Abstract

Title of Dissertation: *The Price-Income Side of an Interindustry Macroeconometric Model: Development and Simulations.*

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Interindustry Macroeconometric (IM) models combine interindustry relationships and industry-level behavior in a macroeconomic framework. Their structure evolves from input-output relationships that define product output as the sum of intermediate and final demand, and product prices as the sum of input costs and income. This dissertation focuses on determining prices and income in an IM model of the U.S. economy.

The main focus of this work is determining industry profits. The equation specification is based on the role profits play in price determination. The specification allows the traditional pass-through of input costs to be relaxed, in that pass-through need not occur immediately, but rather may occur with a lag. Equations for thirty-seven industries comprising the U.S. economy are estimated. Equations for non-profit income also are estimated and included in the Long-term Interindustry Forecasting Tool (LIFT).

Because prior attempts at modeling the price-income side of an IM model resulted in equations that were not robust, the dynamic response of the equations is tested. The equations are included in LIFT, which then is used to make a Base forecast and four alternate scenarios. The response of the model to a change in monetary policy, oil-prices, the exchange-rate, and labor productivity illustrates the properties of the model, including the industry income equations. In all simulations, industry income responds in the expected direction and contributes to the stable properties of the model.

The structure of an IM model has been compared to models based on

the Social Accounting Matrix (SAM). Chapter 8 examines the effects of an increase in agriculture's value added in a SAM model and in LIFT. The LIFT results differ from the SAM results in two respects. First, the SAM analysis is based on fixed-price multipliers, while LIFT includes the effects of changes in relative prices. Second, the SAM gives comparative static results of the shock, while LIFT specifies the dynamic path of the economy's response.

THE PRICE-INCOME SIDE OF AN INTERINDUSTRY MACROECONOMIC MODEL: DEVELOPMENT AND SIMULATIONS

by

Lorraine Sullivan Monaco

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Preface

In a recent paper surveying current developments in macroeconomic theory, N. Gregory Mankiw (1990) addresses the divergence in recent years between "theoretical" and "applied" macroeconomists. He points out that the Keynesian consensus of prior decades is no longer accepted by much of the profession. And, since that consensus led to the development of large-scale macroeconometric forecasting models, those models are, in large part, no longer accepted. In fact, he notes,

> A graduate student today is unlikely to devote his dissertation to improving some (sector of an econometric model). (p. 2)

Mankiw notwithstanding, this dissertation is devoted to improving a large-scale econometric model of the U.S. economy.

For the past twenty-five years, the Interindustry Forecasting Project at the University of Maryland (INFORUM) has been devoted to furthering research on econometric modeling. Although most of the research done directly under INFORUM's auspices has been on the U.S. economy, INFORUM influences have spread to at least fifteen countries around the world, including developed and developing economies, and capitalist and socialist economies. The research effort, under the leadership of Clopper Almon, has concentrated on the importance of capturing industry-specific behavior in building an econometric model for any country. Even in the face of the declining popularity of modeling, as noted by Mankiw, INFORUM has continued to provide a nurturing environment for econometric modeling. I believe there is much to be learned from studying the economy from an empirical point of view, and from using a structural approach to modeling. The work in this dissertation would not have been possible without INFORUM, and I am grateful for the opportunity and privilege to be associated with them over the past nine years.

This dissertation has been completed over a span of five-to-six years, and I consequently owe much to a host of people who have advised and helped over the years. Chapter 2 of the dissertation introduces the history of Interindustry Macroeconomic modeling, and it evolved out of a paper written for a course taught by Professor Dudley Dillard. Professor Dillard's recent death is a great loss for students of economics today, and I am grateful I had the opportunity to learn from him. More recently, I have benefitted from discussions with INFORUM colleagues Doug Nyhus, Jeff Janoska, Charles Griffiths, Costas Christou, Qiang Ma, and Doug Meade, as well as with INFORUM's Italian colleague Maurizio Grassini. I also am grateful to Margaret McCarthy. I am indebted to her for her work maintaining and running the LIFT model, which alone warrants gratitude. In addition, however, her encouragement and support were invaluable. And of course, I owe much to Professor Clopper Almon, not only for his role as my dissertation advisor, but also for his vision and energy which have made INFORUM possible.

Last, but certainly not least, I thank my husband, Ralph. In innumerable ways, this dissertation could not have been completed without him.

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Chapter 1: Introduction and Summary

This dissertation is a study in applied econometric modeling. Econometric equations are estimated; the parameters are included in a model of the U.S. economy; and the model's behavioral properties are examined. The econometric model that plays the starring role in this work is called an Interindustry Macroeconomic (IM) model. As the name suggests, an IM model combines interindustry relationships and industry-level behavioral equations in a macroeconomic framework. The model's structure evolves from relationships derived in input-output analysis that determine product output as the sum of final and intermediate demand, and product prices as the sum of input costs and value added. The determination of prices and income is the main focus of this study.

There have been several dissertations devoted to developing the price-income side of an Interindustry Macroeconometric model.[1] This study differs from previous ones in three respects. First, the goal of this work is to develop equations that not only pass standard tests of econometric integrity and economic reasonableness. In addition, the equations must perform well once they are included in the econometric model. The essence of "performing well" refers to the dynamic properties of the equations: the ability of the equations to respond reasonably to changes in exogenous and endogenous variables in the econometric model.

The second difference between this approach to price-income determination in an IM model and previous approaches, is that this study explicitly allows for lags in the pass-through of cost changes to prices. In the traditional input-output dual equation, prices in any year equal the sum of material costs and value added in that year. A change in material costs is passed through to product prices entirely

[1] See O'Connor (1973), Gilmartin (1976), Belzer (1978) and Hyle (1985).

in the year in which the cost change occurs. In the following approach, value added is made a function of material costs, allowing pass-through of cost changes to occur partially in the year of the change, and only eventually pass through entirely to prices.

The final major difference between this study and earlier ones is the direct estimation of the components of capital income, rather than of the aggregate return to capital by industry. In prior work on the price-income side of the model, attention was paid to modeling total return to capital, which includes profits, depreciation, net interest payments, and several smaller income components. In the following work, emphasis is placed on isolating and explaining industry profits, as well as the other components of capital income. Aggregate return to capital then is calculated as the sum of the individual components.

The outline for the rest of the work is as follows. In the next chapter, the evolution of IM models, their basic structure, and how they compare to other models is described. The final sections of the chapter focus on the price-income side of an IM model and outline the approach for modeling industry income in this study. The main thrust of the econometric work is on estimating profit equations by industry.

Chapters 3 and 4 describe the theoretical basis for and the econometric estimation of industry profit equations. The role of profits in determining prices plays a central part in the specification of the equations. In particular, allowing profits to respond directly to changes in material costs of production permits the traditional assumption of complete, immediate pass-through of cost changes on product prices to be relaxed. The description of the estimation results includes analysis of "static" and "dynamic" forecasts with the equations. The static forecasts are done using projections of the equations' independent variables from a forecast of the LIFT model prior to the addition of the new price-income side. The dynamic forecast is the result of including the profit equations in the model and allowing the independent variables to respond to changes in profits.

Once industry profit equations are estimated, Chapter 5 describes equations for the remaining components of capital income. Most of the non-profit capital equations are estimated using an approach that allows an aggregate equation to capture behavioral activity, which is then distributed to industries. Since the equations developed in Chapters 3-5 are only one part of the IM model, Chapter 6 describes the particular IM model used for this study. The model, called the Long-term Interindustry Forecasting Tool (LIFT), is an annual model that provides industry and macroeconomic projections of the U.S. economy.

In Chapter 7, the newly estimated equations for income by industry are included in LIFT, and the complete model is used to make a Base forecast of the economy. Four alternate scenarios are then performed with LIFT, and the results compared to the Base forecast. By changing (1) monetary policy, (2) labor productivity, (3) exchange rates, and (4) the price of oil, the properties of the entire model, as well as the profit equations, are illustrated.

The structure of an IM model has been compared to Computable General Equilibrium Models (CGE), an alternate modeling framework recently made popular by Jaime de Melo, Sherman Robinson, and others.[2] CGE models are based on a Social Accounting Matrix (SAM), which is an accounting framework for an economy that includes input-output relationships, as well as final demand and income distribution. In Chapter 8, the results of a study using a SAM multiplier model are compared to the results of the same study using LIFT. In particular, Robinson and Adelman use a SAM-multiplier model to analyze the leakages from an increase in the value-added of the agriculture sector. Since the SAM analysis is based on fixed-price multipliers, the results include only the positive income effects of a shock to value added.

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[2] See Dervis et al, and Adelman and Robinson. CGE's have been used often in modeling the economies of developing countries.

When a shock to agriculture's value added is analyzed in the LIFT model, the negative implications of a price shock, as well as the positive effects of the income shock are both considered. In addition, the LIFT results specify the timing of the effect of the shock to value added, while the SAM multiplier analysis gives only the end-result of the shock. Since the timing of effects may be crucial in evaluating the impact of a value added shock, the IM approach is preferred to the SAM multiplier approach.

The final chapter offers conclusions from this study, as well as some suggestions for the direction of future research in the area of price-income modeling.

Chapter 2: Interindustry Macroeconomic Modeling

As the name implies, an Interindustry Macroeconomic (IM) model combines interindustry linkages and industry-level behavior in a macroeconomic framework. The model uses behavioral equations for individual industry and consumer activities and aggregates them to determine macroeconomic totals, such as Gross National Product and Equipment Investment.[3] Interindustry Macro models evolved from early work using input-output tables. The evolution of IM models, their basic structure, and how they compare to alternate modeling approaches are described in the first part of this chapter. To set the stage for developing industry-level income equations in following chapters, the latter part of the chapter focuses on price and income determination in an IM model and outlines this study's approach to modeling income by industry.

Early Development: Input-Output Modeling

The foundation of an IM model is the network of production relationships between industries described by an input-output table. An input-output table shows interindustry flows in an economy: the flow of oil to the steel industry, and the flow of steel to the auto industry. An input-output coefficient, $a_{i,j}$, shows how much of input i is used to make one unit of product j, or real per unit use.

The roots of input-output analysis are found as far back as the early eighteenth century, in the works of the French economist Francois Quesnay. Quesnay designed a <u>tableau economique</u> to illustrate the circular path of production and income among three sectors of the

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[3] A similar combination of input-output and macroeconomic modeling is described in Klein (1986) and referred to as "Keynes-Leontief" modeling. Since "Keynes" implies a specific macro framework, and "Leontief" implies fixed input-output coefficients, the more general term "Interindustry Macroeconomic" model is adopted here.

economy: agriculture, landlords, and manufacturers. The idea that an economy could be described by summarizing transactions among different participants was greeted by both enthusiasm and skepticism. In the eyes of Mirabeau, Quesnay's input-output table ranked as one of the world's three greatest discoveries, along with the invention of writing and money. (Gray, p. 93) Other economists found it unnecessarily complicated, and "It led Eugen Duhring to suspect Quesnay of some mathematical fantasy." (Sweezy, p. 865) Aptly listed in the International Encyclopedia of the Social Sciences between "Innovation" and "Insanity", input-output has evolved from Quesnay's simple, hand-drawn illustration of a three-sector economy, into a powerful tool in economic modeling.

One of the important features of the tableau, or input-output table, is its explicit portrayal of an economic equilibrium.[4] In 1936, Wassily Leontief applied his research on input-output to the United States economy and defined it as "an attempt to construct a Tableau Economique of the United States." (1941, p. 9) He stated that the purpose of later work was to apply the economic theory of general equilibrium to an empirical study of interrelations in an economy. (1953, p. 3) Giving empirical content to Walrasian general equilibrium theory was a breakthrough both for input-output analysis and for Walrasian economics.[5] In The Growth of Economic Thought, Henry Spiegel asserts that Walrasian economics seemed unable to acquire empirical content and become operational until input-output economics entered the picture.

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[4] According to Schumpeter, "It would seem impossible to exaggerate the importance of this achievement if admiring disciples had not already done so." (Schumpeter, p. 242).

[5] This breakthrough was not immediately obvious, however. When Leontief came to Harvard, around 1931, it was with the condition that he be given a research assistant to make what today is called an input-output table. The Economics department agreed to the request but advised him by letter that no one in the department thought that such a project was feasible or of great value if completed.

> Input-output analysis gave numerical content to general equilibrium economics and demonstrated its practical usefulness in economic planning and forecasting. (p. 556)

One of the greatest impacts of Leontief's pioneering work, however, was the impetus it provided for further research in input-output and its use in econometric modeling.

Since Leontief's original work in the 1930's, input-output has expanded in several different directions. The four principal types of models that have developed are: Distributional, Real-Side Dynamic (RSD), Computable General Equilibrium (CGE), and Interindustry Macroeconomic (IM) models.

All of these approaches include the "input-output equation" for determining output:

$$q = Aq + f \qquad (2.1)$$

or

$$q = (I - A)^{-1} f \qquad (2.2)$$

where
- q = vector of product outputs,
- A = matrix of input-output coefficients,
- f = vector of final demands,
- I = identity matrix.

