in Table VII-3 and Table VII-4 Hausman's (1981, 1981) results for the United States are presented in the first of these, and Ashworth and Ulph's (1981) results for the U.K. are presented in the second.

Table VII-3. The Effect of Taxes on Prime-Age Male Labor Supply

Market wage	3.15	4.72	\$5.87	\$7.06	\$10.01
Change in L-supply due to:					
Introduction of taxes	–4.5%	–6.5%	–8.5%	–10.1%	–12.8%
10% tax cut	0.4%	0.5%	0.9%	1.7%	1.47%
30% tax cut	1.3%	1.6%	2.7%	3.1%	4.6%

Source: Hausman (1985).

Hausman's (1981, 1981) calculations of the change in labor supply that results from moving from a system with no taxes to one with a progressive tax system are indicated in the first row of this table. In every case, the imposition of taxes reduces the supply of labor, though the reduction of supply of high-wage earners is almost three times that of low-wage earners. The next two rows show what would happen to labor supply if taxes were cut by 10 percent and 30 percent, respectively. For each wage level, Hausman finds a positive labor supply response to a tax cut, meaning that the substitution effect dominates for every income group. He also finds that the strength of the labor supply response is dependent on the wage, with higher-wage earners responding more strongly to tax cuts. This result is consistent with the observation that, with the linear labor supply model, elasticity increases with nonwage income.

Calculations by Ashworth and Ulph (1981) of the effect of changing the standard rate of tax in the U.K. by plus or minus seven percent or 15 percent from its rate of 30 percent are presented in the table below. The standard rate of tax is the marginal tax rate for almost 90 percent of prime-age males in the U.K.

Table VII-4. The Percentage Change in Labor Supply Due to Taxes on Prime-Age Male Labor Supply

Quintile of income distribution	1	2	3	4	5	Total
15% tax cut	–0.3%	0.7%	0.8%	1.6%	2.1%	1.8%
7% tax cut	-0.1%	0.3%	0.3%	0.9%	0.9%	0.8%
7% tax increase	0.1%	–0.5%	–1.0%	–0.9%	–0.8%	–1.2%
15% tax increase	0.3%	–1.1%	–2.3%	–2.6%	–2.1%	–2.9%

Source: Hausman (1985).

The results presented in Table VII-4 mirror those in Table VII-3; in general there is a positive labor supply response to decreased taxes and a negative response to increased taxes. In both studies, a larger labor supply response is calculated for higher-wage earners. However, unlike the Hausman study, Ashworth and Ulph find that the income effect dominates for the lowest-income group, reversing the sign of the response for this group.

It is important to note that, in both the Hausman (1981) study and the Ashworth and Ulph (1981) study, the rise in labor supply would offset only about 10 percent of the fall in revenues from the tax cut. In his study on labor supply response for prime-age males in Sweden, Blomquist (1983) reports similar results to those of Hausman and Ashworth and Ulph. Blomquist finds that the substitution effect is larger than the income effect for all but the lowest-wage earners and that responsiveness increases with wage level. The magnitude of Blomquist's results is almost twice that of the Hausman study, but this could be explained by the observation that the level of taxation is considerably higher in Sweden than in the United States.

Triest (1990) builds on Hausman's work and similarly finds that the labor supply response of prime-age married men in the United States, measured in number of hours worked, is invariant to net wage. Unlike Hausman however, Triest finds that labor supply response of prime-age married men is invariant to nonwage income.

In contrast to the findings concerning prime-age males, numerous studies estimate positive labor supply elasticities on taxation for married women (Eissa, 1995, Stelcner and Breslaw, 1985), and the consensus in the literature is that married women's labor response is qualitatively and quantitatively different than that for men and female household heads.

Table VII-5. The Percentage Change in Labor Supply Due to Taxes on Married-Women Labor Supply

Market wage	\$2.11	\$2.50	\$3.03	\$3.63	\$5.79	Total
Introduction of taxes	+31.2%	–14.2%	–20.3%	–23.8%	–22.9%	–18.2%
10% tax cut						+4.1%
30% tax cut						+9.4%

Source: Hausman (1985).

Hausman's (1981) calculations of the effect on married women's labor supply of moving from a system without taxes to a system with taxes are presented in the first row of Table VII-5. The effect of taxation, as reported in the table, is to increase labor supply for the lowest-wage quintile but to decrease labor supply for the other quintiles. The strength of the married women's response is about twice that reported for prime-age men in the same study (Table VII-3). Reported in the second and third rows are Hausman's estimates of married women's labor supply response to a 10 percent tax cut and a 30 percent tax cut, respectively. Again, married women's response is about twice that of prime-age men's response as calculated in the same study.

The relatively strong female labor response, as compared to the male response found in most U.S. studies, is repeated in other industrialized countries. For France, Bourguignon and Magnac (1990) find the net-wage elasticity of married men to be negligible while the equivalent elasticity for married women is 0.3 and statistically significant. In Italy, Colombino and Boca (1990) find that only the labor supply of married women is elastic with respect to wage and income variation. Finally, Soest, Woittiez, and Kapteyn (1990) calculate net-wage elasticities for married women in the Netherlands that range from 0.65 to 0.79 while those for married men range from 0.12 to 0.10.

VII.1.3. HIGH-INCOME LABOR SUPPLY RESPONSE TO TAXATION

Like low-income groups, high-income groups are typically faced with high marginal tax rates. However, as noted by Hausman (1985), though high-income groups complain loudly about taxes, none of the empirical literature has found a significant disincentive effect of high tax rates. In his survey article, Hausman (1985) reviews the literature on the effect of taxation on the labor supply of high-income groups, most of which is based on interview surveys. Though some of the surveyed studies calculate a dominate income effect (Break, 1957), some no effect (Fields and Stanbury, 1970, Fields and Stanbury, 1971, Sanders, 1951), and some a dominant substitution effect (Barlow, et al., 1966, Holland, 1969), the consensus of these studies is that the magnitude of the labor supply response for high-income groups is probably very small.

This conclusion is not so easily reached when the labor supply responsiveness of high-income married women is considered. Eissa (1995) studied the labor supply response to tax changes of high-income married women using data from the Current Population Survey for 1988. She finds a labor supply elasticity between 0.6 and 1.0 for women in the 75th percentile and between 0.9 and 1.0 for women in the 90th percentile and a labor-participation elasticity between 0.2 and 0.4 for women in the 75th income percentile and 0.6 for women in the 90th percentile.

For both men and married women in the high-income group, the labor supply response to taxation probably takes a back seat to efforts to mitigate the impact of taxation through investment and tax-avoidance programs. Sanders (1951) argues that the creation of tax-avoidance schemes is the predominant to taxation in the high-income groups. Hausman (1985) observes that the economic cost of this type of response is substantial and has probably increased in magnitude since Sanders' survey. Feldstein (1995) argues that, because of the ability to shift remuneration from wages to lesser taxed forms of compensation (fringe benefits, perquisites, etc.), the responsiveness of taxable income (the tax base) with regard to changes in taxes will be much larger than the responsiveness of labor supply. Feldstein finds that the "evidence shows an elasticity of taxable income with respect to the marginal net-of-tax rate that is at least one and could be substantially higher."

VII.1.4. LOW-INCOME LABOR SUPPLY RESPONSE TO NEGATIVE INCOME TAX

Between 1968 and 1982, the U.S. federal government sponsored four negative income tax (NIT) experiments. The main purpose of these experiments was to determine how families would adjust their labor supply in response to an NIT. Robins (1985) reviews the four NIT in order to compile comparative statistics and evaluate the general findings of the studies. Robins observes that, despite the wide range of methodologies used in the experiments, the results are amazingly consistent. Robins' compilation of the average substitution and total income elasticities for the NIT experiments are presented in Table VII-6. Because changes in NIT and changes in wage level are virtually, if not exactly, identical for the study population, in this paper, Robin's estimates are used to measure tax elasticities.

Table VII-6. Average Substitution and Total Income Elasticities of NIT

	Substitution elasticity (per dollar per hour)	Income elasticity (per thousand dollars)
Husbands	0.08	–0.1
Wives	0.17	–0.06
Single female heads	0.13	–0.16

Source: Robins (1985).

As illustrated above, the elasticities indicate a negative uncompensated wage elasticity for husbands and single females and a positive uncompensated wage elasticity for wives. In general these results indicate that income effects are larger for the lower-income groups resulting in an overall reduction of labor supply with a decrease in taxes. These results correspond to the negative labor supply response reported by Ashworth and Ulph (1981) in Table VII-4 and by Blomquist (1983).

The general results reported by Robins (1985) for the NIT experiments are supported by the bulk of the literature on work-incentive effects of welfare. In his extensive review on the incentive effects of the U.S. welfare system, Moffitt (1992), citing Danziger, Haveman and Plotnick's (1981) review article, states that a program, such as AFDC, generates "nontrivial work disincentives...though there is still considerable uncertainty regarding the magnitude of the effects." For AFDC, Danziger, Haveman, and Plotnick estimate that the reduction in work effort ranges from one hour to 9.8 hours of work per week, corresponding to a reduction of 10 percent to 50 percent of nontransfer labor supply. For his estimates of the effect of AFDC on mean weekly hours of work of all U.S. female family heads, Moffit (1985) uses elasticity estimates that range from 0.05 to 0.2 for wage elasticity and from –0.02 to –0.25 for total income elasticity (i.e., uncompensated elasticities ranging from –0.2 to 0.03).

VII.1.5.SUMMARY OF RESULTS ON LABOR SUPPLY AND TAXATION

The findings of the research review on labor supply and taxation are summarized in the table below. The table is organized to reflect the observation that labor supply response varies with income groups and with status within the household. In the table below the percentage changes reported in the other tables in the chapter have been converted to rough elasticity estimates.

Table VII-7. Summary of Estimates of Labor supply Elasticity with Respect to Taxes for Prime-Age Males

Source	Low income	Mid-	Income	Levels	High income
Hausman		–0.04	–0.07	–0.15	0
Ashworth	+0.02	–0.05	–0.1	–0.13	–0.13
Robins	+0.02				
Triest	0	0	0	0	0
Bourguignon	0	0	0	0	0

for Married Women

Source	Low income	Mid-	Income	Levels	High income
Hausman		–0.4	–0.4	–0.4	
Robins	–0.1				
Eissa					–0.8

for Single Women

Source	Low income	Mid-	Income	Levels	High income
Robins	+0.03				
Triest		–0.2	–0.2	–0.2	

As noted in the paper, for low income groups, a cut in taxes generally leads to a fall in labor supply (positive elasticity of labor supply with respect to taxes, negative elasticity with respect to wages) while, for higher income groups, a cut in taxes leads to progressively larger increases in labor supply as group income goes up (a negative elasticity of labor supply with respect to taxes, positive with respect to wages).

VII.2.LABOR SUPPLY IN DRAM

The primary consensus in the literature on labor supply responsiveness is that the working hours and participation rates of men are relatively insensitive to net wages and to exogenous income while the working hours and participation rates of married women are substantially more sensitive to both. The literature also notes a difference between labor supply responsiveness among income groups.

For the initial calibration of DRAM, household labor supply is modeled as a function of the existing labor supply, the change in statewide wage rates between periods, the change in taxes between periods, and the change in transfer payments between periods.

In order to weight the labor supply elasticities of men and women reviewed in the text for the aggregated elasticity estimates that will be used in DRAM, information on labor-force participation rates for men and women is needed. In 1988, men were 55 percent of the labor force and women were 45 percent (U.S. Bureau of Labor Statistics, 1989). Married women accounted for 50 percent of the women in the labor force in 1988.

For the initial calibration of DRAM, it is assumed that the labor force is 55 percent men, 23 percent unmarried women, and 22 percent married women. Applying these weights to the average of the wage elasticities reported and Table VII-2 results in a general labor supply elasticity with respect to wage of approximately 0.4. This elasticity is applied to income groups for the initial calibration of DRAM on a sliding scale, from zero for the lowest income group, 0.4 for the middle group and 0.8 for the highest income group.

Reflecting the 55-45 labor-force breakdown between men and women, the elasticities of labor supply with respect to taxes range from approximately 0 for the low-income group, approximately –0.15 for the mid-income group, and approximately –0.2 for the high-income group.

The elasticity of labor supply with respect to transfer payments has been set at 0.05 for the lowest income group and zero for other income groups. These numbers reflect the results of NIT experiments reported in the text and the observation that income received by households in the upper-income groups is unaffected by transfer payments.

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VIII. MIGRATION

The rates of net migration and labor-force growth are important elements in determining both the state's personal-income tax base and the demand for public services. The ability of policy makers to forecast state revenue and public-service expenditures depends, in part, on their ability to forecast migration. The ability of policy makers to influence net migration depends on their ability to determine and then control those factors that affect migration.

A short review of the economic migration literature is presented in the sections that follow. For more thorough surveys, see Greenwood (1985, 1975). A review of dynamic migration models is given by Reaume (1983), and a thorough review of migration and job growth in the context of economic development policies is given in Bartik (1991). In the following brief review, the literature concerning the determinants and the consequences of migration is examined.

VIII.1. DETERMINANTS OF MIGRATION

The general consensus in the economic migration literature is that differential economic and amenity characteristics of sending and receiving regions provide incentives for migration and that moving costs and individual or family traits condition the response to these differentials. The most prominent variables that economists have considered as possible determinants in the migration decision are examined below.

VIII.1.1. ECONOMIC CONDITIONS

THEORETICAL RESEARCH

In classical economics, differentials in income or wages were regarded as the primary factor influencing migration. This view is neatly summed up by Hicks (1932) in his statement, "differences in net economic advantages, chiefly differences in wages, are the main causes of migration" (p. 76). In this traditional view, which is echoed in the literature on migration as "investment in human capital" (Sjaastad, 1962), an individual chooses to migrate only if the present value of the difference between the earning stream in the destination and origin regions minus the present value of the difference between the net costs associated with living in the two regions is greater than zero. Taxes, as a determinant of net-wage differentials, should also influence migration. Public-finance economists recognize that the migration incentives inherent in the taxation of income and numerous studies have been devoted to devising taxation schemes that are free of migration distortions (Goodspeed, 1995, Tiebout, 1956, Wheaton, 1975).

The validity of a purely wage-driven theory of migration began to be questioned as early as the 1930s with the "job vacancy" theory (Greenwood, 1985). In this theory, the probability of successfully obtaining employment is as important, or more important, than the regional wage rate. In the more recent literature, the work of Todaro (1969) has been influential in shifting the discussion from regional income differentials to unemployment and expected income differentials. In his work on rural-urban migration in developing regions, Todaro recognized that, though the actual average income differential between the origin and destination region may be positive, the expected income differential may be negative, depending on not only the average wage rate but also the possibility of finding employment. Todaro concluded that the urban unemployment rate serves as a good proxy for the probability that the potential migrant will find employment. Expansion of Todaro's conclusion led to the suggestion that average regional unemployment rates could be an important element in determining migration.

Empirical evidence on long-term systematic wage and unemployment differentials between regions led to a fundamental questioning of two basic assumptions underlying the early theoretical work. The first questionable assumption of the traditional model is that of homogeneous labor. As observed by Greenwood(1975), the traditional two-region, two-factor model of international trade theory upon which most of the early theoretical work is based, assumes a homogeneous labor force. This assumption is highly suspect, particularly in reference to regional migration. Greenwood goes on to comment that the assumption of homogeneous labor ignores many of the most interesting and most difficult problems associated with the consequences of migration. Recent research into the worsening inequality of regional wage rates in the United States hinges on differentiating labor by skill or by gender (Borjas and Ramey, 1994, Topel, 1994).

Direct empirical testing for the heterogeneity of migrants, or more specifically of the hypothesis that internal migrants tend to be of a higher ability or are more motivated than their nonmigrant counterparts,[1] was undertaken by Gabriel and Schmitz (1995). They use the National Longitudinal Survey of Youth to test the favorable self-selection hypothesis for young white males for the period 1985–1990. They find that prospective migrants earned more than nonmigrants (ceteris paribus). If differences in wage reflect differences in ability, then they conclude that there is favorable self-selection of young white males. The research of Borjas, Bronars, and Trejo (1992) supports the hypothesis of skilled regional migration. They find that regional differences in skill returns are a positive determinant in the decision to migrate for young skilled workers. They find that highly skilled workers migrate to regions that offer higher returns to skill level and leave regions that offer lower returns. In another article Borjas, Bronars, and Trejo (1992) find that, though initially internal migrants earn less than natives, within six years migrants' wages equal those of natives.

The second assumption that was questioned in light of the empirical evidence on long-term regional wage differential was the assumption of interregional disequilibrium. The early migration literature on wage and unemployment tended to adopt a disequilibrium model to explain regional migration. These models assumed that interregional wage differentials would encourage migration from low- to high-wage regions thus reducing the wage differential between the two regions. More recent studies on migration and wage have tended to adopt an equilibrium approach to explain regional migration. In these studies, long-term economic differentials between regions are treated as "compensating" differentials and not necessarily as incentives for migration (this literature is reviewed in the section on amenities).

As a result of these two observations, average wage rates and average unemployment rates where rejected as reliable indicators of migration incentives. A primary conclusion from the theoretical literature on economic migration is that reliable proxies for wage and employment probabilities must reflect the wage and employment prospects of the individual migrant. In the most recent literature, it is suggested that migrant-specific expected earnings differentials that are calculated with migrant-

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[1] Recent evidence on international migration to the United States indicates that there has been a reversal of early trends. The educational level of recent immigrants is significantly lower than previous groups, and the empirical evidence indicates that more recent immigrant waves will remain economically disadvantaged throughout their working lives; that this disadvantage may be partly transmitted to their offspring; that recent immigrants are more likely to participate in welfare programs than natives; and that immigration may have contributed to the increase in wage inequality observed during the 1980s (Borjas, 1994).

specific expected wage and job opportunity information capture the essential economic information for the migration decision.

Renewed interest in the link between employment and migration has arisen due to efforts on the part of regional governments to influence regional growth through a variety of development policies. The ability of the local government to affect local employment through job expansion programs or industrial development incentives depends, in part, on the regional mobility of factors, particularly labor. Blanchard and Katz (1992) find that migration is the major labor-market response to state specific shocks to employment, and this result dominates the literature on labor response to job expansion. They find that six to ten years after a negative employment shock, enough workers have moved out of the state to return wages and unemployment to their average levels. Bartik (1991) also concludes that, within approximately six years, migration will bring regional wage levels and employment rates back to their long-run levels.

EMPIRICAL RESULTS

Empirical investigation into the strength of the effect of wages, taxes, and job growth on migration has mirrored theoretical developments. In the early empirical literature, the primary explanatory variables were average wage and unemployment rates while in recent literature these variables have been replaced by more individual-specific rates. Unfortunately, and maybe inescapably, empirical research on the effects of wages, taxes and job growth on migration is confounded by the interconnectedness of these variables. Elasticity estimates vary widely in the empirical literature and are extremely sensitive to the type of "general equilibrium" assumptions inherent in the model. In order to decipher the effect of net wages and job availability on migration, researchers must unravel a sequence of causes and effects, and the manner in which they do this impacts on their results.

Empirical results concerning the impact of net wages on migration are particularly problematic. Wages go up in response to increased demand for labor and fall in response to decreased demand for labor. It is very difficult to differentiate between a change in wages or a change in job availability. Attempts to estimate migration elasticities on net wage, separate from job availability, are very dependent on the causality assumptions inherent in the model. The same is true for estimates of migration elasticities with respect to income taxation.

Most empirical work indicates that money-wage differentials do not have a large impact on migration patterns (Barro and Sala-i-Martin, 1991, Bartik, et al., forthcoming, Blanco, 1963, Greenwood, 1975, Raimon, 1962, Venti and Wise, 1984). Barro and Martin use a neoclassical production function incorporating migration to investigate the effect of per-capita income on migration. They find that a ten percent differential in income per-capita raises net in-migration only by enough to raise that area's population growth by 0.26 percent per year. In an effort to separate the effect of money wage from job prospects, Venti and Wise and Bartik *et al.* examine the effect of money transfers on migration decisions. In two different studies using information on household moving behavior from the Demand Experiment of the Experimental Housing Allowance Program, Venti and Wise and Bartik *et al.* conclude that income differentials provide very weak incentives in the migration decisions of low-income renter households. Venti and Wise estimate that "stayer" households in the Demand Experiment were willing to forego gains from moving to a new house equivalent to 14 percent of household income. Bartik *et al.* estimate that a 50 percent increase in rent would be needed to increase the probability of moving of the median income household.

Though the literature on the impact of money wages on migration reveals weak effects, the literature on the impact of taxes on migration reveals fairly strong effects. This is a surprising result since tax differentials would seem to provide a perfect measure of net-wage differentials between regions, all else equal.

The explanation for this result seems to lie in the observation that most empirical work on taxes and migration traces the impact of taxes through their hypothesized impact on wages and labor demand. The general consensus in this literature is that wages and employment will respond to state tax differentials and that the primary vehicle of this response tends to be migration. The sequence of events depicted in this literature seems to be that, for example, when income taxes go down, firms are able to lower the wage rate that they offer their employees (net wage remains unchanged). A lower wage rate induces firms to substitute lower-priced labor for other inputs, meaning that the demand for labor goes up and so do wages. In response to increased demand and wages, labor from other regions migrates into the area.

In support of the theory that income taxation influences the wage rate offered by employers, Gyourko and Tracy (1989) find that a one percent rise in the local average tax rate leads to a one percent rise in the local average wage. Feldstein and Vaillant (1994) find that a one percent increase in the net-of-tax share for the individual (a decrease in taxes) leads to a one percent fall in wages for that individual.

Vaillant (1994) builds on the assumptions concerning income taxation and net wage to develop a model examining the impact of income taxation on wages and employment for different wage groups. She estimates a general elasticity of wages with respect to own-net-of-tax share of –2.03 (a one percent fall in net-of-tax share is associated with a 2.03 percent increase in wages for that wage group) and a general elasticity of employment with respect to own-net-of-tax share of 2.39 percent. Her employment elasticity results hinge on the fact that workers are highly mobile in her model.

In one of the few studies that directly investigates the link between migration and taxation, Schachter and Althaus (1989) find that average per-capita state and local taxes have an adverse effect on migrants. Specifically, in an equilibrium model of gross migration for Caucasians, they calculate an elasticity of in-migration and out-migration of approximately –2.0 and 0.9, respectively, in response to a tax cut.

A primary observation that arises from the empirical literature on net wages and migration is that the results of the various studies are extremely difficult to decipher in a consistent manner due to the different assumptions embedded in the studies. Empirical testing of the relationship between unemployment and migration is subject to the same difficulties.

Early research into the effects of unemployment yielded unanticipated signs or insignificant coefficients on an unemployment rate variable (Greenwood, 1975, Pissarides and Wadsworth, 1989). One possible explanation for these results is the observation that many of these studies are subject to simultaneous-equation bias due to the use of an end-of-period employment rate to explain migration over the period. Another possible explanation lies in the observation that unemployment tends to be highest in the least mobile groups in the labor force (Lansing and Mueller, 1967). Another possibility (Greenwood) is that higher unemployment rates are of the most concern to the unemployed and might not even enter as a factor in the job-to-job migration decision, particularly because the unemployed are a relatively small percentage of the labor force and an even smaller percentage of the population. In other words, the average employment rate might simply be a poor proxy for the probability that the average educated, high-income migrant will find a job in the region of destination.

As a result of the poor results of early empirical work using average unemployment rates, most recent studies have focused on measures of individual-specific employment opportunities or deviations from regional average unemployment rates. A notable exception is Gabriel et al. (1995), who find a very high correlation between unemployment and net migration in California for the 1982–1995 period. Though they recognize that, “strictly speaking, the statement that a high unemployment rate in the destination state relative to the origin state decreases migration applies in terms of deviations from state-specific mean unemployment rates” (p. 37), they use the gross unemployment rate and find that “changes over time in unemployment rate differentials have dominated the fit of the model for California net in-migration over the sample period and, in particular, explain a large portion of the decline in net migration after 1987” (p. 39). A possible explanation for the remarkable explanatory power of unemployment in the Gabriel et al. work lies in the fact that, during the period of observation, 1981–1995, the largest employment changes in California occurred in Aerospace and Hi-Tech Electronics, two industries that reflect job opportunities for the most typical mobile, skilled worker. It could be that changes in employment in Aerospace, and to a lesser degree in High-tech Electronics, signaled deviations from a California unemployment rate that was of particular interest to workers with the highest propensity to migrate.

Recent empirical work on migration and economic conditions has focused a great deal of effort into deciphering the strength of the migration response to employment shocks. This area of research is of particular concern to local and regional governments contemplating regional development programs. Empirical research into the effect of regional job growth on migration reaches the general consensus that, within six to ten years, migration will bring regional wage levels and employment rates back to their long-run levels [Bartik, 1991; Blanchard, 1992]. However, like the literature on wages, estimates of migration elasticities with respect to job growth are highly sensitive to model assumptions. Bartik presents an extensive survey of the literature on migration and job growth. His table reporting the results of his survey is summarized in Table VIII-1.

Table VIII-1. Effects of Local Growth on Migration

Study	Growth variable	Time period	Dependent variable	Elasticity
Houseman & Abraham (1990)	employment	1 year	population	.09 to .83
Treyz & Stevens (1985)	employment	?	population	.3
Greenwood & Hunt (1984)	employment	1 year	number employed net migrants	.5 proportion*
Bradbury, Down & Small (1982)	employment	5 years	population change	.5
Muth (1971)	sales	10 years	net migrants in labor force	.6 to .7 proportion*

*Increase as proportion of employment increase.
Source: Bartik (1991).

In Table VIII-1 it is shown that, in the five studies reviewed by Bartik (1991), the time frame and the estimated elasticities of migration on employment vary widely. Bartik explains the wide variation on model-specific assumptions concerning both the time lag and the causes of job growth. Bartik argues that it is very difficult to decipher the results of these studies in a consistent manner.

Bartik (1991) derives his own estimates of labor-force response to job growth using both aggregate and micro-data (Bartik’s models are described in more detail in the chapter on labor supply). Using these two models, Bartik derives estimates of the long-run effects of regional job growth on the distribution of jobs. Bartik estimates that, for every 100 new jobs created by an economic development project, six or seven jobs go to local residents who otherwise would be unemployed, 16 go to local residents who otherwise would be out of the labor force, and the remaining 77 or 78 new jobs go to in-migrants.

In order to use Bartik's (1991) results in a model such as DRAM, they must be translated into labor supply or migration elasticities. This is achieved by first assuming that migration will bring regional wage levels and employment rates back to their long-run levels (a general conclusion in the literature). Assuming a reasonable production function, such as a Cobb-Douglas function with a two-thirds labor share, means that a one percent exogenous change in wages would require a three percent increase in the amount of labor to return the system to its long-run equilibrium levels. According to Bartik, 77 percent of the three percent change in labor supply should be attributed to migration. In other words, in the long run, a one percent change in wages results in 2.3 percent change in labor supply due to migration. Assuming that the long-run is achieved within six years, annual changes are derived by dividing the total by six.

All of the empirical estimates discussed above are confounded by the interconnectedness of wages and job availability. In order to avoid the difficulties inherent in trying to estimate separate elasticities for wages and job opportunity, it may be preferable to define a single "economic conditions" variable. Treyz *et al.* (1993) present a model of internal U.S. migration that specifies migration as a function of expected income which is in turn a function of the relative probability of employment in a region (per industry), and the relative values of the outcome as measured the relative real wage rate independent of industry mix, and the index of relative wage mix. Treyz *et al.* also include variables reflecting amenity levels, moving costs, and expected regional growth rates. They find that a one percent exogenous increase in employment, real wage differentials, and an index of relative industrial wage mix increases the population of the area by 1.96 percent in the long run (here, taken to be 20 years) if migration induced by this increase is not allowed to affect these variables. If dynamic feedback is considered (i.e., the possibility that induced migration may reduce relative employment opportunities to the levels they were before the one percent increase), then population rises by only 0.835 percent in the long run. Furthermore, they find that the effects of expected employment opportunity have a greater migratory pull than those of relative wage differentials.

CONCLUSIONS: ECONOMIC CONDITIONS AND MIGRATION

A number of conclusions can be drawn from the theoretical and empirical literature on the effects of economic conditions on migration. The primary conclusions are listed below:

1. Migration is a function of both the probability of finding a job and the expected wage rate.

2. Average unemployment and average wage rates are not as important in the migration decision as individual-specific rates.

3. Migration is the primary response to labor-demand shocks. Migration will return regional wage and unemployment rates to their long-run equilibrium within approximately six years.

4. Though the theoretical literature distinguishes between the effects of wages and employment on migration, it is difficult, if not impossible, to do so in empirical work. Most empirical studies derive results that explicitly or implicitly lump together changes in wage and employment.

5. One of the most reliable studies on labor response, Bartik (1991), derives estimates of long-run labor response to job shocks that correspond to a 2.3 percent change in labor supply due to migration in reaction to a one percent change in wages. This change is spread over a six-year period. This estimate is reasonably similar to the 2.39 percent estimate calculated by Vaillant (1994) and the 1.96–0.835 percent estimate calculated by Treyz *et al.* (1993).

VIII.1.2. WELFARE

Welfare benefits vary tremendously between regions and states, even after controlling for variations in the cost of living (Moffit, 1992), and the question of how welfare differentials affect migration has generated a fairly large literature. This literature is reviewed thoroughly in Moffitt (1992). The early literature on the effect of welfare benefits on migration found rather weak or inconsistent effects, a result that is explained by the high degree of aggregation of the data used in these studies (Cebula, 1979, Weinberg and Germanis, 1988). More recent studies have had the benefit of better, less aggregated data sets and different analytic techniques. The results of the four recent studies reviewed in Moffitt all show positive and generally significant effects of welfare on residential location and geographic mobility (Blank, 1988, Clark, 1990, Gramlich and Laren, 1984, Peterson and Rom, 1989). As pointed out by Moffitt, all of these studies are subject to some degree of error due to the interrelationship between the decision variable (location) and the presumed exogenous source of variation in welfare (location).

VIII.1.3. AMENITY CHARACTERISTICS

Much of the research on the effect of amenity differentials on migration occurred as an extension to the work on equilibrium theories of interregional migration. The assumption underlying much of this work is that, if the interregional system is in equilibrium, wage and rent differentials must be "compensating differential" measuring differentials in environmental or amenity quality (Blomquist, et al., 1988, Graves and Linneman, 1979, Hoehn, et al., 1987, Krumm, 1983, Roback, 1988, Roback, 1982, Rosen, 1979, Schachter and Althaus, 1989). If the system is in equilibrium, only those regional differentials that remain after controlling for amenity differentials across regions represent migration-inducing utility differentials.

Knapp and Graves (1989) provide a generally positive survey of the amenities in migration literature, and a number of studies have provided empirical evidence supporting an equilibrium theory of the distribution of unemployment (Hall, 1970, Marsten, 1985, Reza, 1978). Conversely, Evans (1990) reviews the literature on equilibrium and disequilibrium theories in recent research into U.S. migration and the valuation of amenities. He contends that equilibrium theories of migration and amenity valuation are implausible: "Bluntly, if property values and wage rates do capitalize interregional differences, people would not wish to migrate; if they do wish to migrate, then property values and wage rates cannot accurately capitalize interregional differences" (p. 516).

If the system is not in equilibrium, or if regional markets are slow to clear, then amenity differentials calculated on the basis of rent and wage differentials at any point of time might capture some disequilibrium effect. Evans concludes that, if the economy is actually in disequilibrium, then the valuations of amenities assuming equilibrium would be biased downward in areas of net in-migration and upward in areas of net out-migration. Greenwood *et al.* (1991) use an instrumental-variables, fixed-effect estimate of a migration model with time series data for 51 areas for the 1971–1988 time period to test the importance of both equilibrium and disequilibrium factors in migration. They find that "errors generated in the estimation of compensating differentials by erroneously assuming regional equilibrium appear to be relatively minor, both quantitatively and qualitatively." Furthermore, Greenwood *et al.* find that western and southern areas generally have higher amenity scores than northeastern and midwestern regions, a result that is repeated in other studies.

The debate surrounding amenity valuation and equilibrium versus disequilibrium assumptions has been characterized as a debate on the importance of amenities versus jobs in determining migration. The two camps in this debate can be described as those who favor a disequilibrium theory of migration and stress the importance of jobs in the migration decision and those who favor an equilibrium theory of migration and stress the importance of amenities in the migration decision. This debate has steered the literature back to the question posed by Muth (1971): Do people follow jobs or do jobs follow people? Steinnes(1978), Carlino, and Mills (1987) and Mathur and Stein (1993) all address this question within the framework of the amenities literature. So far the results are inconclusive.

Crane (1995) extends the literature on hedonic pricing of amenities to examine willingness to pay for government-financed amenities. He identifies two problems with hedonic pricing of amenities in establishing tax rates: (1) taxes used to finance local improvements are often distortionary and (2) those amenities which influence property values also impact the fiscal budget and, hence, the tax rate and the final tax burden. In other words, the tax cost of an improvement is endogenous to both the amenity level and to the tax structure. Using a standard urban model with amenities to calculate the value of marginal amenity change to each household, Crane finds that, for each of the financing alternatives considered in the paper (head tax, property tax, and highway toll), aggregated land rents are a biased measure of after-tax amenity benefits.

VIII.1.4. HOUSING COSTS

The literature on housing prices and migration is composed of two fairly distinct areas of research. The first area is concerned with investigating the impact that housing prices have on migration. The major hypothesis in this area is that, much like any income-reducing expense, higher real-estate prices will deter in-migration and encourage out-migration. However, the straight forwardness of the theoretical argument is complicated by the observation that real estate is a capital investment as well as a living expense and that higher real-estate prices translate into increases in both capital assets and living expenses. Empirical investigation into the role of housing prices on migration is relatively small. Gabriel et al. (Gabriel, et al., 1992) use a cross-sectional, logistic model of place-to-place migration among U.S. regions in the late 1980s. They find that relatively high destination house prices deter migration whereas high origin region house prices have little affect on migration. Berger and Blomquist (1992) use micro-data from the 1980 census to estimate the impact of wages, housing costs, quality of life, and moving costs on the probability of moving between counties and on the choice of destination. They find that housing prices are not important in the decision to move but do matter in choosing the destination. More specifically, they find that an increase of $1,000 in the annual housing price differences between two counties (holding constant housing characteristics and quality of life) lowers the probability of choosing an otherwise attractive destination by 10.7 percent.

The second area of research on housing prices and migration is concerned with the impact of economic growth and migration on real-estate prices. Much of the work in this area has taken place in the context of amenity values, where amenity value differentials between regions are captured in wage and housing cost differentials. In these models, migration continues until the value of the amenities is fully capitalized in housing values and wage rates. Graves and Lineman (1979) expand the analysis to argue that, if amenities are normal goods, then economic growth will trigger increased demand for amenities meaning that housing prices and wages will be subject to further increases in amenity-rich areas. Furthermore, since, through past migration, amenity-rich areas already have high housing costs, these regions experience more rapid increases in land values than will other regions as the economy grows. While the impact of job expansion on wages and unemployment levels tends to dissipate with migration, the impact on housing prices becomes more pronounced with migration.

There appears to be some consensus in the literature that house prices respond to changes in employment with elasticities between 0.5 and one (Vaillant, 1994), though numerous studies calculate elasticities that fall outside of this range. In his review of the literature, Bartik reports on eight econometric studies of growth effects on housing and land prices. The estimated percentage effect of a one percent growth (population or employment) on housing or real-estate prices in these studies ranged from 0.3 to 1.0. Gardner, Kang, and Mills (1987) and Bartik *et al.* (1987) examine house-price responses to announcements of auto-plant locations. Both studies calculate elasticities of 1.0. Bartik (1991) examines a cross section of the Municipal Statistician Area (MSA) and finds a short-run (two to four years) elasticity of about 0.5 and a longer run (six years plus) elasticity of about 0.3. Blanchard and Katz (1992) find that four to five years after a negative employment shock, housing prices are depressed by two percent.

VIII.1.5. DISTANCE

The earliest literature on migration produced numerous "gravity-type" models of migration where migration was hypothesized to be related to the size of the origin and destination populations and inversely related to distance (Greenwood, 1975). In the gravity-type models, distance acts as a strong deterrent to migration with migration decreasing with increased distance between the origin and destination. However, early empirical findings showed that, even when the direct expenses involved in relocating were easily recouped in higher earnings, etc., migration did not take place. In order to explain this finding, it is hypothesized that distance serves not only as a proxy for transportation costs but also for psychic costs and information costs (Lansing and Mueller, 1967, Schwartz, 1973). Households with a strong "sense of place" would have particularly high psychological moving costs. Bolton (1989) argues that a strong sense of place is valuable to households because it encourages trust in market and nonmarket relationships and saves time in making decisions.

VIII.1.6. PERSONAL AND HOUSEHOLD CHARACTERISTICS

Since the early literature on economic migration, personal and household characteristics, such as age, level of education, and race, have been included as determinants in the decision to migrate. Age and migration are hypothesized to be negatively correlated for two reasons. First, the present value calculations of the returns to migrations are necessarily lower because they are calculated over a shorter remaining life span (Becker, 1964). Second, job security and family ties are likely to be more important for older persons (Gallaway, 1969). The correlation between education and migration is assumed to be positive because job opportunities, employment information, and locality information are expected to increase with increased education. In addition, education may weaken traditional family ties thus reducing the psychic cost associated with moving (Greenwood, 1975). Race could prove an important determinant in the decision to migrate because race could influence the strength of family ties and the importance of social networks in overcoming information or prejudice barriers.

Recent access to micro-data has allowed researchers to expand the analysis of personal and household characteristics to life-cycle considerations, such as marriage, divorce, the birth and education of children, and retirement. There is growing evidence that life-cycle considerations are critical in an individual's or family's decision to migrate (Greenwood 1985). Some prominent authors, for example Stark (1991), consider personal, micro-level characteristics (such as intrahousehold interactions, individual attitudes toward risks, relative deprivation, and differential access to information) to be paramount in the migration decision.

VIII.2. CONSEQUENCES OF MIGRATION

The consequences of migration are firmly linked to the question of who migrates, an observation that was made early in the economic migration literature. Both Myrdal (1957) and Okun and Richardson (1961) stress the importance of the selective nature of migration in determining the consequences of regional migration. Myrdal asserts that the causes of migration are “circular and cumulative” with migration taking place among younger, better educated, and more highly productive workers to areas where labor demand is growing most rapidly. As a result of selective migration, demand continues to grow in the region of destination and decrease in the region of origin, thus perpetuating the disparities in interregional wage differentials. This in turn leads to further migration, in the same direction, between the two regions.

Johnson (1965) goes further to points out that the region that loses workers whose education has been financed by local taxation also loses the right to tax the higher incomes made possible by the education and, therefore, is unable to recoup the costs of its educational investment.

Weisbrod (1964) makes the observation that the tax effects of migration constitute a conceivably important consequence of migration. He argues that better educated workers tend to have higher salaries and pay higher taxes, but they do not consume a proportionately large amount of public services. In-migration of better educated workers will, therefore, reduce the tax burden on the less educated. Not only the distribution of the tax burden but also the type and quantity of public services demanded by the population could depend on migration. The type and amount of public service consumed could vary with income group (Greenwood, 1975). High-income households might be more likely to consume public services, such as education and fire and police protection, while low-income households might be more likely to consume public services, such as welfare and health.

In recent literature on the consequences of migration, the importance of immigrant skill level in determining the fiscal consequences of immigration is recognized. Because less-skilled workers tend to participate in public-assistance programs, an immigrant flow composed of less-skilled workers would have greater fiscal costs. Estimates of the net fiscal benefits of immigration (the difference between the taxes paid by immigrants and the cost of services provided to immigrants) range from a positive net fiscal benefit of about \$27 billion (Passel and Clark, 1994), to a \$16 billion net loss (Borjas, 1994), to a net loss of over \$40 billion (Huddle, 1993). There is reason to believe that none of these numbers accurately measures the gap between taxes paid by immigrants and the costs of services provided to immigrants due to the difficulty in estimating any change in the costs of services due to increased demand for those services (Borjas, 1995).

In addition to conditioning the fiscal benefits of immigration, the skill level of immigrants could have important consequences in determining the incidence and distribution of any economic surplus generated through migration. Borjas (1995) finds that the level of migration-generated economic surplus enjoyed by the native population (immigration surplus) is proportional to the elasticity of factor price for labor. Theoretically, he finds that, if the increase in labor supply greatly reduces the wage (relatively large elasticity of factor price), the immigration surplus is large but, if the native wage rate is not very sensitive to immigration (relatively low elasticity of factor price), the immigration surplus is nearly zero. Using results reported in Hamermesh (1993), Borjas contends that the elasticity of factor price is greater for skilled workers than for unskilled and, therefore, immigration surplus is larger, and the native population has more to gain, with the immigration of skilled workers. This result rests on the complimentary relationship between skilled immigrant labor and native-owned capital and is reinforced when human capital is allowed to have external effects on production. Borjas also stresses the distribution impact of immigration. He notes that, even when the total gains of immigration to the native population are relatively small, there is a sizable redistribution of native wealth between labor and capital.

Another important issue in the literature on the economic consequences of migration is the question of causality. Which comes first, migration or growth? Research into the simultaneity of migration, job growth, and economic development has generated a fairly large literature (see Mueller (1982), for survey dealing with the simultaneous interaction between the causes and consequences of migration). The seminal work in this area is Muth's (1971) two-equation model examining net migration and employment change. Using cross-sectional data from 1950–1960, Muth finds that net in-migration leads to a direct increase in employment that is approximately proportional to the increase in the labor force caused by migration and that employment growth leads to migration, though not every additional job is filled by a migrant. He estimates the net migration, job-growth ratio at approximately 0.6 or 0.7. In other words he finds that every ten additional jobs are filled with between six and seven net in-migrants.

Greenwood and Hunt (1984) make the observation that migration to cities has probably been a self-reinforcing and cumulative phenomenon, and they use time-series data on migration and employment growth for 171 U.S. regions, 1957–1975, to measure the "migrant-attractive power of another job and the number of local jobs attributable of another migrant." They find that for the country's 57 largest metropolitan areas, an average of 0.451 employed net migrants are directly attracted by one additional job and that, for two-thirds of the nation's major metropolitan areas, one more employed in-migrant results in one additional job while, for the other one-third of the major metropolitan areas, an additional employed migrant results in approximately 1.259 jobs.

Barro and Sala-i-Martin (1992) find that for both the United States and Japan, migration has positive effects on economic growth. For the United States, they find that a one percentage point higher net migration rate is associated with a 0.1 percent higher growth rate. However, when amenity proxies are added to the model (temperature and population density), the coefficient becomes insignificant for both the United States and Japan. The authors conclude that migration has little effect on growth but that the results may be due to weak instruments.

Friedberg and Hunt (1995), in their review article on the impact of immigrants on host-country wages, employment, and growth, find that the empirical evidence points to the conclusion that the effect of immigration on the labor-market outcomes of natives is small. They also find that the theoretical literature on immigration and economic growth indicates that the impact of immigrants on natives' income growth depends crucially on the human-capital levels of the immigrants.