In a Distributional model, the elements of the final demand vector, f, are determined without any reference to output, q. This method has been used to develop detailed forecasting models, such as the model of Data Resources, Inc., where the elements of the f vector come from multiplying variables from the aggregate model by a distributional matrix. Any change in the aggregate economy can be distributed to individual sectors via the input-output table to determine the impact of the change at a detailed level.

One problem with the Distributional model is its neglect of the influence of output growth on investment purchases. In equation 2.2, final demand does not respond directly to changes in production levels.

However, investment decisions by firms clearly depend on current demand, as measured by production levels. In the Real-Side Dynamic models, the input-output equation was expanded, therefore, to take into account the interdependence of production and investment activity. For example, the Dynamic Leontief system is written:

$$x = Ax + B\dot{x} + f \tag{2.3}$$

where

x = vector of product outputs,
A = matrix of input-output coefficients,
B = matrix of capital to output coefficients,
$\dot{x}$ = vector of investment (change in capital stock),
f = vector of final demand.

Real-Side Dynamic models focus on using equation 2.3 to determine production and investment levels. Final demand, excluding investment, is taken as exogenous, as are the A-matrix coefficients.

A major problem in implementing RSD models was their explosive nature. Throughout the 1950's, Leontief was unable to get around this problem. The first solution seems to have been Almon (1961) who used a process based on a series expansion of the final demands. Later work, (Almon, 1966), improved the method of solution for models with forward-looking expectations. (This approach based on forward-looking expectations was called "consistent forecasting" by Almon and later called "rational expectations.") In Almon, et. al. (1974), the forward-looking expectations approach was replaced by an adaptive expectations approach, to get better forecasts.

One problem common to both Distributional models and RSD models is achieving an equilibrium solution. Consider a change in exports using either of these approaches. An increase in aggregate exports will imply an increase in exports of different products, such as cars, for example. Increased production of cars then implies higher demand for steel, plastic, electricity, and other inputs into making cars.

More output of everything leads to more employment. But there the analysis stops. Does consumer demand then increase? Do prices rise? The Distributional and RSD models to not answer these questions. This incompleteness led to both the CGE and IM models.

Development of Interindustry Macroeconomic Approach

In the early 1960s, research on using the Real-Side Dynamic models coincided with two other developments in econometrics and led to the introduction of the Interindustry Macroeconomic modeling approach. The first development was research in developing multisectoral models to deal with prices and incomes. Leif Johansen (1960), for instance, developed a multi-sector model of the Norwegian economy that combined the use of input-output relationships in a framework to simultaneously determine rates of growth of output, employment, prices, and capital. Johansen's work laid the groundwork for Computable General Equilibrium models. Typically, these models have emphasized equilibrium, with little attention paid to the dependence of investment on growth. Similarly, the empirical work usually relies on rather informal methods to specify elasticities and then a single year to calibrate other parameters. They have been applied in countries where data is scarce but understanding of basic economic reactions is important. The second development that led to the IM approach were the advances being made in applying econometric techniques to data to estimate historical behavioral relationships, and to combine estimated parameters into an econometric model.[6]

The Interindustry Macroeconomic (IM) model is based on the input-output equation, but rather than take final demand as given, an IM model uses behavioral equations to determine final demand, and combines those

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[6] See, for instance, Bodkin et. al. who describes the development of macroeconometric models.

estimates with projections of the input-output coefficient matrix to solve for production. In addition, the model is closed with respect to income and prices by using the input-output dual equation that determines prices as the sum of material costs and value added. The equations that serve as the basis for an IM model are:

$$q = Aq + f \tag{2.4}$$

$$p = pA + v \tag{2.5}$$

where

q = vector of product outputs,
p = vector of product prices,
A = matrix of input-output coefficients,
f = vector of final demand by product,
v = vector of value added per unit of output by product.

In an Interindustry Macroeconomic model, real product output is determined by modeling the matrix of input-output coefficients and the components of final demand. Total final demand for each product is the sum of different final demands, such as personal consumption and investment. Ideally, each final demand component is estimated at the product level, so behavioral parameters will differ between products. Purchases of cars, for example, will respond differently to income changes than food purchases. Likewise, investment by the steel industry will respond to changes in interest rates differently than does investment by the plastics industry. This framework mimics the economy, as aggregate results are determined by summing individual sectoral-level behavior.

To determine product outputs, an IM model also needs projections of input-output coefficients. One frequent criticism of input-output modeling in general is an attack on the use of static coefficients to describe the economy. A single input-output table gives a clear, detailed snapshot of an economy at a point in time. Certainly, however, the subject of that picture changes over time. It is a gross simplification to build a model that forecasts ten years into the future but is based on the interindustry structure of today.

One of the advances in using input-output was Almon's development of a method to forecast input-output coefficients and incorporate the forecasts in a model's framework.[7] An IM model is designed to use projections of coefficients that reflect changes in technology and interindustry relationships that occur over time. The coefficients are forecast outside the scope of the IM model and do not respond to changes in the model itself.

On one hand, it is a significant improvement in input-output modeling to use coefficients that change over time. On the other hand, the coefficients do not respond to any of the changes that the model forecasts. Over the long run, it may be reasonable to assume that changes in energy costs, for instance, will affect technological relationships. Attempts to incorporate dynamic coefficient response in a model with much sectoral detail have been largely unsuccessful, however, because of the difficulty of obtaining reliable econometric measures of the sensitivity of the coefficients to price changes.[8] The next best alternative is to view coefficient change as an exogenous assumption for the model. The framework of an IM model allows for running the model under various assumptions about coefficient change. In a forecast based on differing energy costs, for instance, coefficient projections can be modified to reflect energy-induced changes in interindustry structure.

Closing the model: prices and incomes

Product prices are determined by two types of costs: the costs of inputs and the costs of factors of production. Returns to factors of production, or value-added, include labor and capital income, as well as the portion of income that accrues to the government in business

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[7] See Almon et. al., 1974.

[8] See Taylor, 1981.

taxes. The cost of material inputs is determined by multiplying a vector of product prices by the inputs summarized in a column of the input-output coefficient matrix. Defining unit price as the sum of unit costs and then solving for prices yields the following equation

$$p = v\,(I - A)^{-1} \tag{2.6}$$

where

p = vector of unit prices for products,
v = vector of unit value-added by product,
A = matrix of input-output coefficients,
I = identity matrix.

Product prices are determined by combining estimates of input-output coefficients with estimates of per unit value added. As in modeling final demands, the components of value added are ideally modeled at the detailed product or industry level. Behavioral parameters for profits of the steel and plastics industries will differ, for example, as will the determinants of labor compensation in the textile and auto industries.

Summary: the Structure of an Interindustry Macroeconomic Model

The primal and dual input-output equations, combined with forecasts of input-output coefficients and industry-level final demand and income, define the bulk of an IM model. One type of economic activity not yet addressed by this structure is employment. To forecast employment by industry, output by product first is combined with estimates of industry labor productivity, in order to model labor requirements by industry. Combining these labor requirements with projections on the size of the labor force yields employment by industry.

In addition to a myriad of industry-level behavioral equations, an IM model also uses aggregate equations that serve two purposes. On one hand are aggregate equations needed to maintain any accounting relationships. Disposable income must be calculated as personal income less personal income taxes and non-tax payments, for example. On the other hand are equations that maintain key macro relationships. For instance, the IM model of the U.S. economy in this study includes macro equations for the savings rate, as well as for the aggregate manufacturing wage rate. Another important piece of the macro foundations of the model is the determination of interest rates and/or the money supply. The completed IM structure provides a consistent, closed, and dynamic model of an economy.

The specific IM model used for this study is the Long-term Interindustry Forecasting Tool (LIFT).[9] It was developed over the past twenty-five years at the Interindustry Forecasting Project at the University of Maryland (INFORUM), which is a not-for-profit research and consulting group directed by Clopper Almon. LIFT combines over one-thousand equations to forecast the U.S. economy and its industry detail. The goal of this thesis is to improve the price-income side of the model.

A Closer Look at the Price-income Side of an IM Model

As described above, an IM model uses the input-output dual equation to determine prices. The equation is based on the definition of price as the sum of two costs: costs of materials and returns to factors of production. According to equation 2.6, modeling prices is a straightforward process of combining input-output coefficients with estimates of unit value-added. In practice, integrating price determination into an interindustry macro model has proven to be a less-than-straightforward econometric challenge.

A brief history of modeling prices and incomes

No attempt will be made here to provide an encyclopedic review of

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[9] See McCarthy (1991) for a recent description of LIFT. See also Chapter 6 below.

previous approaches to price-income determination in IM models.[10] Instead, a short description of some of the unique characteristics of price-income modeling will be presented, as well as the highlights of previous modeling attempts, to give perspective to the plan of approach for this work. The unique characteristics of price-income modeling that are discussed are: industry and product income data; exogenous and model-determined prices; and the industry income components.

Industry vs Product Income Data

One of the complications of modeling prices arises because of methods of collecting income data. The dual input-output equation defines product prices in terms of unit value added, or value added per dollar of output of any product. To model prices, then, value added must be available by product. In the U.S. National Income and Product Accounts (NIPA), however, value added data is only collected by industry. An industry is defined as a group of establishments engaged in the production of a similar product. Since any single industry may manufacture more than one product, the relationship between product and industry classifications must be summarized in a bridge table. This product-to-industry bridge defines the product composition of every industry's output.[11] In other words, each industry produces some "primary" product, as well as some "secondary" products. The value added from producing each of these products is allocated to the appropriate product columns of the bridge matrix. The Agriculture industry may not only harvest grain (its "primary" product), it may also produce ice-cream (a "secondary" product). The income from the

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[10] See Hyle for a comprehensive summary of previous work on the LIFT model at the University of Maryland.

[11] See Hyle for the development of the product-to-industry bridge currently used in the model for this study. Hyle's work is based on information from the Department of Commerce.

Agriculture industry would be spread to both Agricultural products (grain) and Food and tobacco processing products (ice cream). In addition, the product-to-industry bridge accounts for differences in product and industry definitions. For example, NIPA lists product and industry sectors named "Agriculture, forestry, and fisheries." The product-to-industry match is not exact, however, because Veterinary services are counted as part of the 'product' of Agriculture, but as part of a different 'industry', Medical services.

Exogenous vs Model-Determined Prices

A second complication of modeling the price-income side of an IM model arises when the possibility of specifying prices exogenously is introduced. In the IM model scheme, prices are determined by first solving for industry value added. In practice, a modeler may choose to override a value-added-determined price and specify a product price exogenously. This possibility could arise for two reasons.

1) Exogenous price specification

In some instances, the appropriate level for a price may be determined by factors outside the scope of the model. For instance, the price of agricultural goods depends largely on the weather and on government policy. Since forecasting either the weather or the actions of government policy makers is beyond the capabilities of most economic modelers, it is desirable to specify agricultural prices exogenously.

2) Price simulations

Models are best used not merely as forecasting tools, but also as simulation tools for exploring different scenarios in a consistent econometric framework. To simulate different price shocks, then, it is necessary to override a value-added-determined price and specify an alternate price for any product.

If a product price is set exogenously, value added must be adjusted to insure that the input-output accounting of equation 2.2 is maintained. In effect, this type of adjustment introduces a second product-to-industry bridge that distributes the effects of changes in product prices to the appropriate industries.[12] It is good to keep in mind that allowing prices other than value-added-determined prices implies that results of income by industry equations may be overridden.

Industry Income Components

To model product prices using the Interindustry Macroeconomic structure, income by industry must be estimated. In its most general sense, industry income is simply the value added to the cost of materials in the production of goods and services. That value added can be summarized as the returns to three factors of production: labor, capital, and government. In this study, value added is broken into twelve components:

Labor compensation

Returns to capital
- Corporate profits
- Proprietor income
- Corporate and Non-corporate depreciation allowances
- Corporate and Non-corporate inventory valuation adjustments
- Net interest payments
- Business transfer payments

Rental income

Returns to government
- Indirect business taxes
- Government subsidies

Since labor compensation has been adequately covered in previous

[12] This raises a number of technical modeling issues that are addressed in Monaco, L.S..

work, the bulk of this study concerns returns to capital and government.[13] Of these latter two, returns to capital are the most important in terms of their share of value added and their role in price determination.

Approaches to Modeling Return to Capital

This section describes two methods for modeling return to capital, emphasizing the problems encountered in each approach, to introduce the method for this study.

Return to capital can be viewed as an aggregate income source for every industry, or it can be examined more closely as the sum of its parts. One approach to modeling return to capital emphasizes the first point of view. In this approach, equations for total capital income by industry are estimated. Capital income includes volatile items, such as profits, as well as more stable items, such as net interest payments. Net interest and depreciation allowances are largely determined by historical factors, and move fairly steadily over the business cycle. Profits and proprietor income, on the other hand, are prime indicators of business cycle movement. Because total capital income contains both type of items, it tends to be smoother than profits or proprietor income, and is therefore somewhat easier to estimate than the pieces. The main advantage of estimating total return to capital is that the division between interest and corporate profits depends on choices between debt and equity financing, which are difficult to model. By concentrating on their sum, the choice does not affect total value added. In addition to modeling total capital income, however, the components also must be modeled. In earlier versions of the model used for this study, each component of capital income was estimated

[13] See Hyle Chapter 3 for industry results, and Monaco R.M. Chapter 5 for aggregate equation.

separately.[14] The total of the individual components was then summed, and the difference between that total and the result of the equation for total capital income was spread to the largest income components. In other words, the equations for total return to capital determined capital income for each industry, and the equations for the pieces of income determined the share of each component in the total.

One obvious disadvantage of this aggregate-plus-component approach is its redundancy. Profits are a relatively large component of capital income, and movements in profits dominate cycles in return to capital. Profit equations consequently resemble equations for total capital income. Two sets of equations are being used to do essentially the same task. In addition, the results of the equations for any component, such as profits, are being overridden by the capital equation. As noted earlier, value-added results in an IM model may also be overridden when prices are set exogenously, so the effectiveness of the industry income equations is diminished.[15] The practical issue this raises concerns the tractability of the model. The estimated equations often had little to do with the final forecast result, making it difficult to analyze forecast results.

Figure 2.1 illustrates the type of problem that resulted from aggregate-plus-component approach, by showing forecast results from the January 1989 version of the LIFT model. The profit margin for the Motor vehicle industry is shown. While the overall forecast of the U.S. economy produced by LIFT was reasonable, including product prices and total industry capital income, the individual income components often follow an unreasonable path. After more than twenty years on a downward

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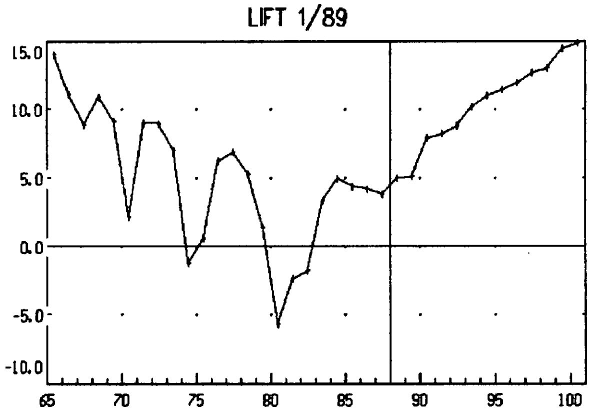
[14] See Monaco, R.M., pp. 91-98.

[15] If one were wedded to the idea of using aggregate RTK equations and component equations, a better approach would use share equations for the components.

trend, the profit margin for the auto industry reverses direction and grows rapidly through the entire forecast. It seems unlikely that profits in the troubled auto industry would enjoy such an optimistic outlook.

Figure 2.1: Profits/Q Motor vehicles



To avoid the problem of redundancy in income determination, Hyle estimated aggregate return to capital equations and equations for all components of capital income except profits. Profits were then calculated as a residual. (Hyle, ch. 4) Because aggregate equations mask movements in the individual pieces, however, the Hyle approach failed to capture adequately the changing share of the components of return to capital. For instance, while net interest payments have increased as a share of total return to capital, at the expense of corporate profits, the Hyle forecasts failed to capture that switch. (Hyle, ch. 6) The Hyle approach illustrates that the philosophy of IM modeling - what happens at the detailed level matters - aptly applies to forecasting capital income. Since capital income is comprised of disparate series, an efficient modeling approach puts behavioral results at the greatest level of detail possible.

To avoid redundancy and to emphasize the importance of building to the aggregate by focusing on the detail, this study will model total capital income for each industry as the sum of the different income components. Directly estimating equations for each of the components of capital income allows a conceptually simpler modeling approach. The factors that affect each component can be isolated and used appropriately. How to model those factors at the industry level is the next step in developing the price-income side of an IM model.

Approaches to Industry Equations

An IM model combines industry-level equations for components of final demand, such as consumption and investment, as well as components of factor income, such as profits and labor compensation. For some of these items, industry-level behavior can be estimated successfully using a single-specification. That is, a single functional form is appropriate for all industries, with parameter values capturing industry differences. A single specification is useful where the dependent variables are, in theory, jointly determined by the same variables. For example, Personal Consumption Expenditures (PCE) on various products depend on relative prices, disposable income, and demographic variables. Each PCE equation uses the same variables, but income and price elasticities differ by commodity.

An alternate approach uses an aggregate equation to summarize the overall behavior of the item, and then estimates industry behavior relative to the aggregate. This approach proves useful for at least two reasons. In some instances, a behavioral variable may be important at the aggregate level, but may be difficult to use at the detailed level. In estimating labor compensation, for instance, it is possible to model the link between money and prices by including monetary variables in the overall manufacturing wage rate. Monetary variables are significant in an aggregate equation, but difficult to use in sectoral wage equations. In this case, it is useful to estimate an equation for aggregate wages that includes a monetary link. Industry wages are then estimated relative to the aggregate wage using sector-specific variables. This approach also is attractive when data is available at an aggregate level that is not available at the industry level. In estimating Inventory Valuation Adjustments (IVA), for instance, the total change in business inventories in the economy is readily available. Detailed change in inventories by industry is not as easily available, however, so it is more difficult to estimate industry-level IVA equations. It is more convenient to estimate an aggregate IVA equation, and then estimate industry IVA relative to the total.

Both approaches assume that each industry's behavior can be summarized by the same functional form, with differing values for behavioral parameters. In some instances, however, specifying a single functional form for all industries is too restrictive. In estimating return to capital by industry, for instance, Hyle started with a single function for all industries. He found however, that many industries did not conform to that specification, so additional variables needed to be introduced for each industry.[16]

Although Edward Leamer did not specifically address the issue of estimating a set of industry equations, he proposes a flexible estimation procedure that represents the opposite extreme of using a single-specification approach. (Leamer, pp.308-313) Leamer proposes that functional form and equation specification should be variable factors in the overall estimation process. Instead of choosing an equation specification and then performing a regression, Leamer proposes

[16] This is a common way of allowing industry-specific variables in a system that starts with a single function for each industry. In the case of return to capital equations, the equations of many industries were improved by the introduction of a number of different variables.

experimenting with different functional forms, variables, and specifications. Ideally, the entire set of possible models would be tested. Since practical limitations preclude such testing, Leamer suggests a piecemeal approach that tests the model with respect to a limited number of its dimensions. An important aspect of this limited testing is the extra knowledge that the researcher brings to the study. For example, part of the testing involves distinguishing two types of independent variables. So-called free variables are those which are always included in the equation. On the other hand are those variables the researcher feels comfortable experimenting with, or the doubtful variables. The distinction between free and doubtful variables should not be arbitrary, Leamer believes, but rather

> the split should be selected to represent as accurately as possible the other relevant information that is required to draw sensible inferences from the given data set. (p. 312)

In other words, the entire set of possible equations can be narrowed by an appropriate choice of doubtful and free variables.

Leamer's approach can be applied to industry equations for an IM model in the following manner. Instead of specifying a single functional form for all industries, a general functional form will be identified. The general function will include both free and doubtful variables, and each industry's equation will be estimated separately.

For example, this study uses a flexible industry approach for estimating profit income. A general set of variables is suggested for profit equations, but unlike previous studies, the equations will not be estimated with a single equation specification. Instead, industry-specific traits will play a role in determining the form of the equation.

Evaluating Equations to be Used in a Model

The usual approach to estimating econometric equations involves some attempt to evaluate the quality of the equation, both econometrically and in terms of economic theory. Standard diagnostics, R^2 and t-statistics, evaluate the econometric fit of the equation and statistical importance of variables. Economic theory judges the appropriateness of variables based on the interpretation of equation parameters. However, equations that are reasonable both econometrically and theoretically often combine in a model to produce results that are unreasonable.[17] In addition, Leamer notes that, in some instances, more than one specification of an equation will produce "reasonable" results. In those cases, additional information supplied by the researcher should be used to select an equation.

In earlier attempts to develop the price-income side of an IM model, equations for industry income passed rigorous tests of econometric integrity and economic reasonableness. When introduced into an IM model, an economically sound forecast was generated. The forecasting properties of the model were not robust, however, to different exogenous assumptions for the IM model. In doing relatively simple exercises with the model, such as simulating changes in monetary policy, the model either broke down completely, or produced results that were economically unreasonable. (Hyle, chapter 6)

In the present study, emphasis is placed on evaluating the robustness of the equations once they are combined into the entire IM model. In estimating equations, standard diagnostic and economic tests will be used. In addition, static forecasts of the equations will be used to evaluate the overall reasonableness of the equations. Finally, the equations will be included in the model and used to forecast under

---

[17] See Almon (1989), as well as Monaco, R., chapter 4, Hyle Chapter 6.

a number of different assumptions about the economy. This last step will be viewed as part of the development of the equations, in order to test their long-run forecasting properties.

Chapter 3: Industry Profit Income: Equation Specification

Profit income is the most volatile component of capital income and consequently occupies center stage in the income side of an economic model. This chapter develops the approach that will be used to estimate profit equations for thirty-seven industries. The specific definition of corporate profits is explained in the first section of the paper. Since the equations will be included in an Interindustry Macroeconomic model, the role of profits in the model are discussed. Unlike most other model structures, the IM approach emphasizes the role profits play in price determination. The remaining sections of the chapter outline the specification of equations to explain industry profits.

Definition of Corporate Profits

Profits are the excess of income over expenditures. Different profit measures arise due to differences in defining expenditures. In the most general sense, "accounting profits" (or book profits) are based on costs as calculated for tax purposes, while "economic profits," as defined in any introductory text in economics, are based on opportunity costs. In the National Income and Product Accounts (NIPA), profits reported by firms, or Before-tax Corporate Profits, are an accounting measure of profits. The NIPA statisticians collect additional data to derive a measure of profits referred to as "profits from current production." This alternate profit measure more closely resembles economic profits than do accounting profits.[18]

Accounting profits are derived by subtracting several expenses from net income, the excess revenue that remains after paying the cost

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[18] See BEA (1985) for description and definition of "profits from current production." (pages 2-4) The NIPA definition of profits measures before-tax earnings from current operations by adjusting for changes in depreciation costs and inventory valuation as described below. The alternate measure does not attempt to subtract normal interest on capital, so it is not truly a measure of "economic" profits.

Figure 3.1: Definition of Profits

```
Total revenue (price * quantity sold)

        -     Cost of materials
        -     Current operating expenses

=       Net income  (Value Added)

        -     Returns to labor   (wages, salaries, benefits)
        -     Returns to government  (indirect business taxes)

=       Returns to capital

        -     Net interest
        -     Capital consumption allowance (depreciation)
        -     Other (Transfers, Subsides, Proprietor income)

=       Before-tax Corporate Profits  ("accounting" profits)

        +     Capital consumption allowance adjustment
        +     Inventory valuation adjustment

=       Before-tax Corporate Profits, adjusted
              ("economic" profits)
```

of materials. The expenses, outlined in Figure 3.1, include labor costs, depreciation, the change in the value of inventories, and indirect business taxes (such as sales taxes). The main difference between economic and accounting profits involves measuring two of these costs: depreciation and the change in the value of inventories.[19]

The accounting definition of depreciation costs in the NIPA is the Capital Consumption Allowance. It differs from an economic definition in two ways. In general, accounting depreciation is calculated with legislated depreciation formulas based on service lives that differ from actual useful lives of plant and equipment. Since the 1981 tax reform, which allows accelerated depreciation formulas, the accounting measure of costs results in higher initial depreciation costs than would be

[19] Table A-1 in BEA (1985) lists the 16 specific differences between tax accounting and National Income and Product Accounting. Depreciation and inventories are the largest and most significant of the differences. (pp. 52-53)

calculated by spreading the life of the equipment over a longer period of time. In addition, however, the accounting definition values the depreciated equipment at its acquisition cost. The economic definition of depreciation, based on opportunity cost, values the equipment at its current replacement cost, which usually exceeds the acquisition cost. To account for these differences in measuring depreciation costs, the NIPA statisticians estimate the presumed actual depreciation of capital by firms. This actual depreciation is estimated by evaluating equipment at current replacement cost. If the charges to depreciation, or Capital Consumption Allowances, exceed that actual depreciation, earnings are considered to be understated. The amount of understatement is then added to corporate profits in the form of a Capital Consumption Adjustment (CCAdj). As shown in Figure 3.2, the CCAdj was negative from 1975 through 1982. This negative adjustment reflects a period of high inflation, when the replacement cost of equipment was significantly larger than the acquisition cost. Since depreciation costs during that time were understated, and earnings consequently overstated, the CCAdj was negative. For most of the 1980's, the CCAdj has been positive, because of changed tax laws and slower inflation, implying that firms have underestimated Before-tax profits. The Accelerated Cost Recovery System (ACRS) introduced in 1981 allowed firms to "front-load" their depreciation costs. In other words, the depreciation on a piece of equipment could be calculated using formulas that count a large share of the equipment's total depreciation in the early years of its life. This front-loading implied that depreciation costs were overstated. Starting in 1982, the CCAadj grew strongly until it reached a peak value of 60 billion dollars in 1985, roughly 28% of Before-tax corporate profits. Since 1985, the adjustment has declined steadily, and, in the fourth quarter of 1990, the CCAdj was negative for the first time since the high-inflation period of the 1970's.