VIII.3. THE MIGRATION EQUATION IN DRAM

The migration equation embodied in DRAM is a simplified version of the equation envisioned for future versions of the model. In the current version, migration or population growth is expressed solely as a function of economic conditions. Subsequent versions of the equation will reflect differential values of the explanatory variables and will include variables that reflect amenity values, housing prices, etc.

In the current version of DRAM, a simple adjustment function for the number of each of our seven household types is imposed. The number of households is a function of its current observation, plus in-migration estimated over a six-year planning horizon which adjusts upward as per-household, after-tax wages rise and downward as the participation rate of that household group falls. Out-migration is subtracted and adjusts in opposite directions in response to the same variables as does in-migration. The responsiveness parameters chosen for migration are high for upper-income households responding to after-tax incomes and zero for their response to participation rates (the proxy for unemployment risk). Responsiveness of low-income households is low towards after-tax incomes and higher for participation rates. The five households between were assigned proportionate intermediate values for these elasticity parameters.

VIII.4. REFERENCES

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IX. MODEL CLOSURE

One element remains to be specified to have a fully formed computable general equilibrium model. The solution to a CGE is a set of relative prices that clears all markets and is consistent with the eleven hundred equations of DRAM. However, the eleven hundred equations are not independent. Specifying one equation for each form of supply and one for each form of demand results in a "square" system of equations. The concept of a square equation system means having as many independent variables as independent equations. However, economic theory imposes one additional equation for each market: quantity supplied equals quantity demanded. This reduces the number of independent equations by one for each market for which equilibrium is imposed. In DRAM, one degree of freedom is lost for each commodity equation and one for each factor equation. Beyond this, the model includes an equation for labor supply from each household type but does not include a specification for labor supply in each sector.

Summing the number of variables and equations is a trivial exercise in economic modeling. GAMS, for example, produces these counts for each solution pass. However, working out all of the interrelationships between equations to ensure an accurate count of independent equations is almost impossible. In accordance with previous work with CGE models, a pragmatic approach to this issue is followed. The value of no variable is fixed and the model is solved twice, maximizing the value of total state personal income and then minimizing the same variable. The solutions differ. Subsequently, the values for selected variables are fixed one by one and the model is solved twice, maximizing and then minimizing personal income. This process is continued until the solution values are identical beyond the sixth digit. At this point it is assumed that the number of fixed variables is equal to the number of interrelated equations.

The result of this exercise is to fix selected units of government spending on goods and factors but no other variables. Other CGE models incorporate a very different approach. Key variables, such as the producer price index and labor supply (or the overall wage rate), are fixed. This approach is avoided for strong theoretical reasons. No two other variables could define a model's results more surely. By preventing overall domestic inflation, exports and imports in these models adjust very little. By removing the incentive to adjust labor demand (by fixing the wage rate) or by forcing the model to distribute all current labor between sectors (i.e., the total demand for labor must equal observed supply), it is difficult to generate changes in production. When factor markets are fixed, the hand of the Walrasian auctioneer becomes obscured. Instead, what becomes evident is the hand of the central economic planner rationing labor to industries so as to use up existing labor supply.

The closure section of the model is used for a second purpose. Several housekeeping equations are imposed to prevent artificial channels of revenue, income, expenditure, etc. from appearing in the model solution. It is notationally compact and convenient to define variables over the range of a larger set and then fix the values of invalid members of that set to zero. An alternative exists. Some modelers define a large number of subsets and then exploit these in defining equations and variables. The choice of either method is one of style, rather than substance.

X. DETAILED MODEL DESCRIPTION

We offer in this section three descriptions of each element of the model: a mathematical equation; the GAMS (General Algebraic Modeling System) form of this; and a very brief narrative describing the equation, its key elements and important economic assumptions embodied in each. We attempt no detailed discussion about the development of each equation or of the sources and development of data for this model—as these are described in the theory-oriented chapters preceding. A complete GAMS listing of the model and a summary of the notation used is found in the appendices.

X.1.HOUSEHOLDS

CONSUMER PRICE INDICES

(X-1)
$$p_h = \frac{\sum_{i\in I} p_i \left(1 + \sum_{g\in GS} \tau^c_{gi}\right) c_{ih}}{\sum_{i\in I} \bar{p}_i \left(1 + \sum_{g\in GS} \tau^q_{gi}\right) c_{ih}} \qquad \forall\, h \in H$$

GAMS: CPI(H) =E= SUM(I, P(I) * (1 + SUM(GS, TAUC(GS,I))) * CH(I,H)) / SUM(I, P0(I) * (1 + SUM(GS, TAUQ(GS,I))) * CH(I,H));

Description: Consumer price indices for each household type (the set 'H' of which 'h' is one member) are calculated against a reference period set at unity.

Data: The share parameters were calculated from IMPLAN data, which were derived from Consumer Expenditure Survey data. These shares differ for triciles of household income. The model uses these shares for roughly representative groups of households.

HOUSEHOLD GROSS INCOMES

(X-2)
$$y_h = \sum_{F\in f} \frac{\alpha_{hf} a^w_h}{\sum_{h\in H} \alpha_{hf} a^w_h}\, y_f \left(1 + \sum_{g\in GF} \tau^h_{gf}\right) \qquad \forall h \in H$$

GAMS: Y(H) =E= SUM(F, A(H,F) * HW(H) / SUM(H1, A(H1,F) * HW(H1)) * Y(F) * (1 - SUM(G, TAUFH(G,F))));

Description: Household gross income is a function of payments to factors supplied by each household group and is apportioned to households on a fixed scale of shares per household type.

Data: The shares of factor incomes that are paid to each household type were derived from FTB tax sample data provided for 1993 returns.

HOUSEHOLD DISPOSABLE INCOMES

(X-3)
$$y^d_h = y_h - \sum_{g\in G} t_{gh}\, a^w_h - \sum_{g\in G} \tau^h_{gh}\, a_h + \sum_{g\in G} w_{hg}\, a^n_h \tau^{pc}_{hg} \qquad \forall h \in H$$

GAMS: YD(H) =E= Y(H) - SUM(GI, PIT(GI,H)) * HW(H) - SUM(G, TAUH(G,H) * HH(H)) + SUM(G, TP(H,G) * HN(H) * TPC(H,G));

Description: Household disposable income is a function of gross household income left after all taxes have been paid and transfer payments received.

Data: There are no new data in these equations.

PRIVATE CONSUMPTION

(X-4) $$c_{ih} = \bar{c}_{ih}\left(\frac{\bar{y}_h^d}{y_h^d} \div \frac{p_h}{\bar{p}_h}\right)^{\beta_{ih}} \prod_{i' \in I} \left[\frac{p_i\left(1+\sum_{g \in GS}\tau_{gi}^c\right)}{\bar{p}_i\left(1+\sum_{g \in GS}\tau_{gi}^q\right)}\right]^{\lambda_{i'i}} \quad \forall i \in I, h \in H$$

GAMS: CH(I,H) =E= CH0(I,H) * ((YD(H) / YD0(H)) / (CPI(H) / CPI0(H))) ** BETA(I,H) * PROD(J, ((P(J) * (1 + SUM(GS, TAUC(GS,J)))) / (P0(J) * (1 + SUM(GS, TAUQ(GS,J))))) ** LAMBDA(J,I));

Description: These demand functions are derived in detail in the more complete model report. We had planned on using demand equations derived from assuming an Almost Ideal Demand System functional form. However, we were unable to find sufficient support for the many parameters required for these functions.

Data: Parameters have been imposed using professional judgment. Given the absence of usable elasticity parameters, we imposed unitary income elasticities, zero cross price elasticities and unitary own price elasticities from published literature.

HOUSEHOLD SAVINGS

(X-5) $$s_h = y_h^d - \sum_{i \in I} c_{ih} p_i \left(1+\sum_{g \in GS}\tau_{gi}^c\right) \quad \forall h \in H$$

GAMS: S(H) =E= YD(H) - SUM(I, P(I) * CH(I,H) * (1 + SUM(GS, TAUC(GS,I))));

Description: The simplest kind of savings function is presented: saving for each household type is the residual of disposable income less household expenditure. Thus, there is no 'motivation' for household savings. Some economists prefer to incorporate inter-temporal consumption preferences into a savings function. This may be appropriate for a national model, if one were to ignore the effects of international capital flows and establish a condition in which savings constrain investment (and, implicitly, investment constrains savings). In a regional economy, the focus on savings is entirely different from a national model. Investment in California is in no way related to savings in California. Thus, savings in a regional economy is a deadweight loss to that region. To minimize the impact of this deadweight loss, we chose the 'savings as residual' functional form above.

Data: The current levels of savings were imposed by professional judgment to reflect overall national averages of savings, but assigned by income level. Given our seven household types, the 9.3% marginal tax group encompasses individuals from higher level wage earners to the very rich. This group was assigned a savings rate of 11%, a modest estimate of this group's savings rate.

X.2.PRODUCERS

VALUE ADDED CALCULATION

(X-6) $$p_i^{va} = p_i^d - \sum_{i' \in I} \alpha_{i'i} p_i \left(1 + \sum_{g \in GS} \tau_{gi'}^{v} \right) \qquad \forall\, i \in I$$

GAMS: PVA(I) =E= PD(I) - SUM(J, AD(J,I) * P(J) * (1 + SUM(GS, TAUV(GS,J))));

Description: This equation and its left-hand side variable are calculating conveniences. The share of domestic price remaining for the payment of factors is calculated as the residual of selling price, less payments for intermediate goods—including sales/use taxes imposed on intermediates. This simplifies the form of the factor demand equations. Since intermediate goods are in fixed proportion to output, their shares of costs do not form a direct part of the profit maximizing use of various intermediates, *i.e.* there is no substitution between intermediate goods, nor between intermediates and factors.

Data: Prices begin at unity. The share parameters for intermediate goods came from IMPLAN data. The tax rates came from careful analysis of California tax data.

PRODUCTION FUNCTION

(X-7) $$q_i = \gamma_i \left[\sum_{f \in F} \alpha_i \left(u_{fi}^d \right)^{-\rho_i} \right]^{-1/\rho_i} \qquad \forall\, i \in I$$

GAMS: DS(I) =E= GAMMA(I) * SUM(F, ALPHA(F,I) * FD(F,I) ** (- RHO(I))) ** (-1 / RHO(I) DS(I) =E= GAMMA(I) * SUM(F, ALPHA(F,I) * FD(F,I) ** (- RHO(I))) ** (-1 / RHO(I));

Description: A Constant Elasticity of Substitution production function is used for each industry. In this, the employment of each factor (the set 'F', of which 'f' is one member: 'L' for labor and 'K' for all other factors) is raised to an exponent and multiplied by a share parameter. The total of these products is raised to the inverse of the substitution exponent. The first parameter is the scale of production.

Data: The current model has the elasticity parameters imposed from those found in published literature. In these data, labor and capital are substitutes in each industry, but not the perfect substitutes that would have been imposed had we employed Cobb-Douglas production functions. While more flexible functional forms (such as Translog) would be theoretically preferable, no satisfactory source of sufficient data for these functional forms was found. The share parameters are taken from IMPLAN data.

FACTOR DEMAND

(X-8) $$r_{fi} r_f^a \left(1 + \sum_{g \in GF} \tau_{fgi}^x \right) u_{fi}^d = p_i^{va} q_i \alpha_{if} + t_i \qquad \forall\, i \in I,\, f \in F$$

GAMS: R(F,I) * RA(F) * (1 + SUM(GF,TAUFX(GF,F,I))) * FD(F,I) =E= PVA(I) * DS(I) * ALPHA(F,I) + SUM(G, FITC(F,G) * ITC(I)

Description: Factor demand functions are calculated by taking the first derivative of the profit function with respect to each factor demand variable—holding prices and other factor demands constant. The expression in the left hand side brackets generates the taxes on factors used in production. Taxes on labor represent employer portions of Social Security, Unemployment Insurance, Workers Compensation and similar taxes. Taxes on capital represent corporate income and franchise taxes. The right hand side represents the marginal benefit of a unit factor, including the value added net revenue plus investment tax credits earned.

Data: The sectoral wage differential is calculated for labor from wage payment and employment data from IMPLAN. The inter-sectoral differences are fixed and the economy-wide variable is allowed to vary. This is reversed for capital. From published literature, initial rates of return by sector were established and the economy-wide variable was fixed at unity.

INTERMEDIATE DEMAND

(X-9) $$v_i = \sum_{i' \in I} \alpha_{ii'} q_{i'} \qquad \forall\, i \in I$$

GAMS: V(I) =E= SUM(J, AD(I,J) * DS(J));

Description: In all industries, intermediate goods are in fixed shares of production. This provides us with a major simplification and size reduction to the model: intermediate demand is not calculated as a separate variable for each industry supplying each other industry, but only as a total demand for intermediates from each industry. This is the sum of shares of production from each other industry and from itself.

Data: All share data came from the IMPLAN input-output table.

FACTOR INCOME

(X-10) $$y_f = \sum_{i \in I} r_{fi} r_i^a u_{fi}^d + \sum_{g \in G} r_f u_{gi}^d \qquad \forall f \in F$$

GAMS: Y(F) =E= SUM(Z, R(F,Z) * RA(F) * FD(F,Z));

Description: This is a simple calculation device to gather all payments to factors from sectors and from governments.

Data: Factor payment data were obtained from ES202 data for 12 months ending July, 1995. These were projected to the current model year using estimates from the Department of Finance econometric model for California. Where required, we used the IMPLAN shares for sectors to distribute these data across sectors.

X.3.TRADE

EXPORT DEMAND

(X-11) $$e_i = \bar{e}_i \left[p_i^d \div \bar{p}_i^w \div \left(1 + \sum_{g \in G} \tau_{gi}^m \right) \right]^{\eta_i^e} \qquad \forall i \in I$$

GAMS: CX(I) =E= CX0(I) * (PD(I) / PW0(I) / (1 + SUM(G, TAUM(G,I)))) ** ETAE(I);

Description: Export demand for domestic production is a simple function of observed exports and the relationship between domestic and world prices. As domestic prices rise in relation to world prices, exports fall. However, they do not drop to zero the instant that domestic prices rise beyond world ones. We represent here a functional form different from some CGE models which have domestic producers not being able to adjust easily between domestic production for domestic consumption and domestic production for foreign consumption. This type of function would be more appropriate for a developing economy which produces a good for domestic consumption not fit for export customers. It would appear inappropriate to model California as such an economy.

Data: Current exports were drawn from IMPLAN data. As we came to doubt the integrity of these data and as there appeared to be no consensus in the published literature, we used moderate elasticities for highly traded industries and low elasticities for less-traded ones. The actual ones used are in the miscellaneous input file appended to this report.

DOMESTIC SHARES

(X-12) $$d_i = \bar{d}_i \left[p_i^d \div \bar{p}_i^w \div \left(1 + \sum_{g \in G} \tau_{gi}^m \right) \right]^{\eta_i^d} \qquad \forall i \in I$$

GAMS: D(I) =E= D0(I) * (PD(I) / PW0(I) / (1 + SUM(G, TAUM(G,I)))) ** ETAD(I);

Description: The domestic share of domestic consumption adjusts in ways similar to that of exports, with the relationship to relative prices. Many CGE modelers use a constant elasticity of substitution function for import demand (the so-called Armington assumption). We use the first order condition of utility maximization form of this. Imports and domestic production are not perfect substitutes in the minds of consumers, firms, governments and investors.

Data: Imports taken from IMPLAN data. As with exports, we came to be unsure of these data and imposed moderate elasticities for highly traded industries and low elasticities for less-traded ones. The actual ones used are in the miscellaneous input file appended to this report.

IMPORT DEMAND

(X-13) $$m_i = (1 - d_i) x_i \qquad \forall i \in I$$

GAMS: M(I) =E= (1 - D(I)) * DD(I);

Description: Imports, given the domestic share function above, are simply the share of domestic consumption that is not supplied by domestic sources. The shares are determined in the preceding equations.

Data: No new data are contained in these equations.

AGGREGATED PRICES

(X-14) $$p_i = d_i p_i^d + \left(1 - d_i\right)\bar{p}_i^w \left(1 + \sum_{g \in G} \tau_{gi}^m\right) \qquad \forall\, i \in I$$

GAMS: P(I) =E= D(I) * PD(I) + (1 - D(I)) * PW0(I) * (1 + SUM(G, TAUM(G,I)));

Description: Average prices faced by domestic households for goods and by firms for intermediate goods are calculated by multiplying the domestic share times the domestic price and adding this to the import share (one minus the domestic share) times the world price. The world prices are augmented by import duty paid to various levels of government services. There is one of these equations for each industry (the set 'I', of which 'i' is one member).

Data: All prices (domestic and foreign) are in relation to current ones, *i.e.* are set to unity prior to solving the model—although the world prices are adjusted by import duties. See the trade section below for a discussion of the domestic ratio.

NET CAPITAL INFLOW

(X-15) $$z = \sum_{i \in I} m_i \bar{p}_i - \sum_{i \in I} e_i p_i^d$$

GAMS: NKI =E= SUM(I, M(I) * PW0(I)) - SUM(I, CX(I) * PD(I));

Description: To keep track of capital flows, the net of outflows (imports less exports) is set to equal inflows. This is a standard feature of CGE models that take explicit account of the circular flow in the economy. This highlights an important feature of a regional economy, as opposed to a national economy. Investment is not bounded by local savings. Capital inflows passively adjust to the demands of the local economy.

Data: There are no new data in this equation.

X.4.INVESTMENT

GROSS INVESTMENT BY SECTOR OF DESTINATION

(X-16) $$n_i = \bar{n}_i \left[\frac{r_{Ki}\left(1 - \sum_{g \in G} \tau_{Kgi}^x\right) u_{Ki} + t_i}{\bar{r}_{Ki}\left(1 - \sum_{g \in G} \tau_{Kgi}\right) u_{Ki} + \bar{t}_i} \right]^{\eta^i} \qquad \forall\, i \in I$$

GAMS: N(I) =E= N0(I) * ((R('K',I) * (1 - SUM(GK, TAUFX(GK,'K',I))) * KS(I) + SUM(G, FITC('K',G) * ITC(I))) / (R0('K',I) * (1 - SUM(GK, TAUF(GK,'K',I))) * KS(I) + SUM(G, FITC('K',G) * ITC0(I)))) ** ETAIX ;

Description: Investment decisions are made sector-by-sector depending on changes in the nominal after tax return to capital in each sector.

Data: Sectoral investment data are not included in IMPLAN for investment by destination. Using the typical CGE assumption that the economy begins in equilibrium, payments to capital were assumed to be reflective of maintenance of existing capital, using a 5% depreciation rate. Applying this to rates of return, capital stocks were established by sector and the depreciation rate applied to develop gross investment by sector of destination initial data.

GROSS INVESTMENT BY SECTOR OF SOURCE

(X-17) $$p_i\left(1+\sum_{g\in GS}\tau^n_{gi}\right)c_{in} = \sum_{j\in I}\beta_{ij}n_i \qquad \forall i \in I$$

GAMS: P(I) * (1 + SUM(GS, TAUN(GS,I))) * CN(I) =E= SUM(J, B(I,J) * N(J));

Description: Investment demand for each sector's output is a fixed share of observed investment demand from all other sectors that invest, using the shares from the capital coefficient matrix. If one assumes that the shares (by source) of investment do not change significantly, there is no need in the model to track investment demand with variables for each source-destination combination.

Data: We obtained the most recent (1982) capital investment matrix from BEA, Department of Commerce and converted this into shares of investment by source and destination.

CAPITAL STOCK

(X-18) $$u^s_{Ki} = \bar{u}^s_{Ki}\left(1-\delta_i\right)+n_i \qquad \forall i \in I$$

GAMS: KS(I) =E= KS0(I) * (1 - DEPR) + N(I) ;

Description: Capital stock is depreciated current capital stock, plus gross investment.

Data: Current sectoral capital stocks were imposed by imposing sector-specific returns to capital derived from published literature and dividing payments from each sector to capital by these rates of return.

INVESTMENT TAX CREDIT

(X-19) $$t_i = \sum_{i'\in I} n_i\beta_{i'i}\frac{\tau^n_{i'i}}{1+\sum_{g\in GS}\tau^n_{gi'}} \qquad \forall i \in I$$

GAMS: ITC(I) =E= SUM(J, N(I) * B(J,I) / (1 + SUM(GS, TAUN(GS,J))) * ITCE(J,I));

Description: The investment tax credit is a function of gross investment distributed across sectors of source and with investment tax credits varying by source and destination.

Data: The key parameters involve the distribution matrix of investment tax credits. The details can be found at the end of the miscellaneous data file in the appendices.

X.5.LABOR SUPPLY

LABOR SUPPLY

(X-20) $$\frac{a_h^w}{a_h} = \frac{\bar{a}_h^w}{\bar{a}_h}\left(\frac{r_L^a}{\bar{r}_L^a}\right)^{\eta_h^{LS}}\left(\frac{\sum_{g\in GI}\bar{t}_{gh}}{\sum_{g\in GI} t_{gh}}\right)^{\eta_h^{PIT}}\left(\frac{\sum_{g\in G}\frac{\bar{w}_{h'g}}{\bar{p}_h}}{\sum_{g\in G}\frac{w_{h'g}}{p_h}}\right)^{\eta_h^{w}} \qquad \forall\, h \in H$$

GAMS: HW(H) / HH(H) =E= HW0(H) / HH0(H) * ((RA('L') / RA0('L')) / (CPI(H) / CPI0(H))) ** ETARA(H) * (SUM(GI, PIT(GI,H)) / SUM(GI, PIT0(GI,H))) ** ETAPIT(H) * (SUM(G, TP(H,G) / CPI(H)) / SUM(G, TP0(H,G) / CPI0(H))) ** ETATP(H);

Description: Labor supply is expressed in terms of the participation rate: the number of working households divided by the number of households in an earnings class. This is a function of initial participation rate times three factors: change in economy-wide wage rates; change in that household's average earnings-related tax rates; and change in that household's average transfer payments when not working. We assume that each household responds with a constant set of elasticities, but vary these across households. High income households have higher elasticities with respect to wages and taxes, but no responsiveness to transfer payments. Low income households have lower elasticities with respect to wages and taxes and higher responsiveness to transfer payments.

Data: Initial factor supply data were taken from IMPLAN data. Employment data began with IMPLAN, but were refined from Department of Finance records. The elasticity exponents can be found in the table MISCH(H,*) in the miscellaneous data input file in the appendices.

X.6.MIGRATION

POPULATION

$$a_h = \bar{a}_h \cdot \pi + \bar{a}_h^i\left(\frac{y_h^d}{a_h} \div \frac{\bar{y}_h^d}{\bar{a}_h} \div \frac{p_h}{\bar{p}_h}\right)^{\eta_h^{yd}}\left(\frac{a_h^n}{a_h} \div \frac{\bar{a}_h^n}{\bar{a}_h}\right)^{\eta_h^{u}}$$

(X-21) $$- \bar{a}_h^o\left(\frac{\bar{y}_h^d}{\bar{a}_h} \div \frac{y_h^d}{a_h} \div \frac{\bar{p}_h}{p_h}\right)^{\eta_h^{yd}}\left(\frac{\bar{a}_h^n}{\bar{a}_h} \div \frac{a_h^n}{a_h}\right)^{\eta_h^{u}}$$

$$\forall h \in H$$

GAMS: HH(H) =E= HH0(H) * NRPG(H) + MI0(H) * ((YD(H) / HH(H)) / (YD0(H) / HH0(H)) / (CPI(H) / CPI0(H))) ** ETAYD(H) * ((HN(H) / HH(H)) / (HN0(H) / HH0(H))) ** ETAU(H) - MO0(H) * ((YD0(H) / HH0(H)) / (YD(H) / HH(H)) / (CPI0(H) / CPI(H))) ** ETAYD(H) * ((HN0(H) / HH0(H)) / (HN(H) / HH(H))) ** ETAU(H);

Description: The population for each household type is a function of existing population, increased by the natural rate and by the effect of net migration, which depends upon after tax incomes and that household's fraction of non-working members. Working population depends on the after-tax return to labor. Total population is a function of the changing attractiveness of California—as measured by real after-tax earnings changes and employment prospects.

Data: Population figures were imposed at this stage of development. Given the functional forms of equations involving these, the change in population becomes more important than the actual levels. Elasticities were chosen to reflect the middle ground found in the literature about migration. Higher income households are more prone to being attracted by high after tax wages and lower income homes focus more on employment prospects. Elasticities chosen can be found in the MISCH(H,*) table in the miscellaneous input file in the appendices.

NUMBER OF NON-WORKING HOUSEHOLDS

(X-22) $$a_h^n = a_h - a_h^w \quad \forall h \in H$$

GAMS: HN(H) =E= HH(H) - HW(H);

Description: The number of non-working households is simply the count of that household's population, less those with jobs.

Data: There are no new data in these equations.

X.7.TAXATION

HOUSEHOLD TAXES

(X-23) $$t_{gh} = \left\{ \tau_{gh}^b + \left[\frac{y_h}{a_h^w} - \tau_{gh}^d - \tau_{gh}^s - \left(\tau_{gh}^o + \sum_{g'} \alpha_{gg'}^\tau t_{gh} \right) \tau_{gh}^i \right] \tau_{gh}^m \right\} \tau_{gh}^c \quad \forall g \in GI, h \in H$$

GAMS: PIT(GI,H) =E= (TAXBASE(GI,H) + (Y(H) / HW(H) - TAXBM(GI,H) - TAXSD(GI,H) - (TAXOD(GI,H) + SUM(GI1, ATAX(GI1,GI) * PIT(GI1,H))) * TAXPI(GI,H)) * MTR(GI,H)) * TAXCVC(GI,H);

Description: Households pay income, sales and property taxes to three levels of government. Sales taxes are embodied in the prices they face in markets and are collected by firms and are determined elsewhere in the model. Direct taxes, per household, (income and property) are a function of average gross household incomes, the fraction of taxes paid to 'lower' level governments in itemized deductions, tax base amounts, average other deductions and marginal tax rates. These totals are corrected to reflect actual tax collection by the final parameter. Households do not migrate between tax brackets in this model and households have been grouped into gross income classes consistent with average taxable incomes found in the California personal income tax brackets.

Data: The data for these equations came from careful analysis of federal, California and local tax data. Readers are encouraged to consult the table in the main GAMS input file in the appendix for the Miscellaneous Input File for the details of these parameters.

X.8.GOVERNMENT

GOVERNMENT INCOME

(X-24)

$$y_g = \sum_{i\in I}\tau^{x}_{qgi}v_i p_i + \sum_{i\in I}\tau^{m}_{gi}m_i p^{w}_i + \sum_{i\in I}\sum_{h\in H}\tau^{x}_{qgi}c_{ih}p_i + \sum_{i\in I}\tau^{x}_{qgi}c_{in}p_i + \sum_{i\in I}\sum_{g'\in G}\tau^{x}_{qgi}c_{ig'}p_i$$
$$+\sum_{i\in I}\sum_{f\in F}\tau^{x}_{gi}r_{fi}r^{a}_{f}u^{d}_{fi} + \sum_{g'\in G}\sum_{f\in F}\tau^{x}_{gi}r_{fg}r^{a}_{f}u^{d}_{fg'} + \sum_{h\in H}\tau^{h}_{f}y_f$$
$$+\sum_{h\in H}\tau^{h}_{hg}a_h + \sum_{h\in H}t_{gh}a^{w}_{h} + \sigma_{gn}\left(-\sum_{i\in I}t_i\right)\Bigg|_{CABAC} \quad \forall g\in G$$

GAMS: Y(G) =E= SUM(I, TAUV(G,I) * V(I) * P(I)) + SUM(I, TAUM(G,I) * M(I) * PW0(I)) + SUM((H,I), TAUC(G,I) * CH(I,H) * P(I)) + SUM(I, TAUN(G,I) * CN(I) * P(I)) + SUM((G1,I), TAUG(G,I) * CG(I,G1) * P(I)) + SUM((F,I), TAUFX(G,F,I) * RA(F) * R(F,I) * FD(F,I)) + SUM((F,G1), TAUFX(G,F,G1) * RA(F) * R(F,G1) * FD(F,G1)) + SUM(F, TAUFH(G,F) * Y(F)) + SUM(H, PIT(G,H) * HW(H)) + SUM(H, TAUH(G,H) * HH(H)) + SAM(G,'INVES') - SUM((I,F), FITC(F,G) * ITC(I));

Description: Government income is the sum of sales taxes collected from domestic consumption (intermediates, imports, household consumption, investment and governments), plus taxes on factor payments, plus taxes collected from households (income taxes and per household taxes), less investment tax credits in the case of the California Bank and Corporation tax.

Data: All tax rates were derived from careful analysis of federal, state and local financial publications.

GOVERNMENT ENDOGENOUS PURCHASES OF GOODS AND SERVICES

(X-25)

$$p_i\left(1+\sum_{g\in GS}\tau^{g}_{gi}\right)c_{ig} = a_{ig}\left(y_g + \sum_{g'\in G}b_{gg'} - \sum_{g'\in G}b_{gg'} - \sum_{h\in H}w_{hg}a^{n}_{h}\tau^{pc}_{hg} - \bar{s}_g\right)$$
$$\forall i\in I, g\in GN$$

GAMS: P(I) * (1 + SUM(GS, TAUG(GS,I))) * CG(I,GN) =E= AG(I,GN) * (Y(GN) + SUM(G1, IGT(GN,G1)) - SUM(G1, IGT(G1,GN)) - SUM(H, TP(H,GN) * HN(H) * TPC(H,GN)) - S0(GN));

Description: Shares of nominal endogenous government spending calculated from existing budgets and financial reports form the basis of these equations. Nominal spending, including taxes paid for goods and services form the left-hand side. The shares are applied to total receipts of these units: tax revenues, plus inter-governmental transfers in, less inter-governmental transfers out, less transfer payments made from this unit, less the observed level of government savings in the original data.

Data: The share calculations were based on careful analysis of government budget and financial reports.

GOVERNMENT ENDOGENOUS RENTAL OF FACTORS

(X-26)

$$u_{fg}^{d} r_{f}^{a} r_{fg} = \alpha_{fg}\left(y_g + \sum_{g' \in G} b_{gg'} - \sum_{g' \in G} b_{gg'} - \sum_{h \in H} w_{hg} a_h^n \tau_{hg}^{pc} - \bar{s}_g \right) \quad \forall f \in F, g \in GN$$

GAMS: FD(F,GN) * RA(F) * R(F,GN) =E= AG(F,GN) * (Y(GN) + SUM(G1, IGT(GN,G1)) - SUM(G1, IGT(G1,GN)) - SUM(H, TP(H,GN) * HN(H) * TPC(H,GN)) - S0(GN));

Description: Parallel with the equations immediately preceding, shares of government spending for factor rentals are applied to government incomes (right-hand side) and set equal to nominal government factor rentals. Government factor taxes paid to other governments do not appear as these were omitted from the share calculations.

Data: See above for Government Endogenous Purchases of Goods and Services.

GOVERNMENT SAVINGS

(X-27)

$$s_g = y_g - \sum_{i \in I} c_{ig} p_i \left(1 + \sum_{g \in GS} \tau_{gi}^{g}\right) - \sum_{f \in F} u_{fg}^{d} r_{fg} r_f^{a}\left(1 + \sum_{g' \in GF} \tau_{fg'i}^{x}\right) - \sum_{h \in H} w_{hg} a_{hg}^{n} \tau_{hg}^{pc}$$

$$- \sum_{g' \in G} b_{g'g} + \sum_{g' \in G} b_{gg'} \quad \forall g \in G$$

GAMS: S(G) =E= Y(G) - SUM(I, CG(I,G) * P(I) * (1 + SUM(GS, TAUG(GS,I)))) - SUM(F, FD(F,G) * R(F,G) * RA(F) * (1 + SUM(GF, TAUFX(GF,F,G)))) - SUM(H, TP(H,G) * HN(H) * TPC(H,G)) - SUM(G1, IGT(G1,G)) + SUM(G1, IGT(G,G1));

Description: As with the household savings function, government saving becomes the residual from government income less government purchases of goods and services less government rental of factors less government welfare payments less net intergovernmental transfers paid.

Data: There are no new data in these equations.

DISTRIBUTION OF TAXES

(X-28)

$$b_{g'g} = \mu_{g'g}\left(y_g - \sum_{h \in H} w_{hg} a_h^n \tau_{hg}^{pc} \right) \quad \forall g, g' \in G$$

GAMS: IGT(G1,G) =E= TAXS(G1,G) * (Y(G) - SUM(H, TP(H,G) * HN(H) * TPC(H,G)) - S0(G));

Description: Taxing units in our model distribute their receipts in two ways: transfers to spending units and in transfer payments. The matrix IGTD in file miscellaneous input file identifies which units are modeled this way. A matrix (TAXS) is established which identifies the shares of net taxes (taxes net of transfer payments) which are distributed to particular units.

Data: The institutional structure reflected in matrix IGTD was developed from careful analysis of government budget and financial reports. The elements of the matrix TAXS are calculated as shares from current distribution of tax revenues.

ENDOGENOUS BALANCE DISTRIBUTION OF CALIFORNIA GENERAL FUNDS

(X-29) $$b_{cahaw,ca\lg f} = y_g + \sum_{g \in G} b_{ca\lg f,g} - \sum_{g \in G'} b_{ca\lg f,g'}$$

GAMS: IGT('CAHAW','CALGF') =E= Y('CALGF') + SUM(G, IGT('CALGF',G)) - SUM(G$IGTD(G,'CALGF'), IGT(G,'CALGF'));

Description: This equation defines the budget balancing of the California General Fund. The residual of General Fund income (the first two elements on the left-hand side), after exogenous transfers out and Proposition 98 transfers, is transferred to California Health and Welfare. This transfer defines the amount of endogenous spending by that unit and its transfer to local Health and Welfare (the equation immediately following).

Data: The current levels of these variables came from careful analysis of government budget and financial reports.

ENDOGENOUS HEALTH AND WELFARE TRANSFER

(X-30) $$b_{lohaw,cahaw} = \bar{b}_{lohaw,cahaw} + b_{cahaw,ca\lg f} - \bar{b}_{cahaw,ca\lg f}$$

GAMS: IGT('LOHAW','CAHAW') =E= IGT0('LOHAW','CAHAW') + IGT('CAHAW','CALGF') - IGT0('CAHAW','CALGF');

Description: The transfer from California Health and Welfare to local Health and Welfare is made proportional to changes in the General Fund transfer to California Health and Welfare.

Data: The current level was established through careful analysis of government budget and financial reports.

ENDOGENOUS TRANSFER PAYMENTS

(X-31) $$w_{hg} a_h^n \tau_{hg}^{pc} = \bar{w}_{hg} \bar{a}_h^n \tau_{hg}^{pc} \left(\sum_{g' \in G} b_{g'g} \right) \div \left(\sum_{g' \in G} \bar{b}_{g'g} \right) \quad \forall g \in GWN$$

GAMS: TP(H,GWN) * HN(H) * TPC(H,GWN) =E= TP0(H,GWN) * HN0(H) * TPC(H,GWN) * SUM(G, IGT(GWN,G)) /SUM(G, IGT0(GWN,G));

Description: The one endogenous set of transfer payments (local Health and Welfare or LOHAW) depends on two key variables: the number of welfare families and the transfers received by local governments from three levels of government. Thus, the model establishes a 'pot' of transfer payments using block grants from the federal government, endogenous budget-balancing funds from California and exogenous transfers from other local funds.

Data: The current level of transfer payments and numbers of recipients were established from careful analysis of government budgets and financial reports.

EDUCATION TRANSFER FOR PROPOSITION 98 - TEST 2

(X-32) $$b_{lok14,calgf} = \bar{b}_{lok14,calgf}\psi \frac{\sum_{h\in H}\left(y_h + \sum_{g\in G} w_{hg} a_h^n \tau_{hg}^{pc} \right) \div \sum_{h\in H} a_h}{\sum_{h\in H}\left(\bar{y}_h + \sum_{g\in G} \bar{w}_{hg} \bar{a}_h^n \tau_{hg}^{pc} \right) \div \sum_{h\in H} \bar{a}_h}$$

GAMS: IGT('LOK14','CALGF') =E= IGT0('LOK14','CALGF') * ADA * SUM(H, Y(H) + SUM(G, TP(H,G) * HN(H) * TPC(H,G))) / SUM(H, HH(H)) / SUM(H, Y0(H) + SUM(G, TP0(H,G) * HN0(H) * TPC(H,G))) * SUM(H, HH0(H)) ;

Description: Test 2 establishes the transfer from the General Fund to local K-14 education as being a function of its present level, corrected by per capita personal income. The scalar applied is for Average Daily Attendance. For each experiment conducted with the model, either this equation using Test 2 or the equation immediately following (Test 3) was used. To avoid attempting to solve a non-linear mixed integer programming problem, it was decided to intervene in the application of Proposition 98 manually. All analyses using the model will be identified as to the assumptions about the test used for Proposition 98.

Data: The current level of K-14 Proposition 98 transfer was obtained by specialists in the Department of Finance.

EDUCATION TRANSFER FOR PROPOSITION 98 - TEST 3

(X-33) $$b_{lok14,calgf} = \bar{b}_{lok14,calgf}\psi \frac{\left(y_{calgf} + \sum_{g\in G} b_{calgf,g} \right) \div \sum_{h\in H} a_h}{\left(\bar{y}_{calgf} + \sum_{g\in G} \bar{b}_{calgf,g} \right) \div \sum_{h\in H} \bar{a}_h}$$

GAMS: IGT('LOK14','CALGF') =E= IGT0('LOK14','CALGF') * ADA * (Y('CALGF') + SUM(G, IGT('CALGF',G))) / SUM(H, HH(H)) / (Y0('CALGF') + SUM(G, IGT0('CALGF',G))) * SUM(H, HH0(H)) ;

Description: Test 3 establishes the transfer from the General Fund to local K-14 education as being a function of its present level, corrected by per capita General Fund revenues. The scalar applied is for Average Daily Attendance.

Data: The current level of K-14 Proposition 98 transfer was obtained by specialists in the Department of Finance.

X.9.MODEL CLOSURE

STATE PERSONAL INCOME

(X-34) $$q = \sum_{h\in H} y_h + \sum_{h\in H}\sum_{g\in G} w_{hg} a_h^n \tau_{hg}^{pc}$$

GAMS: SPI =E= SUM(H, Y(H)) + SUM((H,G), TP(H,G) * HN(H) * TPC(H,G));

Description: Personal income is the sum of 'earned' income (payments from rental of factors by households) and transfer payments. This variable is included for two reasons. First, personal income is a figure of interest to economists analyzing regional economies and changes to its value form an integral part of analyzing the effects of institutional or policy change. Second, since a mathematical programming software (GAMS) that incorporates non-linear optimization software, rather than software to solve simultaneous equations, was used to solve the model, a variable unrestricted in value and without a subscript was required.

Data: There are no new data in these equations.

LABOR MARKET CLEARING

(X-35) $$\sum_{h \in H} a_h^w = \left(\sum_{i \in I} u_{Li}^d + \sum_{g \in G} u_{Lg}^d \right) \varepsilon$$

GAMS: SUM(H, HW(H)) =E= SUM(Z, FD('L',Z)) * JOBCOR;

Description: An important feature of CGE models is that factor markets clear. The interrelationship between household decisions to supply labor (depending on the real return to work) and those of firms to demand labor (depending on the profit maximization decision) is critical to CGE models. The scalar applied to the number of jobs scales households (left-hand side) to jobs (the variables in the brackets on the right-hand side).

Data: There are no new data in these equations.

CAPITAL MARKET CLEARING

(X-36) $$u_{Ki}^s = u_{Ki}^d \quad \forall i \in I$$

GAMS: KS(I) =E= FD('K',I);

Description: As with labor, capital markets clear, sector-by-sector.

Data: There are no new data in these equations.

GOODS MARKET CLEARING

(X-37) $$q_i = x_i + e_i - m_i \quad \forall i \in I$$

GAMS: DS(I) =E= DD(I) + CX(I) - M(I);

Description: Domestic demand is the sum of intermediate, consumer, government and investment demand. The right hand side of this function could have been incorporated into the functions below and into trade demand equations, but has been kept separate for simplifying and transparency reasons.

Data: There are no new data in these equations.

DEFINITION OF DOMESTIC DEMAND

(X-38) $$x_i = v_i + \sum_{h \in H} c_{ih} + \sum_{g \in G} c_{ig} + c_{in} \quad \forall i \in I$$

GAMS: DD(I) =E= V(I) + SUM(H, CH(I,H)) + SUM(G, CG(I,G)) + CN(I);

Description: These equations demonstrate one of the most critical clearing assumptions. The model is forced to balance domestic production with demand for this production (domestic plus foreign demand, less imports).

Data: There are no new data in these equations.

FIX PIT FOR NON-INCOME TAX UNITS TO ZERO

(X-39) $t_{gh} = 0 \quad \forall h \in H, g \notin GI$

GAMS: PIT.FX(G,H)$(NOT GI(G)) = 0;

Description: These are 'housekeeping' equations to ensure that the mathematical programming solver does not create income taxes that do not reflect the institutional structure of governments. The list of taxes modeled as income taxes is to be found near the beginning of the main DRAM input file.

Data: There are no new data in these equations.

FIX INTER-GOVERNMENTAL TRANSFERS TO ZERO IF NOT IN ORIGINAL SAM

(X-40) $b_{gg'} = 0 \quad \forall g, g' \in G \text{ where } \overline{b}_{gg'} = 0$

GAMS: IGT.FX(G,G1)$(NOT IGT0(G,G1)) = 0;

Description: These are 'housekeeping' equations to ensure that the mathematical programming solver does not create inter-governmental transfers that do not reflect the institutional structure of governments.

Data: There are no new data in these equations.

FIX EXOGENOUS INTER-GOVERNMENTAL TRANSFERS

(X-41) $b_{gg'} = \overline{b}_{gg'} \quad \forall g, g' \in G \text{ where defined}$

GAMS: IGT.FX(G,G1)$(IGTD(G,G1) EQ 2) = IGT0(G,G1);

Description: These represent payments from and to each level of government and from taxing authorities (general state government, for example) to spending authorities (such as local corrections). Federal block grants are modeled this way. The matrix IGTD in the miscellaneous input file is used to establish the types of transfers permitted in the model. Remarks with the key to this matrix are found following the matrix in that file.

Data: The current levels of inter-governmental transfers were established from careful analysis of California and local government financial and budget reports.

FIX EXOGENOUS GOVERNMENT SPENDING ON GOODS AND SERVICES

(X-42) $c_{ig} = \overline{c}_{ig} \quad \forall i \in I, g \in GX$

GAMS: CG.FX(I,GX) = CG0(I,GX);

Description: Some government units were modeled with endogenous spending (the set GN) and some as endogenous (the set GX). A list of these units is to be found near the beginning of the main GAMS input file.

Data: Current levels of spending came from careful analysis of California and local government financial and budget reports.

FIX EXOGENOUS GOVERNMENT RENTAL OF FACTORS

(X-43) $u^{d}_{fg} = \bar{u}^{d}_{fg} \quad \forall f \in F, g \in GX$

GAMS: FD.FX(F,GX) = FD0(F,GX);

Description: As with purchases of goods and services immediately above, rentals of factors were made endogenous for some governments (GN) and exogenous for others (GX).