Figure 3.2: Capital Consumption Adjustment
(Billions of dollars)

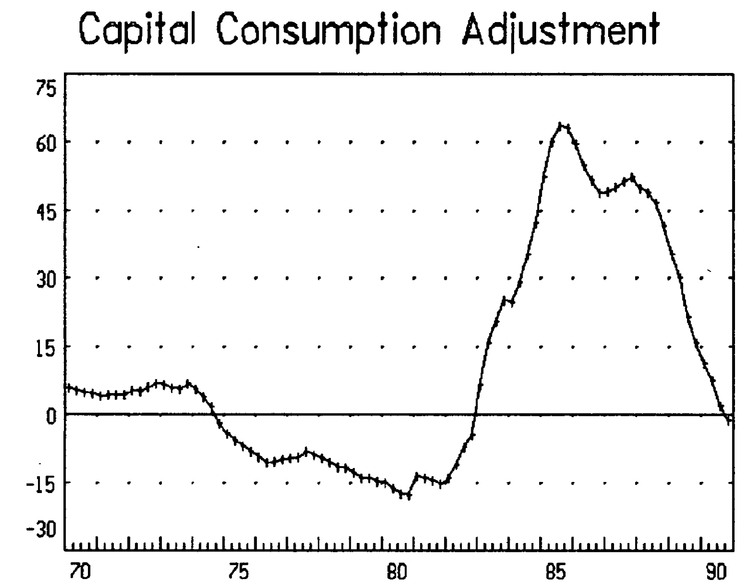
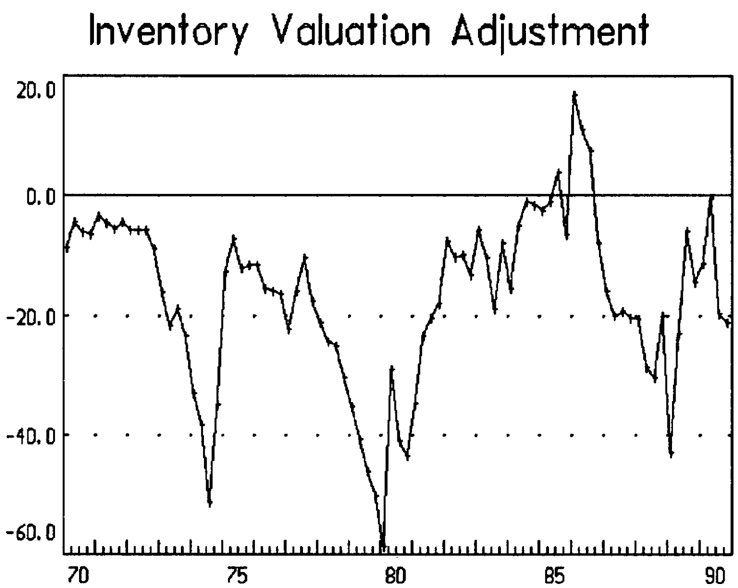


Figure 3.3: Inventory Valuation Adjustment
(Billions of dollars)



The second cost adjustment in defining profits concerns the valuation of inventories. In calculating the cost of goods sold in the current period, accountants subtract an estimate of the cost of goods sold from inventory. There are several different accounting methods for estimating those costs that include valuing the goods at their original acquisition cost (FIFO: first in, first out) or at their current replacement cost (LIFO: last in, first out). The latter method reflects the concept of opportunity cost and is preferred in defining economic costs. In the NIPA, an adjustment is made to ensure that the value of inventory change is defined consistently across industries, and that it reflects opportunity costs. In other words, NIPA converts all inventories to a LIFO basis and determines an Inventory Valuation Adjustment (IVA). Since the IVA is meant to correct for the underestimation of changes in the value of inventories due to inflation, the adjustment is usually negative. In other words, underestimating the cost of inventory change implies that corporate earnings are overstated. As shown in Figure 3.3, the IVA is larger in absolute value during periods of high inflation, such as in 1974 and 1979. Its only positive value occurs in 1986, when falling oil prices led to a short period of deflation, and the change in value of inventories was overestimated. Since the IVA has not been affected by changes in the tax code, it follows a more stable path than does the Capital Consumption Adjustment, and it has averaged a fairly consistent value of about 10% of total Before-tax Corporate Profits.

The adjustments to reported Before-tax Corporate Profits in the NIPA aim to define a measure of <u>aggregate</u> profits that reflects economic, or opportunity costs, and consistency in cost definitions across industries. Since this study aims to model <u>industry</u> profits, however, inventory and depreciation adjustments also must be applied to industry before-tax profits. Although the NIPA report Inventory Valuation Adjustments by industry, the adjustment for depreciation allowances is only reported for total Capital Consumption Allowances. Consequently, an approximation for industry depreciation adjustments must be calculated. A reasonable approach is to distribute the total adjustment to industries based on each industry's share of depreciation in total depreciation allowances.[20] The definition of adjusted industry profits is:

$$PROF_i = CPR_i + IVAi + \left(\frac{CCA_i}{CCA}\right) * CCAdj \qquad (3.1)$$

where

$PROF_i$ = adjusted corporate profits, industry i,
CPR_i = before-tax corporate profits, industry i,
IVA_i = Inventory Valuation Adjustment, industry i,
CCA_i = Capital Consumption Allowance, industry i,
CCA = Capital Consumption Allowance, total,
CCAdj = Capital Consumption Allowance Adjustment, total.

Table 3.1 displays adjusted profits for the thirty-eight industries of this study. The table shows the six most recent years of data, 1982-1987.[21] (For this study, data from 1955-1987 was used.) The last

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[20] This method implicitly assumes that industries with large depreciation costs incur a large share of the depreciation adjustment, regardless of the type of capital being purchased. Hypothetically, this need not be the case. Assume, for instance, that computers may be depreciated at a faster rate than cars, and that the formula for automobiles accurately measures the economic life of the car. Further assume that Industry A buys only cars and no computers, while Industry B buys only computers. If the value of the cars purchased by A exceeds the value of the computers purchased by B, the depreciation costs for industry A will exceed the costs of B. By spreading the adjustment based on depreciation costs, Industry A will absorb more of the adjustment, even though, in this case, its depreciation costs should not be adjusted at all. A better method would spread the adjustment to industries based on the types of equipment and structures being purchased. But, it is precisely the lack of reliable and consistent data on investment by firm that prohibits the Department of Commerce from reporting the CCAdj by industry in the first place. This hypothetical example was based on extreme assumptions about (1) the composition of industry investment and (2) differences in depreciation formulas. Since the conditions assumed for the example are not prevalent in the actual data, the distribution method here remains a reasonable approach.

[21] Industry data through 1988 has recently been made available, but did not arrive in time to be included in this work.

column of the table shows the share of each industry's profits in the total in 1987. In general, the service industries are a larger share of the total than manufacturing industries. The profits of three service industries, Wholesale and retail trade, Finance and insurance, and Rest of world, make up close to half of total profits, while some of the largest manufacturing industries are Chemicals, Food and tobacco, and Motor vehicles.

NIPA reports total profits on a national basis. In other words, it is the total profits from production on which U.S. residents have a claim, wherever the production takes place. The NIPA also include a measure of total profits on a domestic basis, or profits earned from production that takes place in the United States. Domestic profits exclude income earned abroad by U.S. corporations and include income earned in the U.S. by foreigners. The difference between national and domestic profits is called "profits originating in the rest of the world" and is reported as the profits for the Rest of world industry. Since Rest of world profits represents a net transaction, and because it has a special role in the balance of trade accounts, these profits will be treated differently than domestic profits in the following study.[22]

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[22] In the NIPA, Gross domestic product equals Gross national product less Factor income receipts, plus Factor income payments. The difference between factor income receipts (exports) and factor income payments (imports) equals the total product for the Rest of world industry. This total product for the Rest of world industry also is defined as the sum of Labor compensation, Net interest payments and Corporate profits for the Rest of world. (See U.S. Department of Commerce, Survey of Current Business, August 1991, p. 21)

Table 3.1: Before-tax Corporate Profits

Adjusted for Inventory Valuation and Capital Consumption

(millions of $)	1982	1983	1984	1985	1986	1987	Share of Total '87
1 Agriculture	98.7	325.2	916.4	929.8	693.4	662.5	0.2
2 Crude Petroleum	23731.9	17934.1	16710.2	14368.2	-2640.6	5659.9	1.8
3 Mining	147.9	1414.2	1209.3	351.6	1187.5	218.8	0.1
4 Construction	2633.3	2931.1	4634.6	7000.3	8102.7	7978.4	2.6
5 Food & Tobacco	8502.0	9921.1	10202.0	11490.2	12241.5	13507.4	4.4
6 Textile mills	567.8	1536.6	1051.9	1397.4	2451.4	2008.3	0.7
7 Apparel	2345.8	2949.2	1633.9	1696.5	1683.9	2419.0	0.8
8 Paper	3388.7	3302.1	4601.7	4321.0	5162.6	8379.1	2.7
9 Printing	4535.3	5832.3	6973.0	8211.4	7612.8	6942.6	2.3
10 Chemicals	3998.3	7181.0	8411.1	6304.0	11246.1	16933.8	5.5
11 Petroleum	201.3	-147.4	-227.3	628.9	2623.8	556.7	0.2
12 Rubber plastic	1318.4	2111.0	2284.0	2926.7	4049.4	4040.7	1.3
13 Leather	595.4	408.3	257.6	260.6	-14.0	259.5	0.1
14 Lumber	-561.1	1944.1	2564.6	1688.7	3064.1	4406.0	1.4
15 Furniture	1184.4	1374.6	1777.7	2272.6	2089.9	2073.2	0.7
16 Stone,clay,glass	-601.4	1031.8	2010.2	2980.1	3505.1	4488.2	1.5
17 Primary metals	-7324.8	-7574.7	-2423.6	-2488.6	-1872.6	850.8	0.3
18 Metal products	3155.3	4248.7	6261.3	6386.8	7098.1	7318.5	2.4
19 Trans equip	-4959.3	1889.4	4037.3	3025.1	3662.9	3480.3	1.1
20 Nonelect machinery	2994.9	1258.2	4545.7	-789.8	-1461.3	-2466.0	-0.8
21 Elect machinery	1208.9	3307.2	4993.6	3577.9	2617.2	2269.5	0.7
22 Motor vehicles	-1971.7	5050.6	8930.0	8278.0	8154.0	7477.4	2.4
23 Instruments	1209.6	1210.4	2495.1	118.0	-439.7	-908.1	-0.3
24 Misc manuf	1197.3	-159.6	1586.4	905.9	887.4	867.0	0.3
25 Railroads	-603.7	700.9	2148.1	1498.9	1709.3	1469.6	0.5
26 Air transport	-2224.0	-454.9	1220.3	-325.3	846.7	2996.4	1.0
27 Trucking	3805.6	6710.8	5936.9	6250.2	6908.4	5137.8	1.7
28 Communications	6674.7	10485.7	14576.9	16873.1	20497.9	20317.4	6.6
30 Electric,gas,sanita	10067.0	16184.7	22887.3	21667.4	21960.4	17644.2	5.8
31 Wholesale & Retail	40039.2	48863.0	64931.9	68159.3	69597.5	68664.6	22.4
32 Finance, insurance	10634.9	18579.7	14497.2	26733.9	35814.1	35192.3	11.5
33 Real estate	-1785.3	92.4	-653.3	-1346.3	-1106.7	-249.9	-0.1
34 Hotels & non-auto	1341.5	1654.2	1758.1	1389.2	1428.0	1468.2	0.5
35 Misc business	4044.6	5551.8	7398.8	10147.3	10604.4	10985.8	3.6
36 Auto repair	-25.5	411.7	403.3	481.6	534.0	723.4	0.2
37 Motion pictures	635.2	445.4	-610.0	403.4	409.9	732.5	0.2
38 Medical & educational	3483.9	5165.2	5436.8	6242.9	6457.6	5857.2	1.9
46 Rest of world	28047.0	30171.0	30910.0	31167.0	31937.0	36409.0	11.9
Total	151732.0	213841.0	266279.0	275184.0	289304.0	306772.0	100.0
Annual growth	-19.8	40.9	24.5	3.3	5.1	6.0	

Role of Profits in an Interindustry Macroeconomic Model

Since the goal of this study is to develop profit equations that will be part of an Interindustry Macroeconomic model, the equation specification must take into account the role profits play in the model. This role differs from the part profits play in most other models, because profits in an IM model are an integral part of price determination. While most macroeconomic models rely on some sort of aggregate price equation, the IM model determines the aggregate price level by modeling the complete income side of the National Income and Product Accounts. Each component of labor and capital income is determined and then summed to calculate nominal Gross National Product. The ratio of nominal GNP to constant-dollar GNP, from the product side of the accounting framework, yields the implicit GNP price deflator. At the industry level, the dual IO equation determines product prices (and hence relative prices) as the sum of input costs and value added. As a component of value added, profits play a direct role in determining product prices. Recall that product prices are defined as:

$$p - pA + v \qquad (3.2)$$

where

p = vector of product prices,
A = A-matrix of input-output coefficients,
v = vector of value added per unit of output, and

$v = l + k + g$

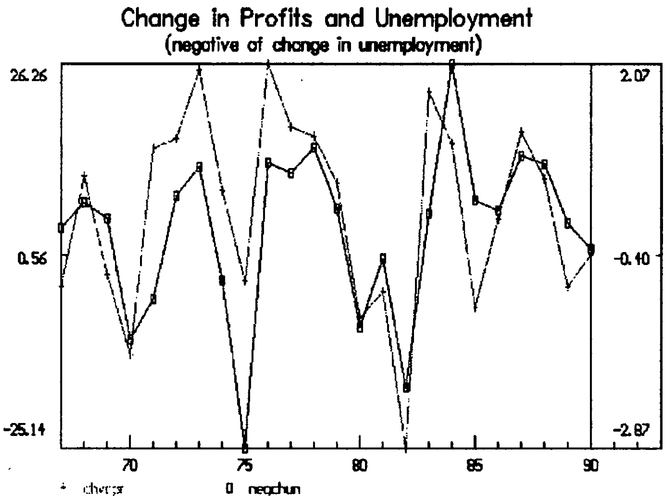
l = returns to labor,
k = returns to capital (profits, etc.)
g = returns to government.

Two aspects of profit behavior are important for the role of profits in price determination. In the most basic supply and demand framework, prices change in response to shifts in the demand curve or to changes in supply. Like prices, profits are sensitive to demand changes and are likely to exhibit strongly cyclical behavior. In fact, this cyclical behavior forms the basis for most aggregate profit equations. On the supply side, profits also respond to cost changes, and in this sense, closely resemble price mark-up behavior. In short, the factors associated with price determination likewise affect profits.

Role of Profits: Response to Demand

Aggregate profits are strongly pro-cyclical; profits increase as demand in the economy strengthens and fall as demand slows. Figure 3.4 illustrates this pro-cyclical relationship by comparing changes in profits and changes in unemployment. (The negative of changes in

Figure 3.4



unemployment are shown, to highlight the pro-cyclical behavior of corporate profits.) As unemployment rises, a signal of slow demand, profits fall. While the graph is suggestive, a more technical analysis by Kydland and Prescott also supports the assertion that profits are highly procyclical. Kydland and Prescott construct a specifically defined measure of trend GNP to study business cycles as movements around that trend. Cyclical behavior is measured by the degree of comovement with real GNP, and they conclude that capital income is strongly procyclical and highly volatile. (p. 23)

Cyclical behavior is an important characteristic of aggregate profits and implies that a measure of demand can be used successfully in a profit equation. Many macroeconomic models use the positive correlation between profits and demand as the basis for an equation to determine aggregate profit income. In Almon's quarterly model, for example, profits are a function of the current level of real Gross Private Product and lagged changes in GPP. In addition, profits respond to a capacity constraint, measured as the difference between actual GPP and potential GPP, where potential GPP is a function of labor productivity. Almon's equation is:

```
cpr =    178.3  +  .01 * gpp      +   .36 * dgpp     +        (3.3)
                   .31 * dgpp[1] +   .27 * dgpp[2] +
                   .24 * dgpp[3] +   .22 * dgpp[4] +
                   .16 * dgpp[5] +   .26 * capac[1]+
                  -.10 * capac[2]
```

where

cpr	=	Corporate profits, adjusted for iva and cadj, deflated by GNP deflator,
gpp	=	Gross Private Product, constant $, (GNP - government compensation)
dgpp	=	First difference in gpp,
capac	=	Percent deviation of actual GNP from potential GNP.

The combination of a demand measure and a capacity constraint also is illustrated in the profit equation for the Data Resources Inc. (DRI) model. (Eckstein, pp. 186-189) The DRI equation differs from the Almon equation in three main respects, however. First, the variables are not deflated, and therefore reflect changes in inflation as well as changes in behavior. Second, the dependent variable is defined as Before-tax profits before the corrections for inventory valuation and depreciation (so-called "book profits"). The profits are not adjusted because, according to Eckstein, "the corrections are quite synthetic and based on very limited information". (p.187) Finally, the equation also includes a measure of relative labor costs, measured by the ratio of a weighted industrial price index to unit labor costs. The equation, estimated with quarterly data from 1960 to the third quarter of 1980, is:

$$\begin{aligned} bkcpr = \; & -324.1 + .173 * GPP \\ & - .109 * (1 - ucap)*GPP \\ & + 187.4 * (temp) \end{aligned} \tag{3.4}$$

where

bkcpr = corporate profits, before tax, excluding adjustments for inventory valuation and historical depreciation, less net factor payment abroad, plus corporate capital consumption allowances (book value), plus the windfall profits tax.
GPP = Gross national product less government compensation,
ucap = capacity utilization rate of manufacturing (FRB),
temp = ratio of a reweighted industrial price index to unit labor costs.

In choosing this particular equation, Eckstein points out that the equation was one of the most difficult equations of the DRI model to estimate. Equations that fit well and had good statistical properties were not hard to find. However, small changes in the specification of the equation were found to substantially alter the sensitivity of profits to changes in independent variables in the model. The equation was chosen over other specifications that showed more cyclical response of profits:

> The particular equation was chosen for its good performance in complete model simulations. The equation's cyclicality is not among the most extreme. In the first year, the elasticity of profits with regard to GNP increments may be as high as four, depending on the composition of GNP change. But after a few more quarters the elasticity settles down near unity. The elasticities found for publicly reported company profits are higher. (page 186)

The difficulty Eckstein found in estimating aggregate corporate profits explains, in part, why few macro models explicitly include an equation to determine profit income. Moreover, even those models that include profit income do not use the results from the equation in determining prices. Rather, inflation is modeled separately, usually with an equation explaining changes in the implicit GNP price deflator based on some autoregressive scheme combined with supply-shock variables, monetary growth, and some measure of import prices.[23]

In summary, aggregate profits are strongly procyclical, and macro models usually concentrate on that behavior in specifying a profit equation. Those models do not, however, use the demand-responsiveness of profits in determining the overall price level. Before turning to the role of profits in determining industry prices, an implication of the cyclical behavior of profits for an econometric model will be discussed.

An Aside: Profits as Business Cycle Stabilizers

The cyclical behavior of profits has some interesting implications for the role of profits in stabilizing the business cycle. While most of profit income is retained by firms (as Undistributed Corporate Profits, or Retained Earnings), a smaller share of that income is distributed to consumers through corporate dividends. This income distribution can have a stabilizing influence during business cycles. In an economic downturn, for example, unemployment rises as demand and income fall. Lower demand implies lower profits and prices. Lower prices (or prices that grow more slowly) have a stimulative effect on the economy and help reverse the downturn. In addition, although profit income has fallen, the part of profits that affects consumer income is slow to adjust to lower profits. As shown in Figure 3.5, Corporate dividends follows a much more stable path than does total Profits. The full effect of a drop in profits is not felt quickly by consumers. On

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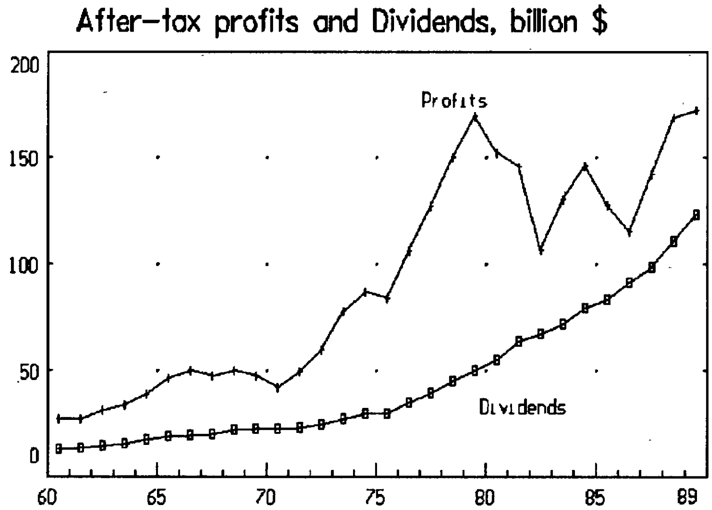
[23] See for example, Fair, Throop, BEA (1986), as well as Almon (1989) and Eckstein.

the other hand, the drop retards the growth of prices. Further, in the model used for this study, there is no direct link between retained earnings and investment demand, since attempts at estimating equations embodying such behavior were unsuccessful. Therefore, profits act as shock absorbers in this model and help stabilize the economy's business cycles.

Figure 3.5: Corporate Profits and Dividends



Role of Profits: Response to Cost

The IM model structure emphasizes the relationship between value added and product prices. As noted earlier, prices in the model are determined by summing costs, both material costs and returns to factors of production.

$$\text{Price} = \text{Material} + \text{Labor} + \text{Capital} + \text{Tax} \quad (3.5)$$

where

Price = producer price of a product,
Material = unit material input costs,
Labor = unit labor costs,
Capital = unit capital costs,
Tax = unit indirect business taxes.

Since profits are a large component of capital income, they play a direct role in determining product prices; an increase in profits, *ceteris paribus*, implies an increase in price.

In setting up industry profit equations, and emphasizing their role in price determination, there is little precedent to follow from other econometric models. As noted in Chapter 2, the IM approach of using structural equations at the industry level is a relatively unusual one, and this is especially true in modeling industry income. Even in the IM structure, there is little attention paid specifically to corporate profit equations. In the Hyle work on industry income, for instance, profits were calculated as a residual after solving for return to capital and all other components. Empirical studies on industry profits exist and usually are found in work involving specific issues in the industrial organization literature. For the most part, however, this empirical work is not suited for developing equations that have the specific purpose of being included in an IM model. Because of their role in price determination, however, industry profit equations share common ground with price equations.

In models that explicitly include industry behavior, prices are usually determined as some mark-up over costs. Both the Wharton Econometric model of the U.S. economy and the Cambridge Dynamic Multisectoral model of the United Kingdom, for example, use equations that determine prices as some mark-up over labor and material costs.[24] Although the BEA model is a macro model, it also uses the mark-up concept in determining prices. To the extent that mark-ups include profit income, the independent variables of a mark-up equation are suggestive in specifying an equation to explain profits.

The equations are based on the idea that prices are determined as some mark-up over "normal" costs, or costs at normal levels of operation. The size of the mark-up depends on demand and supply conditions in the industry, as well as on changes in productivity. Most mark-up equations assume complete pass-through of input costs to prices, although the pass-through may occur with a lag. The mark-up equations also include some measure of labor costs, often expressed as hourly compensation adjusted by productivity, or as compensation as a share of total value added. In addition, the mark-up equations are designed to include the positive effect of demand on prices. The demand effect often is expressed as a capacity variable, or more simply, as changes in real output for the industry. If capacity moves slowly relative to output changes, then demand pressure on capacity, measured as the percent change in the output to capacity ratio, is roughly equivalent to changes in real output.

Although the BEA model is a macro model, it deserves special mention here for its attention to industry behavior in determining prices. Price determination in the model follows a "stage-of-processing" method that emphasizes industry-specific costs. BEA notes that the typical approach to modeling inflation in a macro model uses a single equation to explain, say, the implicit price deflator for GNP. That approach fails, however, when inflation is caused by shocks in commodity prices. The alternate stage-of-processing approach starts by

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[24] See Wharton, and Barker and Peterson. The Wharton approach closely resembles the IM structure, in that prices are determined by material costs and the "value-added price". The value-added price includes labor and capital costs.

determining prices of crude materials, which then determine, in part, the price of manufactured goods, which then partly determine final demand prices. For each stage, the BEA price equations can be summarized as mark-up equations over labor and material costs, where the mark-up includes return to capital and therefore profit income. The stage-of-processing concept is similar to the relationship between material costs and prices implicit in the input-output dual equation. Since the IO equation defines product prices as the sum of input costs and value added, it specifically embodies "stage-of-processing." In addition, the IM structure allows much greater detail in identifying each "stage", since each product price is determined by its own specific costs and value added.

Since industry profits play a direct role in price determination in an IM model, the equation specification should resemble mark-up equations that consider changes in input costs, labor compensation, and demand conditions. In addition, profit behavior should be modeled at a detailed industry level, to emphasize the differences between each industry's response to those factors. For example, the response of profits to demand changes over the business cycle will vary by industry. While profits in total are strongly procyclical, each industry's response to demand changes may be quite different. Capturing those differences is important in integrating industry-based behavior into the IM model. In the next section, the approach for determining industry profits in this study is explained.