Data: Current levels of spending came from careful analysis of California and local government financial and budget reports.

FIX INTER-SECTOR WAGE DIFFERENTIALS

(X-44) $r_{Li} = \bar{r}_{Li} \quad \forall i \in I$

GAMS: R.FX('L',Z) = R0('L',Z);

Description: Inter-sectoral wage differentials are fixed to those calculated using employment and wage data in IMPLAN. Since households respond to the overall change in wages, only the economy-wide wage variable can change, not the sectoral differential rate.

Data: All data were derived from IMPLAN averages.

FIX GOVERNMENT RENTAL RATES FOR CAPITAL

(X-45) $r_{Kg} = \bar{r}_{Kg} \quad \forall g \in G$

GAMS: R.FX('K',G) = R0('K',G);

Description: As government does not respond to a profit maximizing motivation, government rental rate for capital is held exogenous.

Data: There are no new data in these equations. Careful analysis of California and local government budget and financial reports did not allow us to separate rentals of capital by government units. We maintained the equations above to ease the future inclusion of government rentals of capital, despite their levels being set to zero in the current model.

FIX ECONOMY WIDE SCALAR FOR CAPITAL

(X-46) $r^{a}_{f} = \bar{r}^{a}_{f} \quad \forall f \in F$

GAMS: RA.FX('K') = RA0('K');

Description: Since firms make their investment decision based on the change in their own sectoral return to capital, the economy-wide scalar is fixed.

Data: There are no new data in these equations.

FIX EXOGENOUS TRANSFER PAYMENTS

(X-47) $w_{hg} = \overline{w}_{hg} \quad \forall h \in H, g \in GWX$

GAMS: TP.FX(H,GWX) = TP0(H,GWX);

Description: Transfer payments except for those distributed by local health and welfare (LOHAW) are modeled as being exogenous per non-working household. The list of these is to be found near the beginning of the main GAMS input file as the set GWX.

Data: The totals of welfare payments were derived from Department of Finance personal income data and were updated to the current model's date. The numbers of recipients were established by professional judgment using data as available for particular programs such as Aid to Families with Dependent Children.

FIX TRANSFER PAYMENTS TO ZERO IF SO IN ORIGINAL DATA

(X-48) $w_{hg} = 0 \quad \forall\, h \in H, g \in GWX \text{ where } \overline{w}_{hg} = 0$

GAMS: TP.FX(H,G)$(NOT TP0(H,G)) = 0;

Description: These are housekeeping functions to prevent the introduction of transfer payments that did not exist in the base data.

Data: There are no new data in these functions.

XI. SENSITIVITY ANALYSIS

DRAM was developed to guide the analysis of critical policy issues brought before the Governor, Senate and Assembly of the world's seventh largest economy: the State of California. The Department of Finance must be assured of the properties of its model before conducting dynamic revenue analysis using DRAM. One of the ways of learning the properties of a simulation model is sensitivity analysis. Sensitivity analysis exposes a model to shocks in order to identify its properties and to test the implications of values chosen for key parameters. DRAM is a system of almost eleven hundred equations with over forty thousand numbers involved. Further, many key parameters of the model were imposed using professional judgment after a review of published literature. Sensitivity analysis may indicate the relative importance of these parameters.

The model was tested by examining the model solutions with different tax cuts, parameter values and rules for the government sector. Following a test of the calibration of the model (explained below), the first set of experiments tested the model solution in response to three tax cuts. Each involves a cut estimated with static techniques to reduce the tax revenue of California by $1 billion. The taxes in question are the Bank and Corporation Tax, the California Personal Income Tax (PIT) and the Sales and Use Tax.

In the second series, experiments were conducted to test the model's properties and key parameters by varying groups of elasticities and solving the model. The tax cut experiments were repeated in the face of changes in trade, labor supply, migration and investment elasticities being varied plus or minus fifty percent from levels chosen in the base case (by professional judgment in the middle ground of published values).

In the third series, key assumptions made when developing DRAM were altered and tested against a similar set of tax experiments. These assumptions involved the degree to which changes in California PIT affect federal PIT through itemized deductions; the choice of formulae for Proposition 98 funding of K-14 schools; the manner in which the General Fund is balanced; and the degree of interrelationship between federal matching funds for health and welfare and California's expenditures. As final elements in this third series, a set of elasticity levels and assumptions that tend to minimize the feedback effects is identified along with a set of elasticities and assumptions that tend to maximize the feedback effects.

The interaction between the budget balance and Proposition 98 funding for K-14 education deserves explicit description. The equation for determining the General Fund transfer to local education uses one of two tests—the choice of which is set manually. When using the Test 2 version, the transfer is calculated as a function of previous transfer, average daily attendance (held exogenous in the model) and change in per capita personal income (endogenous in the model). In its Test 3 version, the portion for per capita personal income is replaced by a similar one for per capita General Fund revenue. In either case, the residual of General Fund revenue, less the education transfer and transfers to other state departments becomes the transfer to Health and Welfare. Welfare grants per family become a function of this residual. In the sensitivity experiments, the endogenous nature of the Proposition 98 transfer and welfare transfers is tested.

In the sections following, the results of these three series of experiments are reported with the aim of demonstrating the uses and properties of DRAM along with the importance of key parameters imposed.

XI.1.THE BASE CASES

Calibration is the first step in using an applied CGE model. The term calibration applies to a process in which the equations of the CGE are solved without making any policy change. If the model solves in such a way as to replicate its original data, calibration has been achieved. If not, errors in data or model formulation almost certainly exist. DRAM was calibrated before any sensitivity experiments were completed.

Three basic case experiments were conducted, each using key elasticities chosen at their middle ground levels from the literature. As seen in the section following, these key elasticities involve trade, investment, labor supply and migration. In the base cases, we assume that Test 3 will apply to a fully endogenous Proposition 98, California PIT (Personal Income Tax) deductibility from Federal PIT is endogenous, the state budget is balanced and all Federal inter-governmental transfers are exogenous (read: block grants). These assumptions are reversed in the third section.

The three main experiments were to reduce by a $1 billion static estimate the Bank and Corporation Tax, the Personal Income Tax and the Sales and Use Tax. Each of these was reduced in a separate base case experiment, while holding the other two taxes at their current rate levels. The choice of these main experiments was made for the following reasons. First, they are the three main sources of tax revenue for the State and DRAM was developed to guide the Department of Finance in its dynamic analysis of revenue policy change. Second, changing each of these exposes DRAM's functional forms and parameters to significant exogenous shocks—ideally revealing both the model's properties and the appropriateness of key elasticity parameters imposed. Third, public policy debate in the State and elsewhere has focused on the subject of the economic efficiency implications of tax reduction.

Table XI-1 Sensitivity Analysis Base Case Results

	BASE	TODAY	BAC	PIT	SAU
MODEL		LOCALOP	LOCALOP	LOCALOP	LOCALOP
SOLVER		OK	OK	OK	OK
BAC	4.801	4.801	3.830	4.804	4.807
PIT	19.490	19.490	19.567	18.478	19.505
SAU	17.448	17.448	17.497	17.460	16.486
GFREV	42.307	42.307	41.462	41.310	41.507
SFREV	13.403	13.403	13.431	13.409	13.280
STATIC	-	-	(1.000)	(1.000)	(1.000)
DGF	-	-	(0.844)	(0.996)	(0.800)
DSF	-	-	0.028	0.006	(0.124)
DDRE	-	-	0.184	0.010	0.077
PDRE	-	-	18.390	1.003	7.673
SPI	772.177	772.177	773.777	771.439	772.284
GN	67.629	67.629	67.776	67.635	67.645
POP	23.421	23.421	23.434	23.418	23.425
W	100.000	100.000	100.028	99.788	99.962
R	100.000	100.000	99.597	100.006	100.015
LD	12.624	12.624	12.636	12.642	12.634
KD	13.526	13.526	13.674	13.532	13.542

Heading	Description
MODEL	GAMS reports back the type of solution found. LOCALOP means a local optimum.
SOLVER	GAMS reports back the status of the solver at solution. OK means a normal status.
BAC	The billions of dollars of B&C revenue at solution.
PIT	The billions of dollars of PIT revenue at solution.

SAU	The billions of dollars of S&U revenue at solution.
GFREV	The billions of dollars of General Fund Revenue at solution.
SFREV	The billions of dollars of Special Funds Revenue at solution.
STATIC	The static estimate of the tax change.
DGF	The billions of dollars of change in General Fund Revenue from initial conditions.
DSF	The billions of dollars of change in Special Funds Revenue from initial conditions.
DDRE	The billions of dollars of dynamic revenue effects.
PDRE	The percent of dynamic revenue effects expressed in terms of the static cost.
SPI	The billions of dollars of Personal Income statewide.
GN	The billions of dollars of Gross Investment.
POP	The population of households in the state in millions.
W	The change in the wage rate (base = 100)
R	The change in the return to capital (base =100)
LD	Labor demand in millions.
KD	Capital demand in hundreds of billion dollars.
BASE	The initial data supplied to DRAM
TODAY	The first solution using no changes in tax rates.
BAC	The experiment reducing B & C taxes by a static estimate of $1 billion.
PIT	The experiment reducing PIT by a static estimate of $1 billion.
SAU	The experiment reducing S & U taxes by a static estimate of $1 billion.

XI.1.1.THE INITIAL BASE SOLVE: CALIBRATION

Comparison of the results of the second and third columns of the table above (headed by 'Base' and 'Today') indicates the degree to which DRAM has been calibrated to its data. As shown, this has been accomplished to beyond the fifth significant digit. This is an important first step in judging the results of a CGE, whether a simple theoretical simulation model or a large, complex applied model such as DRAM. By achieving this result, one cannot claim more than the fact that the equations of the model are consistent with the initial data. However, this is a non-trivial result when building such a large, complex and interrelated model such as DRAM.

XI.1.2.BASE SOLVE: BANK AND CORPORATION TAX REDUCTION

The third column in the table above indicates the results from DRAM for a reduction in the B&C taxes by a $1 billion static estimate. B&C taxes are modeled as a tax on payments to capital in DRAM. Rates for these were reduced across-the-board by about 20 percent. In the solution, General Fund revenues drop by $844 million and Special Fund revenues rise by $28 million. Thus, tax revenues for the state drop by $816 million, generating the estimate of about eighteen percent dynamic feedback effects. The rental rate for capital falls by 0.4% and the average wage rises marginally. Employment rises by 12,000 and investment rises by $47 million. All of the increase in employment is accounted for by in-migration. How are these results found, i.e. what channels of change are used to find a new equilibrium in the face of a change in the B&C tax rates?

Reductions in the Bank and Corporation Tax (B&C) indicate that producers can be expected to implement substitution of capital for labor as a first step. With reduced total capital payments, firms demand more capital and less labor until the marginal revenue product of each factor is equal to its marginal factor cost. Overall, however, the cost of doing business is reduced. Since DRAM assumes perfect competition, domestic prices fall to domestic marginal costs. Exports increase and imports decrease. Domestic output rises to meet demand, but with some of the initial cost-push deflation being lost. Rising output further increases the demand for capital and labor and firms hire back more than their initial losses in staff.

Concurrently, households receive a higher percentage of available capital payments. They offer more capital to business and trade off some of their after-tax gains in lower rental rates for capital. As increased export and domestic demand increase the demand for capital, most of the rental rate loss is regained by the owners of capital. Owners of labor gain in the overall result. Market wages rise slightly with the increased demand and prices have fallen. Thus, real wages have risen.

While the private sector makes its investment, substitution, supply and demand decisions, the public sector accounts experience a drop in revenues. The initial cut in the B&C tax reduces General Fund revenues by $1 billion. To balance the budget, DRAM first allocates funds transferred to local education on the basis of changes in per capita General Fund revenues—which have now fallen. The remaining portion is modeled as a reduction in California's transfers to local governments in aid of health and welfare expenditures, both transfer payments to individuals and other costs. Reduced education transfers mean fewer jobs in schools and community colleges while less purchasing is made by education authorities. Somewhat over 5,000 fewer public sector jobs exist. The loss of these jobs and the reduced demand for goods and services offset some of the expansive effects of private economic decisions.

However, as any neoclassical CGE would predict, replacing private dollars for public dollars leads to economic expansion. Two elements of DRAM would tend to guide researchers to believe that these results may be an upper bound to those expected from a B&C reduction. First, DRAM does not link the productivity effects of reduced education expenditure on private businesses. To the extent that it would, some of the expansive effects of such a tax reduction may be lost. Second, DRAM does not incorporate the deductibility of California's B&C from federal corporate tax. To the extent that all would be deductible, the results may be overstated by about one-third. However, California apportions profits by weighting sales in California equal to the weights placed on other factors. This reduces the connection between California's production and the tax liability. Further, the vast majority of B&C is paid by companies operating in other jurisdictions and thus being subject to this apportionment formula. To the extent that the lack of deductibility matters, the DRAM results should be viewed as an upper bound—possibly overstating the impact by as much as one-sixth of the feedback shown.

However, the announcement effect of California reducing its corporate profits tax by about 20% may offset these cautions. To the extent that California breaks any lingering corporate perceptions that it is a 'high tax state' by significant reductions in the B&C, feedback effects could increase.

Note that the stages discussed above are not presented in the output file in the table. DRAM solves the model as a set of almost eleven hundred simultaneous non-linear equations. The results should be viewed as answering the question: what would today's economy look like if we had put into place reduced B&C tax rates five or six years ago. The two key lags exist in the real economy suggesting that five or six years are needed to see the full feedback effects come from observations in factor markets. The first impact of investment decisions today begin to be observed about ten quarters later. Full effects are usually found after about five years. Migration is somewhat slower: its full effects are generally accepted to be felt after about six years. Most, if not all, of the dynamic feedback effects demonstrated by DRAM will be found in this time frame.

XI.1.3.BASE SOLVE: PERSONAL INCOME TAX REDUCTION

The fourth column in the table above indicates the results from DRAM for a reduction in the PIT by a $1 billion static estimate. Rates for these were reduced across-the-board by about five percent. In the solution, General Fund revenues drop by $996 million and Special Fund revenues rise by $6 million.

Thus, tax revenues for the state drop by $990 million, generating the estimate of about one percent dynamic feedback effects. The rental rate for capital rises marginally and the average pre-tax market wage falls by 0.2%. Employment rises by 18,000 and investment rises marginally. About a third of the increase in employment is accounted for by net in-migration. Little in the way of dynamic feedback effects are found, yet significant economic changes are made.

Reductions in the PIT begin with households. Their California taxes go down, but the most significant reductions are experienced by high income households who itemize state and local taxes as deductions from income for federal tax purposes. Thus, about one quarter of the California tax reduction leaks out of the state in increased federal taxes. However, after-tax returns to work increase, except for the lowest income group – who have a marginal tax rate of zero. Labor supply increases and in-migration occurs for all but the lowest group. With some increase in labor supplied, pre-tax market wages fall in the model. Of course, in the real California economy, market wages seldom fall. The model's results should be considered to reflect a slowing of wage inflation over several years – say a drop from 3.0 percent a year to 2.9 percent for a couple of years.

Faced with lower wage costs, producers can be expected to implement substitution of labor for capital as a first step. With reduced labor costs, firms demand more labor and less capital until the marginal revenue product of each factor is equal to its marginal factor cost. Overall, however, the cost of doing business is reduced. Since DRAM assumes perfect competition, domestic prices fall to domestic marginal costs. Exports increase and imports decrease. Domestic output rises to meet demand, but with some of the initial cost-push deflation being lost. Rising output further increases the demand for capital and labor and firms begin to demand more capital, restoring investment to slightly higher than its original level.

As with B&C reductions, while the private sector makes its investment, substitution, supply and demand decisions, the public sector accounts experience a drop in revenues. The reductions have very similar effects. However, as any neoclassical CGE would predict, replacing private dollars for public dollars leads to economic expansion. Unlike with B&C, DRAM incorporates the deductibility of PIT in an explicit way. However, it still faces the criticism of not linking spending reductions on education and infrastructure to long-term productivity. The announcement effects would again tend to offset some of this criticism.

At first glance, the overall net feedback effects shown for PIT reductions may seem to imply that there are few, if any, gains to reducing PIT. The reality is far different from first impressions. Given the very large leakage of deductibility (25%) for the group experiencing the largest dollar impact of the reductions and that this group saves at the highest rate (over 10 percent of after-tax income, another leakage in models of regional economies), the feedback effects are very large. Less than one-half of the tax reduction enters the economy of California after these two sources are accommodated. The state's budget is balanced by reducing expenditures by the full amount of the tax reduction. In spite of these forces that would tend to drag down the economic performance, private job gains outstrip public job losses by better than three to one. High income households migrate to California and the economy expands. The results from DRAM imply large real economic gains to reductions in the PIT.

XI.1.4.BASE SOLVE: SALES AND USE TAX REDUCTIONS

The last column in the table above demonstrates the reaction of DRAM to reductions in S&U taxes. Rates for these were reduced across-the-board by about six percent. In the solution, General Fund revenues drop by $800 million and Special Fund revenues fall by $124 million. Thus, tax revenues for the state drop by $924 million, generating the estimate of about eight percent dynamic feedback effects. The rental rate for capital rises marginally and the average wage falls marginally. Employment rises by 10,000 and investment rises marginally. Little of the increase in employment is accounted for by net in-migration. Dynamic feedback is found of a distinctly different form than either B&C or PIT tax reductions.

Feedback for S&U appears to come from two places: the sales tax on intermediate goods and reducing the cost of goods to consumers. California is one of the few states to place a sales tax on intermediate goods. These become a cost of production and California's goods bear these costs when competing for export markets and for domestic markets. Reducing these cuts production costs without making changes in the relative costs of factors of production. Given the perfectly competitive market structure, domestic prices fall and the trade balance improves. Domestic producers increase production. Households face lower costs of goods and consume more goods. This increases the demand for goods, an increased share of which goes to domestic producers.

Overall, S&U feedback effects are significant. While the reduction is small (about 6% of tax rates or less than ½% of sales), significant positive feedback effects exist in DRAM's results. While significant, these results face the same criticisms as PIT reductions in terms of being possible overestimates due to the lack of linking productivity and infrastructure spending and possible understatements due to announcement effects. The latter criticism may be particularly significant in terms of the sales tax on intermediate goods. Being one of the few states to do so, California may receive significant gains from changes to these taxes.

XI.2.THE ELASTICITY EXPERIMENTS

Seven sets of experiments were conducted for each of tax reduction. These involved choosing combinations of key parameters and solving the model for three levels of these parameters:

1. at one half of their current levels;
2. at their current levels; and
3. at one and one half of their current levels.

By solving the model at three levels for combinations of key parameters, the properties of DRAM tend to be exposed, while the importance of the key parameters is explored. Each of these experiments is described in a sub-section below.

XI.2.1.ELASTICITY EXPERIMENTS: TRADE

The responsiveness of exports to relative prices and the responsiveness of domestic share to relative prices are at the core of many of the economic effects explained in the base solves above. Trade represents a very large share of a regional economy and small changes in relative prices can have large changes in the economy. Further, trade data (as stated elsewhere in this report) are those upon which the least confidence should be placed by those analyzing the results from DRAM. Thus, if the model's results are particularly sensitive to the trade elasticities imposed, the recipients of such analyses should be made aware of these implications.

Table XI-2 Trade Elasticity Experiments

		BAC			PIT			SAU		
	BASE	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
BAC	4.801	3.819	3.830	3.836	4.799	4.804	4.807	4.804	4.807	4.809
PIT	19.490	19.509	19.567	19.598	18.454	18.478	18.491	19.491	19.505	19.512
SAU	17.448	17.477	17.497	17.508	17.451	17.460	17.464	16.481	16.486	16.488
GFREV	42.307	41.374	41.462	41.511	41.272	41.310	41.331	41.485	41.507	41.519
SFREV	13.403	13.420	13.431	13.437	13.404	13.409	13.412	13.277	13.280	13.281
STATIC	-	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
DGF	-	(0.933)	(0.844)	(0.796)	(1.034)	(0.996)	(0.976)	(0.821)	(0.800)	(0.788)
DSF	-	0.017	0.028	0.034	0.001	0.006	0.009	(0.126)	(0.124)	(0.122)
DDRE	-	0.084	0.184	0.238	(0.033)	0.010	0.033	0.052	0.077	0.091
PDRE	-	8.441	18.391	23.842	(3.293)	1.003	3.300	5.215	7.673	9.055
SPI	772.177	772.355	773.777	774.548	770.813	771.439	771.775	771.943	772.284	772.471
GN	67.629	67.747	67.776	67.794	67.623	67.635	67.641	67.638	67.645	67.648
POP	23.421	23.429	23.434	23.436	23.417	23.418	23.419	23.424	23.425	23.426
W	100.000	99.843	100.028	100.125	99.705	99.788	99.832	99.919	99.962	99.985
R	100.000	99.570	99.597	99.612	99.994	100.006	100.012	100.009	100.015	100.018
LD	12.624	12.633	12.636	12.637	12.641	12.642	12.643	12.633	12.634	12.634
KD	13.526	13.644	13.674	13.691	13.521	13.532	13.538	13.535	13.542	13.545

The table above demonstrates how the base solves change when these elasticities are set at fifty percent below their current levels (LOW), at their current levels (MEDIUM) and at one hundred and fifty percent of their current levels (HIGH). The results of the MEDIUM column repeat the base case experiment results in this table and those for the other six elasticity experiments reported in succeeding sub-sections. The first observation is that trade elasticities matter. Dynamic feedback percentages vary proportionately with trade elasticities for B&C tax reductions. When trade elasticities are halved, feedback percentages are halved and both increase roughly proportionately. These results should be expected by readers familiar with the use of CGE models to examine economic change. B&C tax reductions lead to domestic deflation, but most of the results come from the trade balance implications of this deflation. The small dynamic feedback effects found for PIT are reversed or increased in similar and symmetric ways. Those for S&U taxes follow the B&C pattern in proportion.

The caution that must come from these results are not only that these elasticities are important, but also that they are applied to the weakest data in DRAM. Regional economic data suffer from being much more sparse than national data, being updated in a much less timely manner and being non-existent in many cases. Trade data do not exist for inter-state trade and international trade data are declining in quality. Care must be expressed in interpreting any of the results from DRAM due to these facts. Further research into trade data and the elasticity parameters appears critical to improving the reliability of the model.

XI.2.2.ELASTICITY EXPERIMENTS: LABOR SUPPLY

The responsiveness from the existing population (the workforce participation rate) to changes in after tax earned incomes and to changes in transfer payments is as important as trade responsiveness in generating the dynamic feedback results reported in the base cases above. While the literature indicates that labor supply responses from the existing population can be expected to be low, small changes in the participation rate compounded with migration effects can be significant. The labor data in DRAM deserve much more confidence than do those for trade. However, their elasticities were established from published studies that used national data. Tests of these rates of response are critical to evaluating the results of DRAM.

Table XI-3 Labor Supply Elasticity Experiments

	BASE	BAC LOW	BAC MEDIUM	BAC HIGH	PIT LOW	PIT MEDIUM	PIT HIGH	SAU LOW	SAU MEDIUM	SAU HIGH
BAC	4.801	3.830	3.830	3.830	4.804	4.804	4.803	4.807	4.807	4.807
PIT	19.490	19.568	19.567	19.567	18.478	18.478	18.479	19.505	19.505	19.504
SAU	17.448	17.495	17.497	17.498	17.462	17.460	17.458	16.484	16.486	16.486
GFREV	42.307	41.460	41.462	41.464	41.312	41.310	41.309	41.506	41.507	41.508
SFREV	13.403	13.430	13.431	13.432	13.411	13.409	13.408	13.279	13.280	13.280
STATIC	-	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
DGF	-	(0.847)	(0.844)	(0.843)	(0.994)	(0.996)	(0.998)	(0.801)	(0.800)	(0.799)
DSF	-	0.027	0.028	0.029	0.008	0.006	0.005	(0.124)	(0.124)	(0.123)
DDRE	-	0.180	0.184	0.187	0.013	0.010	0.007	0.075	0.077	0.078
PDRE	-	18.047	18.391	18.660	1.329	1.003	0.749	7.476	7.673	7.827
SPI	772.177	773.778	773.777	773.776	771.438	771.439	771.441	772.286	772.284	772.282
GN	67.629	67.775	67.776	67.777	67.636	67.635	67.634	67.644	67.645	67.645
POP	23.421	23.433	23.434	23.434	23.419	23.418	23.418	23.425	23.425	23.425
W	100.000	100.059	100.028	100.003	99.759	99.788	99.811	99.981	99.962	99.948
R	100.000	99.596	99.597	99.598	100.007	100.006	100.005	100.014	100.015	100.016
LD	12.624	12.631	12.636	12.640	12.647	12.642	12.638	12.631	12.634	12.636
KD	13.526	13.672	13.674	13.675	13.533	13.532	13.531	13.541	13.542	13.542

These results imply that these elasticities, chosen in the base cases from the middle level of published research, have relatively small effects on the percentage dynamic responses toward tax revenues. This is in agreement with the literature on the labor effects of tax change: the real 'action' in dynamic effect is in migration, rather than changes in the current population's labor supply response, although those elasticities also have little overall effect on the percentage dynamic responses. In both cases (labor supply and migration), the added (or lost) responsiveness is swamped by the equilibrium effects. Since firms accommodate additional workers offering their labor by lowering market wage rates, thus reducing PIT collections while raising employment, the dynamic feedback responses do not change much on an overall level. Thus, while labor supply responsiveness affects the details of the economic response to tax cuts, the net effect on the State's revenues is small.

XI.2.3.ELASTICITY EXPERIMENTS: MIGRATION

The responsiveness of in- and out-migration to changes in after tax incomes appears to be central to CGE analyses of regional economies. There is strong empirical evidence that migration tends to equalize after-tax incomes over the long cycle. The elasticities suggested by the literature were exposed to tests to see how the results of DRAM change with changes in these.

Table XI-4 Migration Elasticity Experiments

	BASE	BAC LOW	BAC MEDIUM	BAC HIGH	PIT LOW	PIT MEDIUM	PIT HIGH	SAU LOW	SAU MEDIUM	SAU HIGH
BAC	4.801	3.830	3.830	3.831	4.804	4.804	4.804	4.807	4.807	4.807
PIT	19.490	19.567	19.567	19.567	18.478	18.478	18.479	19.505	19.505	19.504
SAU	17.448	17.494	17.497	17.499	17.460	17.460	17.459	16.484	16.486	16.486
GFREV	42.307	41.458	41.462	41.466	41.310	41.310	41.310	41.506	41.507	41.508
SFREV	13.403	13.428	13.431	13.434	13.409	13.409	13.409	13.278	13.280	13.281
STATIC	-	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
DGF	-	(0.848)	(0.844)	(0.841)	(0.997)	(0.996)	(0.997)	(0.801)	(0.800)	(0.799)
DSF	-	0.025	0.028	0.031	0.006	0.006	0.006	(0.125)	(0.124)	(0.123)
DDRE	-	0.177	0.184	0.190	0.009	0.010	0.009	0.074	0.077	0.079
PDRE	-	17.687	18.391	19.002	0.943	1.003	0.926	7.406	7.673	7.884
SPI	772.177	773.697	773.777	773.846	771.482	771.439	771.379	772.263	772.284	772.298
GN	67.629	67.775	67.776	67.778	67.635	67.635	67.635	67.644	67.645	67.645
POP	23.421	23.428	23.434	23.439	23.421	23.418	23.415	23.423	23.425	23.426
W	100.000	100.055	100.028	100.004	99.800	99.788	99.781	99.976	99.962	99.950
R	100.000	99.595	99.597	99.598	100.006	100.006	100.005	100.014	100.015	100.016
LD	12.624	12.631	12.636	12.640	12.641	12.642	12.643	12.631	12.634	12.636
KD	13.526	13.672	13.674	13.675	13.532	13.532	13.532	13.541	13.542	13.542

As with labor supply elasticities, the migration ones change the feedback levels only marginally. The same forces are at work: labor responses tend to be balanced by wage and PIT collection changes to have little overall dynamic effect change. As with labor supply, the composition of the economic response changes when the responsiveness of households changes, but the net effect on the State's revenues is small. These results could guide our future research towards topics other than labor supply and migration. However, further investigations are required to determine this. While population falls somewhat in the PIT experiment, it is an artifact of out-migration of low income households and in-migration of middle and upper income households. Since the lower income groups pay little or no PIT, they respond to the pre-tax drop in wages as a drop in after-tax wages. Only middle and upper income groups experience a rise in after-tax wages due to the reduction in marginal tax rates.

XI.2.4.ELASTICITY EXPERIMENTS: INVESTMENT

There are two types of factors in DRAM: labor and capital. The responsiveness of investment to changes in the after-tax return to capital should attract as much attention as labor elasticities. Factor markets are the key to understanding many of the properties of CGE models. In the development of DRAM, considerable efforts were made to focus on the investment supply decision. However, no useful estimates of this key elasticity were found using California data. The national estimate was tested to identify DRAM's sensitivity to the value imposed. The results of these experiments follow.

Table XI-5 Investment Elasticity Experiments

		BAC			PIT			SAU		
	BASE	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
BAC	4.801	3.829	3.830	3.830	4.804	4.804	4.804	4.807	4.807	4.807
PIT	19.490	19.561	19.567	19.569	18.478	18.478	18.479	19.504	19.505	19.505
SAU	17.448	17.491	17.497	17.499	17.459	17.460	17.460	16.485	16.486	16.486
GFREV	42.307	41.449	41.462	41.467	41.310	41.310	41.311	41.505	41.507	41.508
SFREV	13.403	13.428	13.431	13.433	13.409	13.409	13.409	13.279	13.280	13.280
STATIC	-	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
DGF	-	(0.857)	(0.844)	(0.839)	(0.997)	(0.996)	(0.996)	(0.801)	(0.800)	(0.799)
DSF	-	0.025	0.028	0.030	0.006	0.006	0.006	(0.124)	(0.124)	(0.123)
DDRE	-	0.168	0.184	0.190	0.009	0.010	0.010	0.075	0.077	0.077
PDRE	-	16.762	18.391	19.045	0.923	1.003	1.036	7.483	7.673	7.750
SPI	772.177	773.610	773.777	773.844	771.430	771.439	771.443	772.265	772.284	772.291
GN	67.629	67.758	67.776	67.784	67.634	67.635	67.635	67.642	67.645	67.645
POP	23.421	23.432	23.434	23.434	23.418	23.418	23.418	23.425	23.425	23.425
W	100.000	100.016	100.028	100.032	99.787	99.788	99.788	99.961	99.962	99.963
R	100.000	99.704	99.597	99.554	100.010	100.006	100.004	100.027	100.015	100.010
LD	12.624	12.634	12.636	12.636	12.642	12.642	12.642	12.634	12.634	12.634
KD	13.526	13.655	13.674	13.681	13.531	13.532	13.532	13.540	13.542	13.542

Much as the labor and migration elasticities, that for investment matters less than one may expect at first glance. If households are not as responsive (inelastic) to the after tax return to capital, they react less to the B&C tax reduction than if they are highly responsive (elastic) – but the overall effects are not large. The focus of this elasticity is on B&C taxes as this is at the core of the dynamic responses. The overall effects do not change as much as one may expect since the responses tend to result in increasing demand to the point where some of the response is lost through inflationary effects of increasing demand. This is a classic general equilibrium result: dynamic responses cannot stray far from the original values through inflationary and deflating effects of increased and decreased quantities demanded.

As the PIT and S&U tax reductions depend less on investment than on household responses to tax-included prices and producers to lower cost intermediate goods, the effect of the investment elasticity value is small for these taxes.

XI.2.5.ELASTICITY EXPERIMENTS: TRADE AND INVESTMENT

The first and fourth experiments were combined, i.e. trade and investment elasticities were varied simultaneously to identify the interrelationships (if any) that may imply other than linear relationships in the DRAM results. The results follow.

Table XI-6 Trade and Investment Elasticity Experiments

		BAC			PIT			SAU		
	BASE	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
BAC	4.801	3.820	3.830	3.837	4.799	4.804	4.807	4.804	4.807	4.809
PIT	19.490	19.510	19.567	19.603	18.454	18.478	18.492	19.491	19.505	19.513
SAU	17.448	17.474	17.497	17.511	17.451	17.460	17.464	16.480	16.486	16.489
GFREV	42.307	41.371	41.462	41.519	41.273	41.310	41.331	41.485	41.507	41.520
SFREV	13.403	13.418	13.431	13.439	13.404	13.409	13.412	13.276	13.280	13.281
STATIC	-	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
DGF	-	(0.935)	(0.844)	(0.788)	(1.034)	(0.996)	(0.975)	(0.822)	(0.800)	(0.787)
DSF	-	0.015	0.028	0.036	0.001	0.006	0.009	(0.127)	(0.124)	(0.122)
DDRE	-	0.080	0.184	0.248	(0.033)	0.010	0.034	0.052	0.077	0.092
PDRE	-	7.994	18.391	24.837	(3.276)	1.003	3.381	5.170	7.673	9.181
SPI	772.177	772.346	773.777	774.660	770.812	771.439	771.784	771.942	772.284	772.485
GN	67.629	67.734	67.776	67.803	67.624	67.635	67.642	67.637	67.645	67.649
POP	23.421	23.428	23.434	23.437	23.417	23.418	23.420	23.424	23.425	23.426
W	100.000	99.850	100.028	100.136	99.704	99.788	99.833	99.919	99.962	99.987
R	100.000	99.660	99.597	99.566	99.990	100.006	100.008	100.017	100.015	100.013
LD	12.624	12.632	12.636	12.638	12.641	12.642	12.643	12.633	12.634	12.634
KD	13.526	13.631	13.674	13.700	13.521	13.532	13.539	13.534	13.542	13.546

These results mimic those of the trade elasticity experiments – as the trade elasticities are those upon which the results from DRAM depend most significantly. The magnitude of the differences between levels of these elasticities rise slightly, but the directions of response do not vary.

XI.2.6.ELASTICITY EXPERIMENTS: LABOR AND MIGRATION

The second and third experiments were combined, i.e. labor supply and migration elasticities were varied simultaneously, to determine the inter-dependency of these parameters. The results follow.

Table XI-7 Labor and Migration Elasticity Experiments

		BAC			PIT			SAU		
	BASE	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
BAC	4.801	3.829	3.830	3.831	4.804	4.804	4.803	4.807	4.807	4.808
PIT	19.490	19.568	19.567	19.567	18.478	18.478	18.479	19.505	19.505	19.504
SAU	17.448	17.492	17.497	17.501	17.461	17.460	17.457	16.483	16.486	16.487
GFREV	42.307	41.456	41.462	41.467	41.312	41.310	41.308	41.504	41.507	41.509
SFREV	13.403	13.427	13.431	13.435	13.410	13.409	13.408	13.278	13.280	13.281
STATIC	-	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
DGF	-	(0.851)	(0.844)	(0.839)	(0.995)	(0.996)	(0.998)	(0.802)	(0.800)	(0.798)
DSF	-	0.024	0.028	0.032	0.007	0.006	0.005	(0.126)	(0.124)	(0.122)
DDRE	-	0.173	0.184	0.193	0.012	0.010	0.007	0.072	0.077	0.080
PDRE	-	17.343	18.391	19.256	1.219	1.003	0.650	7.209	7.673	8.030
SPI	772.177	773.700	773.777	773.845	771.479	771.439	771.380	772.266	772.284	772.295
GN	67.629	67.773	67.776	67.779	67.636	67.635	67.634	67.643	67.645	67.646
POP	23.421	23.428	23.434	23.439	23.421	23.418	23.415	23.423	23.425	23.427
W	100.000	100.089	100.028	99.981	99.773	99.788	99.805	99.996	99.962	99.937
R	100.000	99.594	99.597	99.599	100.007	100.006	100.004	100.014	100.015	100.016
LD	12.624	12.625	12.636	12.644	12.645	12.642	12.639	12.628	12.634	12.638
KD	13.526	13.670	13.674	13.676	13.533	13.532	13.531	13.540	13.542	13.543

While labor supply and migration elasticities matter little individually, they begin to matter more when varied together. However, feedback percentages change by little more than one percent in all cases when these elasticities are varied plus or minus fifty percent of their base levels. It would appear that labor supply elasticities are not ones with very significant effects on the feedback results reported. However, the range of employment effects are significantly different. There is clear evidence in the wage predictions that added (or lost) responsiveness of labor supply and migration to PIT changes is moderated by downward (or upward) pressure on wages – generating these small differences in feedback effects. Employment changes, but wage accommodation results in similar dynamic feedback estimates.

XI.2.7.ELASTICITY EXPERIMENTS: ALL KEY ELASTICITIES

The first four experiments were combined to identify the overall sensitivity of DRAM's results to massive changes in all key elasticity parameter values. The results follow.

Table XI-8 All Key Elasticity Experiments

		BAC			PIT			SAU		
	BASE	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
BAC	4.801	3.820	3.830	3.839	4.799	4.804	4.806	4.804	4.807	4.810
PIT	19.490	19.513	19.567	19.606	18.450	18.478	18.491	19.495	19.505	19.514
SAU	17.448	17.472	17.497	17.518	17.453	17.460	17.462	16.479	16.486	16.492
GFREV	42.307	41.373	41.462	41.532	41.270	41.310	41.329	41.488	41.507	41.526
SFREV	13.403	13.417	13.431	13.445	13.406	13.409	13.411	13.275	13.280	13.284
STATIC	-	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)
DGF	-	(0.933)	(0.844)	(0.774)	(1.037)	(0.996)	(0.978)	(0.819)	(0.800)	(0.781)
DSF	-	0.014	0.028	0.042	0.002	0.006	0.008	(0.128)	(0.124)	(0.119)
DDRE	-	0.080	0.184	0.268	(0.034)	0.010	0.030	0.054	0.077	0.100
PDRE	-	8.021	18.391	26.757	(3.437)	1.003	2.997	5.367	7.673	9.955
SPI	772.177	772.381	773.777	774.855	770.774	771.439	771.712	772.011	772.284	772.549
GN	67.629	67.734	67.776	67.808	67.624	67.635	67.640	67.637	67.645	67.651
POP	23.421	23.425	23.434	23.444	23.420	23.418	23.416	23.423	23.425	23.428
W	100.000	99.889	100.028	100.084	99.662	99.788	99.842	99.958	99.962	99.963
R	100.000	99.660	99.597	99.569	99.990	100.006	100.007	100.017	100.015	100.014
LD	12.624	12.627	12.636	12.649	12.646	12.642	12.640	12.629	12.634	12.639
KD	13.526	13.631	13.674	13.705	13.521	13.532	13.538	13.534	13.542	13.549

When the trade and investment results (dominated by trade) are combined with the labor and migration results, the overall elasticity experiments are dominated by those for trade. Magnitudes of percentage feedback effects change little when this last table is compared with its counterpart for trade elasticities alone. Direction of change remains constant. The trade elasticities dominate in their effects. Only in the employment and migration variables do we see that the composition of change depends upon the elasticities of labor supply and migration.

In conclusion, the elasticity experiments confirm the expectations that one may have about the properties of DRAM in terms of its responses to various levels for its key elasticities. As one should expect, the model's results depend in their prediction of dynamic feedback responses more on trade elasticities than any others. DRAM's results in detail–especially for employment and migration–depend on these elasticities, without changing the overall dynamic revenue feedback effects significantly.

XI.3.EXPERIMENTS WITH KEY ASSUMPTIONS

Four assumptions contained in DRAM were each investigated to determine the impact of these in comparison with alternative assumptions. A fifth set of experiments was conducted combining assumptions and elasticities that tend to reduce the overall feedback effects as opposed to a set that tend to predict the highest feedback effects. Each of the five sets of experiments is reported in a sub-section following.

XI.3.1.USING TEST 2 FOR PROPOSITION 98

The basic solutions to DRAM incorporate the assumption that Test 3 would apply to General Fund transfers to Local K-14 education. In Test 3, changes in per capita General Fund revenues dominate. An alternative formulation exists: Test 2–in which per capita personal income dominates. The equation for each of these tests is incorporated in the input file of DRAM and this experiment involved removing the 'commenting out' asterisks for Test 2's equation and putting them in for Test 3's. The results change very little from the base solution.

Table XI-9 Using Test 2 for Proposition 98

	BASE	BAC	PIT	SAU
BAC	4.801	3.830	4.803	4.807
PIT	19.490	19.571	18.482	19.508
SAU	17.448	17.495	17.457	16.484
GFREV	42.307	41.463	41.311	41.507
SFREV	13.403	13.430	13.408	13.278
STATIC	-	(1.000)	(1.000)	(1.000)
DGF	-	(0.844)	(0.996)	(0.799)
DSF	-	0.027	0.005	(0.125)
DDRE	-	0.183	0.009	0.076
PDRE	-	18.288	0.869	7.586
SPI	772.177	773.630	771.289	772.157
GN	67.629	67.775	67.633	67.643
POP	23.421	23.431	23.416	23.423
W	100.000	100.032	99.793	99.966
R	100.000	99.595	100.004	100.014
LD	12.624	12.635	12.642	12.634
KD	13.526	13.672	13.530	13.540

Clearly, when these results are compared to those of the base solves, little or no change is felt. As per capita personal income changes very little in the model Test 2 does not seem to present different results. This would not seem to be the basis for disputing DRAM's predictions of dynamic feedback effects. Proposition 98 matters in the model, in that it defines how General Fund revenues are distributed. However, the small differences between the two tests do not seem significant.

XI.3.2.IGNORING CHANGES IN PIT EXEMPTIONS

A much larger issue at work seems to be the degree to which reductions in California's PIT are leaked out of the state through lost deductions for those who itemize deductions on their Federal returns. This issue is most critical for high income Californians – those upon whom we depend in DRAM for their labor supply and migration effects.

Table XI-10 Ignoring Changes in PIT Exemptions

	BASE	BAC	PIT	SAU
BAC	4.801	3.830	4.805	4.807
PIT	19.490	19.567	18.484	19.505
SAU	17.448	17.497	17.465	16.486
GFREV	42.307	41.462	41.322	41.507
SFREV	13.403	13.431	13.413	13.280
STATIC	-	(1.000)	(1.000)	(1.000)
DGF	-	(0.845)	(0.984)	(0.800)
DSF	-	0.028	0.010	(0.123)
DDRE	-	0.183	0.025	0.077
PDRE	-	18.316	2.508	7.693
SPI	772.177	773.774	771.503	772.285
GN	67.629	67.776	67.637	67.645
POP	23.421	23.434	23.418	23.425
W	100.000	100.028	99.772	99.962
R	100.000	99.597	100.008	100.015
LD	12.624	12.635	12.647	12.634
KD	13.526	13.673	13.534	13.542

The results for B&C and S&U change little – as expected. The feedback effect for PIT almost triple, but still remain at low levels. Employment increases from the base case solution by 25% more. The deductibility of California's PIT from incomes subject to Federal PIT clearly matters in PIT reductions for California, but the dynamic feedback effects of a PIT reduction remain modest compared with those for B&C and S&U taxes.

XI.3.3.ENDOGENOUS FEDERAL HEALTH AND WELFARE TRANSFERS

Early in the model development process, it was assumed that Federal transfers for Health and Welfare would become Block Grants and thus not be subject to changes in state support of these programs. As of the writing of this report, it remains uncertain whether block grants will be implemented in the near future or not. The effect of block grants in the base case experiments is to remove linkage between the mechanism to balance the budget using state support of health and welfare programs and the flow of federal funds. Making federal grants change in proportion to California's support of these programs produced the changes in the table following.

Table XI-11 Endogenous Federal Health and Welfare Transfers

	BASE	BAC	PIT	SAU
BAC	4.801	3.830	4.803	4.807
PIT	19.490	19.559	18.469	19.497
SAU	17.448	17.492	17.454	16.481
GFREV	42.307	41.449	41.294	41.494
SFREV	13.403	13.428	13.405	13.276
STATIC	-	(1.000)	(1.000)	(1.000)
DGF	-	(0.858)	(1.012)	(0.813)
DSF	-	0.025	0.002	(0.127)
DDRE	-	0.167	(0.010)	0.061
PDRE	-	16.687	(1.013)	6.052
SPI	772.177	773.333	770.905	771.858
GN	67.629	67.775	67.633	67.643
POP	23.421	23.430	23.414	23.422
W	100.000	99.981	99.732	99.918
R	100.000	99.595	100.003	100.013
LD	12.624	12.634	12.641	12.633
KD	13.526	13.672	13.530	13.540

All feedback effects are reduced by this change and each is changed by about two percent. In each case, a leakage is created when California reduces its transfer to Local Government for health and welfare programs. The effect on the PIT reduction is most obvious, with the small positive feedback effects becoming negative. The combined effect of leakage from Federal transfers, deductibility and savings overcomes the expansive effect of income tax reduction. Clearly, the status of block grants matters in considering the model used to evaluate tax policy change. Just as clearly the order of magnitude and relative levels of feedback effects of the three types of tax reductions do not change with changes in the status of federal grants for health and welfare.

XI.3.4.IGNORING THE BUDGET BALANCE

California does not have a constitutional requirement to maintain a budget balance. Clearly, its experience with bond markets over the last few years has shown that bond financed deficits face accelerating interest costs. Thus, whether one considers the efforts of the Administration towards budget balance to be a starting point or a position that will be enforced by markets, the assumption in DRAM is that the General Fund will be in balance. However, the current financial position of the state has improved significantly since the deficit years of the early 1990's. Not only is current expenditure less than current revenue, but also the interest and principal of the deficit bonds are being repaid. One could consider that the state's financial status to be in surplus and that any tax reduction would be financed from that surplus.

To explore this notion, the budget balance constraint in DRAM was relaxed. The budget is balanced in the base case by making California's transfer to Local Governments for Health and Welfare the residual of General Fund revenues less K-14 Proposition 98 transfers and exogenous transfers to the non-Health and Welfare components of State government. To explore the effect of ignoring the budget balance requirement, both the Proposition 98 transfer from the General Fund and the Health and Welfare transfer were made exogenous. The effects of these assumptions are shown below.

Table XI-12 Ignoring the Budget Balance

	BASE	BAC	PIT	SAU
BAC	4.801	3.831	4.805	4.808
PIT	19.490	19.588	18.502	19.525
SAU	17.448	17.505	17.470	16.493
GFREV	42.307	41.493	41.346	41.536
SFREV	13.403	13.438	13.417	13.285
STATIC	-	(1.000)	(1.000)	(1.000)
DGF	-	(0.814)	(0.961)	(0.771)
DSF	-	0.035	0.014	(0.118)
DDRE	-	0.221	0.053	0.112
PDRE	-	22.108	5.296	11.177
SPI	772.177	774.636	772.459	773.101
GN	67.629	67.779	67.638	67.647
POP	23.421	23.439	23.425	23.430
W	100.000	100.135	99.915	100.064
R	100.000	99.600	100.009	100.018
LD	12.624	12.638	12.645	12.636
KD	13.526	13.676	13.535	13.544
GF Balance	-	(0.814)	(0.961)	(0.771)

All of the dynamic feedback percentages increase about four percentage points. Those for PIT increase from less than one percent to over five percent. Realistically, this means that ninety-five percent of the tax reduction becomes a loss in revenue to the state. However, with positive feedback effects, the PIT reduction decision would become more attractive for more than the job creation effects previously described. The feedback effects indicate that, in the short run, tax financed surpluses have a drag on the economy. They become another source of leakage. This is not to state a position against the State saving money – especially as a reserve against economic uncertainty. The release of such reserves may have overpoweringly positive effects in the face of bad economic times when compared to expenditure reductions and tax increases at these times.

It is important to note that an underlying assumption may imply that these results are indications of the upper bounds of assuming away the requirement for spending cuts to offset tax reductions. Inherent in the assumption that the budget need not be balanced is the assumption that capital markets would not adjust the State's bond rating, driving up the cost of financing deficit or infrastructure spending and thus reducing the spending potential on real goods, services and factor rentals. To the extent that such relationships between real state spending and capital markets would exist in the face of deficit spending, the four percentage point implication of this experiment would be reduced or removed.

XI.3.5.MAXIMIZING AND MINIMIZING THE FEEDBACK EFFECTS FROM DRAM

A final pair of experiments was conducted. Combining the assumptions and elasticities that tend to reduce or reverse feedback effects was one: combining those that tend to increase feedback effects was the other. The results follow.

Table XI-13 Minimizing the Feedback Effects

	BASE	BAC	PIT	SAU
BAC	4.801	3.816	4.795	4.801
PIT	19.490	19.492	18.441	19.477
SAU	17.448	17.460	17.437	16.469
GFREV	42.307	41.336	41.242	41.456
SFREV	13.403	13.408	13.395	13.268
STATIC	-	(1.000)	(1.000)	(1.000)
DGF	-	(0.971)	(1.065)	(0.850)
DSF	-	0.005	(0.008)	(0.135)
DDRE	-	0.035	(0.073)	0.015
PDRE	-	3.464	(7.306)	1.466
SPI	772.177	771.221	769.866	771.031
GN	67.629	67.726	67.617	67.631
POP	23.421	23.420	23.414	23.418
W	100.000	99.760	99.669	99.858
R	100.000	99.644	99.976	100.004
LD	12.624	12.626	12.630	12.627
KD	13.526	13.623	13.514	13.528
GF Balance	-	-	-	-

These minimizing results come from combining elasticities at one-half of those used for the base case, Test 2 for Proposition 98, keeping California PIT deductions endogenous to federal PIT, making federal transfers to Health and Welfare endogenous and retaining the budget balance requirement (i.e. assuming that no surplus exists in fiscal 1995/96).

The results should come as no surprise, given the preceding experiments. Feedback effects for B&C and S&U almost disappear, especially for S&U. Those for PIT are reversed in sign and significantly increased in magnitude. The economy gets smaller in each case. These results seem improbable in the extreme. The elasticities used are at the extreme lower end of those found in the literature – trade, especially, becomes inelastic in every commodity type. Test 2 would not apply to Proposition 98 transfers with a reduction in per capita General Fund revenues, unless a legislator and Governor chose to do so in the face of reduced expenditures. California's PIT deductions would affect federal PIT payable. There is some chance that block grants will not happen in the near future, but they are expected within the next few years. Finally, the budget for California is not now in balance, although the initial data for DRAM would indicate that it is (DRAM uses the original budget, not revised estimates as the fiscal year progresses).

Table XI-14 Maximizing the Feedback Effects

	BASE	BAC	PIT	SAU
BAC	4.801	3.838	4.812	4.810
PIT	19.490	19.618	18.523	19.529
SAU	17.448	17.523	17.489	16.499
GFREV	42.307	41.548	41.394	41.549
SFREV	13.403	13.449	13.429	13.290
STATIC	-	(1.000)	(1.000)	(1.000)
DGF	-	(0.759)	(0.912)	(0.758)
DSF	-	0.046	0.026	(0.113)
DDRE	-	0.287	0.114	0.129
PDRE	-	28.702	11.376	12.938
SPI	772.177	775.495	772.805	773.255
GN	67.629	67.806	67.654	67.652
POP	23.421	23.451	23.424	23.435
W	100.000	100.178	99.792	100.024
R	100.000	99.568	100.016	100.015
LD	12.624	12.648	12.675	12.645
KD	13.526	13.703	13.551	13.549
GF Balance	-	(0.759)	(0.912)	(0.758)

These maximizing results come from combining elasticities at one and one-half of those used for the base case, Test 3 for Proposition 98, keeping California PIT deductions exogenous to federal PIT, making federal transfers to Health and Welfare exogenous (i.e. block grants) and discarding the budget balance requirement (i.e. assuming that a surplus exists in fiscal 1995/96 sufficient to fund the dynamic tax losses).

The dynamic revenue effects begin to exceed even those predicted by tax reduction optimists. The B&C becomes almost thirty-percent 'self-financing', the S&U tax feedback effects nearly double while the PIT reduction begins to have significant positive feedback effects nearly equal to those for S&U. A $1 billion PIT reduction (static estimate) creates 50,000 jobs and the in-migration of average and high income families more than offsets the out-migration of low income ones.

However, extreme caution must be put to the use of these results. This last experiment was an extreme test of DRAM's ability to accommodate major changes. The elasticities used cannot be supported in the literature, except in extremes. Although the use of Test 3 and block grants seems appropriate, California PIT deductions must affect federal taxes. The position on the budget balance would be difficult to support in that the original data for DRAM do not include a surplus – in fact the model would need to be re-calibrated to model this explicitly.

XI.4.CONCLUSIONS

The results from the sensitivity analysis experiments are very encouraging. When capital taxes are reduced, firms appear to switch from labor to capital, reduce prices and improve the domestic balance. When income taxes are reduced, the residual after deductibility is considered is sufficient to induce labor supply and migration effects sufficient to overcome the leakage. When exposed to significant alternative assumptions, changes to DRAM's structure were modest and easy to accommodate. Its results reflect the kind of results one should expect from a CGE embodying perfect competition.

Much further work is required. Further sensitivity experiments of more focused tax cuts, those of tax increases and exogenous economic shocks would reveal more properties of DRAM, including the importance of its key parameters.

XII. APPENDICES

XII.1. LITERATURE SEARCH, SUMMER 1995

A CGE Model For California Tax Policy Analysis: A Review of Literature

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In a recent law—SB 1837 (chapter 383 Statutes of 1994)—the California legislature required the Department of Finance to use dynamic estimation techniques to analyze "probable behavioral responses of tax payers, businesses and other citizens" to large tax change proposals. This report is a review of the use of Computable General Equilibrium (CGE) models to make dynamic analyses.

Since large tax policy changes are likely to affect the whole of California economy, we recommend the use of a general equilibrium, rather than partial equilibrium or fixed price model, to understand their economic and revenue effects. We recommend the use of a dynamic model so that the effects of tax policy on migration, investment, infrastructure, and human capital can be included in the analysis.

Section 2 of this review presents a brief description of the main structures of all CGE models. The reason for using general rather than partial equilibrium or fixed price models is explained. We highlight behavioral and technical assumptions that are commonly made in these models.

In section 3 we look at models that have examined tax-incidence issues using CGE techniques. We also review two innovations that make CGE models dynamic: investment behavior and labor migration.

Based on our review of the literature, we find that net-of-tax rate of return and wages are important determinants of capital stock (investment) and labor supply, respectively. The literature also supports the view that government-provided inputs increase the productivity of private sector business. The two most discussed governmental inputs to production are infrastructure and education. Infrastructure is viewed as reducing transport costs, expanding market size and encouraging concentration (agglomeration) of economic activities. Business is likely to locate in places with good infrastructure. Educational services are used by individuals to increase their human capital. Producers are attracted to places with workers who have high productivity brought about by high human capital. These statements suggests that investment will be higher in such areas. Section 4 takes up the review of these issues. Section 5 highlights some limitations of CGEs. The Appendix, which is section 6, contains exact formulas for the variable that is considered crucial to investment.

2 WHAT IS A CGE?

A CGE model is a set of equations that describes the economic activities of consumers, producers, government, and traders in the markets for factors of production, output, and net imports. The model asserts that the supply and demand in each of these markets is equilibrated by a market-clearing price. The model is called computable because one uses a computer to find the prices that clear the markets. The following paragraphs describe a very simple CGE and explain what is computable and what is general. They also contrast a CGE to an Input-Output (I-O) model and a Social Accounting Matrix (SAM) model.

CGEs and all other empirical tax models aggregate the vast array of goods available in the economy into a small number of sectors. That is, instead of considering all types of paper and chemicals as different goods, these models lump them all together as the single sector, paper and chemicals. Similarly, labor and capital are used as aggregates, typically one type of capital good for each sector and a few types of labor, perhaps skilled and unskilled. Thus, there are only a few dozen different goods—the product of each sector and each factor is an economic good. A CGE model asserts that prices will make the supply and demand for each of these goods to equal. The model is used to find how prices and quantities will respond to a policy change, such as a tax change.

2.1 CONSUMERS

Consumers receive income from firms and buy products from domestic or foreign firms. The CGE model incorporates the economic theory that consumers choice of goods is made within their budget constraint. The solution to the consumers problem is their demand curve (quantity as a function of price) for each marketed good and their supply of labor. The model is called general, rather than partial, equilibrium because the income of consumers is determined within the model.

2.2 PRODUCERS

Producers are assumed to maximize profits. That is, in each sector, producers choose the inputs—capital, labor, and intermediate goods—-that leads to the output that makes the most possible money. This choice is a function of the prices of the output and the inputs. Writing the demand for inputs as a function of prices gives the demand for factors, and writing the output as a function of prices gives the supply curve. When dynamic producer behavior is introduced, production and investment (more later) are said to be induced by adjustment costs. These costs can be either actual external costs (oil shocks, new discoveries, etc.) or forgone output.

2.3 GOVERNMENT

Government is taken as having behavior exogenous to the model. It chooses a set of tax policies and spending policies. It is then, sometimes, constrained to balance its budget. In the case of California, there is a constitutional requirement to balance the budget. Consequently, subtle issues that arise when models allow governments to run deficits will be ignored.

2.4 FOREIGN SECTOR

Agents outside the modeled area, called foreign, even though that would include the non-California U.S. as well as other countries in this model, are taken as having a known net demand curve for each good. Net demand is a device to capture exports and imports in the same equation. When price (in California) is low, foreign agents will have a positive net demand. That is, they will buy domestic (i.e., California) product. When price is high, they will have a negative net demand; that is, they will sell foreign (non-California) product into the domestic market. Real CGEs make provisions for two-way trade, but that need not concern us here.

2.5 MARKET ASSUMPTIONS AND EQUILIBRIUM

The market-clearing equations for a CGE are that there are a set of prices that make:

- the consumer demand plus the government demand plus the industry demand for intermediates plus the net export demand equal to the supply of each good, and
- demand equal to supply for each factor.

2.6 COMPARISON TO I-O AND SAM MODELS

Neither an I-O model nor a SAM model are very useful, by themselves, for tax policy incidence computations.

An I-O table shows the inputs needed to make an output. It assumes that the technology for making that output is a fixed coefficient technology; that is, each unit of output of good one requires exactly alpha units of good two. I-O models are used to compute multipliers for exogenous changes in economic activity. For example, suppose that an outside entity bought an extra airplane from California. An I-O analysis would reveal how much additional labor went into making the aircraft, and it would also reveal how much labor went into making the electronics that were an input to making the aircraft and how much labor went into making the chips that were in the electronics that went in to making the aircraft, ad-infinitum. Thus, in an I-O analysis, one can easily get that an aircraft order leads to three times as many jobs indirectly (through the electronics) as it leads to directly. In a CGE model, either the labor for the new aircraft would have to come from another sector of the economy or it would have to come from additional hours or workers lured to work by higher wages. The same is true with all other factors of production. Thus, an I-O model is a very special case—-the case where labor and other factors are available in limitless supply at the current price.

A SAM model is an extension of an I-O model to include consumers and government. In a SAM model, the gross receipts of a firm are distributed to government (taxes) and consumers (rents and employment income). These agents, in turn, spend these receipts on goods. Thus, in a SAM model, an extra aircraft will also generate additional demand for goods through the consumption demand of consumers. That is, the aircraft will result in an increase in after-tax income which will result in more purchases at the grocery store (giving more grocery store jobs) which will result in more food being bought and consumed, hence more agricultural chemicals and so on. As in an I-O model, the method in which these demands are met is taken as outside the scope of the model.

In both SAM and I-O work, there is only one way to make each output, so a tax can have no effect on the input mix. That is, a tax on capital cannot lead the firm to use less capital per unit of output. In fact, the linearity of these models assures that either a tax has no effect on the production sector other than raising prices or it shuts the sector down completely. Since labor is supplied without regard for price in these models, all taxes have the same effect, which is to say no effect, on labor. Thus I-O and SAM models cannot be used alone for tax work.

Put somewhat differently, an I-O model is a particular and unrealistic representation of the production side of an economy. A SAM model extends an I-O model to income distribution, taxation, and consumption. A CGE encompasses both of these and generalizes them by making demand and supply of goods and factors dependent on price. Since taxes add to prices, one must have a price-dependent model to do tax work.

2.7 STATIC VERSUS DYNAMIC ISSUES

A CGE is said to be static when the number of laborers and total amount of available capital do not respond to economic incentives. This is thought to be the case in the short-run, perhaps a year or so. When labor and capital respond to economic incentives over time, the CGE is dynamic. The responses of capital are investment and depreciation. The responses of labor are migration, labor-force participation, and more hours worked. The simplest way in which a model is made dynamic is for it to be solved for more than one year. The capital stock and labor variables are adjusted in each succeeding year by the amount of investment and changed number of workers and hours.

3. DYNAMIC CGE MODELS FOR TAX-POLICY ANALYSIS

There is a long history of using CGE models, even dynamic CGE models, for tax-incidence work. The spirit of most dynamic models can be traced to the formulations in the papers by Bell and Devarajan [19 and 20]. Without going into details of these papers, the exposition is as follows. Consider the problem as was first formulated by Little and Mirrlees [65]. Imagine a government, say, a developing country, that is negotiating for a project with the World Bank. Both parties would like to know if the project is socially profitable. To do so, it is important to use prices that reflect true social scarcities. If the government had all the information it needed about inputs and outputs, valuing the project would not be difficult. However, for various reasons, the true market prices of inputs and outputs are not always known.

Facing such difficulty, Little and Mirrlees proposed valuing all tradeable inputs to the project at the "border prices" (that is, what these inputs would sell at in world markets) and all nontradeable inputs at their opportunity cost. The problem is that, to determine the opportunity cost of, say, a worker who would work on this project require that we know her alternative employment. One strategy, which Bell and Devarajan and all subsequent CGE model builders have followed, is to acknowledge that a project confers benefits and costs over multiple periods. One can then solve for the prices of these inputs over multiple time periods. In the process, one respects the true social benefit-cost accounting recommended for projects by the World Bank, while maintaining the dynamic properties of the model.

Bell and Devarajan thought that a project serves the role of a shock to an economy that was at an equilibrium. If the economy is small and open, such as that of Cyprus which they use for exposition, it may finance its investments by borrowing from outside. To prevent it from accumulating unlimited debt, they made borrowing costly. In that way, the society that undertakes the change is compelled to meet the costs of the change.

The first comprehensive survey on applied general equilibrium models that was done in 1984 by Shoven and Whalley [92] found nine tax models. These models were used to evaluate drastic changes in the tax system, such as consumption rather than income tax or complete indexation of the U.S. tax system for inflation. At the time of this survey, the emphasis was on making substitution elasticities different from unity (a consequence of Cobb-Douglas forms) and it was considered novel to have factor mobility [92, p.1029].

The second major survey was done by Pereira and Shoven [72]. They surveyed dynamic models. That is to say that factors' mobility—-migration and investment—were now commonplace enough to merit a survey of their own. Altogether 16 models were reviewed, not all of them dynamic. The contents of their modelling assumptions concerning consumers, producers, foreign trade, government, and the type of tax policy can be found in [72, pp. 404-411]. Below we summarize some fundamental issues that all these models share in terms of their structure.

Before we turn to that, remember that, in general, estimating economic effects, say, growth, of broad policy changes such as taxes must take into consideration two issues. The first involves how well the data (such as factor shares, depreciation rates) that are observable and generated by the economy are calibrated. The second set of issues concerns how one incorporates elasticities of substitution in production and preferences as well as labor supply elasticities, all of which are not easily observable. The challenge for people who model these large policy changes is evaluating the sensitivity of growth and interest rates to these hard-to-observe parameters[1].

In a recent study, calibrated for U.S. data, Stokey and Rebelo [96] showed that large growth effects from distortionary taxes are consequences of what one assumes about input factors. If labor supply is inelastic (i.e., the number of workers is fixed) they showed that the magnitudes of growth and interest rates in a model with flat-rate taxes are sensitive to the shares of labor (or human capital) and physical capital in the inputs producing sectors. Furthermore, the interest rate, the rate of growth and government revenues do not respond to changes in elasticities of substitution in production between capital and labor. If the number of workers is not fixed, however, the effect of taxes on the interest rate is almost entirely captured through labor-supply elasticity. The importance of elastic labor supply in producing large growth effects is greater the smaller the share of capital in physical and human capital producing sectors. Finally, Stokey and Rebelo warn that calculated growth effects of taxation are also sensitive to assumptions about the rate of depreciation and tax treatment of depreciation.

3.1 CONSUMERS

In the survey by Pereira and Shoven, 11 models that include at least some dynamic structures were reviewed. The greatest progress has been made in modeling dynamic household behavior. Sometimes households are said to behave as if they maximize a separable and time-invariant utility function over the consumption good. Other times, it is postulated to have a life cycle. Accordingly, households are divided into groups by age and their lifetime plans for consumption and savings specified. Within that time period, they maximizes an intertemporal budget constraint that equalizes their present value of income and expenditures.

3.2 PRODUCERS

Incorporating dynamics into producer behavior has been less successful, despite some promising innovations. In the studies where dynamic behavior has been introduced, firms' production and investment decisions are sensitive to adjustment costs. The later are meant to capture imperfect mobility of capital across industries and costs to install capital [72, p. 416]. The downside of these innovations has been to reduce the level of disaggregation of the production side of the economy.

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[1] See Stokey and Rebelo [96].

3.3 GOVERNMENT

In some dynamic models, the government may be allowed to run deficits to finance expenditures in excess of tax revenues. Others determine the path of deficits/surpluses and government expenditures by solving the government's objective function: maximizing a social welfare function. Financing of deficits is dealt with either through additional tax revenues or bond issues. But, as noted above in section 2 under subsection on governments, a California CGE will be calibrated under balanced budget.

3.4 TRADE

The foreign sector in this class of models assumes a balanced trade. On one hand, none has yet built in international capital flows because doing so is considerably harder. On the other hand, modelling commodity import demand is not only done, but considered important in applied general equilibrium for policy-impact analysis. By far the most popular approach in open-economy specification for trade is Armington assumption.

3.4.1 ARMINGTON MODEL

This is a disaggregated model which identifies goods by country of origin. The import demand is separable and determined in a two-step procedure. Within a market, trade patterns change only with relative price changes. The elasticities of substitution between all pairs of goods are assumed to be both identical and constant, which amount to strong restrictions on demand.

Its advantages include calculation of cross-price elasticities between imports using only estimates of aggregate price elasticity of demand for imports, a single elasticity of substitution and trade shares. It is flexible, easy to use, and gives results that are judged plausible and statistically significant.

Some have argued that these advantages come at a cost. Alston et al. [4] tested the restrictions implied by the Armington specification for U.S. wheat imports to China, Brazil, Egypt, former Soviet Union and Japan and rejected them. These authors argue that the real consequence of Armington assumption—when such an assumption does not in reality hold—is equivalent to omitting an explanatory variable. In their case, and probably in many others too, these omitted variables are prices of substitutes. For clarity, consider the wheat import example. A complete specification of the demand for wheat imports by any of the countries mentioned would have the quantity demanded to be a function of the price of wheat in the United States, price of wheat in the rest of the world, and the price of substitutes such as barley. Alston et al. conclude that the Armington model does not accommodate the price of substitutes as important variables and, for that reason, it underestimates—relative to double-log and Almost Ideal Demand System (AIDS) models—the own-price elasticities of goods that are traded.

Low estimated substitution elasticities were also found by Shiells and Reinert [91], between U.S. domestic production for 22 mining and manufacturing sectors and imports from Mexico, Canada, and the rest of the world, using data for the period 1980-1988.

In another study, Reinert and Roland-Holst [74] used Armington specification to check for substitutability between imports and domestic goods with the help of U.S. trade data for 163 mining and manufacturing sectors. General results indicate that substitution possibilities between U.S. domestic goods and imported goods were limited; the elasticities ranged from 0.14 to 3.49.

There are two things to note here. First, it may be true that, in partial equilibrium econometrics models such as Alston et al., the omission of substitutes may have significant effects on estimated elasticities. We do not think that, in the general equilibrium case where sectoralization is more aggregated, the Armington assumptions are crucial to the results. Second, even if the assumptions were crucial to the outcome, our results could be considered as lower bounds of a range of estimates.

3.5 DYNAMIC ISSUES

3.5.1 INVESTMENT

By investment, we mean net additions to capital stock. It is the difference between the capital stock this period and that of last period net of depreciation.

The most commonly used theory of investment, called the q-theory, for applied work takes its inspiration from the work of Tobin [100][1]. As defined by Tobin and subsequent studies, q is the ratio of the stock market value of the capital stock of a firm to the replacement cost of the same capital. By replacement cost, we mean the reproduction cost of the firm's capital that is reported in form 10-K, as required by Securities and Exchange Commission. Two things should be kept in mind about replacement costs in general. First, its reporting is limited to firms whose inventories plus gross property, plant, and equipment exceed $100 million and comprise 10% of assets. Second, because it is reported by the managers of the firm, it necessarily includes subjective estimates[2].

The q-theory formulation links the monetary (financial) sector to the goods producing (real) sector. It says that, if there were no distortions, such as taxes, firms will invest whenever a dollar spent buying capital raises the market value of the firm by more than a dollar.

There are factors that have made q-theory appealing to those interested in modelling investment behavior. It allows output to be variable and determined by the behavioral processes we presuppose for the firm(s). Unlike its neoclassical counterpart (discussed below), it is forward-looking.

1. **Empirical Investment Models:**

   - **Tobin's q:**

   In the old style of q-theory, q was the value of firms divided by the capital stock. This old style of q-theory did not take taxes into account. It only looked at the value of stocks per unit of capital. Accordingly, the significant variable was a crude ratio of the market value of the firm relative to the book value.

   More precisely, $$\frac{I_t}{K_t} = g(q_t);$$

   where

   I_t : investment in period t

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[1] See Sargent [86] and Summers [97] for a good discussion

[2] When the reporting requirement was first mandated by the Securities and Exchange Commision [89], it was hoped that replacement costs would help "professional analysts and investors to determine the costs of inventories and productive capacity of assets as a measure of the current economic investment in these assets at the balance sheet date." The replacement cost model concerns itself with the current cost of substituting the best available asset (capital) which will duplicate the output of the services of an old asset in its present condition. It is supposed to account for the reproduction cost of each asset while paying attention to technological improvements. Presumably, the replacement cost less liabilities is supposed to be an indication of the firm's net worth. But this ignores the income generated from the assets which may well be the true indicator of net worth, as pointed out in Frank et al. [47] .

K_t : capital stock in period t

q_t : shadow price of capital

Besides not fitting the facts of U.S. economy as Summers showed, there are some other problems. For practical work, the usefulness of the q-theory of investment is made difficult by the unobservability of replacement cost of capital. It also does not allow for explicit analysis of the repercussions of temporary versus permanent changes in tax policy[1].

The unobservability of replacement cost of capital is often handled by accepting the numbers reported by firms to the SEC on form 10-K as good approximations of cost of capital. The main improvement to q, therefore, has involved adjusting it for various taxes. To include taxes, it is necessary to redefine how different taxes will affect the basic q, and by consequence investment. The tax adjusted q, often called Q, is currently the most widely used variable in econometric studies[2].

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[1] See Summers [97] and Schaller [88].

[2] Empirical studies of investment behavior have so far been either stock- or flow-oriented. [1] On one hand, the stock-oriented studies assume an exogenous rental price of capital and then proceed to determine the level of investment that would be chosen at that price. The flow-oriented models, on the other, hand aspire to determine the rate of investment directly. The optimal rate of investment is determined by equating marginal value of newly installed capital and its marginal cost.

The real difference between the approaches though is over the time horizon of interest. Stock-oriented models say something about the long-run pattern of investment while the flow-oriented approaches inform us of the short-run behavior.

Since these methodologies tell us something about the trade-offs which the firm must deal with, we shall go over them briefly. We begin by looking at a firm that produces an output each period. The output sells for an exogenously given price. Given that price, it wants to produce the output that will give it the most amount of net cash flow (that is, total revenue less direct costs). In addition, the firm wants to increase its capital stock. Such a decision entails putting aside part of the output, or equivalently a fraction of revenues, for that purpose. Increasing capital stock is costly. We call such a cost, the shadow price of capital. One way to think about it is by looking at how much your net cash flow increases if you increase your capital stock, say, by a unit. Obviously, this cost will depend on how often you invest and how much output you forgo in each of the periods you invest. In economic theory, the rule suggested for profit-maximizing firms is to set the cost of a unit increase in investment to the shadow price of capital.

In some instances, the price of capital is said to be constant over time. This would be true, mostly if our unit of analysis (a firm, the economy of a state) is smaller relative to a larger reference in which the unit is located (the industry, the world economy). In such a case, the determination of investment is simple. If the economy or the firm starts with an initial level of capital, say, K_o, and an additional unit of capital adds positively to net cash flow, the firm will add the unit. It shall continue to do so until an additional unit stops adding positively to cash flow. This is the stock-oriented approach. Since it concerns itself less with how long the firms take to get to the point of breaking even (only that they will eventually do so) its time horizon is considered long term.

In other cases, one takes the ratio of the shadow price of capital to that of a unit of forgone output to be constant. One then compares such a price ratio to the cost of adding a unit each period. As long as the costs are less than the price, the firm will adjust its capital stock, even though costs are an increasing function of investment (hence, the name adjustment cost model). It will stop, again, at the point where it breaks even. Notice that the subtle difference between this case and the previous one is that here the firm is compelled to break even each period it undertakes to install the units of capital. For that reason, it is said to be a short-run view of investment.

Another alternative has been to view the economy as producing only two goods: consumption and investment. In the working of this economy, the trade-offs are between consuming more now and investing

- **Q-theory:**

Recall that q is the ratio of the market value of capital to the replacement cost of the same capital. Although in principle it is observable, there is reason to suspect the accuracy of the denominator of the ratio[1].

Summers' investment model for the corporate United States was among the first to take various taxes into account. In his model,

$$\frac{I_t}{K_t} = f(Q);$$

For empirical estimation, he assumed the linear functional form,

$$\frac{I_t}{K_t} = \alpha + \frac{1}{\beta} Q;$$

where α and β are parameters from a quadratic adjustment-cost function.

If the markets are assumed to be perfectly competitive, one can derive a formula for Q[1]. The precise formula will differ depending on what kinds of taxes one takes into consideration.

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less or vice versa. If we start from an initial allocation between consumption and investment, we can then determine the direction of investment, for any change in relative prices between these goods.).

[1] Some scholars, such as Abel [1], have, therefore, estimated q by using data of something that is observable and, to a good approximation, has a pattern much like q.

The empirical models such as that of Abel, rely on adjustment-cost investment theory. There are two parts to it. If investment is proceeding at a rate of 0, the rate of return to a unit of capital should exactly equal its cost (here, called replacement cost). Suppose, for heuristic purposes, the rate of return and the replacement cost are \$1.00 each. Next, as investment increases, the cost of a new unit of capital increases. The addition above the \$1.00 is called the adjustment cost.

In Abel, the adjustment-cost model postulates a relationship between the output (of the consumption good) of the firm, the investment, good and two inputs (labor and capital). Suppose now that the price of a consumption good is 1 and that of capital is q. Labor costs w. Assuming that the firm maximizes profits allows us to write the investment equation to be solely a function of q. Note that, although we are using Abel's notation, in truth his q should strictly be considered Q because he does adjust for investment tax credit and depreciation allowance.

Since q_t is not observable, Abel uses the discounted marginal product of capital as an approximation. The exact specification used by Abel is

$$q_t = \sum_{s=t}^{\infty} \frac{y_s}{\left[1 + r + \delta\right]^{t-s}}$$

where:

y_s is the marginal product of capital

r is the real interest rate

d is the depreciation rate

In a more recent and theoretical paper, Abel and Eberly [2], suggest circumventing the unobservability of q by restricting one's analysis to competitive firms with linear technologies of production. In this way, q can be shown to be equal to average value of capital which is observable in the stock market or a function of output price, real interest rate, and parameters of the production function.

For most of the components of Q, as posited in the Appendix, measurement problems should not arise. For publicly traded firms, only unobservable K presents problems. In Summers formula, K is taken to be the sum of equipment, structures, and inventories all valued at current replacement cost.

In Schaller the definition of Q, as provided in the Appendix, is very similar to that of Summers. However, his calculation of the capital stock takes the following structure:

$$K_t = K_{t-1}\left(\frac{P_t^I}{P_{t-1}^I}\right)(1-\delta) + I_t$$

Here, K includes equipment and structures but may or may not include inventories, all valued at replacement cost. Apparently, whether or not one includes inventories in the capital stock accounting in Q makes a difference in the results of the investment equation.

In Ciccolo and Fromm [34], the market value of the firm is defined in terms of its profitability. The numerator, or the market value of capital stock, is proposed to be a function of output, output price, wages and cost of capital, depreciation, and the relative change in the price of capital goods. The denominator is calculated from the capital structure of the firm, which is the same as the different financial obligations (equity, debt) that are held by the firm.

Using panel data for several U.K. companies for the period 1975-1986, Blundell et al. [25] found Q to be significant in explaining company investment. Similar results were obtained by Alonso-Borega and Bentolila [3] from a study of 68 Spanish firms for the period 1983-1987. The most complete firm level data appear to be the study by Hayashi and Inoue [57] for a sample of Japanese firms. In their work, the investment equation is a scalar index of multiple capital inputs (and not the sum of investments). The denominator in the Q-ratio is the capital aggregate, not the sum of nominal capital stocks as is usually done. The data that they used were detailed enough that they were able to break down capital stock into several categories (nonresidential, machinery, etc.) and use different depreciation rates. Capital aggregate used is the divisia index. The latter is a rule for obtaining the aggregate level of capital stock. The rule says that an increase in aggregate capital between two time periods is the change in aggregate stock induced by a unit increase in a capital good multiplied by the change in the level of the capital good. If we have more than one capital good, we sum the product just stated over all these goods.

- **Jorgenson's investment model:**

The main competitor to the q- and Q-theories of investment is Jorgenson's model[2]. It is based on specifying an optimal accumulation of capital based on the rate of return. There are two versions to Jorgenson's model. In one instance, capital gains are considered transitory and, therefore, excluded from calculations of the rate of return. In the other, capital gains are included. In either case, desired capital—which is another term for investment—is proportional to the ratio of value of output to the price of capital services. Written formally, this translates into the following equation:

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[1] In the Appendix, we write down the complete formula as well as that found in Schaller [88].

[2] The person often credited with this model is Dale Jorgenson. For a review of his investment model as well as variants of Keynesian alternatives, see Jorgenson [59].

$$A_t = f\left(\frac{pQ}{c}\right)$$

pQ = Gross Value Added and can be found in National Income and Product Accounts

c = cost of capital service and is the product of cost of capital, r, and price of investment goods,q

r = the ratio of after-tax corporate profits plus net monetary interest to the value of outstanding securities. The value of outstanding securities is share earnings per price ratio for manufacturing corporations reported by Sandard and Poor.

In a more complete form,

$$c = q\left[\frac{1-uv}{1-u} + \frac{1-uw}{1-u} r\right];$$

where,

A_t is gross investment

p is price of output

Q is output

c is price of capital services, which, in turn, is a function of several variables including:

q: is price of investment goods

u is tax rate, (in the Appendix)

v proportion of depreciation deductible from income for tax purposes

w proportion of cost of capital deductible from income

r is cost of capital

In the Appendix, the complete econometric model is specified. The only difference between the model in the Appendix and the one shown here is that, in full econometric estimation, Jorgenson-type models include past values of the main determinant of investment—the ratio of the value of output to price of capital services, pQ÷c.

To summarize, there are three investment models. Tobin's q depends on the ratio of stock-market- to book-value of the firm. Summers' Q adjusts Tobin's q for taxes. Jorgenson's model depends on the ratio of value added to tax-adjusted cost of capital, c.

2. Investment in Open Economies

Sometimes, particularly when one assumes that an economy is both open and small relative to the world economy, modelling of investment has to take the issue of exchange rates very seriously. The argument is rather simple. When countries trade, they prefer to be paid in some currency—mostly their own and at other times in another country's. Such an exchange has the following structure. A country, call it A, determines how much it wants to invest in another country, call it B. Country A then has to sell its own currency in exchange for country B's, with which it then buys machinery and all that is necessary to install a plant in the latter country. Because such flows of investment between countries with different currencies is common, introducing real exchange rates into the model matters. In our California CGE, we shall not worry about that because the rest of the world (that is, the rest of the U.S.) has the same currency.

3.5.2 LABOR MOBILITY

The impact of tax policy on labor-supply decisions has been an area that has been studied extensively. The theoretical results, however, are ambiguous regarding the direction of change[1]. The ambiguity is brought about by two simultaneous processes following an increase or cut in a wage tax. Consider a single worker whose after-tax wage goes up. The increase in wages would render the time spent not working expensive. This is so because every hour not worked now involves more monetary losses. On one hand, we should expect this increase in income (income effect) to induce more hours worked. On the other hand, the increase in wages allows our worker to have the same income for less hours. She could, therefore, maintain her previous level of well-being by allocating more hours to leisure (substitution effect). When put together, these two opposing actions make the theoretical resolution of the problem difficult.

Suppose we consider more than a single worker. As well, let the economy be large. Imagine, too, that some workers were not in the labor force before the tax cut. Following the latter, we may find some workers who were not in the labor force joining it. While this is happening, some who were in may be cutting on the number of hours they worked. How the total number of hours worked comes out is not then clear. While we are at it, let us introduce the possibility of increased after-tax wages inducing migration. Even if all the migrants enter the labor force, we need to know how many hours the existing labor force has chosen to supply to know the direction of the change. Although the net hours worked appear to be more difficult to determine, whether or not there is positive migration into the economy with less taxes is not obvious either.

From theory alone there are several labor supply responses to an after-tax wage change. First, we may see a reduction in labor supply because substitution effect dominates. Second, labor supply may be positive because income effect dominates[2]. Third, no changes may be evident because the two effects offset each other exactly. Fourth, an increase in migration may or may not happen. Though theoretically plausible, a negative or zero labor-supply response to a cut in wage tax seems rather hard to accept. But rather than speculate, we look at the empirical literature for a verdict.

1. Labor Force Participation and Hours Worked:

Most of the recent econometric studies on labor supply draw from the influential work of Jerry Hausman [56]. Using such methods, Triest [103] found the labor-supply response, measured in number of hours worked, of prime age married men in the United States to be invariant to net wage and virtual income. A removal of federal and state tax effects from the estimated model reduced the mean hours worked from 2,208 to 2,150 (a 2.6% reduction). Yet, the same cannot be said about married women. The direction and magnitude of their

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[1] See, for instance, Rosen [82] and Snow and Warren [93].

[2] Sandmo [85] has a model of many consumers facing redistributive or progressive taxes that assert the dominance of substitution effect.

labor supply response depended on further assumptions. As an example, when the data on nonparticipants in the labor force were included, the estimated elasticities became much larger.

Robins [76] looked at four U.S. government experiments on the effects of negative income tax on household labor supply. The after-tax wage elasticities were found to be significantly negative for men and single female household heads[1], suggesting that households reduced the hours worked if income taxes increased. Similar results come out of the work of Cogan [35], using the data for the New Jersey-Pennsylvania negative income tax experiment. The estimated elasticities for women, in Robins' study, were found to be positive. The implication here is that women would join the work force, following a reduction of hours by their spouses, so as to maintain the family income. The positive elasticity of labor supply to after-tax wages for married women has also been reported by Eissa [45] and Stelcner and Breslaw [95].

Using Denver Income Maintenace Experiment data, MaCurdy [68] found large substitution and income effect estimates for a consumption and labor-supply model with taxes and uncertainty.

The uncomfortable indeterminacy of tax effects on labor supply response, according to Gwartney and Stroup [55] and Lindbeck [64], is perhaps a peculiar problem of partial equilibrium analysis. They contend that a consideration of general equilibrium effects leads to non-ambigous results, especially if tax receipts can be used by the government to provide public goods that offset the income effect. In such an environment, only substitution effect remains. We should then expect to see positive net wage elasticities.

Unfortunately things are not as straightforward as proponents of general equilibrium think they are. Other studies have shown that, even in simple theoretical models, general equilibrium analysis does not necessarily eliminate income effects as argued by Betson et al. [21], Bohanon et al. [27], Gahvari [49] and Wilde et al. [108].

What Triest found for the United States appears to hold for other industrialized countries as well. In Sweden, Blomquist and Hansson-Brusewitz [24] report an increase in hours worked of 0.4%-1.5% by married men, if marginal income tax rate is decreased by 5%. For France, Bourguignon and Magnac [28] found the net-wage elasticity of 0.1 for married men to be negligible. But the equivalent elasticity for married women was 0.30 and statistically significant. In Italy, too, only labor supply of married women was found to be elastic with respect to wage and income variation. The estimated coefficient of 1.087 was statistically significant. At 0.044 and a standard error of 0.04, Colombino and Boca [36] found married men's labor-supply function to be inelastic with respect to wage and income variation. Finally, net-wage elasticities for married women in Netherlands ranged from 0.65-0.79 while those of married men were in the 0.12-0.10 interval[2].

2. Labor Migration

[1] See Killingsworth [61] and Macrae and Macrae [67] for a contradictory statement.

[2] These values are considered small by van Soest et al.[105]. However, Blomquist and Hansson-Brusewitz think that even an elasticity of 0.08 is not really small. They argue that, if changes in marginal tax rates can result in changes in net-wage rates in the order of 40%, then an elasticity of 0.08 can have very large effects on hours worked.

The first comprehensive review of the literature on internal migration in the United States was done by Michael Greenwood [54] approximately twenty years ago. At the time, Greenwood identified four factors that were said to influence the decision to migrate[1]:

a) locational costs, which encompass transportational and psychic costs

b) expected future earnings—the idea being that, if an individual were to move from location A to B, he/she does so only if Net Present Value of Earnings at A, (NPV_A) is less than (NPV_B)

c) information costs, according to which people are said to migrate to places about which they have more information

d) personal characteristics, such as level of education, age, and race.

Notice, however, that these factors cannot be taken to have independent influences on migration. For instance, a determination of NPV by a migrant cannot be done without locational and informational costs. Besides, these costs are almost surely different across individuals on account of their personal characteristics.