Determining Industry Profits in a Set of Equations

As explained in Chapter 2, there are several approaches to estimating a set of industry equations. Restrictive forms impose one functional form on every industry equation. The opposite view models each industry equation separately and makes no attempt to use similar functions for different industries. For this study of profits, a middle approach is taken. Previous efforts using the single-function approach proved unsatisfactory. (Hyle, ch. 7) On the other hand, the previous sections identified two principal factors that affect industry profits: demand and costs. A general functional form for industry profits is chosen, therefore, and each industry's profits are estimated based on the types of variables selected for the general function. The general function shows profits as a function of both labor and material costs and some measure of demand for the industry:

$$PROF(i) = f(IC, LC, D) \tag{3.6}$$

where

IC = material input costs,
LC = labor costs,
D = demand
PROF(i) = profits of industry i.

In this general function, each of the independent variables may be lagged. This function satisfies the requirements that the equations should be responsive to demand, as well as to cost changes. The parameter estimates, lag lengths, and the appropriate measures of demand differ across industries.

Variable Definition and Measurement

The Dependent Variable

The measure of profits used in the equations is an industry-specific profit margin that provides a constant-dollar measure of industry profits whose scale is independent of industry size. The margin is calculated as the ratio of Before-tax corporate profits adjusted for IVA and CCADJ to sales, or output.[25] In effect, profits

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[25] Other types of profit margins were tried originally, such as profit to capital rates, but the data problems encountered with these measures far outweighed any benefits from using them. The use of output provided a consistent scaler for industries, satisfied the requirements for obtaining reasonable equations, and consequently was chosen over alternate methods.

are deflated by an industry-specific output deflator and then shown as a percent of real output. Since profits are a partial determinant of prices, however, deflating by current prices raises a simultaneity problem in the equation estimation. Sales consequently are measured in last year's prices.

Specifically, the dependent variable is defined as follows:

$$dprof(i)_t = Profm(i)_t - Profm(i)_{t-1} \qquad (3.7)$$

where

$$Profm(i)_t = \frac{Prof(i)_t}{dfl(i)_{t-1}} * \frac{1}{Output(i)_t}$$

dprof(i)	=	First difference in profit margin, industry i,
Profm(i)	=	Profit margin for industry i,
Prof(i)	=	Adjusted corporate profits industry i,
dfl(i)	=	Output deflator for industry i,
Output(i)	=	Output for industry i,
t	=	Current time period (current year),
t-1	=	Time lagged once (previous year).[26]

In specifying the general profit function by industry, then, the dependent variable will be defined as the first difference in the profit margin as shown in equation 3.4.[27] Next, the independent variables of the equation must be specified.

Changes in Material Costs

In using the price mark-up concept to determine profits, changes in input costs must be explicitly considered. Implicit in the input-output dual equation is immediate and full pass-through to prices of increased costs of production. Recall that product prices are defined

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26 Output by industry is defined as real output by product that is distributed to industries based on the product-to-industry bridge for value added. It has been defined elsewhere as "real value-added weighted output", or revawo. See Hyle, and McCarthy.

27 The first difference is used rather than the level since the profit margins, in general, are non-stationary. Augmented Dickey-Fuller tests for industry profit margins accept stationarity at the 5% level for nine of the thirty-seven industries, and at the 1% level for only two of the thirty-seven industries.

as follows:

$$p_{j,t} = \sum_i p_{i,t} * a_{(i,j)t} + v_{j,t} \qquad (3.8)$$

An increase in the price of a material input is passed through to the product price, p_j:

$$\Delta p_{j,t} = \sum_i \Delta p_{i,t} * a_{(i,j)t} + \Delta v_{j,t} \qquad (3.9)$$

$$\text{if} \quad \Delta v_{j,t} = 0 \qquad (\text{i.e.} \quad \delta v_j \,/\, \delta p_i = 0\ ) \qquad (3.10)$$

$$\text{then} \quad \Delta p_{j,t} = \sum \Delta p_{i,t} * a_{(i,j)t} \qquad (3.11)$$

where

$p_{j,t}$ = product price j, time t,
$p_{i,t}$ = input price i, time t,
$a_{(i,j)t}$ = input-output coefficient at time t,
$v_{j,t}$ = unit value added for product j, at time t,
$\Delta p_{i,t}$ = change in price of input i.

If value added does not respond directly to input costs, then pass-through of cost changes is immediate and complete. In the development of interindustry macro models for the United States and other countries, this type of pass-through has consistently been assumed.[28] Clearly, however, there are cases when pass-through may not occur immediately. Normal-cost pricing theory suggests, for instance, that product prices are based on some concept of normal costs.[29] While definitions of normal costs vary, the central idea is that only deviations from the normal cost will affect product prices. Over the business cycle, a change in costs from the normal level is considered a temporary change. In that case, the cost is absorbed by profits, rather than as a change

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[28] For the U.S., see the McCarthy (1991), Almon (1991), Hyle and Monaco R.M. descriptions of the LIFT model. See Nyhus (1991) for descriptions of models for Japan, Austria, France, Belgium, and Canada. See Grassini for description of model of Italy.

[29] See Neild, for example, who examines the pro-cyclical movements of a markup over costs in pricing. In addition, Coutts, Godley and Nordhaus attempt a similar study based on British pricing.

in the product price. It is only when the cost change affects the level of normal costs that it will be passed on to the product price.

Willingness to pass on changes in input costs in the form of higher product prices also may be affected by industry structure and demand conditions. There are a number of competing theories on pricing in less than perfectly competitive industries.[30] In general, however, industries that face highly elastic demand are less willing to pass on higher costs to consumers than industries with inelastic demand.[31] In addition, the response of price to a cost change may imply that costs are more than fully passed through to prices. In an oligopolistic industry, for instance, price leadership may lead to costs passed more than fully through to prices. Likewise, Meyer (1967) showed that even in a competitive model, an increase in costs may lead to higher profits.

In the interindustry macro model structure, delayed pass through of cost changes can be modeled only if some component of value added is a function of material costs. An alternative to immediate pass-through, therefore, is to allow profits to absorb cost changes. Although cost changes eventually should be passed fully through to product prices, modeling profits as a function of costs allows the pass-through to occur with a lag, or at an accelerated pace when appropriate.

Material input costs for any industry are easily obtained in an interindustry macro model, since the model is based on an input-output table. (The term "material" is used here to distinguish between input costs and labor costs. The inputs will include both material goods, such as steel, and services, such as electric utilities and economic

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[30] See Stigler, Sweezy (1939), Hall, and Blinder, for example.

[31] This is a relatively short list of possible explanations for price-stickiness. A recent paper by Alan Blinder considers twelve competing theories to explain why prices may not adjust immediately to changes in costs and demand. The work by Blinder makes an interesting contribution to the study of industry prices, as he is conducting interviews of real-world price-setters and comparing their decision-making process with economists' theories about that decision-making.

consulting.) A column of the input-output table shows the material requirements per unit of output of a product. Multiplying by prices yields the total cost of materials per unit of output.

$$VUC_j(t) = \sum_i p_i(t) * a_{i,j}(t) \qquad (3.12)$$

where

$VUC_j(t)$ = Value of unit material costs, product j, time t,
$p_i(t)$ = Producer price of input i, at time t,
$a_{i,j}(t)$ = Amount of i needed to produce one unit of j, time t.

The product costs are then distributed using the product to industry bridge defined earlier to determine the unit costs by industry.[32]

Changes in Labor Costs

Profits are determined in part by their response to changes in material costs. In addition, however, profits can be thought of as part of a mark-up over labor costs. One way of incorporating that concept into an interindustry macro model is to explicitly consider changes in labor costs per unit of output in determining profits. As with material costs, an increase in labor costs may temporarily squeeze profits if the increase cannot be passed on through a price increase. The strength of the effect on profits may depend on the relative bargaining power of

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[32] This process assumes that the product composition of industry value added can be used accurately to distribute production costs. For example, costs of the "product" Agriculture, forestry and fishery services must be distributed to two industries: Agriculture and Medical (since Veterinary services are part of the "product" agriculture, but the medical "industry.") The product-to-industry bridge shows, in a base year, total value added for the product Agriculture and its composition between the Agriculture and Medical industries, say 95% to Agriculture and 5% to Medical. The total cost of production will be distributed to the two industries based on the weights implied by their value-added share. This approach has the advantage of distributing the costs to the industry <u>most likely</u> to have incurred them in production. In the example here, the cost of production for Agriculture may jump due to an increase in oil prices. By weighting the cost by value-added shares, the large increase in costs will have a greater impact on the Agriculture industry than on Medical services. Although a true "make" table of input-output data, showing product to industry flows exactly, might be a superior tool for distributing product costs, this value-added-share method provides a sensible and reasonable alternative.

labor and capital in the industry, as well as on the demand conditions facing the industry. If demand is highly inelastic, a change in labor costs may be passed on in higher prices more easily than if demand is elastic.

Labor costs are defined in a manner similar to the definition of profit margins earlier. To compute a constant dollar measure of costs that is industry-specific, the ratio of labor compensation to output is computed, where labor compensation is deflated by last year's prices. Specifically,

$$\text{Labcst(i)}_t = \frac{\text{Labor Compensation(i)}_t}{\text{Deflator(i)}_{t-1}} * \frac{1}{\text{Output(i)}_t} \qquad (3.13)$$

where

Labcst(i) = Labor cost per unit of output, industry i,
Deflator(i) = Output deflator for industry i,
Output(i) = Constant dollar output, industry i,
Compensation= Total labor compensation current$, industry i,
t = Current time period (current year),
t-1 = Time period lagged once (previous year).

Changes in Demand

In aggregate profit equations, some measure of changes in aggregate activity is used to measure demand. In specifying demand by industry, two approaches will be used. The first approach considers industry-specific measures of demand, usually the change in industry output. The second approach widens the possibilities to include macroeconomic variables. For example, service industries tend to respond more to overall economic conditions than to sectoral output. The unemployment rate is used in several equations, therefore, as a measure of overall demand in the economy.

Long-run Forecasting Properties of the Equations

The general function developed here describes industry profits as a function of material costs, labor costs, and demand. One final consideration in setting up the equation estimations concerns the long-run properties of the equations. Econometric equations, especially those intended for inclusion in a long-term forecasting model, should provide for reasonable behavior at long-run (or steady-state) conditions.[33] This requirement has several implications for estimating industry profit equations using the general function developed here. Changes in the profit rate are estimated as a function of changes in demand and costs. If either demand or costs are unchanged (or are changing at some constant, steady-state, rate), then profits should not change either. This implies that there should be no intercept in the estimated equations. In addition, the coefficients on the independent variables must ensure neutral long-run behavior. A change in material costs, for example, should lead to a <u>temporary</u> change in the profit rate. To ensure that the effect is temporary, the coefficients on the current and lagged variables should sum to zero. This also ensures that there eventually is complete pass-through of cost changes to product prices. Changes in labor costs likewise should imply temporary changes in the profit rate, and the coefficients on current and lagged variables should sum to zero. In considering the long-run effect of demand changes on the profit rate, the specification of the demand variable is important. If demand is measured as the percent change in industry output, then the current and lagged coefficients should sum to zero, so that a change in demand leads to a temporary change in the profit rate. In those cases where changes in the unemployment rate are used to measure demand, no special constraint on the coefficient is required. It is reasonable to assume that, as the economy approaches some long-run trend growth, the unemployment rate will remain unchanged, so changes in the rate will equal zero.[34]

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[33] Almon refers to this condition as "avoiding asymptotic idiocy." (1989, ch. 5)

[34] The implication of avoiding asymptotic idiocy is that, absent shocks, the best forecast of an industry's profit margin ten years from now is the current value of the profit margin. In other words, the

Conclusions

The general profit function developed here was used to estimate equations for thirty-seven industries comprising the U.S. economy. The data used was annual, with observations from 1960-1987. Although the general function was used as a starting point, each industry's profit equation was developed separately. The next chapter describes the results of the equation estimations.

Chapter 4: Industry Profit Income: Equation Estimation

The preceding chapter outlined the approach that is used in this chapter to estimate equations for Corporate Profits for thirty-seven industries. The first section of this chapter presents results for an industry whose equation is used to illustrate the estimation process: Wholesale and retail trade. In the second section, summary results for all industries are presented. Finally, the concluding sections describe the results of specific industry profit equations.