The studies that have appeared since then seem to be of the opinion that regional wage differentials (actual and expected), comparative unemployment rates and unemployment compensation, public policies and amenity differentials are a few of the critical determinants of interstate migration [63]. In fact, for Stark [94], details at the micro level (such as intra-household interactions, individual attitudes toward risks, relative deprivation[2], and differential access to information) should be considered paramount.

Treyz et al. [102] model internal U.S. migration as a function of differential net present value of income between regions, amenity levels, moving costs, and expected regional growth rates. They found through a simulation exercise that a 1% exogenous increase in three variables—employment, real wage differentials, and an index of relative industrial wage mix—increases the population of the area by 1.96% in the long run (here, taken to be 20 years), if migration induced by this increase is not allowed to affect these variables[3]. Furthermore, they found that the effects of expected employment opportunity have a greater migratory pull than those of relative wage differentials[4]. If one considers dynamic feedbacks (i.e., the possibility that induced migration may reduce relative employment opportunities to the levels they were before the 1% increase), then population rises by only 0.835% in the long run.

Barro and Martin [14 and 16] use a neoclassical production function incorporating migration to answer two questions. What are the determinants of migration in the United States, and is it responsible for interregional convergence? The answer to the last question is negative. As

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1 Those who are interested in elaborations on these matters are referred to this survey and its very lengthy bibliography.

2 See Taylor [99] on this as well.

3 The effects from relative wage differentials and the index of industrial wage mix are 1.26% and 1.53%, respectively.

4 For a study that stresses the importance of relative wage gains in the context of Canadian interprovincial migration, see Robinson and Tomes [77].

for the determinants, they found population density and heating degree-days to have a negative effect while per capita income at a given starting period had a positive impact. More specifically, they argue that a 10% differential in income per capita raises net in-migration only by enough to raise the area's population growth by 0.26% per year.

According to Greenwood et al. [53], if wages and prices adjust quickly to demand and supply shocks, then an interregional system is in equilibrium and any observed differences in wages and prices are simply compensating differentials[1]. Put differently, regional differences in wages and prices do not necessarily reflect utility differences that can be arbitraged away through induced migration. Instead, they argue that they may reveal more about amenity differentials between regions. The authors do not quite tell us the universe that these amenities cover except to remark that 12 of 13 and 10 of 17 western and southern states, respectively, are amenity rich.

Topel [101] agrees that interregional differences are not entirely capitalized into wages and property values. Two points come out of his study. First, elasticity of interarea supply of workers is larger for permanent demand shifts than for transitory ones. Second, the local market effects on wages; that is, the demand increases that lead to wage increases are smaller among more educated and mobile workers.

Kraybill and Pai [62] admit that some of the increase in aggregate employment under Ohio job tax credit program when there are no retaliatory programs from the rest of the United States are due to in-migration. They do not, however, say what proportion of the 27,106 jobs created are taken by in-migrants. They note too that, when retaliatory policies are enacted by the neighboring states, wage and employment growth are minimal and so the few jobs (1,572-2,012 in total) created are entirely due to sectoral reallocation of workers.

Vaillant [104] looked at how five federal and state taxes affected state employment growth directly. She found the employment effects of state personal income taxes to be large. Quantitatively, a 1% decrease in the fraction of income a worker keeps after taxes leads to almost 1.8% (1.77% to be exact) fall in employment. For the purpose of our review, it is noteworthy that the observed employment change is due entirely to cross-state migration. The response is even higher for men. That is, a 1% decrease in net-of-tax share of wages leads to a 3.63% drop in the working male population of a state.

Weyerbrock's [107] study is a six-region CGE model. The regions—United States, European Community, Eastern Europe, former Soviet Union, European Free Trade Area, and the rest of the world) are linked by flows of labor and trade. Although this is an explicit CGE model in which the primary focus is labor migration between Eastern and Western Europe, it makes the crucial assumption that migration is exogenous. The modelling strategy is to introduce in an ad hoc way a certain number of immigrants into EC and then observe how factor markets are affected under different wage regimes. Put differently, the thrust of the study is to carry out thought experiments of the following sort. Suppose 3.5 million immigrants enter the EC and the labor market wage in EC is flexible. What then happens to urban-rural wages, rates of return on capital, employment, and income? How would the answers to these questions change if the labor market regime was dominated by fixed wages?

[1] See also Evans [46] for a review of equilibrium theories of migration.

Some of the main results are that, if the wage rate is fixed, some unemployment will take place. There is also a fall in average rural wages, a rise in rates of return to capital, and a decrease in per-capita income of between 2.15%-4.31% depending on whether 3.5 million or 7.0 million immigrants enter the EC. If the labor market is mediated by flexible wages, however, most of the adjustment problems cited above can be substantially reduced. With flexible wage regime and no growth, per capita-income loss amounts to a mere 0.35%. If growth is allowed for, per capita-income in fact increases by 0.85% if 3.5 million move into EC (0.70% with 7 million). In addition, trade volumes and gross domestic product (GDP) go up.

Robinson et al. [78] examined an 11-sector 3-country regional CGE trade model between United States and Mexico that explicitly accounted for labor migration. The model has as its focus the trade-offs between trade gains, agricultural program costs, and migration flows following an agreement to liberalize trade between the two countries. There are three labor-flow possibilities: rural-urban migration within Mexico, urban unskilled Mexican to urban unskilled U.S. labor market, and rural Mexican to rural U.S. labor migration. Migration itself is modelled as a function of wage differentials across these linked labor markets. The results were derived for different liberalization scenarios.

In one, all agricultural programs in both countries remain protected, but industry trade is liberalized. The model then predicts that Mexican rural to U.S. rural migration increases by 4,000 workers while Mexican urban to U.S. urban goes up by 142,000. But, if all trade is liberalized (i.e. all tariffs and quotas are eliminated), the corresponding migration flows are 21,000 and 406,000, respectively. These flows are even higher, at 31,000 and 685,000, respectively, when all trade is liberalized and support programs to Mexican farmers are eliminated. The figures are reduced though, to 8,000 and -61,000, respectively, if there is partial liberalization accompanied by Mexican capital growth. The latter policy includes imposition of tariffs on agricultural imports into Mexico at half the tariff equivalent of base year quotas, cutting Mexican agricultural subsidies by half, eliminating deficiency program in Mexico and a 10% capital growth in Mexico.

Other factors that are cited as responsible for internal migration in the United States include attractive local provision of public goods such as higher educational spending, especially if it is not at the same time accompanied by higher local property taxation [31, 33 and 39], and costs of living, especially housing costs [32]. Schachter and Althaus [87] estimated an in-migration and out-migration model, using the systems equations method. The variable they chose to explain is gross migration of Whites for the period 1975-1980. The sets of equations included not only climatic amenities, but government services and taxes. The quantitative results of relevance to us are that high taxes deter in-migration. A $100 increase in average per capita state and local tax collections in a state would lead to an out-migration of about 1% (0.64%-0.9% to be exact). It is not clear whether this effect is for the whole period or annually, though. A surprising finding of this study is that a $100 increase in government services would give rise to negligible in-migration but a 0.65% increase in out-migration. The same increase in annual public payments to Caucasian households reduces in-migration by about 1%. The explanation given by the authors for these counterintuitive results are speculative. Perhaps, they argue, the potential migrants disapprove of the policies that give rise to such an economic environment.

3.6 MARKET CLEARING

The models' equilibrium and market clearing equations use the same notion as stated in section 2 above. The interpretation of economic equilibrium in a dynamic context, however, uses the notion of expectations. Accordingly, prices in each period depend on expected future prices and tax variables, both of which are fully anticipated. In the few cases, where prices and tax variables are not perfectly anticipated, revisions of new prices are built in.

3.7 TAX REFORMS AS NATURAL EXPERIMENTS

From the preceding discussion on Q-theory, it is generally believed that investment is sensitive to net returns on capital. Cummins et al. [37] used tax reforms beginning in 1962 to estimate the responsiveness of business fixed investment to the determinants of net returns. The study found the effects of Q to be economically more significant than those obtained in other studies that used traditional techniques. Especially revealing is the finding that, subsequent to every tax reform since 1962, the cross-sectional pattern of investment changed significantly and that this is even more pronounced among firms that faced the greatest tax changes. The finding of Cummins et al. is important because it suggests that, should California change its tax structure, its investment levels may rise significantly, even though we may observe little change in overall U.S. investments.

Auerbach and Hassett [9] also find that taxes have played an independent role in affecting postwar U.S. investment behavior, particularly in machinery and equipment. This is important for policy because recent such as DeLong and Summers [40] studies have shown that equipment investment is important for sustained growth[1].

3.8 EMPIRICAL RESULTS FROM SELECTED POLICY ISSUES

Dynamic tax models have revealed some interesting insights that static models were not able to capture.

3.8.1 CONSUMPTION TAX

One of the models reviewed in Pereira and Shoven [72]—Fullerton, Shoven, and Whalley [48]—looked at the impact of replacing the 1973 U.S. tax system with a progressive consumption tax. They found both tax systems to be distortionary. Also, they show that sheltering more savings from the tax system could improve economic efficiency, even if marginal tax rates increase to maintain government revenue.

3.8.2 INVESTMENT TAX CREDIT

In Goulder and Summers [52], the issue of interest is what happens to intersectoral capital formation and economic growth if investment tax credit is eliminated. According to this study, elimination of investment tax credit will cause a reduction in the rate of investment of about 7% in the short run and 12% in the long run. If such a policy is simultaneously complemented by reduced corporate taxes, however, investment will be reduced by 3.5%.

3.8.3 CORPORATE TAX INTEGRATION

Corporate income tax has been criticized for creating differential rates of return to capital in different industries. Specifically, it is argued that allocation of investment in the economy is distorted in favor

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[1] One should see a skeptical response by Auerbach et al. [10].

of lowly incorporated sectors. It also doubly taxes income at both personal and corporate levels. Therefore some have proposed integrating the two tax systems.

Pereira [71], looked at intertemporal and intersectoral efficiency and distributional effects of integrating corporate and personal income taxes. The model is specialized to U.S. economy. It accommodates optimal intertemporal investment decisions and allocation across sectors, intertemporal household consumption and savings, government deficits, and crowding out.

The results show that eliminating corporate income tax and replacing it by increased income tax rates would yield long-run benefits that are at best 0.17% of the present value of future consumption and leisure. Also, average long run gains are three times larger than average short-run gains.

The study also finds that partial integration yields negative gains. Further, in its distributional effects, it is shown that, with integration, highly incorporated sectors undertake more capital formation and low-income households become worse off.

3.8.4 OHIO JOB TAX CREDIT PROGRAM

In a recent study, Kraybill and Pai [62] evaluated the effects of a job tax credit program that Ohio began in 1992 in response to a similar program launched in Kentucky in 1989. According to the program, the state government is permitted to decrease the state corporate income tax liability of new or expanding firms by an amount equal to 100% of the personal income tax withheld for every new employee for a period lasting 10 years.

Some of the features of the model include endogenously determined labor supplies and capital stock, inclusion of investment multipliers, and a state and local government balanced-budget requirement. The initial credit was the creation of 32,000 jobs in the goods-producing sector.

The state output growth, investment, and exports differ according to whether or not there is a retaliatory program from neighboring states. When surrounding states do not introduce tax abatement programs similar to Ohio's, the study finds that real output goes up by 1.6% annually, investment increases by 2.6%, and exports expand by 3.6%. If there is full retaliation, however, the growth rates are 0.27% for real output, 0.1% for exports, and a 0.6% for investments. Furthermore, annual wages decline for all skill categories compared to the case when there is no retaliation.

3.8.5 PROPERTY TAX POLICY STUDY IN OREGON

In 1990, voters in Oregon passed a ballot measure that placed a ceiling on local property tax rates at 1.5% of their market value. And any resulting shortfalls in local education expenditures were to be met with transfers from general state funds at the expense of other programs. [106]

The study is a counterfactual projection of the following sort. Suppose that assessed property values remained at 1990 levels. What then is the impact of measure 5 on state fiscal year 1996?

According to the results, education tax revenues decrease by 74%, while compensating transfers to education from state general funds increase by 90%. At the same time, state non-education tax revenues go up by a mere 1.1%-1.2%.

3.8.6 CAPITAL GAINS TAX AND REVENUE

An important source of tax payers' marginal tax-rate differences is state income taxes. The incentive effects of this difference is important in light of observed growing reliance of states on income taxes. The paper by Bogart and Gentry [26] is a study that looks at the relation between the marginal tax rates on capital gains and revenue realizations in the contiguous states plus Washington, D.C.

In the opinion of Bogart and Gentry, using state-level data improves upon previous studies that used either aggregate time-series or cross-section data in that aggregating across individuals in a state eliminates endogeneity problems that arise if one used data on a cross section of individuals. Besides, the data span several years in which significant federal tax changes occurred. Additionally, interstate variation in marginal tax rates constitute a large fraction of total variation among tax payers. Finally, the fact that these differences persist over time implies that investor expectations of future tax rates would not be expected to create problems for identifying the way realizations respond to tax rates.

The controversies surrounding capital gains realizations is whether the estimated coefficient is greater or less than 1 in absolute value. If the elasticity is less than -1, decreasing capital-gains tax rate would lead to an increase in revenue from capital-gains taxation. Using a random-year effects model, Bogart and Gentry calculate an elasticity of -0.65, which is greater than -1. This means that cuts in capital-gains tax rates do not lead to sufficient generation of revenue to offset the losses from tax cuts. These estimates are, however, reduced form, and equations estimated without random-year effects give rise to elasticities less than -1. So a word of caution is called for in interpretation. Besides, even if -0.65 is the estimate that is favored by Bogart and Gentry, it is not that far from the typical time-series estimates of -0.5 to -0.9[1].

3.9 ECONOMY OF INTEREST: U.S. VS STATES

A dynamic model for U.S. tax incidence needs to be sensitive to very different factors than a dynamic model for California tax incidence. The major differences between working with a state rather than the nation are the endogeneity of interest rates, the degree of labor migration, and regional specificity of investment.

From the point of view of California, the interest rate is simply a fixed number that California law cannot change. No matter how much California encourages personal savings, interest rates will not fall. This is simply because California is too small a part of a thoroughly integrated national (and international) capital market. Put another way, if California makes a change in its tax law that encourages savings, the extra savings will flow to national and international capital markets and have no noticeable effect on investment in California. Thus, dynamic modelling of consumers, which makes sense in a model explaining national capital formation, would be a lot of largely wasted effort in a California model.

Modelling the United States is much easier than modelling California from the point of view of labor migration. There is very little migration in or out of the United States compared to the size of the labor force. For example, in the last 50 years, the state grew from 6.9 million to 31.5 million largely through migration. For the period 1850 to 1990, California's decennial growth rate, due mostly to migration, has averaged 55%. Thus, labor migration is a much more important issue for a dynamic state CGE than for a U.S. CGE.

Finally, investment in the United States by industry is much more stable than investment in individual states. For instance, the semi-conductor industry is heavily concentrated near San Jose. The ability of California tax law to both encourage investment in an industry and encourage an investment that was inevitable in that industry to happen in California makes investment more important in a state than in a national dynamic model.

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1 See Auten and Cordes [11].

4. PUBLIC INPUTS AND PRODUCTIVITY GROWTH

Since Lucas [60] and Romer [79] first identified the importance of spillovers from human capital and knowledge from private research activities, respectively, many scholars have began looking for purposive private- and public-sector choices that hold the potential to create sustained differentials in per-capita GDP and growth rates. The appeal of such a research agenda is more than theoretical. In practical terms, it hopes to identify strategies that societies can undertake in order to reduce the glaring differences in standards of living. Currently, the list of claimed determinants of long-run growth is long. And, while all the listed variables hold exciting research possibilities, in the following pages we make narrower choices.

When discussing dynamic issues, we mentioned that investment is sensitive to rates of return and labor supply responds to after-tax net wages. Differences in quality of education and infrastructure feature significantly in productivity differences across nations or states. The claim is that firms located in regions that have a high network infrastructure would have lower costs and so higher profits, *ceteris paribus*. With regard to education, the fine-grained analysis is that firms would be willing to pay higher wages to those persons whose quality of education is better. If you also believe that economic agents go about their business in order to better themselves, then public inputs can be considered important determinants of interregional flows of capital and labor.

In the remainder of this review, we shall look at the impact that differences in public capital investments have on productivity differences across regions or states. In particular, we focus on two publicly-provided inputs: infrastructure and education. Our aim is to review the estimated magnitudes of the effect of these inputs on growth across regions of the United States. There is one good reason why such a study is in order. As Barro and Sala-i-Martin [17, p. 5] recently stated, “if we can learn about government policy options that have even small effects on long-term growth rate, then we can contribute much more to improvements in standards of living than has been provided by the entire history of macroeconomic analysis of countercyclical policy and fine-tuning.”

We shall proceed as follows. First we review the empirical findings of studies that have looked at infrastructure. We then take up the contribution of education to productivity improvements.

4.1 INFRASTRUCTURE

The idea that infrastructure is important for regional development is not new. In theory, at least, its study has been a favorite of regional scientists[1]. Some of the more commonly cited reasons regarding the importance of infrastructure are that it reduces transport costs and leads to increased trade volume between any two regions. The benefits are said to be more evident when public capital enters directly into firms' production functions. In this capacity, it is theorized that such capital reduces firms' variable costs and make them more profitable. Existing firms respond to reductions in costs by expanding while new ones enter the market. The payoffs to the region that undertakes investments in public capital include increased incomes, employment, and growth. With some lag, it is argued that structural shifts and agglomeration effects, i.e., the emergence of concentration of industry in one (or several locations) enjoying increasing returns, will follow.

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[1] See a recent special issue of the *Annals of Regional Science*, especially the article by Rietveld [75].

To agree that infrastructure matters, however, is not as difficult to demonstrate as how much it does matter. Recently, partly in response to the national debate on the causes of productivity slowdown[1], some scholars have chosen the task of isolating factors responsible for the slow down through empirical methods.

4.1.1 ESTIMATED MAGNITUDES OF INFRASTRUCTURE

In a series of papers, Aschauer [5, 6 and 7] included public capital in an aggregate production function and found the influence of public investment on private-sector productivity to be large. In one case, using total federal, state, and local capital stock (i.e., equipment and structures) data for the period 1949-1989, all in 1982 dollars, Aschauer [5] found that a 1% increase in public capital per unit of private capital increased private-sector productivity by 0.35%-0.56%. In fact, for a specific sector such as the trucking industry, the estimated contribution of a 1% increase in stock of highways, led to a 0.8% increase in the output in that industry. At the aggregate level, these coefficients were robust to choice of sample period and disaggregation of public-capital stock into military and non-military. Only when non-military capital stock was decomposed into a "core" (comprising highways, airports, mass transit, water, and sewerage systems) and others was the former found to be decisive—taking up almost 70% of public sector-influence.

Using these estimates, Aschauer [5] then sought to answer a simple question. What difference could there have been to private investments, returns to private capital, and productivity growth if the level of public nonmilitary investment was increased by 1% for the period 1970-1986. The simulation results showed that these variables would have been 0.6%, 1.7%, and 0.7% higher, respectively, than their actual historical levels for that period. The startling result is that the simulated results remained very close to the average for the period 1953-1969. So, it would appear, from the point of view of Aschauer, that declines in public-sector investment account for nearly all of the decrease in private-sector productivity that has been much talked about in recent years.

These coefficients are derived from an environment where public capital investments are assumed exogenous. Failure to account for the direction of causality may account for such a large coefficient. In a subsequent work, Aschauer [7] did use state-level data and tried to sort out causality issues. In that work, the estimated marginal product of infrastructure (educational services inclusive) turned out to be 2.226. This estimate corresponds to an output elasticity with respect to infrastructure of 0.055 which is substantially higher than the nominal share (0.025) of infrastructure spending in output. When the variable is decomposed into a core infrastructure and education, the estimated values are 1.96 (se =0.496) and 0.136 (se = 0.422), respectively. Still despite the claim, causality problems are not adequately resolved and the estimates were arrived at under assumptions that are too stringent.

Munnell's [70] estimate of 0.15 on public capital is noticeably smaller than Aschauer's. She uses state-level data computed from national totals for the period 1969-1988. The aggregate model is Cobb-Douglas. According to this study, a $1.00 increase in public-capital stock will increase output by $0.35, which is exactly the effect a $1.00 increase in private capital will have. When employment growth is the variable to be explained, the study concludes that a $1000 increase in public infrastructure is accompanied by 0.2% increase in employment. The insight is that the states that

[1] If public capital is as important as recent writings about it claim, then some recent trends in U.S. public capital-formation are worrisome. Two issues are noteworthy. Rates of public-capital formation in 1970s and 1980s have fallen to one-half of those in 1950s and 1960s about the same time that the average growth rate of output has fallen to one-third in the same period. The ratio of public to private capital stock has fallen steadily from 1.10 to 0.78 for the period 1964 to 1986 and does not appear to be going up soon.

invest more in infrastructure tend to have greater output, more private investment, and more employment growth.

In a study whose approach is similar to that of Aschauer and Munnell[1], Garcia-Mila and McGuire [50] found the output elasticity of highway expenditures to be in the order of 0.045. Though statistically significant, this particular estimate suggests that highways do not have a large impact on gross state product (GSP).

When value-added rather than aggregate output is used as the dependent variable, the elasticities associated with public capital are 0.189, 0.200, and 0.259 for manufacturing, all sectors, and non-agricultural value-added respectively[2].

One other observation that emerges from these studies is that we do not have a clear picture about the relationship between private inputs and public capital. Often the association is a conjectured complementarity without any verification ex post. So that, while Costa, Ellson and Martin report finding no clear relationship between private and public capital, Lynde and Richmond [66] find the two to be complements[3].

If the motivation for these papers is to determine a reasonably accurate impact that public capital has on economic growth, it is rather surprising that all of them have been formulated outside of the large literature on models of growth[4]. The exception is Holtz-Eakin and Schwartz [58] who, using Cobb-Douglas production function and Munnell's data, find the coefficient on public capital to be at most 0.10.

The range of estimates from these studies using very close methodologies and similar data sources is too large to be desirable[5]. From one point of view, such variance speaks to the infancy of our measurement skills. Or it may be that aggregate data cannot permit us to bring evidence to bear on questions like growth and development that are based on concepts, such as increasing returns and externalities, which are of aggregate importance. The evidence from studies that have looked at the public capital's contribution to productivity changes at lower units of economic organization—large cities—is not emphatic either.

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[1] Usually these studies specify an aggregate production function, often Cobb-Douglas, and then do a pooled time-series cross-section study of 48 contigous states in the United States.

[2] See Costa, Ellson and Martin [38]. In this study, the authors were able to calculate state-specific elasticities of value added in the three sectors mentioned above with respect to public capital. For California, percentage response in value added to a 1% change in public capital as of 1972 stood at 0.021, -0.262, 0.11 for manufacturing, all and non-agricultural sectors, respectively. The cross-sectional elasticities at mean for the same sectors were 0.19, 0.20, and 0.26, repectively.

[3] Lynde and Richmond used a translog cost function to estimate the contribution of public capital to private productivity. The data are time-series for the contigous states in United States for the period 1958-1989. In one model they took total federal, state, and local public-capital expenditures as their public input. The estimated elasticity, which they found to be significant, is in the order of 0.336. When the public is disaggregated into federal on one hand and state and local on the other, the estimates were 0.067 and 0.286, respectively. They also found that the former is not statistically significant.

[4] However, see Barro [12], Barro and Martin [15], and Glomm and Ravikumar [51] for theoretical models incorporating public capital in growth models.

[5] Recall that Aschauer's [6] estimates imply that returns to public capital are 146% or five times that of private capital, using 1988 capital-stock levels.

Consider, for instance, two studies using exactly the same information. Using data for 38 Standard Metropolitan Statistical Areas in the United States, Deno [41] found the output elasticities for highways, sewers, and water to be 0.313, 0.300, and 0.075, respectively. The estimated value for the total is 0.688. With the same data, Eberts' [43] estimate for total public capital is only 0.04[1]. Such a low estimate, 0.046 to be exact, is what comes out of Shah's [90] study too which used data for 26 three-digit Mexican industries for the period 1970-1987.

The dichotomy between these estimates is more than of passing theoretical interest. If they were to be used to draw policy conclusions, they would have dramatically different impacts. From the point of view of Deno, a 10% increase in total stock of public capital will induce a 6%-7% increase in output. If we were to believe Eberts, however, we should expect a meager 0.4% increase in output for an equivalent increase in total public stock[2]. It seems that the fact that Deno used a translog profit function and, unlike Eberts, allowed output and variable inputs to adjust doesn't still account for why his estimate should be 17 times larger or Eberts' that much smaller. It is more likely, provisionally anyway, that these results are not robust to functional choice. This makes a more careful study built from sound economic theory and more informative data all the more necessary. For now, in keeping with our objective set out in the introduction, we turn to some empirical work on the contribution that education has made to growth.

4.2 EDUCATION

The special role that education plays in economic growth and, therefore, the wealth of nations has been recognized much earlier than the present attention that infrastructure is getting. The area in economics that has long been concerned with theories and empirics of this issue—human capital theory—has traditionally looked at education as an activity by which individuals acquire specific skills. Interesting questions have for sometime revolved around looking at how individual decisions to acquire knowledge affect their productivity and, therefore, their earnings. But in recent times, in part due to a vigorous pursuit of the role of increasing returns in production more generally, assertions about the centrality of human capital to growth have taken on an all-encompassing tone. Especially in a number of endogenous growth models, human capital has been asserted to be the real "engine of growth." It is the claim of some of these studies[3] that increases in the initial levels of human capital lower fertility rates and so give us benefits that accelerate growth beyond what is attributable to its capacity to add to physical capital investment.

In Romer [80 and 81] human capital enters as a key input into the research sector's production function. Because the sector is credited with producing new goods that are responsible for technological improvements, it is easy to see why people who work in it are considered important to growth. Lucas [60] as well as Becker, Murphy and Tamura [18] and Tamura [98] stress the importance to growth of knowledge spillovers. The theoretical conjectures in this subfield have grown in elegance. The empirical verifications of them have been fairly successful when the studies have been confined to returns to individual decisions to invest in education. What has proven difficult to quantify are the potentially more important conjectures of recent theories: returns to

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[1] In another paper, Eberts [44] asserts an even stronger result: the average annual growth rate in public-capital stock has no contribution to total factor productivity for the period after 1973.

[2] In a joint work, Duffy-Deno and Eberts [42], employing a simultaneous equations approach found a 10% increase in public investment to lead to at most 1.1% increase in per capita incomes.

[3] See Becker, Murphy and Tamura [18], and Rosenzweig [83 and 84].

investment in human capital by any one person exceed that person's private returns, and these externalities have large repercussions for aggregate growth. Despite the difficulties, there has been empirical attempts and below we review a sample.

4.2.1 ESTIMATED MAGNITUDES OF EDUCATION

In a recent significant empirical study, Barro [13] used the percent of school-age children attending secondary school as a proxy for the level of human capital in a country to estimate the contribution of education to variations in per-capita growth rates in a cross-section of countries. The sample range of human capital proxy "explained" a range of variation in per-capita growth rates of about 5%. Mankiw, Romer, and Weil [69] conducted a similar study, using a Solow-type Cobb-Douglas aggregate production function, and found the coefficient on human capital to be one-third. Garcia-Mila and McGuire's [50] study used educational expenditures as a proxy for governmental provision of a public good that is important in production. They found a significant output elasticity of education that is in the order of 0.165.

Because the meaning one attaches to these estimated coefficients is often subtle and passed over in silence, it is important to make clear at the outset what they mean here. In Barro's case, the claim is straightforward. It simply says that the country with the lowest human capital investment grew by 5% lower than the one with the highest, using the 1960 secondary school attendance levels. Equivalently, suppose country A had the lowest secondary school attendance level in 1960 and grew at an average annual rate of 2% for the period 1960-1985. And say country B had the highest secondary school attendance levels in 1960 and grew at 8% per annum for that same period. Then, from the point of view of Barro's study, the claim is that of the 6% difference in growth rates, 5% is due to those initial differences in human capital and only 1% is due to other variables. In Mankiw, Romer, and Weil and Garcia-Mila and McGuire the implication is that, if the average percent of secondary school attendance or education expenditures is increased by 1%, the average growth rate in per-capita income will go up by 0.33% or 0.165%, respectively. Lest you consider these effects small, remember that small increments to growth have large cumulative effects.

Quan and Beck [73] looked specifically at the effect of education spending on wages, employment, and per-capita income within the United States. They compared the Northeast and the Sunbelt[1]. Their conclusion is surprising, if not wrong. They find that the effect of educational expenditures on the levels of wages and employment are positive and significant for the Northeast but negative and significant in the Sunbelt. In particular, while a 10% increase in K-12 education spending increases wages in the Northeast by 2%, it reduces them in the Sunbelt by 2.8%.

Were one interested in making rough order of magnitude estimates concerning the significance of education and using them for making broad policy guidelines, aggregative models would suffice. With caution, one can even argue that the estimated magnitudes approximate the true social (private plus spillover effects) returns to education. The problem is that there is little to be confident about making a causal linkage between higher growth and higher enrollment rates or higher expenditures on education, which are the two common variables used in aggregate models. If we add to this observation the fact that spillovers from education are difficult to measure, it should come as no surprise that magnitudes that are derived from estimating individual returns to education have been more persuasive.

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[1] This region includes several states in the south, southeast, and California regions.

In a recent study using a relatively large sample available from the 1980 Census, Card and Krueger [29] estimated rates of return to education by state of birth and cohort. Because the study is both long and interesting in what it says about returns to education, we have chosen to give it a relatively lengthy discussion.

The first goal of Card and Krueger was to determine rates of return to education to three cohorts of white men born between 1920-1949 in mainland U.S. They found that average rates of return to education at 5.1% per annum are lower for older workers than they are, at 7.4% per year, for younger workers[1]. Furthermore, the rates of return vary across regions of residence by as much as 2% per year of education. In particular, Card and Krueger found that returns are lowest in the Mountain and Pacific regions and highest in the East-South Central and West-South Central regions[2].

Because rates of return vary between cohorts and regions, it was natural to try and account for such differences, an exercise undertaken by Card and Krueger, by relating rates of return by cohort and state to the characteristics of public school systems. Three school-quality measures were used: student/teacher ratio, relative teacher salary, and school term length.

As a summary statement, returns to education are significantly related to all three measures of school quality. They found that a decrease in student/teacher ratio by 10 students translated to an increase in estimated rate of return to education of 0.9% to years of schooling above the threshold level. To see this, consider that the threshold level of schooling is 8 years. Imagine, furthermore, that these threshold years are unaffected by school quality. Then the said reduction of student/teacher ratio would raise earnings to high-school graduates by 3.6%. A 10% increase in teachers' pay is associated with a 0.1% increase in the rate of return to schooling. The significance of these estimated effects due to school-quality variables stands even when differences in family incomes and tastes[3] have been taken into account. They are also confirmed by natural experiments, such as that which happened to African Americans[4].

A shortcoming with a focus on return to education is that changes in school quality may affect the variance but not the mean incomes. That is, it is conceivable that those who are more educated earn more but at the expense of those who are less educated. Alternatively, changes in school quality may alter the years spent in schooling thereby affecting the mean (slope) in earnings-schooling relation, without any discernible effect on the variance of earnings.

A sensitivity analysis that explored the effect of school quality on years of schooling and following that, estimating a reduced-form equation that links school quality and levels of education on earnings, yields the following results. A reduction of student/teacher ratio by 10 students predicts raising earnings by 4.2% and raising average education by 0.6 years. In contrast to the conventional return to

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[1] There are three cohorts grouped into 10-year categories, so the older cohort was aged 50-59 in 1979.

[2] As an example, note that, while the rates of return to education for white men born in California, at 5.76% per year, ranked 9th in the nation for the 1920-29 cohort, the returns to 1940-49 cohort, at 6.96% ranked 33rd.

[3] A choice between private- and public-school attendance is what is used here as the primary variable for taste.

[4] In a related study, Card and Krueger [30] used data for southern born white and black men working in northern cities in 1960, 1970 or 1980 censuses to test the effect that dramatic improvements in school quality among black schools of the segregated southern states had on closing the earnings differential between black and white men.

education coefficient[1] of 5.38%, a 0.6 year increase in average education raises earnings by 3.2%. Taken together, these results say that a reduction of student/teacher ratio by 10 students increases earnings by 30% more than would have been expected on the basis of increase in average education alone.

Similar calculations for relative teacher salaries show that a 30% increase in salaries raises average education by 0.18 years and average earnings by 1.34%, which is a 40% gain in earnings than would result from increases in education alone.

There are two central conclusions from this study. First, increases in school quality during the past century are associated with increases in years of schooling and average wages. Second, increases in earnings appear to reflect both a gain for the added years of education and an increase in the return for each existing year of education.

Since this influential study, other studies to validate the general plausibility of these findings have been undertaken using different data sets. Using the National Longitudinal Survey of Youth for the 1979-1989 cohort of white males, Betts [22] found the same school-quality variables as used in Card and Krueger to bear no significance at all to earnings differential. But estimates of returns to schooling, by Ashenfelter and Krueger [8], using a sample of twins show that an additional year of schooling increases wages by 12%-16%. However, this estimate is much higher than that reported by previous studies and, more recently, by Blackburn and Neumark [23]. In this later study, the rate of return to education is 5.3%-5.8% when there is no control for ability but only 4.2% when it is controlled for, suggesting that ordinary least square estimates of returns to schooling are biased upward when ability is omitted.

5. WHAT CGES DON'T AND PROBABLY WON'T DO

5.1 ACCOUNT FOR TAX AVOIDANCE

When a tax law change is made, it is common practice to account for legal avoidance strategies. For instance, suppose that the government were to raise the standard deduction. The static analysis would be to estimate revenue loss as the increase in the deduction times the number of people who take the deduction. The dynamic analysis would account for the additional people who would claim the now higher-standard deduction. No CGE that we know of has incorporated this type of dynamic analysis. However, this sort of dynamic analysis is standardly done in tax revenue estimating models. For instance, it is the way that Department of Finance (DOF) would estimate the revenue effects to California of such a personal income tax change. A CGE would use the output of the personal income tax model as an input.

5.2 PROPERLY TRACK IDIOSYNCRATIC INDUSTRIES OR TAXES

Real tax law has very specific treatment for some large firms. Such firms are routinely given a tax holiday for locating in a way favored by government. The CGE models track taxes at a sectoral level, so it is not possible to say what will happen to an individual firm. The DOF corporate tax model, however, is quite specific as to which firms are affected by a change in the corporate tax. Again, the idiosyncratic effects predicted by a corporate tax model would be aggregated to the sectoral level and then used as an input for a CGE model.

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[1] In other words, the coefficient of education when it is added to the list of variables in the earnings model and school quality variables are excluded.

5.3 PROVIDE BEST POSSIBLE DESCRIPTION OF EFFECT ON AN INDUSTRY

Analysts working with a CGE must expend their limited time and money to make a model that encompasses income distribution, consumers' purchases of all goods, and producers' sales of all goods. For a tax change that is broad in its effect and large enough to cause migration and investment, this is a reasonable strategy.

However, this strategy comes at the cost of not closely modelling individual industries. For example, a tax on television broadcasting, where lack of frequencies restricts competition, would work completely differently from a tax on a competitive industry such as dry cleaning. These differences in industrial organization are not picked up in a CGE. A CGE model is also not characterized by careful econometric estimation of each industries supply curve. For these reasons, a tax that falls on one narrow industry and does not make much difference for overall state revenue would be best analyzed by an ad-hoc model that considered that one industry in great detail rather than by a CGE that considers all industries but in less detail.

6. APPENDIX:

6.1 FORMULA FOR Q

In this section we give two representative formulas for Q, which, as we have remarked before, are distinguished by the taxes they include. In Summers,

$$Q = \frac{\left[\frac{V - B}{pK}\frac{1 - c}{1 - \tau} - 1 + b + ITC + z\right]}{1 - \tau};$$

where

V is the value of the firm

B is the present discounted value of depreciation allowance owned by the firm

p is the price of one unit of capital stock

K is the capital stock (equipment, structures plus inventories) valued at replacement cost

c is the capital gains tax

θ is the dividends tax

b is the fraction of investment externally financed at rate of return of capital

ITC is the investment tax credit

z is the value of depreciation allowance of \$1.00 of new capital

τ is the corporate tax rate.

In Schaller,

$$Q = \left[\frac{V + B - A}{(1 - \alpha)P^I K_1 + (1 - \eta - \tau z))}\right]\frac{P^I}{P}\frac{1}{1 - \tau}$$

where we have ignored time subscripts and

V is as defined above

B is the market value of the firm's debt (this is the book value of debt which is defined as current liabilities and long term debt)

A is the depreciation bond

P^I is the implicit price deflator for gross private fixed nonresidential investment

K_l is the lagged value of capital stock valued at replacement cost

η is the investment tax credit

τ is the present value of depreciation allowance on a unit of new capital

δ is the rate of economic depreciation

P is the implicit price deflator for output.

Jorgenson's Investment Model

$$A_t = \beta_o + \beta_1\Delta\left(\frac{pQ}{c}\right)_{t-4} + \beta_2\Delta\left(\frac{pQ}{c}\right)_{t-5} + \beta_3\Delta\left(\frac{pQ}{c}\right)_{t-6} + \beta_4\Delta\left(\frac{pQ}{c}\right)_{t-7} + \beta_5(a - \delta K)_{t-1} + \beta_6(a - \delta K)_{t-2} + \beta_7 K_t + \varepsilon_t$$

Notice that all the variables were defined earlier in the text except K_t, which denote capital stock, estimated from investment data using a perpetual inventory method of a declining balance replacement, and ε_t, which denote a random error term. Finally, δ, denote depreciation rate or replacement-rate of capital.