Sample Estimation Results: Wholesale and retail trade

Because the following equations are to be included in a long-term forecasting model, the estimation process involved an attempt to ensure they have reasonable dynamic properties. In other words, each equation not only must provide a reasonable explanation of historical behavior, it also must provide reasonable behavior of industry profits as part of an Interindustry Macroeconomic model. The equations first were evaluated in terms of standard diagnostics, such as R^2 and a visual comparison of actual data and the regression prediction. In addition, the reasonableness of coefficients was evaluated based on the equation specification outlined in the previous chapter, and based on the requirement to ensure reasonable long-run properties. In addition, an attempt was made to evaluate the forecasting properties of the equation by conducting a "static" forecast of industry profits. This forecast is based on projections of the independent variables from a base forecast with the LIFT model. The forecast of the dependent variable is static in the sense that there is no feedback from the profit variable to the remaining variables in LIFT (the independent variables in the equation). Finally, once all the industry profit equations were estimated, a "dynamic" forecast of profits was generated by including the new equations in LIFT. The behavior of profits in the dynamic

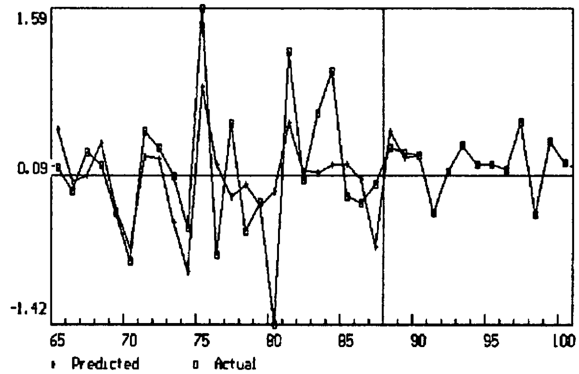
Figure 4.1: Estimation of Wholesale & retail trade Profits

```
title First Difference in Profits/Output: 31 Wholesale & retail trade
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4

:              FD in Profits/Output: 31 Wholesale & retail trade
  SEE   =        0.53 RSQ   = 0.3596 RHO =   -0.26 Obser  =   23 from 1965.000
  SEE+1 =        0.50 RBSQ  = 0.2173 DW  =    2.52 DoFree =   18 to   1987.000
  MAPE  =      386.27
    Variable name           Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                  - - - - - - - - - - - - - - - - - -          0.02
  1 pcwage                  -0.10770     9.5  -1.891  -1.45  -0.430      0.32
  2 pcwage[1]                0.10770     9.5   1.891   0.25   0.371      0.05
  3 pcvuc                   -0.04943     2.9  -1.030 -10.73  -0.295      5.11
  4 pcvuc[1]                 0.04943     2.9   1.030  10.57   0.299      5.03
  5 fduninv                  8.68225     8.2   1.750  -0.51   0.396     -0.00
```

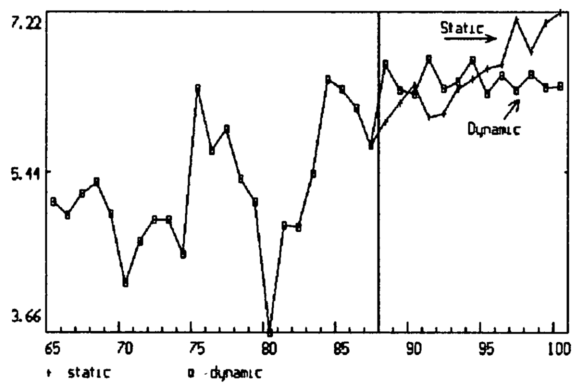
31 Wholesale & retail trade

First Diff in Profits/Output



31 Wholesale and retail Profits/Output

Dynamic and Static Forecast (7/5/91)



forecast provided a final check on each equation.

The results for the Wholesale and retail trade equation are shown in Figure 4.1. The industry includes establishments engaged in middleman selling, as well as those in direct customer retailing. Wholesale and retail trade activities are closely linked to overall demand in the economy, and one of the variables in the equation is the unemployment rate. An increase in unemployment, signalling a slowdown in demand, leads to a fall in the profit margin. The variable used in the equation is the first difference of the inverse of the unemployment rate. Using the inverse allows the effect on the profit margin to be stronger at lower rates of unemployment than at higher rates, since lower unemployment rates represent relatively tighter labor markets than higher rates.

In addition to responding to aggregate demand, the Wholesale and retail trade profit rate also is influenced by industry-specific costs. Increases in either material or labor costs initially are partially absorbed by a fall in the profit margin. In both cases, the profit margin recovers in the following year. To ensure reasonable asymptotic behavior in the model, the coefficients on each set of cost variables were constrained to sum to zero, and there is no intercept in the equation.

The importance of imposing reasonable long-run properties on the equation can be illustrated by examining an equation with no such properties imposed. For instance, with no constraints on the coefficients and an intercept, the equation for Wholesale and retail trade profits is:

(1) $fdpr = .1159 - .05516*pcm + .05971*pcm[1] - .10864*pcw + .12159*pcw[1] + 8.9*fdu$
$R^2 = .3730$

where

fdpr = First difference in profit rate for W&R trade,
pcm = Percent change in unit material costs,
pcw = Percent change in unit labor costs,
fdu = First difference in 1/unemployment rate.

The statistical fit of the equation, as summarized by the R^2, improves modestly, from .3596 to .3730, compared to the constrained equation in Figure 4.1. However, the implications for asymptotic behavior of the profit margin are unreasonable. According to this equation, a one percent increase in material costs leads to a permanent increase in the profit margin of .005. Likewise, a one percent increase in labor costs leads to a permanent .013 increase in the profit margin. Every one percent of inflation, therefore, leads to a permanent increase in the profit rate of .018 per year. Over ten years, with inflation at, say, 4% per year, the profit margin would increase by .72. In addition, the intercept implies the margin increases by .12 per year, which adds an additional 1.2 percentage points to the profit margin over ten years. Imposing such a trend on the profit rate, especially in the absence of any such trend over the historical period, imparts unreasonable behavior to the model.

The static forecasts shown in Figure 4.2 highlight the implications of allowing a trend in the equation specification. The graph compares two static forecasts of the profit margin using forecasts of the independent variables from a Base forecast with the LIFT model. The forecast labeled 'Intercept' shows a projection based on equation (1) above, while the line labeled 'Constrained' shows the static forecast of the equation chosen for the model. By the year 2000, the 'Intercept' forecast is almost 1.5 points greater than the 'Constrained' forecast. Although the forecasts are based on the same economic outlook, the equation with an intercept and no constraints shows a significant trend that dominates the forecast for the profit margin. Since profits affect the level of prices, based on the input-output dual equation for price determination, the forecast with the trended profit margin implies a higher price for Trade than in the alternate forecast. The trend imposes a change in relative prices in the economy that is not based on any economic, or behavioral, reason.

Of course, the final test of the equation is how it performs as part of the LIFT model. The second graph of Figure 4.1 shows the dynamic forecast of the profit margin and compares it to the static forecast. While oscillating in response to changes in demand and costs, the dynamic forecast of the profit margin is absent any significant trend. In fact, the dynamic forecast is less trended than the static forecast. In the static outlook, overall economic growth had not stablized by the end of the forecast horizon, and the unemployment rate, especially, was trending down. In contrast, the macroeconomic forecast for the Dynamic outlook shows stable growth in the last five years of the forecast. The dynamic model results can be summarized by the changes in real GNP in Figure 4.3. The model projects a significant slowdown through 1991, a short, modest recovery in 1992, followed by another slowdown, before growth eventually stabilizes around 2.0% from 1995 to 2000. The dynamic forecast of the profit margin for Trade is responsive to that overall pattern of demand changes.

Figure 4.2 - Static Forecasts
Wholesale & retail trade

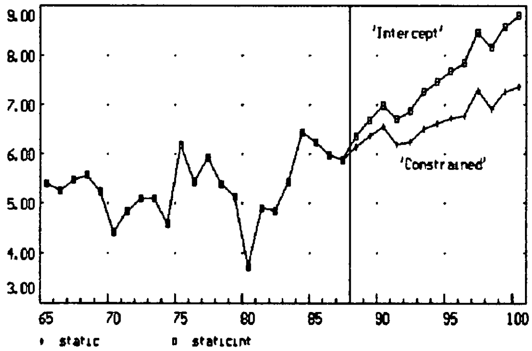
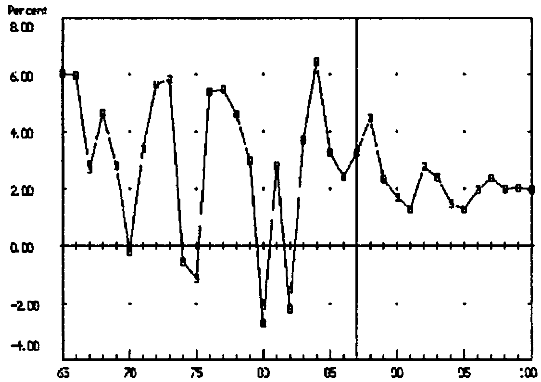


Figure 4.3 % Change in GNP
"Dynamic Forecast"



<u>Corporate Profit Equations for All Industries</u>

Although equations for each industry's profits were developed separately, some generalizations about the equations as a whole can be made. Table 4.1 summarizes the estimation results for the thirty-seven industries of this study. For the majority of industries, the dependent variable of the equation is the first difference in the profit- to-output rate (as defined earlier). The first group of columns summarizes the variables that are included in each equation, and the last group of columns shows summary statistics for the equation as a whole. The potential variables for each equation include the percent change in unit costs of production (Costs), percent changes in the real labor compensation share of output (Labor), percent changes in real output in the industry (Output), and the first difference in the inverse of the Civilian unemployment rate (1/un). For each of these variables, the current value of the variable, as well as several lags, may be included. If the current value of an independent variable is included in the equation, the sign of the coefficient, + or -, will appear in the column labeled t. If a 1-year lag is used, the sign of that coefficient will appear in the column labeled 1, and so on. In addition, several equations include an additional variable, (Other). The next three

Table 4.1 Summary of Equation Results

Sector	Costs			Labor			Output			un	Other	R^2	r	r
	t	1	2	t	1	2	t	1	2	t			"p"	"a"
GROUP I														
Motor vehicles	-	-	+	-	+	+						.6301	.668	.879
Food	-	-	+				-	+				.6665	.688	.784
Apparel	-	+	-	-	+	+						.5092	.746	.540
Chemicals	+	-	+	-	+					+		.4288	.713	.927
Metal Industry	+	-	-							+	cars	.3850	.837	.872
Metal Products	+	+	-				+	-				.4928	.584	.781
GROUP II														
Whole & Retail	-	+		-	+					+		.3596	.228	.639
Misc Manufact	-	+		-	+		-	+				.3270	.507	.278
Instruments	-	+		-	+					+	dummy	.4816	.912	.952
Movies	+	-		+	-						PCE,dummy	.3073	.705	.824
Medicine,Educ	+	-		-	+						PCE	.2079	.574	.977
GROUP III														
Finance, Insur	+	-					+	-		+	dummy	.6794	.927	.969
Business Service	-	+					+	-				.2194	.484	.549
Auto Repair	-	+					+	-				.2388	.655	.917
Elect Machinery	-	+					+	-		+		.5231	.675	.880
Printing	-	+					-	+		+		.3124	.242	.594
Utilities	-	+								+		.1254	.127	.915
GROUP IV														
Textiles				-	+		+	-		+		.3927	.830	.844
Paper				+	-		+	-				.3766	.318	.566
Hotels,Repairs							+	-	+	+	interest	.4352	.608	.870
GROUP V														
Communication	-	+					-	+			regul	.2755	.777	.965
Air transport	+	-	+	-	+						regul	.5432	.510	.803
Railroads		-	+	-	+		+				regul	.6095	.054	.883
Trucking		-	+	+	-					+		.0707	.039	.389
GROUP VI														
Construction				-	+						house	.0488	.278	.707
Furniture	-	+									house,rate	.2678	.812	.768
Real Estate										+	house	.5417	.734	.966
Lumber							+	-			mortgage,prod	.4618	.611	.731
Stone, clay,	-	+	+				+	-			mortgage	.5329	.721	.853
GROUP VII														
Plastic,Rubber				-	+		+	-			oil price	.4955	.724	.680
Petrol refinin							-	+			oil price	.4907	.371	.819
Trans equip							+				oil price	.3405	na	na
Agriculture *							+	+	+		depend var	.5220	.722	.725
Crude oil *							+	+	+		depend var	.6466	.804	.876
Nonelect mach	-	+	-				+	-	-			.4340	.373	.963
Leather		+	-				+	-			imports	.3655	.735	.650

NOTES:

t,1,2	=	t is current value, 1 is one-year lag, 2 is two year lag
Costs	=	Material costs per unit of output, change
Labor	=	Real labor compensation as share of real output, change
Output	=	Percent change in real output
un	=	First difference in the inverse of the unemployment rate
Other	=	Other variables included in the equation
R^2	=	Coefficient of determination for equation
r "p"	=	Simple correlation coefficient between the actual profit rate and the predicted profit rate computed by using cumulative predictions
r "a"	=	Simple correlation coefficient between the actual profit rate and the predicted profit rate computed as one-year ahead prediction
interest	=	Interest rate on AAA-rated bonds, adjusted for inflation
oil price	=	Changes in the price of petroleum
imports	=	Percent change in real imports
mortgage	=	Interest rate on 30-year commercial mortgages
cars	=	Percent change in real output of motor vehicle industry
house	=	Percent change in real residential structures
PCE	=	Percent change in total real Personal Consumption Expenditures
*	=	Dependent variable is profit rate (not first difference)

columns show the R^2 and two simple correlation coefficients between the predicted profit rate and the actual rate. The first correlation coefficient, r "p", measures the correlation between the actual profit rate and the predicted profit rate computed by using cumulative predictions from the estimated equation. The second, r "a", is a correlation coefficient between the actual profit rate and the predicted profit rate computed as a one-step-ahead prediction. Specifically, the predicted first differences are added to the actual value of the profit rate for the prior year. The correlation coefficients are calculated as an indicator of the strength of the equations in predicting movements in the profit margins.