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XII.2.NOTATION

We have used the following notational forms for this model:

Element	Convention	Examples
Endogenous Variables	Roman alphabet lower case	x_i
Exogenous Variables	Roman alphabet lower case with overbar	$\overline{x}_i$
Parameters	Greek alphabet lower case	δ_i
Sets	Lower case Roman a member of upper case Roman	$i \in I$
Alias of Set	When a set is used within an equation defined over that set, an alias is used in GAMS and math	`ALIAS(I,J)` $i' \in I$

The following logical and mathematical shorthand expressions have been used:

Symbol	Definition	Example
$\in$	is a member of	i∈I={AGRIC, ... , OSERV) *i.e.* sectors
$\forall$	for all	∀i∈I, *i.e.* 'i' is defined over all sectors
Σ	the summation operator	$\sum_{i \in I} a_i = a_1 + a_2 + \dots + a_I$
Π	the product operator	$\prod_{i \in I} a_i = a_1 \times a_2 \times \dots \times a_I$

XII.3.SUMMARY OF SET, PARAMETER AND VARIABLE NAMES

Sets	Dimension	Math	GAMS
Factors	2	$f \in F$	F
Governments - All	36	$g \in G$	G
Governments - California General Fund Sources	12	$g \in GC$	GC
Governments - Factor Taxes	5	$g \in GF$	GF
Governments - Per Household Taxes	6	$g \in GH$	GH
Governments - Income Taxes	3	$g \in GI$	GI
Governments - Capital Income Taxes	2	$g \in GK$	GK
Governments - Endogenous Spending	9	$g \in GN$	GN
Governments - Sales or Excise Taxes	11	$g \in GS$	GS
Governments - Endogenous Transfer Payments	1	$g \in GWN$	GWN
Governments - Exogenous Transfer Payments	4	$g \in GWX$	GWX
Governments - Exogenous Spending	27	$g \in GX$	GX
Households	7	$h \in H$	H
Industries	28	$i \in I$ or $j \in I$	I
All Social Accounting Matrix Accounts	75	$z \in Z$	Z

Parameters	Dimension	Math	GAMS
Input Output Coefficients	75 x 75	-	A(Z,Z1)
Domestic Input Output Coefficients	28 x 28	α_{ii}	AD(Z,Z1)
Average Daily Attendance	1	ψ	ADA
Government Spending Shares of Net Income	30 x 35	α_{ig} ,α_{fg}	AG(Z,G)
Factor Share Exponenets in Production Function	2 x 28	α_{fi}	ALPHA(F,I)
Initial Shares of Consumption	28 x 7	α_{ih}	ALPHA(I,H)
Deductability of Taxes (MISC.DR1)	3 x 3	α_{gg}^{t}	ATAX(G,G1)
Income Elasticities of Demand	28 x 7	β_{ih}	BETA(I,H)
Capital Coefficient Matrix (CCM.DR1)	28 x 28	β_{ii}	CCM(I,J)
Depreciation Rate	1	δ	DEPR
Export Price Elasticities	28	η_{i}^{e}	ETAE(I)
Investment Supply Elasticity	1	η_{i}	ETAI
Labor Supply Elasticities with respect to Incomes	7	η_{h}^{ls}	ETALS(H)
Labor Supply Elasticity with respect to TP's	7	η_{h}^{tp}	ETATP(H)
Responsiveness of In-Migration to Unemployment	7	η_{h}^{u}	ETAU(H)
Production Function Scale	28	γ_{i}	GAMMA(I)
Types of Inter-Government Transfers (MISC.DR1)	35 x 35	-	IGTD(G,G1)
Correction Factor between Households and Jobs	1	ε	JOBCOR
Cross-Price Elasticities	28 x 28	$\lambda_{ii'}$	LAMBDA(I,J)
Miscellaneous Industry Parameters (MISC.DR1)	28 x 7	-	MISC(Z,*)
Income Tax Table Data in Input File (MISC.DR1)	7 x 7	-	MISCG(G,H,*)
Miscellaneous Household Parameters (MISC.DR1)	7 x 7	-	MISCH(H,*)
Marginal Tax Rates	3 x 7	τ_{gh}^{m}	MTR(G,H)
Natural Rate of Population Growth	7	π_{η}	NRPG(H)
Substitution Exponent in Production Function	28	ρ_{i}	RHO(I)
Social Accounting Matrix (SAM.DR1)	75 x 75	-	SAM(Z,Z1)
Consumption Sales and Excise Tax Rates	11 x 28	τ_{gi}^{c}	TAUC(G,I)
Factor Tax Rates	5 x 2 x 75	τ_{gfz}	TAUF(G,F,Z)
Factor Taxes applied to Factors (MISC.DR1)	5 x 2	-	TAUFF(GF,G)
Employee Portion of Factor Taxes	5 x 2	τ_{gf}	TAUFH(G,F)
Experimental Factor Tax Rates	5 x 2 x 75	τ_{gfz}^{x}	TAUFX(G,F,Z)
Government Sales and Excise Tax Rates	11 x 28	τ_{gi}^{g}	TAUG(G,I)
Household Taxes other than PIT	6 x 7	τ_{gh}	TAUH(G,H)
Import Duty Rates	28	τ_{gi}^{m}	TAUM(G,I)
Investment Sales and Excise Tax Rates	11 x 28	τ_{gi}^{n}	TAUN(G,I)
Sales and Excise Tax Rates	11 x 28	τ_{qi}^{q}	TAUQ(G,I)
Intermediate Good Sales and Excise Tax Rates	11 x 28	τ_{gi}^{v}	TAUV(G,I)
Tax Bracket Base Amount	3 x 7	τ_{gh}^{b}	TAXBASE(G,H)
Tax Bracket Minimum Taxable Earnings	3 x 7	τ_{gh}^{d}	TAXBM(G,H)
Tax Constant to Correct Calculated to Observed	3 x 7	τ_{gh}^{c}	TAXCVC(G,H)
Tax Deduction other than Standard and other PIT	3 x 7	τ_{gh}^{o}	TAXOD(G,H)
Percentage Itemizing	3 x 7	τ_{gh}^{i}	TAXPI(G,H)
Tax Destination Shares	35 x 35	$\mu_{gg'}$	TAXS(G,G1)
Tax Deduction for Standard Deductions	3 x 7	τ_{gh}^{s}	TAXSD(G,H)
Percent of Households Receiving TP's (MISC.DR1)	7 x 5	τ_{hg}^{pc}	TPC(H,G)

Variables	**Dimension**	**Math**	**GAMS**
Public Consumption	28 x 35	c_{ig}	CG(I,G)
Private Consumption	28 x 7	c_{ih}	CH(I,H)
Gross Investment by Sector of Source	28	c_{in}	CN(I)
Consumer Price Index	7	p_h	CPI(H)
Exports	28	e_i	CX(I)
Domestic Share of Domestic Consumption	28	d_i	D(I)
Domestic Supply	28	q_i	DS(I)
Sectoral Factor Demand	2 x 28	u_{fi}	FD(F,I)
Number of Households	7	a_h	HH(H)
Number of Non-Working Households	7	a_h^n	HN(H)
Number of Working Households	7	a_h^w	HW(H)
Inter-Governmental Transfers	35 x 35	$b_{ig'}$	IGT(G,G1)
Investment Tax Credit	28	t_i	ITC(I)
Capital Stock	28	u_{Ki}^s	KS(I)
Imports	28	m_i	M(I)
Gross Investment by Sector of Destination	28	n_i	N(I)
Net Capital Inflow	1	z	NKI
Aggregate Price	28	p_i	P(I)
Aggregate Price including Sales/Excise Taxes	28	p_i^c	PC(I)
Domestic Producer Price	28	p_i^d	PD(I)
Per Household Personal Income Taxes	35 x 7	t_{gh}	PIT(G,H)
Producer Price Index	1	p	PPI
Value Added Price	28	p_i^{va}	PVA(I)
World Price (Rest of US and Rest of World)	28	p_i^w	PW(I)
Sectoral Factor Rental Rates	2 x 75	r_{fi}, r_{gi}	R(Z,I)
Economy Wide Scalar for Factor Rental Rates	2	r_f^a	RA(F)
Government Savings	35	s_g	S(G)
Private Savings	7	s_h	S(H)
State Personal Income	1	q	SPI
Transfer Payments	7 x 35	w_{hg}	TP(H,G)
Intermediate Goods	28	v_i	V(I)
Factor Income	2	y_f	Y(F)
Government Income	35	y_g	Y(G)
Household Income	7	y_h	Y(H)
Household after Tax Income including TP's	7	y_i^d	YD(H)

XII.4.GAMS INPUT FILES

XII.4.1.MAIN INPUT FILE

```
$TITLE DYNAMIC REVENUE ANALYSIS MODEL - DRAM0

* PIT                ENDOGENOUS DEDUCTIONS
* PROP 98            TEST 3
* FED HAW TRANSFERS EXOGENOUS
* INCLUDES ITC

*------------------------------------------------------------------------------------------------------------
* 1.1 CONTROLS PLACED ON OUTPUT GENERATION
*------------------------------------------------------------------------------------------------------------

$OFFSYMLIST OFFSYMXREF

  OPTIONS SYSOUT=OFF, SOLPRINT=OFF, LIMROW=0, LIMCOL=0;

*------------------------------------------------------------------------------------------------------------
* 1.2 SET UP FILE FOR SOLUTION VALUES
*------------------------------------------------------------------------------------------------------------

  FILE RES /DRAM0.RES/; RES.PW = 250; RES.ND = 3; RES.LW = 10;
                        RES.NW =  10; RES.LJ = 1; PUT RES;

*------------------------------------------------------------------------------------------------------------
* 2. SET DEFINITION
*------------------------------------------------------------------------------------------------------------
* 2.1 EXPLICIT SET DECLARATION
*------------------------------------------------------------------------------------------------------------

SETS  Z  ALL ACCOUNTS IN SOCIAL ACCOUNTING MATRIX /
                 AGRIC   AGRICULTURE
                 ENMIN   ENERGY MINING
                 OTHPR   OTHER PRIMARY
                 CONST   CONSTRUCTION
                 FOODS   FOOD MANUFACTURING
                 ALTOH   ALCOHOL TOBACCO AND HORSERACING
                 APPAR   APPAREL
                 MFRCO   CONSTRUCTION ORIENTED MANUFACTURING
                 PAPER   PAPER PRINTING PUBLISHING
                 CHEMS   CHEMICALS RUBBER PLASTICS
                 PETRO   PETROLEUM
                 ELECT   ELECTRONIC TECHNOLOGY
                 AEROS   AEROSPACE
                 MOTOR   MOTOR VEHICLES
                 OTHMA   OTHER MANUFACTURING
                 TRANS   TRANSPORTATION
                 COMMU   COMMUNICATION
                 UTILI   UTILITIES
                 WHOLE   WHOLESALE
                 RETAI   RETAIL
                 BANKS   BANKS AND OTHER CREDIT INSTITUTIONS
                 INSUR   INSURANCE
                 REALE   REAL ESTATE
                 OFIRE   OTHER FINANCE INSURANCE AND REAL ESTATE
                 BSERV   BUSINESS SERVICES
                 HEALT   HEALTH
                 ENTER   ENTERTAINMENT
                 OSERV   OTHER SERVICES
                 L       LABOR
                 K       CAPITAL LAND ENTREPRENEURSHIP
                 0P0MT   ZERO POINT ZERO MARGINAL CA TAX RATE HOUSEHOLDS
                 1P0MT   ONE POINT ZERO MARGINAL CA TAX RATE HOUSEHOLDS
                 2P0MT   TWO POINT ZERO MARGINAL CA TAX RATE HOUSEHOLDS
                 4P0MT   FOUR POINT ZERO MARGINAL CA TAX RATE HOUSEHOLDS
                 6P0MT   SIX POINT ZERO MARGINAL CA TAX RATE HOUSEHOLDS
                 8P0MT   EIGHT POINT ZERO MARGINAL CA TAX RATE HOUSEHOLDS
                 9P3MT   NINE POINT THREE MARGINAL CA TAX RATE HOUSEHOLDS
                 INVES   INVESTMENT
                 USSOC   TAX   FEDERAL     SOCIAL SECURITY
                 USPIT   TAX   FEDERAL     PERSONAL INCOME TAXES
                 USCOR   TAX   FEDERAL     CORPORATION TAXES
                 USDUT   TAX   FEDERAL     IMPORT DUTIES
                 USMSC   TAX   FEDERAL     MISCELLANEOUS EXCISE TAXES
                 CAMSC   TAX   CALIFORNIA  MISCELLANEOUS TAXES
                 CASIN   TAX   CALIFORNIA  SIN TAXES - TOBACCO ALCOHOL AND HORSES
                 CAENE   TAX   CALIFORNIA  ENERGY EXTRACTION REVENUES
                 CAOPR   TAX   CALIFORNIA  OTHER PRIMARY REVENUES
                 CAINS   TAX   CALIFORNIA  INSURANCE PREMIUM TAXES
                 CAMVS   TAX   CALIFORNIA  MOTOR VEHICLE TAXES
                 CAGAS   TAX   CALIFORNIA  GASOLINE AND DIESEL TAXES
                 CALSU   TAX   CALIFORNIA  SALES AND USE TAXES
                 CABAC   TAX   CALIFORNIA  BANK AND CORPORATION TAXES
                 CAUDI   TAX   CALIFORNIA  UNEMPLOYMENT AND DISIBILITY
                 CALWC   TAX   CALIFORNIA  WORKERS COMPENSATION
                 CAPIT   TAX   CALIFORNIA  PERSONAL INCOME TAXES
                 CASUF   TAX   CALIFORNIA  CSU FEES
                 CAINH   TAX   CALIFORNIA  INHERITANCE TAX
                 CALGF   TAX   CALIFORNIA  GENERAL FUNDS
                 LOPRP   TAX   LOCAL       PROPERTY TAXES
```

```
            LOFEE   TAX   LOCAL       FEES
            LOMSC   TAX   LOCAL       MISCELLANEOUS TAXES
            FEDNO   SPEND FEDERAL     NON DEFENSE
            FEDDE   SPEND FEDERAL     DEFENSE
            CATRA   SPEND CALIFORNIA  TRANS CHP DMV
            CACOR   SPEND CALIFORNIA  YOUTH AND ADULT CORRECTIONS
            CAK14   SPEND CALIFORNIA  K TO 14 EDUCATION
            CAOED   SPEND CALIFORNIA  OTHER EDUCATION
            CAHAW   SPEND CALIFORNIA  HEALTH AND WELFARE
            CAOTH   SPEND CALIFORNIA  ALL OTHER GOVERNMENT
            LOTRA   SPEND LOCAL GOVTS ROADS TRAFFIC AND RELATED
            LOCOR   SPEND LOCAL GOVTS JUDICIARY AND CORRECTIONS
            LOK14   SPEND LOCAL GOVTS K TO 14 EDUCATION
            LOHAW   SPEND LOCAL GOVTS HEALTH AND WELFARE
            LOOTH   SPEND LOCAL GOVTS ALL OTHER GOVERNMENT
            ROW     REST OF WORLD /

 F(Z)      FACTORS                  / L, K /

 G(Z)      GOVERNMENTS              / USSOC, USPIT, USCOR, USDUT, USMSC,
                                      CAMSC, CASIN, CAENE, CAOPR, CAINS,
                                      CAMVS, CAGAS, CALSU, CABAC, CAUDI,
                                      CALWC, CAPIT, CASUF, CAINH, CALGF,
                                      LOPRP, LOFEE, LOMSC, FEDNO, FEDDE,
                                      CATRA, CACOR, CAK14, CAOED, CAHAW,
                                      CAOTH, LOTRA, LOCOR, LOK14, LOHAW,
                                      LOOTH /

 GN(G)     ENDOGENOUS GOVERNMENTS   / CATRA, CACOR, CAK14, CAOED, CAHAW,
                                      CAOTH, LOTRA, LOK14, LOHAW /

 GX(G)     EXOGENOUS GOVERNMENTS    / USSOC, USPIT, USCOR, USDUT, USMSC,
                                      CAMSC, CASIN, CAENE, CAOPR, CAINS,
                                      CAMVS, CAGAS, CALSU, CABAC, CAUDI,
                                      CALWC, CAPIT, CASUF, CAINH, CALGF,
                                      LOPRP, LOFEE, LOMSC, FEDNO, FEDDE,
                                      LOCOR, LOOTH /

 GS(G)     SALES OR EXCISE TAXES    / USMSC, CAMSC, CASIN, CAENE, CAOPR,
                                      CAINS, CAMVS, CAGAS, CALSU, LOPRP,
                                      LOFEE, LOMSC /

 GF(G)     FACTOR TAXES             / USSOC, USCOR, CABAC, CAUDI, CALWC/

 GI(G)     INCOME TAX UNITS         / USPIT, CAPIT, LOPRP /

 GH(G)     HOUSEHOLD TAX UNITS      / USMSC, CAMVS, CASUF, CAINH, LOFEE,
                                      LOMSC /

 GK(G)     CAPITAL INCOME TAXES     / USCOR, CABAC /

 GWX(G)    EXOGENOUS TRANSFER PMT   / USSOC, FEDNO, CAUDI, CALWC /

 GWN(G)    ENDOGENOUS TRANSFER PMT  / LOHAW /

 GC(G)     CA SPECIAL FUNDS UNITS   / CAMSC, CASIN, CAENE, CAOPR, CAINS,
                                      CAMVS, CAGAS, CALSU, CABAC, CAPIT,
                                      CASUF, CAINH /

 H(Z)      HOUSEHOLDS               / 0P0MT, 1P0MT, 2P0MT, 4P0MT, 6P0MT,
                                      8P0MT, 9P3MT /

 I(Z)      INDUSTRY SECTORS         / AGRIC, ENMIN, OTHPR, CONST, FOODS,
                                      ALTOH, APPAR, MFRCO, PAPER, CHEMS,
                                      PETRO, ELECT, AEROS, MOTOR, OTHMA,
                                      TRANS, COMMU, UTILI, WHOLE, RETAI,
                                      BANKS, INSUR, REALE, OFIRE, BSERV,
                                      HEALT, ENTER, OSERV /

 T         TAX LOOP                 / BASE, TODAY, BAC, PIT, SAU /

 R1H       REPORT 1 FOR SCALARS     / BAC, PIT, SAU, GFREV, SFREV,
                                      STATIC, DGF, DSF, DDRE, PDRE, SPI,
                                      GN, NKI, POP, W, R, LD, KD, GFSAV /

 R2H       REPORT 2 FOR STATUS      / M-STAT, S-STAT /

 MS        LABELS FOR MODEL STATUS  / OPTIMAL, LOCALOP, UNBOUND,
                                      INFSBLE, INFSLOC, INFSINT,
                                      NOOPTML, MIPSOLN, NOINTGR,
                                      INFSMIP, UNUSED,  UNKNOWN,
                                      NOSOLUT /

 SS        LABELS FOR SOLVER STATUS / OK,      ITERATE, RESRCE,
                                      SOLVER,  EVALUATE,NOTKNWN,
                                      NOTUSED, PRE-PROC,SETUP,
                                      SLVFAIL, SLVINTER,POST-PROC,
                                      METSYS / ;

*----------------------------------------------------------------------------------------------------------
* 2.2 ALIASES
*----------------------------------------------------------------------------------------------------------

  ALIAS (I,J), (I,I1), (Z,Z1), (F,F1), (G,G1), (G,G2), (GI,GI1), (GS,GS1),
        (GH,GH1), (GF,GF1), (H,H1);
```

```
*-----------------------------------------------------------------------------------------------------------
* 3. PARAMETERS AND EXOGENOUS VARIABLES
*-----------------------------------------------------------------------------------------------------------
* 3.1 SOCIAL ACCOUNTING MATRIX, CAPITAL COEFFICIENT MATRIX AND PARAMETERS
*-----------------------------------------------------------------------------------------------------------

$INCLUDE DRAM.SAM
$INCLUDE DRAM.CCM
$INCLUDE DRAM.MSC

*-----------------------------------------------------------------------------------------------------------
* 3.2 PARAMETER DECLARATION
*-----------------------------------------------------------------------------------------------------------

  SCALARS

  ADA           DOF     CHANGE IN AVERAGE DAILY ATTENDANCE  / 1.00 /
  DEPR          DOF     DEPRECIATION RATE
  ETAI          UCB     INVESTMENT SUPPLY ELASTICITY        / 1.50 /;

  PARAMETERS

* PARAMETERS CALCULATED FROM SOCIAL ACCOUNTING MATRIX DATA

  A(Z,Z1)       IMPLAN  INPUT OUTPUT COEFFICIENTS
  AD(Z,Z1)      IMPLAN  DOMESTIC INPUT OUTPUT COEFFICIENTS
  AG(Z,G)       IMPLAN  GOVERNMENT SPENDING SHARES OF NET INCOME
  ALPHA(F,I)    IMPLAN  FACTOR SHARE EXPONENTS IN PRODUCTION FUNCTION
  FITC(F,G)     DOF     ALLOCATION OF ITC TO FACTORS
  GAMMA(I)      CALC    PRODUCTION FUNCTION SCALE
  TAUF(G,F,Z)   DOF     FACTOR TAXES
  TAUFX(G,F,Z)  DOF     EXPERIMENTAL FACTOR TAXES
  TAUFH(G,F)    DOF     EMPLOYEE PORTION OF FACTOR TAXES
  TAUH(G,H)     DOF     HOUSEHOLD TAXES OTHER THAN PIT
  TAUM(G,I)     DOF     IMPORT DUTY RATES
  TAUQ(G,I)     DOF     AVERAGE SALES TAX RATES
  TAUC(G,I)     DOF     EXPERIMENTAL CONSUMPTION SALES TAX RATES
  TAUV(G,I)     DOF     EXPERIMENTAL CONSUMPTION SALES TAX RATES
  TAUN(G,I)     DOF     EXPERIMENTAL CONSUMPTION SALES TAX RATES
  TAUG(G,I)     DOF     EXPERIMENTAL CONSUMPTION SALES TAX RATES
  TAXS(G,G1)    DOF     TAX DESTINATION SHARES

* ELASTICITIES AND PIT TAX DATA IMPOSED

  BETA(I,H)     UCB     INCOME ELASTICITY OF DEMAND
  ETAD(I)       CALC    DOMESTIC SHARE PRICE ELASTICITIES
  ETAE(I)       UCB     EXPORT ELASTICITIES WITH RESPECT TO DOMESTIC PRICE
  ETAIX         UCB     EXPERIMENTAL INVESTMENT SUPPLY ELASTICITY
  ETAM(I)       UCB     IMPORT ELASTICITIES WITH RESPECT TO DOMESTIC PRICE
  ETARA(H)      UCB     L SUPPLY ELASTICITY WITH RESPECT TO AVERAGE WAGE
  ETAPIT(H)     UCB     L SUPPLY ELASTICITY WITH RESPECT TO TAXES
  ETAYD(H)      UCB     RESPONSIVENESS OF INMIGRATION TO AFTER TAX EARNINGS
  ETAU(H)       UCB     RESPONSIVENESS OF INMIGRATION TO UNEMPLOYMENT
  ETATP(H)      UCB     HOUSEHOLD RESPONSE TO TRANSFER PAYMENTS
  ITCX(Z,Z1)    DOF     INVESTMENT TAX CREDIT SHARE ALLOWED
  JOBCOR        CALC    CORRECTION FACTOR BETWEEN HOUSEHOLDS AND JOBS
  LAMBDA(I,J)   UCB     CROSS PRICE ELASTICITIES
  MTR(G,H)      DOF     MARGINAL TAX RATES
  NRPG(H)       UCB     NATURAL RATE OF POPULATION GROWTH
  RHO(I)        UCB     EXPONENT IN PRODUCTION FUNCTION
  TAXBASE(G,H)  DOF     BASE TAX AMOUNTS
  TAXBM(G,H)    DOF     TAX BRACKET MINIMUM
  TAXCVC(G,H)   DOF     TAX CONSTANT TO CORRECT TO OBSERVED TAXES
  TAXOD(G,H)    DOF     TAX OTHER DEDUCTIONS PER RETURN
  TAXPI(G,H)    DOF     TAX PERCENT ITEMIZING
  TAXSD(G,H)    DOF     TAX STANDARD DEDUCTIONS PER RETURN

* ARRAYS BUILT TO EXPORT RESULTS TO SEPARATE FILE

  R1(R1H,T)     REPORT  SCALAR VARIABLES
  R2(R2H,T)     REPORT  SOLVER AND MODEL STATUS VALUES

* INITIAL VALUES OF ENDOGENOUS VARIABLES

  CG0(I,G)      DOF     REAL    GOVERNMENT CONSUMPTION
  CH0(I,H)      IMPLAN  REAL    PRIVATE CONSUMPTION
  CN0(I)        IMPLAN  REAL    INVESTMENT BY SECTOR OF SOURCE
  CPI0(H)       CALC    PRICE   CONSUMER PRICE INDICES
  CX0(I)        IMPLAN  REAL    EXPORT CONSUMPTION
  D0(I)         CALC    RATIO   DOMESTIC SUPPLY SHARE OF DOMESTIC DEMAND
  DD0(Z)        CALC    REAL    DOMESTIC DEMAND
  DS0(Z)        CALC    REAL    DOMESTIC SUPPLY QUANTITIES
  FD0(F,Z)      IMPLAN  REAL    FACTOR DEMAND
  IGT0(G,G1)    DOF     NOMINAL INTER GOVERNMENTAL TRANSFERS
  KS0(I)        CALC    REAL    CAPITAL STOCK
  HH0(H)        DOF     HHDS    NUMBER OF HOUSEHOLDS
  HN0(H)        DOF     HHDS    NUMBER OF NONWORKING HOUSEHOLDS
  HW0(H)        DOF     HHDS    NUMBER OF WORKING HOUSEHOLDS
  ITC0(I)       DOF     NOMINAL INVESTMENT TAX CREDIT
  M0(I)         IMPLAN  REAL    IMPORTS
  MI0(H)        DOF     REAL    IN MIGRATION
  MO0(H)        DOF     REAL    OUT MIGRATION
  N0(I)         CALC    REAL    GROSS INVESTMENT BY SECTOR OF DESTINATION
  NKI0          CALC    NOMINAL NET CAPITAL INFLOW
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  P0(I)         CALC    PRICE   AGGREGATE PRICES
  PD0(I)        CALC    PRICE   DOMESTIC PRICES
  PIT0(G,H)     DOF     NOMINAL TAX PER WORKING HOUSEHOLD
  PVA0(I)       CALC    PRICE   VALUE ADDED PRICES
  PW0(I)        CALC    PRICE   EXOGENOUS PRICES IN EXTERNAL MARKETS
  Q0(Z)         DOF     REAL    SOCIAL ACCOUNTING MATRIX TOTALS
  R0(F,Z)       IMPLAN  PRICE   INITIAL SECTORAL RENTAL RATE FOR FACTOR
  RA0(F)        IMPLAN  AVERAGE RENTAL RATES FOR FACTORS
  S0(Z)         DOF     NOMINAL SAVINGS
  SPI0          CALC    NOMINAL STATE PERSONAL INCOME
  V0(I)         IMPLAN  REAL    INTERMEDIATE DEMAND
  TP0(H,G)      DOF     NOMINAL GOVERNMENT TRANSFER PAYMENTS
  YD0(H)        CALC    NOMINAL AFTER TAX TOTAL HOUSEHOLD INCOMES
  Y0(Z)         CALC    NOMINAL GROSS HOUSEHOLD INCOMES;

*--------------------------------------------------------------------------------------------------------------
* 3.3 CALCULATIONS OF PARAMETERS AND INITIAL VALUES
*--------------------------------------------------------------------------------------------------------------

  TABLE TXE(T,*) TAX EXPERIMENTS
          CABAC  CAPIT  CALSU
  BASE    0.000  0.000  0.000
  TODAY   0.000  0.000  0.000
  BAC    -1.000  0.000  0.000
  PIT     0.000 -1.000  0.000
  SAU     0.000  0.000 -1.000;

  ETAIX = ETAI;

* CALCULATE COLUMN AND ROW TOTALS OF SAM TO COMPARE FOR BALANCE

  Q0(Z) = SUM(Z1,SAM(Z,Z1) ); DISPLAY Q0;

  Q0(Z) = SUM(Z1,SAM(Z1,Z) ); DISPLAY Q0;

* READ IN ELASTICITY PARAMETERS FROM MISC.CA0

  BETA(I,H)     =  MISC(I,'ETAY');

  LAMBDA(I,I)   =  MISC(I,'ETAOP');

  ETAE(I)       =  MISC(I,'ETAE');

  ETAM(I)       =  MISC(I,'ETAM');

  RHO(I)        = ( 1 - MISC(I,'SIGMA') ) / MISC(I,'SIGMA');

  R0('K',I)     = MISC(I,'R0') * 100;

  ETARA(H)      = MISCH(H,'ETARA');

  ETAPIT(H)     = MISCH(H,'ETAPIT');

  ETATP(H)      = MISCH(H,'ETATP');

  ETAYD(H)      = MISCH(H,'ETAYD');

  NRPG(H)       = MISCH(H,'NRPG');

  ETAU(H)       = MISCH(H,'ETAU');

  TAXBASE(G,H) = MISCG(G,H,'TAXBASE');

  TAXBM(G,H)    = MISCG(G,H,'TAXBM');

  TAXSD(G,H)    = MISCG(G,H,'TAXSD');

  TAXOD(G,H)    = MISCG(G,H,'TAXOD');

  TAXPI(G,H)    = MISCG(G,H,'TAXPI');

  TAXCVC(G,H)   = MISCG(G,H,'TAXCVC');

  MTR(G,H)      = MISCG(G,H,'MTR');

* CALCULATE TAX RATES FROM SAM INFORMATION

  TAUQ(GS,I) = SAM(GS,I) / (  SUM(J, SAM(I,J) ) + SUM(H, SAM(I,H) )
                            + SUM(G, SAM(I,G) ) + SAM(I,'INVES')
                            - SUM(GS1, SAM(GS1,I) ) );

  TAUC(GS,I) = TAUQ(GS,I);
  TAUV(GS,I) = TAUQ(GS,I);
  TAUN(GS,I) = TAUQ(GS,I);
  TAUG(GS,I) = TAUQ(GS,I);

  TAUM('USDUT',I) = SAM('USDUT',I) / SAM('ROW',I);

  TAUF(GF,F,I)$(SAM(F,I) AND TAUFF(GF,F)) = SAM(GF,I) / SAM(F,I);

  TAUF(GF,F,G)$(SAM(F,G) AND TAUFF(GF,F)) = SAM(GF,G) / SAM(F,G);

  TAUFX(GF,F,Z) = TAUF(GF,F,Z);

  TAUFH(GF,F)$TAUFF(GF,F) = SAM(GF,F) / SUM(Z, SAM(Z,F));
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  TAXS(G,G1)$(IGTD(G,G1) EQ 1) =  SAM(G,G1)
                              / SUM(G2$(IGTD(G2,G1) EQ 1), SAM(G2,G1) );

* SET INITIAL INTER GOVERNMENTAL TRANSFERS

  IGT0(G,G1) = SAM(G,G1);

  IGT0(GF,G) = 0;

* SET INITIAL PRICES TO UNITY LESS SALES AND EXCISE TAXES

  PW0(I)   = 1 / ( 1 + SUM(G, TAUM(G,I) ) );

  P0(I)   = 1;

  PD0(I)  = 1;

  CPI0(H) = 1;

* HOUSEHOLD TRANSFER PAYMENTS AND PERSONAL INCOME TAXES

  HH0(H)      = MISCH(H,'HH0');

  HW0(H)      = MISCH(H,'HW0');

  HN0(H)      = HH0(H) - HW0(H);

  TP0(H,G)$(HN0(H) * TPC(H,G)) = SAM(H,G) / ( HN0(H) * TPC(H,G) );

* FACTOR RENTALS

  JOBCOR      = SUM(H, HW0(H) ) / SUM(Z, MISC(Z,'JOBS') ) * 1000000;

  R0('K',G)   = 1;

  R0('L',I)   = SAM('L',I) / MISC(I,'JOBS') * 1000000;

  R0('L',G)$MISC(G,'JOBS') = SAM('L',G) / MISC(G,'JOBS') * 1000000;

  FD0('L',I)  = MISC(I,'JOBS') / 1000000;

  FD0('K',I)  = SAM('K',I) / R0('K',I);

  FD0('L',G)  = MISC(G,'JOBS') / 1000000;

  FD0('K',G)  = SAM('K',G) / R0('K',G);

  KS0(I)      = FD0('K',I);

* SHARES FOUND IN THE SOCIAL ACCOUNTING MATRIX DATA

  A(Z,Z1)     = SAM(Z,Z1) / Q0(Z1);

  AG(I,G)$(SUM(J, SAM(J,G) ) + SUM(F, SAM(F,G) ) + SUM(GF, SAM(GF,G) ) )
              =  SAM(I,G) / ( SUM(J, SAM(J,G) ) + SUM(F, SAM(F,G) )
               + SUM(GF, SAM(GF,G) ) );

  AG(F,G)$(SUM(I, SAM(I,G) ) + SUM(F1, SAM(F1,G) ) + SUM(GF, SAM(GF,G) ) )
              =  SAM(F,G) / ( SUM(I, SAM(I,G) ) + SUM(F1, SAM(F1,G) )
               + SUM(GF, SAM(GF,G) ) );

* TRADE INTERMEDIATES CONSUMPTION INVESTMENT INITIAL LEVELS

  CX0(I)      = SAM(I,'ROW');

  M0(I)       = SAM('ROW',I) / PW0(I);

  V0(I)       = SUM(J, SAM(I,J) ) / P0(I) / ( 1 + SUM(GS, TAUV(GS,I) ) );

  CH0(I,H)    = SAM(I,H) / P0(I) / ( 1 + SUM(GS, TAUC(GS,I) ) );

  CG0(I,G)    = SAM(I,G) / P0(I) / ( 1 + SUM(GS, TAUG(GS,I) ) );

  DEPR        = SUM(I, SAM(I,'INVES') ) / SUM(I, KS0(I) );

  N0(I)       = KS0(I) * DEPR;

  CN0(I)      = SUM(J, B(I,J) * N0(J) ) / P0(I) / ( 1 + SUM(GS, TAUN(GS,I) ) );

  DD0(I)      = SUM(H, CH0(I,H) ) + SUM(G, CG0(I,G) ) + CN0(I) + V0(I);

  D0(I)       = 1 - M0(I) / DD0(I);

* CORRECT IMPORT ELASTICITY TO DOMESTIC SHARE ELASTICITY

  ETAD(I)     = - ETAM(I) * M0(I) / ( DD0(I) * D0(I) );

* PRODUCTION DATA

  DS0(I)      = DD0(I) + CX0(I) - M0(I);

  AD(I,J)     = SAM(I,J) / P0(I) / ( 1 + SUM(GS, TAUV(GS,I) ) ) / DS0(J);

  PVA0(I)     = PD0(I) - SUM(J, AD(J,I) * P0(J) * ( 1 + SUM(GS, TAUV(GS,J) ) ) );
```

```
  RA0(F)       = 1;

  ALPHA(F,I)  =    ( SAM(F,I)            + SUM(GF$TAUFF(GF,F), SAM(GF,I) ) )
                / ( SUM(F1, SAM(F1,I) ) + SUM(GF, SAM(GF,I)             ) );

  GAMMA(I)     = DS0(I) / ( SUM(F, ALPHA(F,I) * FD0(F,I) ** ( - RHO(I) ) ) ) ** ( -1 / RHO(I) );

* OTHER DATA

  NKI0         = SAM('INVES','ROW');

  Y0(F)        = Q0(F);

  Y0(H)        = SUM(F, SAM(H,F) );

  A(H,F)       = SAM(H,F) / HW0(H) / Y0(F);

  TAUH(GH,H)  = SAM(GH,H) / HH0(H);

  S0(H)        = SAM('INVES',H);

  YD0(H)       = SUM(I, SAM(I,H) ) + S0(H);

  Y0(G)        = SUM(Z, SAM(G,Z) ) - SUM(G1, IGT0(G,G1) );

  S0(G)        = SAM('INVES',G);

  SPI0         = SUM(H, Y0(H) ) + SUM((H,G), TP0(H,G) * HN0(H) * TPC(H,G) );

  PIT0(GI,H)  = SAM(GI,H) / HW0(H);

  MI0(H)       = HH0(H) * 0.09;

  MO0(H)       = HH0(H) * 0.09;

  FITC(F,G) = 0;

  FITC('K','CABAC') = 1;

  ITC0(I) = SUM(J, N0(I) * B(J,I) / ( 1 + SUM(GS, TAUN(GS,J) ) ) * ITCE(J,I) );

  TAUF('CABAC','K',I) = ( SAM('CABAC',I) + ITC0(I) ) / SAM('K',I);

  TAUFX('CABAC','K',I) = TAUF('CABAC','K',I);


*-----------------------------------------------------------------------------------------------------------
* 4. VARIABLES
*-----------------------------------------------------------------------------------------------------------
* 4.1 VARIABLE DECLARATION
*-----------------------------------------------------------------------------------------------------------
  VARIABLES

  CG(I,G)    PUBLIC CONSUMPTION
  CH(I,H)    PRIVATE CONSUMPTION
  CN(I)      GROSS INVESTMENT BY SECTOR OF SOURCE
  CPI(H)     CONSUMER PRICE INDEX
  CX(I)      EXPORT DEMAND
  D(I)       DOMESTIC SHARE OF DOMESTIC DEMAND
  DD(I)      DOMESTIC DEMAND
  DS(I)      DOMESTIC SUPPLY
  FD(F,Z)    SECTORAL FACTOR DEMAND
  HH(H)      NUMBER OF HOUSEHOLDS
  HN(H)      NUMBER OF NONWORKING HOUSEHOLDS
  HW(H)      NUMBER OF WORKING HOUSEHOLDS
  IGT(G,G1)  INTER GOVERNMENTAL TRANSFERS
  ITC(I)     INVESTMENT TAX CREDIT AMOUNT
  KS(I)      CAPITAL STOCK
  M(I)       IMPORTS
  N(I)       GROSS INVESTMENT BY SECTOR OF DESTINATION
  NKI        NET CAPITAL INFLOW
  P(I)       AGGREGATE DOMESTIC PRICE PAID BY PURCHASERS
  PD(I)      DOMESTIC PRICE RECEIVED BY SUPPLIERS
  PIT(G,H)   PER HOUSEHOLD INCOME TAXES
  PVA(I)     VALUE ADDED PRICE
  RA(F)      ECONOMY WIDE SCALAR RENTAL RATES OF FACTORS
  R(F,Z)     SECTORAL RENTAL RATES
  S(Z)       SAVINGS
  SPI        STATE PERSONAL INCOME
  TP(H,G)    GOVERNMENT TRANSFER PAYMENTS
  V(I)       INTERMEDIATE GOODS
  Y(Z)       GROSS INCOMES
  YD(H)      AFTER TAX TOTAL HOUSEHOLD INCOMES;

*-----------------------------------------------------------------------------------------------------------
* 4.2 INITIALIZATION OF VARIABLES AND REMOVING TRACE NUMBERS
*-----------------------------------------------------------------------------------------------------------

  P.L(I)       = P0(I);          PD.L(I)      = PD0(I);
  PVA.L(I)     = PVA0(I);        RA.L(F)      = RA0(F);
  R.L(F,Z)     = R0(F,Z);        CPI.L(H)     = CPI0(H);
  DS.L(I)      = DS0(I);         DD.L(I)      = DD0(I);
  V.L(I)       = V0(I);          FD.L(F,Z)    = FD0(F,Z);
  HH.L(H)      = HH0(H);         HN.L(H)      = HN0(H);
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  HW.L(H)      = HW0(H);         KS.L(I)      = KS0(I);
  CN.L(I)      = CN0(I);         N.L(I)       = N0(I);
  D.L(I)       = D0(I);          CX.L(I)      = CX0(I);
  M.L(I)       = M0(I);          NKI.L        = NKI0;
  TP.L(H,G)    = TP0(H,G);       Y.L(Z)       = Y0(Z);
  YD.L(H)      = YD0(H);         PIT.L(G,H)   = PIT0(G,H);
  IGT.L(G,G1)  = IGT0(G,G1);     CH.L(I,H)    = CH0(I,H);
  CG.L(I,G)    = CG0(I,G);       S.L(Z)       = S0(Z);
  SPI.L        = SPI0;           ITC.L(I)     = ITC0(I);

* REMOVE TRACE NUMBERS FOR COMPUTATIONAL PURPOSES

  P.L(I)$(ABS(P.L(I))            LT 0.00000001) = 0;
  PD.L(I)$(ABS(PD.L(I))          LT 0.00000001) = 0;
  PVA.L(I)$(ABS(PVA.L(I))        LT 0.00000001) = 0;
  RA.L(F)$(ABS(RA.L(F))          LT 0.00000001) = 0;
  R.L(F,Z)$(ABS(R.L(F,Z))        LT 0.00000001) = 0;
  CPI.L(H)$(ABS(CPI.L(H))        LT 0.00000001) = 0;
  DS.L(I)$(ABS(DS.L(I))          LT 0.00000001) = 0;
  DD.L(I)$(ABS(DD.L(I))          LT 0.00000001) = 0;
  V.L(I)$(ABS(V.L(I))            LT 0.00000001) = 0;
  FD.L(F,Z)$(ABS(FD.L(F,Z))      LT 0.00000001) = 0;
  HH.L(H)$(ABS(HH.L(H))          LT 0.00000001) = 0;
  HN.L(H)$(ABS(HN.L(H))          LT 0.00000001) = 0;
  HW.L(H)$(ABS(HW.L(H))          LT 0.00000001) = 0;
  KS.L(I)$(ABS(KS.L(I))          LT 0.00000001) = 0;
  CN.L(I)$(ABS(CN.L(I))          LT 0.00000001) = 0;
  N.L(I)$(ABS(N.L(I))            LT 0.00000001) = 0;
  D.L(I)$(ABS(D.L(I))            LT 0.00000001) = 0;
  CX.L(I)$(ABS(CX.L(I))          LT 0.00000001) = 0;
  M.L(I)$(ABS(M.L(I))            LT 0.00000001) = 0;
  NKI.L$(ABS(NKI.L)              LT 0.00000001) = 0;
  TP.L(H,G)$(ABS(TP.L(H,G))      LT 0.00000001) = 0;
  Y.L(Z)$(ABS(Y.L(Z))            LT 0.00000001) = 0;
  YD.L(H)$(ABS(YD.L(H))          LT 0.00000001) = 0;
  PIT.L(G,H)$(ABS(PIT.L(G,H))    LT 0.00000001) = 0;
  IGT.L(G,G1)$(ABS(IGT.L(G,G1))  LT 0.00000001) = 0;
  CH.L(I,H)$(ABS(CH.L(I,H))      LT 0.00000001) = 0;
  CG.L(I,G)$(ABS(CG.L(I,G))      LT 0.00000001) = 0;
  S.L(Z)$(ABS(S.L(Z))            LT 0.00000001) = 0;
  SPI.L$(ABS(SPI.L)              LT 0.00000001) = 0;

*-----------------------------------------------------------------------------------------------------------------
* 4.2 INITIALIZATION OF VARIABLES AND REMOVING TRACE NUMBERS
*-----------------------------------------------------------------------------------------------------------------

  P.LO(I)      = P.L(I)     / 1000;   P.UP(I)      = P.L(I)     * 1000;
  PD.LO(I)     = PD.L(I)    / 1000;   PD.UP(I)     = PD.L(I)    * 1000;
  PVA.LO(I)    = PVA.L(I)   / 1000;   PVA.UP(I)    = PVA.L(I)   * 1000;
  RA.LO(F)     = RA.L(F)    / 1000;   RA.UP(F)     = RA.L(F)    * 1000;
  CPI.LO(H)    = CPI.L(H)   / 1000;   CPI.UP(H)    = CPI.L(H)   * 1000;
  DS.LO(I)     = DS.L(I)    / 1000;   DS.UP(I)     = DS.L(I)    * 1000;
  DD.LO(I)     = DD.L(I)    / 1000;   DD.UP(I)     = DD.L(I)    * 1000;
  D.LO(I)      = D.L(I)     / 1000;   D.UP(I)      = D.L(I)     * 1000;
  V.LO(I)      = V.L(I)     / 1000;   V.UP(I)      = V.L(I)     * 1000;
  FD.LO(F,Z)   = FD.L(F,Z)  / 1000;   FD.UP(F,Z)   = FD.L(F,Z)  * 1000;
  HH.LO(H)     = HH.L(H)    / 1000;   HH.UP(H)     = HH.L(H)    * 1000;
  HW.LO(H)     = HW.L(H)    / 1000;   HW.UP(H)     = HW.L(H)    * 1000;
  HN.LO(H)     = HN.L(H)    / 1000;   HN.UP(H)     = HN.L(H)    * 1000;
  KS.LO(I)     = KS.L(I)    / 1000;   KS.UP(I)     = KS.L(I)    * 1000;
  M.LO(I)      = M.L(I)     / 1000;   M.UP(I)      = M.L(I)     * 1000;
  Y.LO(Z)      = Y.L(Z)     / 1000;   Y.UP(Z)      = Y.L(Z)     * 1000;
  YD.LO(H)     = YD.L(H)    / 1000;   YD.UP(H)     = YD.L(H)    * 1000;
  CH.LO(I,H)   = CH.L(I,H)  / 1000;   CH.UP(I,H)   = CH.L(I,H)  * 1000;
  CG.LO(I,G)   = CG.L(I,G)  / 1000;   CG.UP(I,G)   = CG.L(I,G)  * 1000;
  CN.LO(I)     = 0;
  CX.LO(I)     = CX.L(I)    / 1000;   CX.UP(I)     = CX.L(I)    * 1000;
  N.LO(I)      = 0;
  TP.LO(H,G)   = TP.L(H,G)  / 1000;   TP.UP(H,G)   = TP.L(H,G)  * 1000;
  R.LO(F,I)    = R.L(F,I)   / 1000;   R.UP(F,I)    = R.L(F,I)   * 1000;
  PIT.LO(GI,H) = 0;

*-----------------------------------------------------------------------------------------------------------------
* 5. PRE-MODEL CHECK OF PARAMETERS AND INITIAL VALUES OF VARIABLES
*-----------------------------------------------------------------------------------------------------------------
* 5.1 PRINTING OF CALCULATED PARAMETERS AND EXOGENOUS VARIABLES
*-----------------------------------------------------------------------------------------------------------------

  DISPLAY DEPR, GAMMA, JOBCOR, TAUM, TAUF, TAUFH, TAUQ, TAXS, ALPHA, AG, AD, A;

*-----------------------------------------------------------------------------------------------------------------
* 5.2 SAVING OF INITIAL VALUES FOR VARIABLES
*-----------------------------------------------------------------------------------------------------------------

  R1('BAC',T)      = Y.L('CABAC');
  R1('PIT',T)      = Y.L('CAPIT');
  R1('SAU',T)      = Y.L('CALSU');
  R1('GFREV',T)    = Y.L('CALGF') + SUM(G, IGT.L('CALGF',G) );
  R1('SFREV',T)    = SUM(GC, Y.L(GC) - IGT.L('CALGF',GC) );
  R1('STATIC',T)   = 0;
  R1('DGF',T)      = 0;
  R1('DSF',T)      = 0;
  R1('DDRE',T)     = 0;
  R1('PDRE',T)     = 0;
  R1('NKI',T)      = NKI.L;
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```
  R1('SPI',T)     = SPI.L;
  R1('GN',T)      = SUM(I, N.L(I) );
  R1('POP',T)     = SUM(H, HH.L(H) );
  R1('W',T)       = RA.L('L') / RA0('L') * 100;
  R1('R',T)       = SUM(I, R.L('K',I) * KS.L(I) ) / SUM(I, R0('K',I) * KS.L(I) ) * 100;
  R1('LD',T)      = SUM(Z, FD.L('L',Z) );
  R1('KD',T)      = SUM(Z, FD.L('K',Z) );
  R1('GFSAV',T)   = S.L('CALGF');

*------------------------------------------------------------------------------------------------------------
* 6. EQUATIONS
*------------------------------------------------------------------------------------------------------------
* 6.1 EQUATION DECLARATION
*------------------------------------------------------------------------------------------------------------
  EQUATIONS

* HOUSEHOLDS
  CPIEQ(H)    CONSUMER PRICE INDICES
  YEQ(H)      HOUSEHOLD GROSS INCOMES
  YDEQ(H)     HOUSEHOLD DISPOSABLE INCOMES
  CHEQ(I,H)   PRIVATE CONSUMPTION
  SHEQ(H)     HOUSEHOLD SAVINGS

* PRODUCERS
  PVAEQ(I)    VALUE ADDED
  PFEQ(I)     PRODUCTION FUNCTION
  FDEQ(F,I)   FACTOR DEMAND
  VEQ(I)      INTERMEDIATE DEMAND
  YFEQ(F)     FACTOR INCOME

* TRADE
  XEQ(I)      EXPORT DEMAND
  DEQ(I)      DOMESTIC SHARES
  MEQ(I)      IMPORT DEMAND
  PEQ(I)      AGGREGATED PRICES
  NKIEQ       NET CAPITAL INFLOW

* INVESTMENT
  NEQ(I)      GROSS INVESTMENT BY SECTOR OF DESTINATION
  CNEQ(I)     GROSS INVESTMENT BY SECTOR OF SOURCE
  KSEQ(I)     CAPITAL STOCK
  ITCEQ(I)    INVESTMENT TAX CREDIT

* LABOR SUPPLY
  LSEQ(H)     LABOR SUPPLY

* MIGRATION
  POPEQ(H)    POPULATION
  ANEQ(H)     NUMBER OF NON WORKING HOUSEHOLDS

* TAXATION
  PITEQ(GI,H) HOUSEHOLD TAXES

* GOVERNMENT
  YGEQ(G)     GOVERNMENT INCOME
  CGEQ(I,GN)  GOVERNMENT ENDOGENOUS PURCHASES OF GOODS AND SERVICES
  GFEQ(F,GN)  GOVERNMENT ENDOGENOUS RENTAL OF FACTORS
  GSEQ(G)     GOVERNMENT SAVINGS
  TDEQ(G,G1)  DISTRIBUTION OF TAXES
  CGFBEQ      ENDOGENOUS BALANCE DISTRIBUTION OF CALIFORNIA GENERAL FUND
  HWIGTEQ     ENDOGENOUS HEALTH AND WELFARE TRANSFER
  TPEQ(H,GWN) ENDOGENOUS TRANSFER PAYMENTS
* PROP98      EDUCATION TRANSFER FOR PROPOSITION 98 TEST 2
  PROP98      EDUCATION TRANSFER FOR PROPOSITION 98 TEST 3

* MODEL CLOSURE
  SPIEQ       STATE PERSONAL INCOME
  LMEQ        LABOR MARKET CLEARING
  KMEQ(I)     CAPITAL MARKET CLEARING
  GMEQ(I)     GOODS MARKET CLEARING
  DDEQ(I)     DEFINITION OF DOMESTIC DEMAND ;

*------------------------------------------------------------------------------------------------------------
* 6.2 EQUATION ASSIGNMENT
*------------------------------------------------------------------------------------------------------------

* HOUSEHOLDS

  CPIEQ(H).. CPI(H) =E= SUM(I, P(I)  * ( 1 + SUM(GS, TAUC(GS,I) ) ) * CH(I,H) )
                      / SUM(I, P0(I) * ( 1 + SUM(GS, TAUQ(GS,I) ) ) * CH(I,H) );

  YEQ(H).. Y(H) =E= SUM(F,  A(H,F) * HW(H)
                          / SUM(H1, A(H1,F) * HW(H1) )
                          * Y(F) * ( 1 - SUM(G, TAUFH(G,F) ) ) );

  YDEQ(H).. YD(H) =E=   Y(H)
                      - SUM(GI, PIT(GI,H) ) * HW(H)
                      - SUM(G, TAUH(G,H) * HH(H) )
                      + SUM(G, TP(H,G) * HN(H) * TPC(H,G) );

  CHEQ(I,H).. CH(I,H) =E= CH0(I,H)
                         * ( ( YD(H)  / YD0(H)  )
                           / ( CPI(H) / CPI0(H) ) ) ** BETA(I,H)
                         * PROD(J, ( ( P(J)  * ( 1 + SUM(GS, TAUC(GS,J) ) ) )
                                   / ( P0(J) * ( 1 + SUM(GS, TAUQ(GS,J) ) ) ) )
```

```
                                                  ** LAMBDA(J,I) );

  SHEQ(H).. S(H) =E= YD(H) - SUM(I, P(I) * CH(I,H) * ( 1 + SUM(GS, TAUC(GS,I) ) ));

* PRODUCERS

  PVAEQ(I).. PVA(I) =E= PD(I) - SUM(J, AD(J,I) * P(J) * ( 1 + SUM(GS, TAUV(GS,J) ) ) );

  PFEQ(I).. DS(I) =E= GAMMA(I) * SUM(F, ALPHA(F,I) * FD(F,I) ** ( - RHO(I) ) ) ** ( -1 / RHO(I) );

  FDEQ(F,I).. R(F,I) * RA(F) * ( 1 + SUM(GF,TAUFX(GF,F,I) ) ) * FD(F,I)
              =E= PVA(I) * DS(I) * ALPHA(F,I) + SUM(G, FITC(F,G) * ITC(I) );

  VEQ(I).. V(I) =E= SUM(J, AD(I,J) * DS(J) );

  YFEQ(F).. Y(F) =E= SUM(Z, R(F,Z) * RA(F) * FD(F,Z) );

* TRADE

  XEQ(I).. CX(I) =E= CX0(I) * ( PD(I) / PW0(I) / ( 1 + SUM(G, TAUM(G,I) ) ) ) ** ETAE(I);

  DEQ(I).. D(I) =E= D0(I) * ( PD(I) / PW0(I) / ( 1 + SUM(G, TAUM(G,I) ) ) ) ** ETAD(I);

  MEQ(I).. M(I) =E= ( 1 - D(I) ) * DD(I);

  PEQ(I).. P(I) =E= D(I) * PD(I) + ( 1 - D(I) ) * PW0(I) * ( 1 + SUM(G, TAUM(G,I) ) );

  NKIEQ.. NKI =E= SUM(I, M(I) * PW0(I) ) - SUM(I, CX(I) * PD(I) );

* INVESTMENT

  NEQ(I).. N(I) =E= N0(I) * (  ( R('K',I)  * ( 1 - SUM(GK, TAUFX(GK,'K',I) ) ) * KS(I) + SUM(G, FITC('K',G) * ITC(I)  ) )
                           / ( R0('K',I) * ( 1 - SUM(GK, TAUF(GK,'K',I)  ) ) * KS(I) + SUM(G, FITC('K',G) * ITC0(I) ) ) )
** ETAIX ;

  CNEQ(I).. P(I) * ( 1 + SUM(GS, TAUN(GS,I) ) ) * CN(I) =E= SUM(J, B(I,J) * N(J) );

  KSEQ(I).. KS(I) =E= KS0(I) * ( 1 - DEPR ) + N(I) ;

  ITCEQ(I).. ITC(I) =E= SUM(J, N(I) * B(J,I) / ( 1 + SUM(GS, TAUN(GS,J) ) ) * ITCE(J,I) );

* LABOR SUPPLY

  LSEQ(H).. HW(H) / HH(H) =E= HW0(H) / HH0(H)  * ( ( RA('L') / RA0('L') )
                                                 / ( CPI(H) / CPI0(H) ) ) ** ETARA(H)
                                               * ( SUM(GI, PIT(GI,H) )
                                                 / SUM(GI, PIT0(GI,H) ) ) ** ETAPIT(H)
                                               * ( SUM(G, TP(H,G) / CPI(H) )
                                                 / SUM(G, TP0(H,G) / CPI0(H) ) ) ** ETATP(H);

* MIGRATION

  POPEQ(H).. HH(H) =E= HH0(H) * NRPG(H)
                     + MI0(H) * ( ( YD(H)   / HH(H)   )
                                / ( YD0(H)  / HH0(H)  )
                                / ( CPI(H)  / CPI0(H) ) ) ** ETAYD(H)
                              * ( ( HN(H)   / HH(H)   )
                                / ( HN0(H)  / HH0(H)  ) ) ** ETAU(H)
                     - MO0(H) * ( ( YD0(H)  / HH0(H)  )
                                / ( YD(H)   / HH(H)   )
                                / ( CPI0(H) / CPI(H)  ) ) ** ETAYD(H)
                              * ( ( HN0(H)  / HH0(H)  )
                                / ( HN(H)   / HH(H)   ) ) ** ETAU(H);

  ANEQ(H).. HN(H) =E= HH(H) - HW(H);

* TAXATION

  PITEQ(GI,H).. PIT(GI,H) =E= ( TAXBASE(GI,H)
                              + (  Y(H) / HW(H)
                                 - TAXBM(GI,H)
                                 - TAXSD(GI,H)
                                 - ( TAXOD(GI,H)
                                   + SUM(GI1, ATAX(GI1,GI) * PIT(GI1,H) ) )
                                   * TAXPI(GI,H) )
                                 * MTR(GI,H) ) * TAXCVC(GI,H);

* GOVERNMENT

  YGEQ(G).. Y(G) =E=   SUM(I, TAUV(G,I) * V(I) * P(I) )
                       + SUM(I, TAUM(G,I) * M(I) * PW0(I) )
                       + SUM((H,I), TAUC(G,I) * CH(I,H) * P(I) )
                       + SUM(I, TAUN(G,I) * CN(I) * P(I) )
                       + SUM((G1,I), TAUG(G,I) * CG(I,G1) * P(I) )
                       + SUM((F,I), TAUFX(G,F,I) * RA(F) * R(F,I) * FD(F,I) )
                       + SUM((F,G1), TAUFX(G,F,G1) * RA(F) * R(F,G1) * FD(F,G1) )
                       + SUM(F, TAUFH(G,F) * Y(F) )
                       + SUM(H, PIT(G,H) * HW(H) )
                       + SUM(H, TAUH(G,H) * HH(H) )
                       + SAM(G,'INVES')
                       - SUM((I,F), FITC(F,G) * ITC(I) );

  CGEQ(I,GN).. P(I) * ( 1 + SUM(GS, TAUG(GS,I) ) ) * CG(I,GN)
                =E= AG(I,GN) * (  Y(GN) + SUM(G1, IGT(GN,G1) )
                                        - SUM(G1, IGT(G1,GN) )
```

```
                                    - SUM(H, TP(H,GN) * HN(H) * TPC(H,GN) )
                                    - S0(GN) );

  GFEQ(F,GN).. FD(F,GN) * RA(F) * R(F,GN)
              =E= AG(F,GN) * (  Y(GN)
                              + SUM(G1, IGT(GN,G1) )
                              - SUM(G1, IGT(G1,GN) )
                              - SUM(H, TP(H,GN) * HN(H) * TPC(H,GN) )
                              - S0(GN) );

  GSEQ(G).. S(G) =E= Y(G) - SUM(I, CG(I,G) * P(I) * ( 1 + SUM(GS, TAUG(GS,I) ) ) )
                        - SUM(F, FD(F,G) * R(F,G) * RA(F) * ( 1 + SUM(GF, TAUFX(GF,F,G))) )
                        - SUM(H, TP(H,G) * HN(H) * TPC(H,G) )
                        - SUM(G1, IGT(G1,G) )
                        + SUM(G1, IGT(G,G1) );

  TDEQ(G1,G)$(IGTD(G1,G) EQ 1).. IGT(G1,G) =E= TAXS(G1,G) * ( Y(G) - SUM(H, TP(H,G) * HN(H) * TPC(H,G) ) - S0(G) );

  CGFBEQ.. IGT('CAHAW','CALGF') =E= Y('CALGF') + SUM(G, IGT('CALGF',G) )
                                  - SUM(G$IGTD(G,'CALGF'), IGT(G,'CALGF') );

  HWIGTEQ.. IGT('LOHAW','CAHAW') =E=  IGT0('LOHAW','CAHAW')
                                  + IGT('CAHAW','CALGF')
                                  - IGT0('CAHAW','CALGF');

  TPEQ(H,GWN).. TP(H,GWN) * HN(H) * TPC(H,GWN)
             =E= TP0(H,GWN) * HN0(H) * TPC(H,GWN)
                 * SUM(G, IGT(GWN,G) ) / SUM(G, IGT0(GWN,G) );

* PROP98.. IGT('LOK14','CALGF')
*            =E=  IGT0('LOK14','CALGF') * ADA
*               * SUM(H, Y(H)  + SUM(G, TP(H,G)  * HN(H)  * TPC(H,G) ) ) / SUM(H, HH(H) )
*               / SUM(H, Y0(H) + SUM(G, TP0(H,G) * HN0(H) * TPC(H,G) ) ) * SUM(H, HH0(H) ) ;

  PROP98.. IGT('LOK14','CALGF')
            =E= IGT0('LOK14','CALGF') * ADA
               * ( Y('CALGF')  + SUM(G, IGT('CALGF',G)  ) ) / SUM(H, HH(H)  )
               / ( Y0('CALGF') + SUM(G, IGT0('CALGF',G) ) ) * SUM(H, HH0(H) ) ;

* MODEL CLOSURE

  SPIEQ.. SPI =E= SUM(H, Y(H) ) + SUM((H,G), TP(H,G) * HN(H) * TPC(H,G) );

  LMEQ.. SUM(H, HW(H) ) =E= SUM(Z, FD('L',Z) ) * JOBCOR;

  KMEQ(I).. KS(I) =E= FD('K',I);

  GMEQ(I).. DS(I) =E= DD(I) + CX(I) - M(I);

  DDEQ(I).. DD(I) =E= V(I) + SUM(H, CH(I,H) ) + SUM(G, CG(I,G) ) + CN(I);

*-----------------------------------------------------------------------------------------------------------
* 6.3 MODEL CLOSURE
*-----------------------------------------------------------------------------------------------------------

* FIX PIT FOR NON INCOME TAX UNITS TO ZERO
  PIT.FX(G,H)$(NOT GI(G)) = 0;

* FIX INTER GOVERNMENTAL TRANSFERS TO ZERO IF NOT IN ORIGINAL SAM
  IGT.FX(G,G1)$(NOT IGT0(G,G1)) = 0;

* FIX EXOGENOUS INTERGOVERNMENTAL TRANSFERS
  IGT.FX(G,G1)$(IGTD(G,G1) EQ 2) = IGT0(G,G1);

* FIX GOVERNMENT DEMAND FOR EXOGENOUS GOVERNMENT UNITS
  CG.FX(I,GX) = CG0(I,GX);
  FD.FX(F,GX) = FD0(F,GX);

* FIX INTER SECTORAL WAGE DIFFERENTIALS
  R.FX('L',Z) = R0('L',Z);

* FIX GOVERNMENT RENTAL RATE FOR CAPITAL TO INITIAL LEVEL
  R.FX('K',G) = R0('K',G);

* FIX ECONOMY WIDE SCALAR FOR CAPITAL
  RA.FX('K') = RA0('K');

* FIX EXOGENOUS TRANSFER PAYMENT LEVELS
  TP.FX(H,GWX) = TP0(H,GWX);
  TP.FX(H,G)$(NOT TP0(H,G)) = 0;

*-----------------------------------------------------------------------------------------------------------
* 7. SOLVE AND OUTPUT PREPARATION
*-----------------------------------------------------------------------------------------------------------

  MODEL DRAM0 /ALL/;

* TAX EXPERIMENT LOOP

  LOOP(T$(ORD(T) GT 1),

  TAUFX('CABAC','K',I) = TAUF('CABAC','K',I)
                     * ( Y0('CABAC') + SUM(I1, ITC0(I1) ) + TXE(T,'CABAC') )
                     / ( Y0('CABAC') + SUM(I1, ITC0(I1) ) );
```

```
  TAXCVC('CAPIT',H) = MISCG('CAPIT',H,'TAXCVC')
                      * ( Y0('CAPIT') + TXE(T,'CAPIT') )
                      / Y0('CAPIT');

  TAUC('CALSU',I) = TAUQ('CALSU',I)
                    * ( Y0('CALSU') + TXE(T,'CALSU') )
                    / Y0('CALSU');

  TAUV('CALSU',I) = TAUC('CALSU',I);

  TAUG('CALSU',I) = TAUC('CALSU',I);

  TAUN('CALSU',I) = TAUC('CALSU',I);

  SOLVE DRAM0 MAXIMIZING SPI USING NLP;

  R1('BAC',T)      = Y.L('CABAC');
  R1('PIT',T)      = Y.L('CAPIT');
  R1('SAU',T)      = Y.L('CALSU');
  R1('GFREV',T)    = Y.L('CALGF') + SUM(G, IGT.L('CALGF',G) );
  R1('SFREV',T)    = SUM(GC, Y.L(GC) - IGT.L('CALGF',GC) );
  R1('STATIC',T)   = TXE(T,'CABAC') + TXE(T,'CAPIT') + TXE(T,'CALSU');
  R1('DGF',T)      = R1('GFREV',T) - R1('GFREV','TODAY');
  R1('DSF',T)      = R1('SFREV',T) - R1('SFREV','TODAY');
  R1('DDRE',T)     = R1('DGF',T) + R1('DSF',T) - R1('STATIC',T);
  R1('PDRE',T)$R1('STATIC',T) = R1('DDRE',T) / R1('STATIC',T) * 100;
  R1('NKI',T)      = NKI.L;
  R1('SPI',T)      = SPI.L;
  R1('GN',T)       = SUM(I, N.L(I) );
  R1('POP',T)      = SUM(H, HH.L(H) );
  R1('W',T)        = RA.L('L') / RA0('L') * 100;
  R1('R',T)        = SUM(I, R.L('K',I) * KS.L(I) ) / SUM(I, R0('K',I) * KS.L(I) ) * 100;
  R1('LD',T)       = SUM(Z, FD.L('L',Z) );
  R1('KD',T)       = SUM(Z, FD.L('K',Z) );
  R1('GFSAV',T)    = S.L('CALGF');
  R2('M-STAT',T)   = DRAM0.MODELSTAT;
  R2('S-STAT',T)   = DRAM0.SOLVESTAT);


* PUT RESULTS INTO OUTPUT FILE

  PUT 'DRAM0              ';
  LOOP(T, PUT T.TL);
  PUT /;

  PUT '           ',' MODEL    ','           ';
  LOOP(T$(ORD(T) GT 1), LOOP(MS$(R2('M-STAT',T) EQ ORD(MS) ), PUT MS.TL ) );
  PUT /;

  PUT '           ',' SOLVER   ', PUT '           ';
  LOOP(T$(ORD(T) GT 1), LOOP(SS$(R2('S-STAT',T) EQ ORD(SS) ), PUT SS.TL ) );
  PUT /;

  LOOP(R1H, PUT '           ';
            PUT R1H.TL,
            LOOP(T, PUT R1(R1H,T) );
            PUT / );
```

XII.4.2.SOCIAL ACCOUNTING MATRIX INPUT FILE

TABLE SAM(Z,Z1) SOCIAL ACCOUNTING MATRIX

	AGRIC	ENMIN	OTHPR	CONST	FOODS	ALTOH	APPAR
AGRIC	0.566244	0.000018	0.025990	0.001749	4.430580	0.479098	0.000091
ENMIN	0.001147	0.025106	0.007212	0.007097	0.011694	0.001162	0.000707
OTHPR	0.000195	0.000778	0.401988	0.026116	0.012056	0.000027	0.001174
CONST	0.100316	1.089888	0.195344	0.084378	0.226323	0.030332	0.035533
FOODS	0.130187	0.000500	0.046755	0.000231	3.865049	0.018062	0.001253
ALTOH	0.000153	0.000011	0.000065	0.000051	0.003430	0.128469	0.000024
APPAR	0.010594	0.000265	0.003525	0.035880	0.009738	0.000104	1.195101
MFRCO	0.039555	0.007703	0.035269	3.102881	0.794878	0.621418	0.004095
PAPER	0.059044	0.030902	0.013015	0.034026	1.801656	0.290775	0.123477
CHEMS	0.107178	0.042346	0.128442	0.882097	0.255042	0.005850	0.027349
PETRO	0.067104	0.026303	0.157188	0.445186	0.088217	0.004842	0.011169
ELECT	0.000084	0.000636	0.008992	0.408520	0.005171	0.001357	0.001705
AEROS	0.000024	0.000288	0.001589	0.045013	0.000215	0.000056	0.000565
MOTOR	0.000290	0.000011	0.000231	0.000905	0.000031	0.000004	0.000027
OTHMA	0.057992	0.014727	0.090629	0.885673	0.105661	0.028192	0.559953
TRANS	0.279736	0.034950	0.169308	1.576944	1.191805	0.148955	0.071738
COMMU	0.011562	0.017260	0.007971	0.134845	0.265582	0.066575	0.038212
UTILI	0.115380	0.135835	0.535192	0.192337	0.589141	0.063378	0.074324
WHOLE	0.452626	0.045321	0.193674	3.814602	2.667937	0.356745	0.444393
RETAI	0.011418	0.001216	0.006447	3.200273	0.016032	0.002547	0.007235
BANKS	0.043333	0.007951	0.059227	0.522182	0.054520	0.026222	0.028354
INSUR	0.064851	0.001276	0.021897	0.236467	0.041746	0.014945	0.011243
REALE	0.317179	0.878830	0.105967	0.209430	0.105609	0.030268	0.049121
OFIRE	0.000112	0.001456	0.011280	0.000014	0.008021	0.002408	0.001105
BSERV	2.223266	0.089729	1.051737	5.371953	0.870189	0.177548	0.166207
HEALT	0.080764	0.000005	0.000015	0.000251	0.000041	0.000010	0.000016
ENTER	0.000003	0.000962	0.002620	0.024873	0.003928	0.000880	0.000843
OSERV	0.051055	0.018619	0.162705	1.370051	0.142024	0.021359	0.073938
L	3.500416	1.941129	4.234632	18.950869	8.443057	1.358443	3.010861
K	8.840805	2.820192	0.788853	17.584640	5.572442	0.900695	1.325401
0P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
6P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
8P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
9P3MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
INVES	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USSOC	0.272863	0.151314	0.330096	1.477251	0.658150	0.105893	0.234701
USPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USCOR	0.665569	0.212315	0.059388	1.323838	0.419514	0.067808	0.099781
USDUT	0.029654	0.009344	0.004623	0.224818	0.123156	0.009950	0.036996
USMSC	0.041848	0.006672	0.002647	0.297865	0.108194	0.063594	0.069276
CAMSC	0.023900	0.003811	0.001512	0.170114	0.061791	0.036320	0.039564
CASIN	0.000000	0.000000	0.000000	0.000000	0.000000	1.045657	0.000000
CAENE	0.000000	0.105352	0.000000	0.000000	0.000000	0.000000	0.000000
CAOPR	0.000000	0.000000	0.035117	0.000000	0.000000	0.000000	0.000000
CAINS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMVS	0.007193	0.000224	0.001469	0.022419	0.000641	0.000084	0.000669
CAGAS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALSU	0.000000	0.052694	0.020908	2.352331	0.854441	0.502224	0.547095
CABAC	0.207809	0.066290	0.018543	0.413338	0.130984	0.021171	0.031154
CAUDI	0.015915	0.008826	0.019253	0.086163	0.038387	0.006176	0.013689
CALWC	0.013240	0.007342	0.016017	0.071679	0.031935	0.005138	0.011388
CAPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASUF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALGF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOPRP	0.000000	0.086534	0.024205	0.539561	0.170983	0.027637	0.040668
LOFEE	0.151586	0.064007	0.074921	0.523345	0.279431	0.042299	0.064281
LOMSC	0.014512	0.006128	0.007172	0.050101	0.026750	0.004049	0.006154
FEDNO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDDE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CATRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CACOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOED	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOTRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ROW	3.013103	0.887088	0.438870	14.569279	11.646706	11.008908	7.903738

+	MFRCO	PAPER	CHEMS	PETRO	ELECT	AEROS	MOTOR
AGRIC	0.001064	0.000523	0.022529	0.000079	0.000151	0.000136	0.000118
ENMIN	0.016012	0.004403	0.029578	0.532619	0.003129	0.003172	0.000740
OTHPR	0.046413	0.004754	0.119505	0.003379	0.010239	0.000243	0.000068
CONST	0.525997	0.147996	0.220849	0.273872	0.467600	0.370629	0.037650
FOODS	0.003688	0.004403	0.104415	0.001754	0.001317	0.000441	0.000012
ALTOH	0.000199	0.000120	0.000114	0.000009	0.000064	0.000058	0.000007
APPAR	0.015294	0.001586	0.006592	0.000048	0.005180	0.067442	0.160272
MFRCO	1.846881	0.101808	0.249629	0.013245	0.316310	0.217346	0.157939
PAPER	0.591061	0.804975	0.585267	0.017844	0.201190	0.395523	0.048475
CHEMS	0.366470	0.592447	3.673812	0.131790	0.210172	0.059060	0.028919
PETRO	0.138379	0.114370	0.973072	1.019830	0.067332	0.036269	0.007504
ELECT	0.028619	0.054449	0.036721	0.003894	6.890735	3.399753	0.072779
AEROS	0.001968	0.001355	0.003260	0.000199	0.049752	2.373779	0.002258
MOTOR	0.000567	0.000098	0.000099	0.000010	0.000070	0.000300	0.027801
OTHMA	0.393386	0.151346	0.189519	0.006182	0.407227	0.721956	0.360348
TRANS	0.924471	0.686125	0.890349	1.068391	0.323079	0.422381	0.126996
COMMU	0.148906	0.090511	0.098408	0.015695	0.108328	0.239301	0.022801
UTILI	0.742763	0.325395	0.750994	0.426500	0.347211	0.304172	0.033454
WHOLE	1.668924	0.901408	1.394265	0.973058	1.639115	0.914208	0.413304
RETAI	0.029926	0.034208	0.015874	0.003286	0.020214	0.021451	0.004833
BANKS	0.096210	0.053393	0.054382	0.079750	0.108778	0.142819	0.007676
INSUR	0.054546	0.045569	0.038391	0.048996	0.038393	0.046595	0.010197
REALE	0.134740	0.182865	0.118880	0.070428	0.187709	0.207363	0.005357
OFIRE	0.010486	0.005413	0.005990	0.024090	0.010701	0.001652	0.001323
BSERV	0.793682	1.036652	1.007435	0.214157	0.784200	1.081766	0.076223
HEALT	0.000065	0.000075	0.000132	0.000079	0.000070	0.000068	0.000010
ENTER	0.010307	0.011367	0.005888	0.001430	0.029274	0.025542	0.005119
OSERV	0.268821	0.248851	0.294463	0.125829	0.330008	0.366398	0.043991
L	8.852733	7.946198	6.159341	3.731721	9.671163	9.741793	1.023766
K	4.203681	4.341787	5.527103	0.991293	6.571043	4.697193	0.391187
0P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
6P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
8P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
9P3MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
INVES	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USSOC	0.690085	0.619419	0.480131	0.290894	0.753883	0.759388	0.079804
USPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USCOR	0.316469	0.326866	0.416101	0.074628	0.494693	0.353622	0.029450
USDUT	0.097724	0.082569	0.074041	0.188741	0.096104	0.138663	0.025433
USMSC	0.075672	0.066083	0.102081	0.136997	0.133529	0.038387	0.035165
CAMSC	0.043218	0.037741	0.058300	0.078241	0.076260	0.021923	0.020083
CASIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMVS	0.014081	0.002370	0.002370	0.000167	0.002063	0.009006	0.624229
CAGAS	0.000000	0.000000	0.000000	2.734225	0.000000	0.000000	0.000000
CALSU	0.597609	0.521879	0.806165	1.081907	1.054524	0.303154	0.277712
CABAC	0.098810	0.102057	0.129918	0.023301	0.154457	0.110411	0.009195
CAUDI	0.040250	0.036128	0.028004	0.016967	0.043971	0.044292	0.004655
CALWC	0.033484	0.030055	0.023297	0.014115	0.036580	0.036847	0.003872
CAPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASUF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALGF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOPRP	0.128984	0.133222	0.169592	0.000000	0.201624	0.144127	0.012003
LOFEE	0.193911	0.158327	0.199756	0.086527	0.254815	0.228794	0.027173
LOMSC	0.018563	0.015157	0.019123	0.008283	0.024394	0.021903	0.002601
FEDNO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDDE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CATRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CACOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOED	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOTRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ROW	10.464357	8.788851	9.114324	21.520796	11.210109	4.711912	4.810991

+	OTHMA	TRANS	COMMU	UTILI	WHOLE	RETAI	BANKS
AGRIC	0.017703	0.003901	0.000020	0.000107	0.000958	0.130509	0.000850
ENMIN	0.015167	0.023038	0.000169	0.403044	0.015085	0.010818	0.000980
OTHPR	0.064596	0.000162	0.000001	0.002517	0.000100	0.005986	0.000001
CONST	0.734197	0.733619	0.849283	2.130155	0.597643	1.495763	0.359657
FOODS	0.021308	0.014517	0.000046	0.001258	0.003047	2.393195	0.000016
ALTOH	0.000260	0.009332	0.000064	0.000050	0.001049	0.096887	0.000086
APPAR	0.047184	0.023519	0.004069	0.000644	0.031424	0.006752	0.021879
MFRCO	0.714896	0.033785	0.009043	0.058638	0.173325	0.036534	0.002800
PAPER	0.960555	0.236888	0.060766	0.015758	1.210716	1.433771	0.282889
CHEMS	0.587809	0.043217	0.013956	0.101030	0.034750	0.031136	0.006241
PETRO	0.181877	1.990533	0.007482	0.976345	0.283977	0.227768	0.034468
ELECT	3.196361	0.070805	0.517199	0.127147	0.028603	0.046086	0.185614
AEROS	0.067398	0.264168	0.009474	0.004777	0.000279	0.000099	0.000320
MOTOR	0.004734	0.000924	0.000020	0.001347	0.000298	0.000238	0.000049
OTHMA	1.963685	0.123967	0.043739	0.117779	0.108747	0.114892	0.113353
TRANS	0.966361	5.114940	0.063804	0.576882	0.641618	0.497923	0.737175
COMMU	0.331630	0.248752	1.002653	0.016751	0.479362	0.819330	0.276639
UTILI	0.912667	0.305978	0.117672	5.238277	0.559344	1.442781	0.170412
WHOLE	3.277314	0.762768	0.075367	0.471494	1.268921	1.044890	0.133003
RETAI	0.057783	0.438463	0.009891	0.026262	0.181082	0.210140	0.054183
BANKS	0.162341	0.397779	0.071390	0.093259	0.338662	0.329101	1.399890
INSUR	0.089092	0.225506	0.003968	0.289877	0.050199	0.056603	0.295593
REALE	0.315495	0.496380	0.220160	0.090015	0.886099	2.739466	0.648558
OFIRE	0.017279	0.013429	0.007166	0.035550	0.003826	0.009445	1.203043
BSERV	1.757499	1.348444	0.447875	0.572922	4.132096	5.735684	4.048999
HEALT	0.000136	0.000244	0.000042	0.000034	0.000294	0.000371	0.000515
ENTER	0.030531	0.033756	1.552163	0.003574	0.334866	0.336309	0.050803
OSERV	0.648148	0.649536	0.104208	0.157833	1.710603	0.972008	0.234428
L	21.426265	11.257358	9.835290	7.816789	31.503454	46.958176	6.106540
K	7.454023	5.367150	6.028861	7.080198	7.093416	13.054623	0.996660
0P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
6P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
8P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
9P3MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
INVES	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USSOC	1.670212	0.877529	0.766677	0.609331	2.455745	3.660465	0.476015
USPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USCOR	0.561167	0.404059	0.453875	0.533024	0.534019	0.982801	0.075032
USDUT	0.170579	0.072870	0.018295	0.074025	0.047990	0.093967	0.055434
USMSC	0.138226	0.160483	0.079259	0.158761	0.309264	0.625746	0.152926
CAMSC	0.078942	0.091654	0.045266	0.090671	0.176625	0.357372	0.087338
CASIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMVS	0.103532	0.027099	0.000435	0.026374	0.007502	0.005838	0.001772
CAGAS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALSU	1.091611	0.000000	0.000000	0.000000	2.442357	4.941712	0.000000
CABAC	0.175212	0.126158	0.141712	0.166425	0.166735	0.306857	0.023427
CAUDI	0.097417	0.051183	0.044717	0.035540	0.143234	0.213501	0.027764
CALWC	0.081041	0.042579	0.037200	0.029566	0.119157	0.177612	0.023097
CAPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASUF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALGF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOPRP	0.228717	0.164684	0.184988	0.217246	0.217652	0.400564	0.000000
LOFEE	0.407215	0.267495	0.186298	0.233674	0.457201	0.709926	0.153648
LOMSC	0.038983	0.025608	0.017835	0.022370	0.043769	0.067962	0.014709
FEDNO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDDE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CATRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CACOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOED	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOTRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ROW	15.479817	13.558861	2.399646	10.764488	14.314782	57.826071	17.044826

+	INSUR	REALE	OFIRE	BSERV	HEALT	ENTER	OSERV
AGRIC	0.000079	0.010159	0.000036	0.841793	0.014249	0.003225	0.024905
ENMIN	0.000169	0.004120	0.000073	0.005130	0.008842	0.002931	0.027154
OTHPR	0.000000	0.000010	0.000000	0.002276	0.015791	0.000057	0.001640
CONST	0.157694	11.477058	0.038058	0.469051	0.351496	0.384601	4.139890
FOODS	0.000004	0.000256	0.000003	0.007592	0.157436	0.144925	0.327554
ALTOH	0.000074	0.001725	0.000040	0.026368	0.000261	0.001862	0.002876
APPAR	0.001161	0.001728	0.000118	0.049196	0.060019	0.047320	0.187595
MFRCO	0.000360	0.026367	0.000507	0.046678	0.066897	0.045160	0.497902
PAPER	0.196431	1.948344	0.080831	0.595169	0.148266	0.320163	1.396194
CHEMS	0.001578	0.068951	0.000817	0.507160	1.567714	0.034183	0.320489
PETRO	0.011484	0.200239	0.006091	0.194582	0.217457	0.019592	0.625553
ELECT	0.034450	0.040283	0.014342	1.758149	0.081050	0.018031	0.761893
AEROS	0.000053	0.000107	0.000016	0.004044	0.002023	0.000161	0.004567
MOTOR	0.000036	0.000194	0.000015	0.000432	0.000128	0.000189	0.030731
OTHMA	0.047940	0.132964	0.022808	0.457069	1.113472	0.086823	1.350869
TRANS	0.149859	0.887576	0.128460	0.971889	0.212782	0.127239	0.964350
COMMU	0.177553	1.112055	0.090873	0.467122	0.129040	0.195419	0.692564
UTILI	0.026712	0.217250	0.040231	0.289233	0.361743	0.220821	1.274562
WHOLE	0.040940	0.314332	0.019845	0.971448	0.713037	0.126489	2.185302
RETAI	0.064147	0.410262	0.025004	0.153484	0.047264	0.027735	1.362228
BANKS	0.416315	1.725408	0.028849	0.312699	0.075946	0.070177	0.486359
INSUR	0.009720	3.212086	0.137999	0.116503	0.084988	0.016105	0.383898
REALE	0.572311	14.455702	0.187054	1.721324	1.519839	0.733743	4.964304
OFIRE	4.515158	0.183132	0.276855	0.036760	0.002422	0.003210	0.217516
BSERV	1.400809	7.941151	0.681803	10.670592	1.929570	2.057828	5.086295
HEALT	0.000085	0.000612	0.000044	0.001483	1.223909	0.000132	0.000642
ENTER	0.033653	0.187222	0.017426	0.164850	0.029297	9.737109	0.619921
OSERV	0.242579	1.403079	0.106870	2.052488	0.362242	0.336147	2.067183
L	2.393339	26.813218	3.583146	38.137364	33.708975	16.217685	49.020679
K	0.165154	31.805364	4.457593	25.380365	13.845372	7.792259	9.171358
0P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
6P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
8P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
9P3MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
INVES	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USSOC	0.186565	2.090133	0.279312	2.972868	2.627668	1.264195	3.821240
USPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USCOR	0.012433	2.394427	0.335584	1.910729	1.042332	0.586630	0.690454
USDUT	0.051138	0.055601	0.014488	0.113239	0.047187	0.031171	0.133198
USMSC	0.132685	0.243694	0.065959	0.449572	0.418220	0.104362	0.366794
CAMSC	0.075778	0.139177	0.037670	0.256757	0.238851	0.059603	0.209481
CASIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINS	1.252000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMVS	0.001412	0.001802	0.000541	0.013012	0.003327	0.004159	0.554604
CAGAS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALSU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CABAC	0.003882	0.747606	0.104779	0.596582	0.325445	0.183162	0.215579
CAUDI	0.010882	0.121910	0.016291	0.173396	0.153262	0.073736	0.222879
CALWC	0.009052	0.101417	0.013553	0.144249	0.127499	0.061341	0.185413
CAPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASUF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALGF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOPRP	0.005068	0.975905	0.136775	0.778763	0.424827	0.239095	0.281411
LOFEE	0.094317	0.925314	0.087999	0.764561	0.513630	0.343042	0.780352
LOMSC	0.009029	0.088582	0.008424	0.073193	0.049171	0.032840	0.074704
FEDNO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDDE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CATRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CACOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOED	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOTRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ROW	25.662473	5.278323	3.702123	28.363879	35.367342	1.824284	7.077273

+	L	K	0P0MT	1P0MT	2P0MT	4P0MT	6P0MT
AGRIC	0.000000	0.000000	0.358061	0.495912	0.466273	0.386365	0.468474
ENMIN	0.000000	0.000000	0.055136	0.076363	0.070811	0.058676	0.073120
OTHPR	0.000000	0.000000	0.005572	0.007717	0.007972	0.006606	0.008569
CONST	0.000000	0.000000	0.327993	0.454268	0.838787	0.695038	1.320497
FOODS	0.000000	0.000000	1.951361	2.702621	2.502475	2.073608	2.480910
ALTOH	0.000000	0.000000	0.858920	1.189598	2.369889	1.963745	2.437041
APPAR	0.000000	0.000000	1.067755	1.478833	1.935844	1.604085	2.224666
MFRCO	0.000000	0.000000	0.259889	0.359944	0.489600	0.405694	0.755170
PAPER	0.000000	0.000000	0.104781	0.145120	0.219080	0.181535	0.294779
CHEMS	0.000000	0.000000	1.297906	1.797590	1.509421	1.250740	1.544921
PETRO	0.000000	0.000000	1.675714	2.320852	2.932164	2.429658	2.858524
ELECT	0.000000	0.000000	0.051131	0.070816	0.096226	0.079735	0.117971
AEROS	0.000000	0.000000	0.003907	0.005411	0.007164	0.005936	0.011704
MOTOR	0.000000	0.000000	0.103241	0.142989	0.291831	0.241818	0.438636
OTHMA	0.000000	0.000000	0.562232	0.778687	0.893189	0.740117	1.031115
TRANS	0.000000	0.000000	1.055260	1.461528	1.670674	1.384359	2.337996
COMMU	0.000000	0.000000	1.025213	1.419913	1.368155	1.133685	1.322767
UTILI	0.000000	0.000000	1.962568	2.718143	2.393097	1.982975	2.376460
WHOLE	0.000000	0.000000	3.100927	4.294761	4.905727	4.064998	5.480057
RETAI	0.000000	0.000000	8.057526	11.159615	17.112254	14.179606	24.782565
BANKS	0.000000	0.000000	2.148663	2.975882	3.834854	3.177648	3.976272
INSUR	0.000000	0.000000	2.074523	2.873199	3.663250	3.035453	4.407559
REALE	0.000000	0.000000	4.175995	5.783722	4.478427	3.710928	3.371753
OFIRE	0.000000	0.000000	0.199144	0.275813	0.520428	0.431239	0.764565
BSERV	0.000000	0.000000	1.247471	1.727739	2.380328	1.972394	2.956340
HEALT	0.000000	0.000000	9.577620	13.264935	15.094263	12.507453	12.676558
ENTER	0.000000	0.000000	0.733840	1.016364	1.554416	1.288025	2.146297
OSERV	0.000000	0.000000	4.651483	6.442270	8.212872	6.805374	12.341207
L	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
K	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0P0MT	1.303050	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1P0MT	27.807957	15.291292	0.000000	0.000000	0.000000	0.000000	0.000000
2P0MT	60.149047	25.355064	0.000000	0.000000	0.000000	0.000000	0.000000
4P0MT	60.242895	18.398676	0.000000	0.000000	0.000000	0.000000	0.000000
6P0MT	96.227284	25.447480	0.000000	0.000000	0.000000	0.000000	0.000000
8P0MT	34.399484	9.729667	0.000000	0.000000	0.000000	0.000000	0.000000
9P3MT	163.300765	110.026532	0.000000	0.000000	0.000000	0.000000	0.000000
INVES	0.000000	0.000000	1.711309	3.075309	6.135482	5.835355	12.252666
USSOC	37.488395	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USPIT	0.000000	0.000000	0.000000	1.190392	5.949906	7.241797	13.370886
USCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USDUT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMVS	0.000000	0.000000	0.267072	0.646393	0.535019	0.382393	0.507436
CAGAS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALSU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CABAC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAUDI	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALWC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAPIT	0.000000	0.000000	0.000000	0.073029	0.703226	1.290320	2.772911
CASUF	0.000000	0.000000	0.090322	0.183156	0.107374	0.061186	0.065826
CAINH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALGF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOPRP	0.000000	0.000000	0.026459	0.875155	1.736211	1.596863	2.470677
LOFEE	0.000000	0.000000	0.038931	1.287668	2.554590	2.349560	3.635254
LOMSC	0.000000	0.000000	0.003727	0.123271	0.244556	0.224928	0.348009
FEDNO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDDE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CATRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CACOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOED	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOTRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ROW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

+	8P0MT	9P3MT	INVES	USSOC	USPIT	USCOR	USDUT
AGRIC	0.151760	0.789662	0.000000	0.000000	0.000000	0.000000	0.000000
ENMIN	0.023687	0.123251	0.005740	0.000000	0.000000	0.000000	0.000000
OTHPR	0.002776	0.014444	0.099337	0.000000	0.000000	0.000000	0.000000
CONST	0.427767	2.225834	28.094163	0.000000	0.000000	0.000000	0.000000
FOODS	0.803676	4.181830	0.000000	0.000000	0.000000	0.000000	0.000000
ALTOH	0.789465	4.107884	0.000000	0.000000	0.000000	0.000000	0.000000
APPAR	0.720668	3.749905	0.000000	0.000000	0.000000	0.000000	0.000000
MFRCO	0.244633	1.272917	3.024523	0.000000	0.000000	0.000000	0.000000
PAPER	0.095492	0.496881	0.000000	0.000000	0.000000	0.000000	0.000000
CHEMS	0.500468	2.604124	0.168134	0.000000	0.000000	0.000000	0.000000
PETRO	0.926002	4.818338	0.000000	0.000000	0.000000	0.000000	0.000000
ELECT	0.038216	0.198852	6.659832	0.000000	0.000000	0.000000	0.000000
AEROS	0.003792	0.019729	0.532716	0.000000	0.000000	0.000000	0.000000
MOTOR	0.142094	0.739366	5.483911	0.000000	0.000000	0.000000	0.000000
OTHMA	0.334024	1.738051	12.120923	0.000000	0.000000	0.000000	0.000000
TRANS	0.757380	3.940935	0.422334	0.000000	0.000000	0.000000	0.000000
COMMU	0.428503	2.229661	0.471569	0.000000	0.000000	0.000000	0.000000
UTILI	0.769840	4.005769	0.000000	0.000000	0.000000	0.000000	0.000000
WHOLE	1.775233	9.237202	4.833177	0.000000	0.000000	0.000000	0.000000
RETAI	8.028168	41.773573	4.833177	0.000000	0.000000	0.000000	0.000000
BANKS	1.288090	6.702417	0.000000	0.000000	0.000000	0.000000	0.000000
INSUR	1.427803	7.429396	0.000000	0.000000	0.000000	0.000000	0.000000
REALE	1.092260	5.683438	0.121025	0.000000	0.000000	0.000000	0.000000
OFIRE	0.247676	1.288753	0.000000	0.000000	0.000000	0.000000	0.000000
BSERV	0.957689	4.983216	0.758015	0.000000	0.000000	0.000000	0.000000
HEALT	4.106498	21.367648	0.000000	0.000000	0.000000	0.000000	0.000000
ENTER	0.695281	3.617806	0.000000	0.000000	0.000000	0.000000	0.000000
OSERV	3.997863	20.802379	0.000000	0.000000	0.000000	0.000000	0.000000
L	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
K	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0P0MT	0.000000	0.000000	0.000000	22.523045	0.000000	0.000000	0.000000
1P0MT	0.000000	0.000000	0.000000	21.531233	0.000000	0.000000	0.000000
2P0MT	0.000000	0.000000	0.000000	9.817560	0.000000	0.000000	0.000000
4P0MT	0.000000	0.000000	0.000000	5.594456	0.000000	0.000000	0.000000
6P0MT	0.000000	0.000000	0.000000	6.018643	0.000000	0.000000	0.000000
8P0MT	0.000000	0.000000	0.000000	1.642905	0.000000	0.000000	0.000000
9P3MT	0.000000	0.000000	0.000000	4.477305	0.000000	0.000000	0.000000
INVES	5.899513	41.923295	0.000000	0.000000	0.000000	0.000000	0.000000
USSOC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USPIT	5.306267	49.706977	0.000000	0.000000	0.000000	0.000000	0.000000
USCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USDUT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USMSC	0.643145	1.929435	0.000000	0.000000	0.000000	0.000000	0.000000
CAMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMVS	0.166797	0.851150	0.000000	0.000000	0.000000	0.000000	0.000000
CAGAS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALSU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CABAC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAUDI	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALWC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAPIT	1.229889	13.420625	0.000000	0.000000	0.000000	0.000000	0.000000
CASUF	0.017968	0.048968	0.000000	0.000000	0.000000	0.000000	0.000000
CAINH	0.138000	0.414000	0.000000	0.000000	0.000000	0.000000	0.000000
CALGF	0.000000	0.000000	0.258642	0.000000	0.000000	0.000000	0.000000
LOPRP	0.896068	5.550069	0.000000	0.000000	0.000000	0.000000	0.000000
LOFEE	1.318438	8.166149	0.000000	0.000000	0.000000	0.000000	0.000000
LOMSC	0.126216	0.781760	0.000000	0.000000	0.000000	0.000000	0.000000
FEDNO	0.000000	0.000000	0.000000	3.371645	82.766225	15.376608	2.120998
FEDDE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CATRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CACOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOED	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOTH	0.000000	0.000000	0.103782	0.000000	0.000000	0.000000	0.000000
LOTRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ROW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

+	USMSC	CAMSC	CASIN	CAENE	CAOPR	CAINS	CAMVS
AGRIC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENMIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OTHPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CONST	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FOODS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ALTOH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
APPAR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MFRCO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
PAPER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CHEMS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
PETRO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ELECT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
AEROS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MOTOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OTHMA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
TRANS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
COMMU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
UTILI	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WHOLE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
RETAI	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
BANKS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
INSUR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
REALE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OFIRE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
BSERV	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
HEALT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENTER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OSERV	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
L	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
K	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
6P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
8P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
9P3MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
INVES	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USSOC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USDUT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMVS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAGAS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALSU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CABAC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAUDI	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALWC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASUF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALGF	0.000000	0.372414	0.507300	0.068288	0.022762	1.252000	0.036297
LOPRP	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOFEE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDNO	7.156541	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDDE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CATRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	2.594884
CACOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAK14	0.000000	0.054845	0.000000	0.000000	0.000000	0.000000	0.000000
CAOED	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOTH	0.000000	2.190704	0.538357	0.000000	0.000000	0.000000	0.000000
LOTRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	2.163473
LOCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOOTH	0.000000	0.000000	0.000000	0.037064	0.012355	0.000000	0.000000
ROW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

+	CAGAS	CALSU	CABAC	CAUDI	CALWC	CAPIT	CASUF
AGRIC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENMIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OTHPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CONST	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FOODS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ALTOH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
APPAR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MFRCO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
PAPER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CHEMS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
PETRO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ELECT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
AEROS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MOTOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OTHMA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
TRANS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
COMMU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
UTILI	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WHOLE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
RETAI	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
BANKS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
INSUR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
REALE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OFIRE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
BSERV	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
HEALT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENTER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OSERV	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
L	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
K	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0P0MT	0.000000	0.000000	0.000000	1.086375	0.636134	0.000000	0.000000
1P0MT	0.000000	0.000000	0.000000	1.038536	0.608121	0.000000	0.000000
2P0MT	0.000000	0.000000	0.000000	0.473540	0.277284	0.000000	0.000000
4P0MT	0.000000	0.000000	0.000000	0.269843	0.158008	0.000000	0.000000
6P0MT	0.000000	0.000000	0.000000	0.290303	0.169989	0.000000	0.000000
8P0MT	0.000000	0.000000	0.000000	0.079244	0.046402	0.000000	0.000000
9P3MT	0.000000	0.000000	0.000000	0.215958	0.126456	0.000000	0.000000
INVES	0.000000	0.000000	0.000000	-1.267243	-0.203392	0.000000	0.000000
USSOC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USDUT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMVS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAGAS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALSU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CABAC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAUDI	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALWC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASUF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALGF	0.000000	14.947003	4.799999	0.000000	0.000000	19.490000	0.000000
LOPRP	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOFEE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDNO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDDE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CATRA	1.879579	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CACOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOED	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.574800
CAHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOTH	0.000000	2.501320	0.001000	0.000000	0.000000	0.000000	0.000000
LOTRA	0.854646	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOHAW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ROW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

+	CAINH	CALGF	LOPRP	LOFEE	LOMSC	FEDNO	FEDDE
AGRIC	0.000000	0.000000	0.000000	0.000000	0.000000	0.004452	0.001618
ENMIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000832	0.017634
OTHPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000528	0.000172
CONST	0.000000	0.000000	0.000000	0.000000	0.000000	0.028268	0.000989
FOODS	0.000000	0.000000	0.000000	0.000000	0.000000	0.044588	0.056956
ALTOH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000843	0.000013
APPAR	0.000000	0.000000	0.000000	0.000000	0.000000	0.008435	0.012793
MFRCO	0.000000	0.000000	0.000000	0.000000	0.000000	0.008483	0.351650
PAPER	0.000000	0.000000	0.000000	0.000000	0.000000	0.022657	0.005088
CHEMS	0.000000	0.000000	0.000000	0.000000	0.000000	0.013883	0.057135
PETRO	0.000000	0.000000	0.000000	0.000000	0.000000	0.011765	1.484888
ELECT	0.000000	0.000000	0.000000	0.000000	0.000000	0.057395	1.725815
AEROS	0.000000	0.000000	0.000000	0.000000	0.000000	0.081287	4.277216
MOTOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000437	0.040828
OTHMA	0.000000	0.000000	0.000000	0.000000	0.000000	0.046763	0.614560
TRANS	0.000000	0.000000	0.000000	0.000000	0.000000	0.369622	0.242554
COMMU	0.000000	0.000000	0.000000	0.000000	0.000000	0.011723	0.223604
UTILI	0.000000	0.000000	0.000000	0.000000	0.000000	0.067193	0.228881
WHOLE	0.000000	0.000000	0.000000	0.000000	0.000000	0.060679	0.496745
RETAI	0.000000	0.000000	0.000000	0.000000	0.000000	0.004176	0.065072
BANKS	0.000000	0.000000	0.000000	0.000000	0.000000	0.001803	0.004981
INSUR	0.000000	0.000000	0.000000	0.000000	0.000000	0.004136	0.331982
REALE	0.000000	0.000000	0.000000	0.000000	0.000000	0.090038	0.000000
OFIRE	0.000000	0.000000	0.000000	0.000000	0.000000	0.006062	0.000000
BSERV	0.000000	0.000000	0.000000	0.000000	0.000000	0.777137	9.910061
HEALT	0.000000	0.000000	0.000000	0.000000	0.000000	0.029085	1.611359
ENTER	0.000000	0.000000	0.000000	0.000000	0.000000	0.015703	0.023119
OSERV	0.000000	0.000000	0.000000	0.000000	0.000000	0.441153	0.278931
L	0.000000	0.000000	0.000000	0.000000	0.000000	10.472603	8.918154
K	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	10.502260	0.000000
1P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	8.617839	0.000000
2P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	3.713340	0.000000
4P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	2.116017	0.000000
6P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	2.276459	0.000000
8P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.621403	0.000000
9P3MT	0.000000	0.000000	0.000000	0.000000	0.000000	4.788673	0.000000
INVES	0.000000	0.000000	0.000000	0.000000	0.000000	-0.143594	0.000000
USSOC	0.000000	0.000000	0.000000	0.000000	0.000000	0.816356	0.695184
USPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USDUT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMVS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAGAS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALSU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CABAC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAUDI	0.000000	0.000000	0.000000	0.000000	0.000000	0.047615	0.040548
CALWC	0.000000	0.000000	0.000000	0.000000	0.000000	0.039611	0.033732
CAPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASUF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALGF	0.552000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOPRP	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOFEE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDNO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDDE	0.000000	0.000000	0.000000	0.000000	0.000000	31.752265	0.000000
CATRA	0.000000	0.000060	0.000000	0.000000	0.000000	1.722349	0.000000
CACOR	0.000000	3.703919	0.000000	0.000000	0.000000	0.430073	0.000000
CAK14	0.000000	1.374590	0.000000	0.000000	0.000000	0.076865	0.000000
CAOED	0.000000	3.903601	0.000000	0.000000	0.000000	4.067642	0.000000
CAHAW	0.000000	11.388392	0.000000	0.000000	0.000000	1.525273	0.000000
CAOTH	0.000000	5.768822	0.000000	0.000000	0.000000	0.792760	0.000000
LOTRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.558000	0.000000
LOCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOK14	0.000000	16.167321	9.666092	0.000000	2.644536	2.418009	0.000000
LOHAW	0.000000	0.000000	0.000000	0.000000	0.000000	9.890361	0.000000
LOOTH	0.000000	0.000000	9.420245	27.624435	0.000000	11.480715	0.000000
ROW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

+	CATRA	CACOR	CAK14	CAOED	CAHAW	CAOTH	LOTRA
AGRIC	0.003404	0.005293	0.003284	0.013925	0.000697	0.008210	0.016548
ENMIN	0.001764	0.002742	0.001702	0.007216	0.000361	0.004254	0.008575
OTHPR	0.000416	0.000647	0.000401	0.001701	0.000085	0.001003	0.002022
CONST	2.335614	0.081115	0.000000	0.023840	0.003969	0.290234	2.529437
FOODS	0.011533	0.017934	0.011127	0.047185	0.002363	0.027818	0.056071
ALTOH	0.000029	0.000045	0.000028	0.000118	0.000006	0.000069	0.000140
APPAR	0.011006	0.017114	0.010619	0.045029	0.002255	0.026547	0.053509
MFRCO	0.011176	0.017378	0.010782	0.045722	0.002289	0.026956	0.054332
PAPER	0.009437	0.014674	0.009105	0.038607	0.001933	0.022761	0.045878
CHEMS	0.049170	0.076455	0.047439	0.201160	0.010073	0.118596	0.239042
PETRO	0.056330	0.087589	0.054347	0.230453	0.011540	0.135866	0.273852
ELECT	0.011732	0.018242	0.011319	0.047996	0.002403	0.028296	0.057034
AEROS	0.001997	0.003105	0.001927	0.008169	0.000409	0.004816	0.009708
MOTOR	0.000540	0.000840	0.000521	0.002211	0.000111	0.001304	0.002627
OTHMA	0.045103	0.070132	0.043515	0.184523	0.009240	0.108787	0.219272
TRANS	0.026337	0.040953	0.025410	0.107749	0.005395	0.063525	0.128041
COMMU	0.021171	0.032919	0.020426	0.086614	0.004337	0.051064	0.102925
UTILI	0.094527	0.146983	0.091199	0.386723	0.019365	0.227997	0.459551
WHOLE	0.072810	0.113215	0.070247	0.297877	0.014916	0.175616	0.353973
RETAI	0.029260	0.045496	0.028229	0.119705	0.005994	0.070573	0.142248
BANKS	0.061675	0.095901	0.059504	0.252322	0.012635	0.148759	0.299839
INSUR	0.002878	0.004475	0.002776	0.011773	0.000590	0.006941	0.013990
REALE	0.058111	0.090359	0.056065	0.237740	0.011905	0.140162	0.282512
OFIRE	0.026968	0.041934	0.026019	0.110331	0.005525	0.065047	0.131109
BSERV	0.218099	0.339128	0.210421	0.892273	0.044679	0.526048	1.060305
HEALT	0.011702	0.018195	0.011290	0.047873	0.002397	0.028224	0.056889
ENTER	0.000691	0.001075	0.000667	0.002828	0.000142	0.001667	0.003361
OSERV	0.054204	0.084283	0.052296	0.221756	0.011104	0.130739	0.263518
L	1.819060	2.453047	0.142842	4.252699	1.952163	3.366438	1.433652
K	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
4P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
6P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
8P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
9P3MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
INVES	0.156023	0.000000	0.000000	0.000000	0.000000	0.001778	0.000000
USSOC	0.141799	0.191219	0.011135	0.331505	0.152174	0.262419	0.111755
USPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USCOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USDUT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAMVS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAGAS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALSU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CABAC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAUDI	0.008271	0.011153	0.000649	0.019335	0.008876	0.015306	0.006518
CALWC	0.006880	0.009278	0.000540	0.016085	0.007384	0.012733	0.005421
CAPIT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CASUF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAINH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CALGF	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOPRP	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOFEE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOMSC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDNO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDDE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CATRA	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CACOR	0.000000	0.000000	0.000000	0.000000	0.000000	0.082546	0.000000
CAK14	0.000000	0.000000	0.000000	0.000000	0.000000	0.012324	0.000000
CAOED	0.000000	0.000000	0.000000	0.000000	0.000000	-0.010784	0.000000
CAHAW	0.000000	0.000000	0.000000	0.000000	0.000000	3.652469	0.000000
CAOTH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOTRA	0.837155	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOCOR	0.000000	0.083620	0.000000	0.000000	0.000000	0.000000	0.000000
LOK14	0.000000	0.000000	0.502793	0.242216	0.000000	0.000000	0.000000
LOHAW	0.000000	0.000000	0.000000	0.000000	14.258819	0.000000	0.000000
LOOTH	0.000000	0.000000	0.000000	0.000000	0.000000	2.059637	0.000000
ROW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

+	LOCOR	LOK14	LOHAW	LOOTH	ROW
AGRIC	0.004200	0.049546	0.018492	0.069556	11.697209
ENMIN	0.002176	0.014243	0.009582	0.036042	7.147749
OTHPR	0.000513	0.001898	0.002259	0.008498	8.629292
CONST	0.008924	2.713674	0.061490	4.189248	6.895615
FOODS	0.014232	0.085022	0.062657	0.235683	21.514004
ALTOH	0.000035	0.001514	0.000156	0.000587	3.733801
APPAR	0.013581	0.013978	0.059794	0.224915	1.088808
MFRCO	0.013790	0.180022	0.060714	0.228376	17.683587
PAPER	0.011644	0.268777	0.051267	0.192839	12.698868
CHEMS	0.060672	0.097496	0.267121	1.004768	11.453740
PETRO	0.069508	0.745554	0.306020	1.151086	5.320983
ELECT	0.014476	0.174666	0.063734	0.239733	15.777712
AEROS	0.002464	0.021932	0.010848	0.040805	24.888389
MOTOR	0.000667	0.030715	0.002936	0.011044	1.285047
OTHMA	0.055654	0.247210	0.245028	0.921668	35.566274
TRANS	0.032499	0.610874	0.143081	0.538196	10.782332
COMMU	0.026124	0.279629	0.115015	0.432626	7.318701
UTILI	0.116641	0.683602	0.513532	1.931637	2.381366
WHOLE	0.089843	0.790253	0.395552	1.487859	3.713478
RETAI	0.036104	0.029667	0.158957	0.597911	12.904914
BANKS	0.076103	0.003215	0.335060	1.260319	1.592718
INSUR	0.003551	0.075032	0.015634	0.058805	7.075566
REALE	0.071705	0.108037	0.315697	1.187485	54.523285
OFIRE	0.033277	0.000000	0.146509	0.551092	3.268972
BSERV	0.269120	1.337706	1.184853	4.456796	22.056964
HEALT	0.014439	0.000302	0.063571	0.239121	7.350722
ENTER	0.000853	0.033149	0.003755	0.014125	19.171261
OSERV	0.066884	0.429063	0.294471	1.107647	21.555394
L	1.209563	26.197846	5.325327	20.031083	0.000000
K	0.000000	0.000000	0.000000	0.000000	0.000000
0P0MT	0.000000	0.000000	14.780788	0.000000	0.000000
1P0MT	0.000000	0.000000	0.000000	0.000000	0.000000
2P0MT	0.000000	0.000000	0.000000	0.000000	0.000000
4P0MT	0.000000	0.000000	0.000000	0.000000	0.000000
6P0MT	0.000000	0.000000	0.000000	0.000000	0.000000
8P0MT	0.000000	0.000000	0.000000	0.000000	0.000000
9P3MT	0.000000	0.000000	0.000000	0.000000	0.000000
INVES	0.000000	0.000000	0.000000	-7.061970	-0.323531
USSOC	0.094287	2.042164	0.415118	1.561455	0.000000
USPIT	0.000000	0.000000	0.000000	0.000000	0.000000
USCOR	0.000000	0.000000	0.000000	0.000000	0.000000
USDUT	0.000000	0.000000	0.000000	0.000000	0.000000
USMSC	0.000000	0.000000	0.000000	0.000000	0.000000
CAMSC	0.000000	0.000000	0.000000	0.000000	0.000000
CASIN	0.000000	0.000000	0.000000	0.000000	0.000000
CAENE	0.000000	0.000000	0.000000	0.000000	0.000000
CAOPR	0.000000	0.000000	0.000000	0.000000	0.000000
CAINS	0.000000	0.000000	0.000000	0.000000	0.000000
CAMVS	0.000000	0.000000	0.000000	0.000000	0.000000
CAGAS	0.000000	0.000000	0.000000	0.000000	0.000000
CALSU	0.000000	0.000000	0.000000	0.000000	0.000000
CABAC	0.000000	0.000000	0.000000	0.000000	0.000000
CAUDI	0.005499	0.119112	0.024212	0.091074	0.000000
CALWC	0.004578	0.099088	0.020142	0.075765	0.000000
CAPIT	0.000000	0.000000	0.000000	0.000000	0.000000
CASUF	0.000000	0.000000	0.000000	0.000000	0.000000
CAINH	0.000000	0.000000	0.000000	0.000000	0.000000
CALGF	0.000000	0.000000	0.000000	0.000000	0.000000
LOPRP	0.000000	0.000000	0.000000	0.000000	0.000000
LOFEE	0.000000	0.000000	0.000000	0.000000	0.000000
LOMSC	0.000000	0.000000	0.000000	0.000000	0.000000
FEDNO	0.000000	0.000000	0.000000	0.000000	0.000000
FEDDE	0.000000	0.000000	0.000000	0.000000	0.000000
CATRA	0.000000	0.000000	0.000000	0.000000	0.000000
CACOR	0.000000	0.000000	0.000000	0.000000	0.000000
CAK14	0.000000	0.000000	0.000000	0.000000	0.000000
CAOED	0.000000	0.000000	0.000000	0.000000	0.000000
CAHAW	0.000000	0.000000	0.000000	0.000000	0.000000
CAOTH	0.000000	0.000000	0.000000	0.000000	0.000000
LOTRA	0.000000	0.000000	0.000000	4.010380	0.000000
LOCOR	0.000000	0.000000	0.000000	2.339986	0.000000
LOK14	0.000000	0.000000	0.000000	5.844019	0.000000
LOHAW	0.000000	0.000000	0.000000	1.324192	0.000000
LOOTH	0.000000	0.000000	0.000000	0.000000	0.000000
ROW	0.000000	0.000000	0.000000	0.000000	0.000000;

XII.4.3.CAPITAL COEFFICIENT MATRIX INPUT FILE

TABLE B(I,J) CAPITAL COEFFICIENT MATRIX

	AGRIC	ENMIN	OTHPR	CONST	FOODS	ALTOH	APPAR	MFRCO	PAPER	CHEMS
AGRIC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENMIN	0.000000	0.004490	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OTHPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CONST	0.248584	0.836809	0.361188	0.128225	0.303808	0.551199	0.358387	0.290563	0.181382	0.283089
FOODS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ALTOH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
APPAR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MFRCO	0.003030	0.047597	0.165871	0.333552	0.055566	0.009061	0.022057	0.036217	0.041064	0.096833
PAPER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CHEMS	0.000000	0.000000	0.000000	0.000187	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
PETRO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ELECT	0.000807	0.011546	0.015036	0.023659	0.046865	0.076177	0.069893	0.055336	0.108030	0.117571
AEROS	0.000794	0.009084	0.006153	0.003076	0.004058	0.017160	0.005690	0.014755	0.007487	0.004293
MOTOR	0.103655	0.021841	0.157898	0.175073	0.060037	0.091893	0.137679	0.080014	0.102206	0.020507
OTHMA	0.385342	0.030324	0.115426	0.091547	0.311170	0.161174	0.236724	0.336454	0.371638	0.337876
TRANS	0.010203	0.001422	0.007816	0.013581	0.005186	0.005453	0.006182	0.005751	0.008163	0.004538
COMMU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
UTILI	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WHOLE	0.123577	0.017057	0.075935	0.109933	0.102602	0.041937	0.069402	0.078158	0.085916	0.062037
RETAI	0.123577	0.017057	0.075935	0.109933	0.102602	0.041937	0.069402	0.078158	0.085916	0.062037
BANKS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
INSUR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
REALE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OFIRE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
BSERV	0.000430	0.002772	0.018741	0.011233	0.008106	0.004009	0.024586	0.024595	0.008199	0.011219
HEALT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENTER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OSERV	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

+	PETRO	ELECT	AEROS	MOTOR	OTHMA	TRANS	COMMU	UTILI	WHOLE	RETAI
AGRIC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENMIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OTHPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.024223	0.000000	0.000000
CONST	0.539359	0.369608	0.359784	0.326438	0.237592	0.235303	0.314806	0.632949	0.232816	0.232816
FOODS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ALTOH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
APPAR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MFRCO	0.052244	0.010769	0.012841	0.005323	0.022399	0.047084	0.001820	0.027547	0.055662	0.055662
PAPER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CHEMS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000005	0.000007	0.040352	0.000253	0.000253
PETRO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ELECT	0.074741	0.183043	0.094608	0.054712	0.073897	0.166212	0.442748	0.038777	0.120074	0.120074
AEROS	0.011737	0.009069	0.007278	0.006438	0.010761	0.153373	0.001637	0.002040	0.009887	0.009887
MOTOR	0.019382	0.031938	0.028865	0.045450	0.050950	0.276490	0.003999	0.023085	0.268389	0.268389
OTHMA	0.194454	0.206794	0.258213	0.464215	0.407260	0.018613	0.018843	0.154663	0.121119	0.121119
TRANS	0.003115	0.003696	0.002764	0.005097	0.004885	0.008586	0.001631	0.003258	0.014276	0.014276
COMMU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.153465	0.000000	0.000000	0.000000
UTILI	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WHOLE	0.050628	0.062068	0.055841	0.042824	0.076184	0.044457	0.030262	0.025801	0.087141	0.087141
RETAI	0.050628	0.062068	0.055841	0.042824	0.076184	0.044457	0.030262	0.025801	0.087141	0.087141
BANKS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
INSUR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
REALE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OFIRE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
BSERV	0.003710	0.060947	0.123963	0.006678	0.039886	0.005420	0.000522	0.001503	0.003241	0.003241
HEALT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENTER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OSERV	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

+	BANKS	INSUR	REALE	OFIRE	BSERV	HEALT	ENTER	OSERV
AGRIC	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENMIN	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OTHPR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000399	0.000000	0.000000
CONST	0.402083	0.402083	0.849575	0.402083	0.190726	0.508372	0.217997	0.384326
FOODS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ALTOH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
APPAR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MFRCO	0.062665	0.062665	0.001484	0.062665	0.075294	0.014852	0.018312	0.062370
PAPER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CHEMS	0.000045	0.000045	0.000124	0.000045	0.000000	0.000043	0.000000	0.000436
PETRO	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ELECT	0.223190	0.223190	0.007030	0.223190	0.262791	0.166569	0.010623	0.022131
AEROS	0.013916	0.013916	0.000142	0.013916	0.015289	0.002870	0.000383	0.001639
MOTOR	0.079224	0.079224	0.030882	0.079224	0.062388	0.012405	0.078271	0.139075
OTHMA	0.065442	0.065442	0.028844	0.065442	0.185511	0.161788	0.361654	0.196451
TRANS	0.007086	0.007086	0.000966	0.007086	0.005693	0.002173	0.021917	0.009570
COMMU	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
UTILI	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
WHOLE	0.068530	0.068530	0.034266	0.068530	0.097513	0.065140	0.145421	0.091855
RETAI	0.068530	0.068530	0.034266	0.068530	0.097513	0.065140	0.145421	0.091855
BANKS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
INSUR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
REALE	0.000000	0.000000	0.010000	0.000000	0.000000	0.000000	0.000000	0.000000
OFIRE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
BSERV	0.009289	0.009289	0.002421	0.009289	0.007282	0.000251	0.000000	0.000291
HEALT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
ENTER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
OSERV	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000;

XII.4.4.MISCELLANEOUS INPUT FILE

TABLE MISCG(G,H,*) TAX TABLE FIGURES

	TAXBASE	TAXBM	MTR	TAXSD	TAXOD	TAXPI	TAXCVC
LOPRP.0P0MT	0.079083	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
LOPRP.1P0MT	0.205216	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
LOPRP.2P0MT	0.595254	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
LOPRP.4P0MT	0.960756	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
LOPRP.6P0MT	1.381723	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
LOPRP.8P0MT	1.835829	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
LOPRP.9P3MT	4.172395	0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
CAPIT.0P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAPIT.1P0MT	0.000000	0.000000	0.010000	2.966204	0.681204	0.084546	0.242380
CAPIT.2P0MT	0.091040	9.104000	0.020000	2.690230	2.171953	0.245839	0.563518
CAPIT.4P0MT	0.340520	21.578000	0.040000	2.093722	4.256539	0.437749	0.649702
CAPIT.6P0MT	0.839560	34.054000	0.060000	1.419604	7.716495	0.645846	0.635196
CAPIT.8P0MT	1.632760	47.274000	0.080000	0.907962	11.184798	0.783731	0.600707
CAPIT.9P3MT	2.630520	59.746000	0.093000	0.498850	18.194416	0.880974	0.705303
USPIT.0P0MT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
USPIT.1P0MT	0.000000	0.000000	0.150000	4.484490	0.589620	0.085848	0.335167
USPIT.2P0MT	0.000000	0.000000	0.150000	8.358389	1.731661	0.222011	0.667084
USPIT.4P0MT	0.000000	0.000000	0.150000	7.874152	4.010424	0.441211	0.787077
USPIT.6P0MT	5.535000	36.900000	0.280000	7.676073	7.654921	0.679811	0.740990
USPIT.8P0MT	5.535000	36.900000	0.280000	7.921216	12.494817	0.857144	0.762587
USPIT.9P3MT	20.165000	89.150000	0.310000	6.564118	17.432650	0.946956	0.832473;

TABLE MISC(Z,*) MISCELLANEOUS DATA

	JOBS	ETAM	ETAE	ETAY	ETAOP	SIGMA	R0
AGRIC	217241.67	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.071700
ENMIN	10191.67	1.500000	-1.650000	1.000000	-1.000000	0.800000	0.110300
OTHPR	20358.33	1.500000	-1.650000	1.000000	-1.000000	0.800000	0.110300
CONST	478766.67	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.291100
FOODS	143616.67	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.108200
ALTOH	29066.67	1.500000	-1.650000	1.000000	-1.000000	0.800000	0.204900
APPAR	149633.33	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.105700
MFRCO	262883.33	1.500000	-1.650000	1.000000	-1.000000	0.800000	0.123500
PAPER	188975.00	1.500000	-1.650000	1.000000	-1.000000	0.800000	0.111400
CHEMS	141666.67	1.500000	-1.650000	1.000000	-1.000000	0.800000	0.150100
PETRO	22108.33	1.500000	-1.650000	1.000000	-1.000000	0.800000	0.110300
ELECT	256041.67	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.128900
AEROS	142241.67	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.128900
MOTOR	92666.67	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.252000
OTHMA	349700.00	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.169100
TRANS	396925.00	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.239300
COMMU	149441.67	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.098100
UTILI	82166.67	1.500000	-1.650000	1.000000	-1.000000	0.800000	0.087400
WHOLE	728533.33	0.500000	-0.650000	1.000000	-1.000000	0.900000	0.200800
RETAI	2187675.00	0.500000	-0.650000	1.000000	-1.000000	0.900000	0.159300
BANKS	219641.67	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.131400
INSUR	123391.67	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.131400
REALE	181650.00	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.131400
OFIRE	205325.00	1.500000	-1.650000	1.000000	-1.000000	0.900000	0.131400
BSERV	1633700.00	1.500000	-1.650000	1.000000	-1.000000	0.800000	0.225800
HEALT	834325.00	0.500000	-0.650000	1.000000	-1.000000	0.800000	0.225800
ENTER	337191.67	0.500000	-0.650000	1.000000	-1.000000	0.800000	0.225800
OSERV	1048016.67	0.500000	-0.650000	1.000000	-1.000000	0.800000	0.225800
FEDNO	222541.67	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
FEDDE	98216.67	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CATRA	40934.10	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CACOR	46675.10	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAK14	2734.40	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOED	88957.50	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAHAW	43444.70	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CAOTH	64100.70	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOTRA	200000.00	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOCOR	40000.00	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOK14	627608.33	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOHAW	300000.00	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LOOTH	215266.67	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000;

TABLE MISCH(H,*) MISCELLANEOUS HOUSEHOLD DATA

	ETAPIT	ETATP	HH0	HW0	ETARA	NRPG	ETAYD	ETAU
0P0MT	-0.000	-0.050000	3.680325	0.334575	0.000000	1.000000	1.300000	-0.800000
1P0MT	-0.100	0.000000	7.462977	4.264558	0.200000	1.000000	1.500000	-0.700000
2P0MT	-0.150	0.000000	4.375133	2.916755	0.300000	1.000000	1.600000	-0.600000
4P0MT	-0.200	0.000000	2.493134	1.662089	0.400000	1.000000	1.800000	-0.500000
6P0MT	-0.250	0.000000	2.682170	1.788113	0.500000	1.000000	2.000000	-0.400000
8P0MT	-0.350	0.000000	0.732150	0.488100	0.700000	1.000000	2.100000	-0.300000
9P3MT	-0.400	0.000000	1.995282	1.330188	0.800000	1.000000	2.300000	-0.200000;

TABLE TPC(H,G) FRACTION ON NON-WORKING HOUSEHOLDS COLLECTING TRANSFER PAYMENTS

	USSOC	CAUDI	CALWC	FEDNO	LOHAW
0P0MT	0.100000	0.100000	0.100000	0.500000	0.700000
1P0MT	0.100000	0.100000	0.100000	0.500000	0.000000
2P0MT	0.100000	0.100000	0.100000	0.500000	0.000000
4P0MT	0.100000	0.100000	0.100000	0.500000	0.000000
6P0MT	0.100000	0.100000	0.100000	0.500000	0.000000
8P0MT	0.100000	0.100000	0.100000	0.500000	0.000000
9P3MT	0.100000	0.100000	0.100000	0.500000	0.000000;

TABLE ATAX(GI1,GI) DEDUCTABILITY OF OTHER TAXES

	USPIT	CAPIT	LOPRP	
USPIT	0	0	0	
CAPIT	1	0	0	
LOPRP	1	1	0	;

TABLE TAUFF(G,F) ASSIGNMENT OF FACTOR TAXES

	L	K	
USSOC	1		
USCOR		1	
CABAC		1	
CAUDI	1		
CALWC	1		;

TABLE IGTD(G,G1) INTER GOVERNMENTAL TRANSFER TYPES

	USSOC	USPIT	USCOR	USDUT	USMSC	CAMSC	CASIN	CAENE
USSOC	0	0	0	0	0	0	0	0
USPIT	0	0	0	0	0	0	0	0
USCOR	0	0	0	0	0	0	0	0
USDUT	0	0	0	0	0	0	0	0
USMSC	0	0	0	0	0	0	0	0
CAMSC	0	0	0	0	0	0	0	0
CASIN	0	0	0	0	0	0	0	0
CAENE	0	0	0	0	0	0	0	0
CAOPR	0	0	0	0	0	0	0	0
CAINS	0	0	0	0	0	0	0	0
CAMVS	0	0	0	0	0	0	0	0
CAGAS	0	0	0	0	0	0	0	0
CALSU	0	0	0	0	0	0	0	0
CABAC	0	0	0	0	0	0	0	0
CAUDI	0	0	0	0	0	0	0	0
CALWC	0	0	0	0	0	0	0	0
CAPIT	0	0	0	0	0	0	0	0
CASUF	0	0	0	0	0	0	0	0
CAINH	0	0	0	0	0	0	0	0
CALGF	0	0	0	0	0	1	1	1
LOPRP	0	0	0	0	0	0	0	0
LOFEE	0	0	0	0	0	0	0	0
LOMSC	0	0	0	0	0	0	0	0
FEDNO	1	1	1	1	1	0	0	0
FEDDE	0	0	0	0	0	0	0	0
CATRA	0	0	0	0	0	0	0	0
CACOR	0	0	0	0	0	0	0	0
CAK14	0	0	0	0	0	1	0	0
CAOED	0	0	0	0	0	0	0	0
CAHAW	0	0	0	0	0	0	0	0
CAOTH	0	0	0	0	0	1	1	0
LOTRA	0	0	0	0	0	0	0	0
LOCOR	0	0	0	0	0	0	0	0
LOK14	0	0	0	0	0	0	0	0
LOHAW	0	0	0	0	0	0	0	0
LOOTH	0	0	0	0	0	0	0	1

+	CAOPR	CAINS	CAMVS	CAGAS	CALSU	CABAC	CAUDI	CALWC
USSOC	0	0	0	0	0	0	0	0
USPIT	0	0	0	0	0	0	0	0
USCOR	0	0	0	0	0	0	0	0
USDUT	0	0	0	0	0	0	0	0
USMSC	0	0	0	0	0	0	0	0
CAMSC	0	0	0	0	0	0	0	0
CASIN	0	0	0	0	0	0	0	0
CAENE	0	0	0	0	0	0	0	0
CAOPR	0	0	0	0	0	0	0	0
CAINS	0	0	0	0	0	0	0	0
CAMVS	0	0	0	0	0	0	0	0
CAGAS	0	0	0	0	0	0	0	0
CALSU	0	0	0	0	0	0	0	0
CABAC	0	0	0	0	0	0	0	0
CAUDI	0	0	0	0	0	0	0	0
CALWC	0	0	0	0	0	0	0	0
CAPIT	0	0	0	0	0	0	0	0
CASUF	0	0	0	0	0	0	0	0
CAINH	0	0	0	0	0	0	0	0
CALGF	1	1	1	0	1	1	0	0
LOPRP	0	0	0	0	0	0	0	0
LOFEE	0	0	0	0	0	0	0	0
LOMSC	0	0	0	0	0	0	0	0
FEDNO	0	0	0	0	0	0	0	0
FEDDE	0	0	0	0	0	0	0	0
CATRA	0	0	1	1	0	0	0	0
CACOR	0	0	0	0	0	0	0	0
CAK14	0	0	0	0	0	0	0	0
CAOED	0	0	0	0	0	0	0	0
CAHAW	0	0	0	0	0	0	0	0
CAOTH	0	0	0	0	1	1	0	0
LOTRA	0	0	1	1	0	0	0	0
LOCOR	0	0	0	0	0	0	0	0
LOK14	0	0	0	0	0	0	0	0
LOHAW	0	0	0	0	0	0	0	0
LOOTH	1	0	0	0	0	0	0	0

+	CAPIT	CASUF	CAINH	CALGF	LOPRP	LOFEE	LOMSC	FEDNO
USSOC	0	0	0	0	0	0	0	0
USPIT	0	0	0	0	0	0	0	0
USCOR	0	0	0	0	0	0	0	0
USDUT	0	0	0	0	0	0	0	0
USMSC	0	0	0	0	0	0	0	0
CAMSC	0	0	0	0	0	0	0	0
CASIN	0	0	0	0	0	0	0	0
CAENE	0	0	0	0	0	0	0	0
CAOPR	0	0	0	0	0	0	0	0
CAINS	0	0	0	0	0	0	0	0
CAMVS	0	0	0	0	0	0	0	0
CAGAS	0	0	0	0	0	0	0	0
CALSU	0	0	0	0	0	0	0	0
CABAC	0	0	0	0	0	0	0	0
CAUDI	0	0	0	0	0	0	0	0
CALWC	0	0	0	0	0	0	0	0
CAPIT	0	0	0	0	0	0	0	0
CASUF	0	0	0	0	0	0	0	0
CAINH	0	0	0	0	0	0	0	0
CALGF	1	0	1	0	0	0	0	0
LOPRP	0	0	0	0	0	0	0	0
LOFEE	0	0	0	0	0	0	0	0
LOMSC	0	0	0	0	0	0	0	0
FEDNO	0	0	0	0	0	0	0	0
FEDDE	0	0	0	0	0	0	0	2
CATRA	0	0	0	2	0	0	0	2
CACOR	0	0	0	2	0	0	0	2
CAK14	0	0	0	2	0	0	0	2
CAOED	0	1	0	2	0	0	0	2
CAHAW	0	0	0	0	0	0	0	2
CAOTH	0	0	0	2	0	0	0	2
LOTRA	0	0	0	0	0	0	0	2
LOCOR	0	0	0	0	0	0	0	0
LOK14	0	0	0	4	1	0	1	2
LOHAW	0	0	0	0	0	0	0	2
LOOTH	0	0	0	0	1	1	0	2

+	FEDDE	CATRA	CACOR	CAK14	CAOED	CAHAW	CAOTH	LOTRA
USSOC	0	0	0	0	0	0	0	0
USPIT	0	0	0	0	0	0	0	0
USCOR	0	0	0	0	0	0	0	0
USDUT	0	0	0	0	0	0	0	0
USMSC	0	0	0	0	0	0	0	0
CAMSC	0	0	0	0	0	0	0	0
CASIN	0	0	0	0	0	0	0	0
CAENE	0	0	0	0	0	0	0	0
CAOPR	0	0	0	0	0	0	0	0
CAINS	0	0	0	0	0	0	0	0
CAMVS	0	0	0	0	0	0	0	0
CAGAS	0	0	0	0	0	0	0	0
CALSU	0	0	0	0	0	0	0	0
CABAC	0	0	0	0	0	0	0	0
CAUDI	0	0	0	0	0	0	0	0
CALWC	0	0	0	0	0	0	0	0
CAPIT	0	0	0	0	0	0	0	0
CASUF	0	0	0	0	0	0	0	0
CAINH	0	0	0	0	0	0	0	0
CALGF	0	0	0	0	0	0	0	0
LOPRP	0	0	0	0	0	0	0	0
LOFEE	0	0	0	0	0	0	0	0
LOMSC	0	0	0	0	0	0	0	0
FEDNO	0	0	0	0	0	0	0	0
FEDDE	0	0	0	0	0	0	0	0
CATRA	0	0	0	0	0	0	0	0
CACOR	0	0	0	0	0	0	2	0
CAK14	0	0	0	0	0	0	2	0
CAOED	0	0	0	0	0	0	2	0
CAHAW	0	0	0	0	0	0	2	0
CAOTH	0	0	0	0	0	0	0	0
LOTRA	0	2	0	0	0	0	0	0
LOCOR	0	0	2	0	0	0	0	0
LOK14	0	0	0	2	2	0	0	0
LOHAW	0	0	0	0	0	0	0	0
LOOTH	0	0	0	0	0	0	2	0

```
+                  LOCOR          LOK14          LOHAW          LOOTH
USSOC                0              0              0              0
USPIT                0              0              0              0
USCOR                0              0              0              0
USDUT                0              0              0              0
USMSC                0              0              0              0
CAMSC                0              0              0              0
CASIN                0              0              0              0
CAENE                0              0              0              0
CAOPR                0              0              0              0
CAINS                0              0              0              0
CAMVS                0              0              0              0
CAGAS                0              0              0              0
CALSU                0              0              0              0
CABAC                0              0              0              0
CAUDI                0              0              0              0
CALWC                0              0              0              0
CAPIT                0              0              0              0
CASUF                0              0              0              0
CAINH                0              0              0              0
CALGF                0              0              0              0
LOPRP                0              0              0              0
LOFEE                0              0              0              0
LOMSC                0              0              0              0
FEDNO                0              0              0              0
FEDDE                0              0              0              0
CATRA                0              0              0              0
CACOR                0              0              0              0
CAK14                0              0              0              0
CAOED                0              0              0              0
CAHAW                0              0              0              0
CAOTH                0              0              0              0
LOTRA                0              0              0              2
LOCOR                0              0              0              2
LOK14                0              0              0              2
LOHAW                0              0              0              2
LOOTH                0              0              0              0        ;

* KEY:         1 = BALANCE OF TAX REVENUE AFTER WELFARE PAYMENTS
*              2 = EXOGENOUS
*              4 = MAIN PROP 98 TRANSFER

TABLE ITCE(Z,Z1) ELIGIBILITY FOR INVESTMENT TAX CREDIT

      FOODS ALTOH APPAR MFRCO PAPER CHEMS PETRO ELECT AEROS MOTOR OTHMA
CONST  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03  0.03
MFRCO  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06
PAPER  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06
ELECT  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06
AEROS  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06
MOTOR  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06
OTHMA  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06
WHOLE  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06
RETAI  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06  0.06;
```