Summary of results: material costs, labor and demand

The equations in Table 4.1 are summarized in terms of their use of the input cost variable. Almost all of the equations used the input cost variable, with most using the current change in costs and one lagged value.[35] The labor share variable showed up in almost half of the equations, and again, the current and lagged variables were most prevalent. In the interest of achieving reasonable steady-state properties, the coefficients on the cost and labor variables were constrained to ensure that they summed to zero.

Several different measures of demand were used in the industry profit equations. Profits of most manufacturing industries depend on industry-specific changes in output, while profits in the service sectors depend on the overall unemployment rate. Profits in several industries, such as Furniture and Lumber, respond to changes in interest rates. The implications of demand and cost changes for each industry are discussed in greater detail in the following section on the

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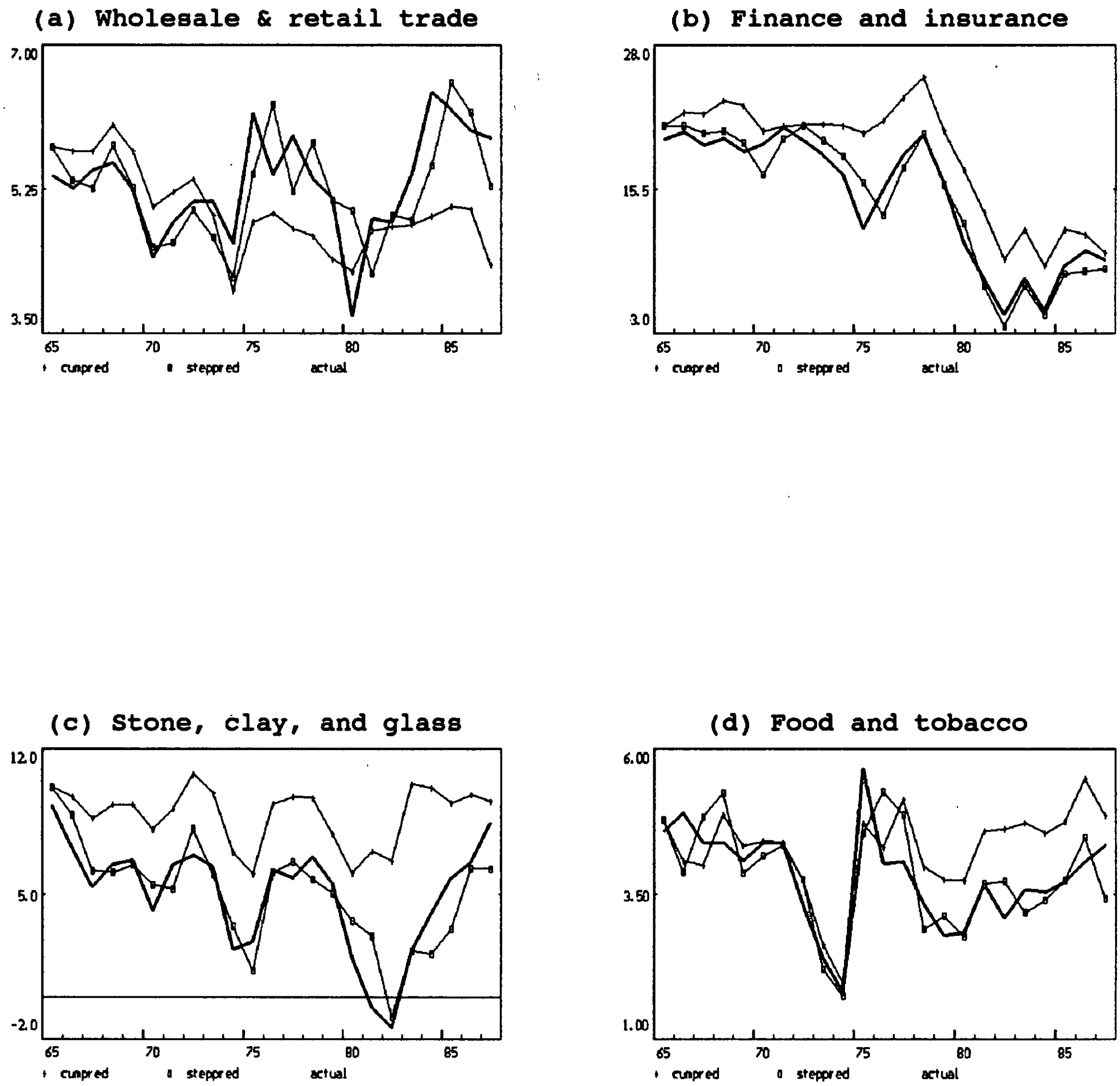
35 The lag lengths on material costs are consistent with preliminary findings reported by Blinder in his interview study on why prices are sticky.

individual equation results.

Equation statistics

As expected when estimating equations in first difference form, the fit of the equations, as summarized by the R^2, is low. More encouraging are the relatively high correlations between the predicted level of the profit rate and actual profit rate for each industry. Using the more rigorous test for correlation, where the actual data is compared with cumulative predictions (r "p"), twenty-two of thirty-four industries have a greater than 60% correlation between the predicted rate and the actual rate. When a one-period-ahead prediction is calculated that does not build on past errors, the correlation coefficients for most industries exceed 80%. Some examples of the comparison between the cumulative predictions of the profit margin and the step-ahead predictions are shown in Figure 4.4. Wholesale and retail trade is representative of equations that performed fair in terms of the correlation between the actual profit rate and the predicted rate as given by the equation for the first difference of the rate. The correlation between the cumulative predictions and the actual rate is .228. When the predictions are added to last year's actual profit rate, the correlation between the predicted and actual rate improves to .639, and, as illustrated in the graph, the predictions capture most of the turning points in the series. The result for Stone, clay, and glass (Figure 4.4(c)) is shown as an example of industries where the volatility of the profit rate is captured well, even when the more rigorous test of the cumulative predictions is used. The equation does not do well at capturing the magnitude of the changes, however. It should be noted that, in many cases, the performance of the cumulative predictions (and the fit of the equation in first differences) is greatly improved when coefficient constraints are removed. Since

Figure 4.4 Profit Margin Estimations



removing those constraints violates the condition for reasonable long-run behavior, however, the constraints are imposed. The remaining examples in Figure 4.4 illustrate cases where both the cumulative predictions and step-ahead predictions fit reasonably well with the actual profit rate. In the case of Finance and insurance, a dummy variable in the equation helps capture the 1980-1982 drop in the margin, while in the case of Food and tobacco, the profit margin is explained extremely well with the price of its largest input, Agricultural goods.

In general, industry profits are responsive to current and lagged changes in costs of production and to different measures of changes in demand. Although it is useful to summarize the results as a whole, the intriguing story is the detailed results for each industry.

Profit Equations by Industry

For each equation estimation, the estimation results and two graphs are presented. The first graph is of the regression results and shows predicted and actual values of the dependent variable. The graph shows the predicted and actual values for the period of estimation, as well as a projection of the dependent variable based on forecasts of the independent variables.[36] The second graph compares two forecasts of the level of the profit margin (rather than the first difference of the margin). The "static" forecast is based on the projection of the first difference shown in the first graph. The second forecast was obtained after including the profit equations in the LIFT model and forecasting with the model to the year 2000. This "dynamic" forecast of the profit margin includes feedback from profits to other variables in the model,

[36] Two projections are shown: the solution to the regression equation ("prediction") and a rho-adjusted solution to the equation. (The forecast is adjusted based on the last error of the estimation and the estimated rho value.) Since the equations are estimated as first differences, the rho adjustment is of minor importance.

including the independent variables of the regression estimation. A word of explanation on the LIFT forecast used for the dynamic analysis is in order.

There are two principal differences between the LIFT forecast used for the static profit projections and the one used for the dynamic analysis: price-side specification and data. As explained in Chapter 2, the price side of the original LIFT model used equations for total return to capital, as well as all components of capital income. In the work for this study, no equations for total industry return to capital were used. Rather, the total is calculated as the sum of individually estimated income components. For pragmatic reasons, introducing new profit equations in LIFT could not easily be accomplished without introducing all new equations for the price side.[37] The equations for non-profit components of capital income consequently differ between the static and dynamic forecast models. (Those equations are described in Chapter 5).

The second difference between the two forecasts involves data. The profit equations were estimated using data only through 1987 (the most current available data at the time). At the time that the dynamic forecast was completed, data for most variables in the economy were available through 1990.[38] To conduct a test of the profit equations, the model was used to produce a "sim-fore", or combination historical simulation and forecast. Where possible, mostly for macroeconomic aggregates and real-side variables, actual values of data were used through 1990. In terms of income by industry, no industry detail was used from 1988 to 1990. For every income component but profits,

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[37] A large part of the work for this study involved reprogramming the price-income side of LIFT. The new program structure for solving the price side was incompatible with the original programming, so the transition to the new specification was an "all-or-nothing" process.

[38] Macroeconomic aggregates are available for 1990. Not all industry data, however, is available that currently.

however, the known aggregate is imposed on the model for those years. From 1988 to 1990, therefore, the profit equations are generating a crude historical simulation, since actual values of most independent variables are being used by the model. From 1990 onward, however, the model is generating a traditional econometric forecast. Since the goal of this run of the model was to examine the forecasting properties of the profit equations, no attempt was made here to evaluate the overall reasonableness of the forecast outlook. That task is reserved for Chapter 6, when a Base forecast with the new model is developed. The importance of the forecast here is to illustrate the difference between the static and dynamic projections of profits by industry.

The discussion of the industry results is divided into several groups, which are based on the extent to which the equations rely on the input cost variable. The first group consists of industries whose equations use two lags on input costs (in addition to current costs) in determining the profit margin. In that group, some industries also used the labor share variable, while others relied more on demand variables. Since most of the industries used only one lag of input costs, the second group contains industries with only one lag on input costs plus the labor share variable. The next group contains those industries with one lag on input costs, but with demand variables rather than labor costs. The next group contains those few industries for which input costs were not used in the equations. Because government regulation affected some industries, these are discussed in a single group. The sixth group contains those industries related in some way to construction activity. Finally, there is a miscellaneous collection of industries that are grouped mainly for the reason that each does not belong in any other group.

Group 1: Lagged costs

The six industries in this group are: Motor vehicles, Apparel, Primary metal industries, Metal products, Chemicals and Food processing. (The Air transportation industry and Stone, clay, and glass also fall into this group, but are discussed below in the sections on regulated industries and construction-related industries.) Each equation uses current input costs and costs lagged for two years. Of all thirty-some equations, very few shared identical specifications. The first equations discussed here, Motor vehicles and Apparel, are an exception, however. Although at first glance, cars and clothes may not appear to be similar items, both industries share a history of import competition and strong labor unions, which has made their profits sensitive to changes in costs.

Motor Vehicles (22)

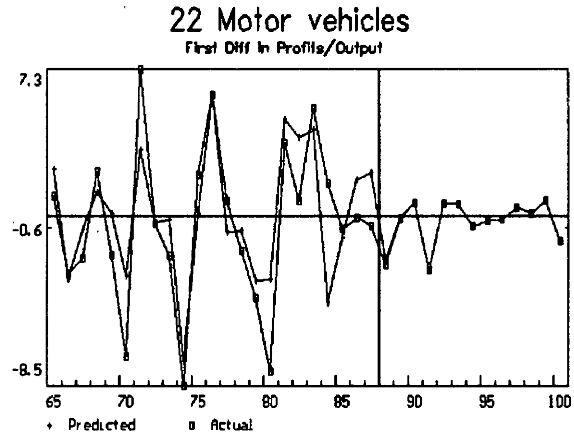
The Motor vehicle industry manufactures cars and trucks, including parts and accessories. Although many attempts were made to incorporate some measure of demand (including demand for imports) in the equation, the Motor vehicle profit margin is determined by current and lagged costs. Material inputs for the industry include steel and other metal products, rubber, plastic, textiles, and electronic equipment. Cost increases are not passed on in higher prices initially, but are absorbed partially by a fall in profits. Likewise, an increase in labor costs leads to an initial fall in the profit margin, which recovers after two years. Without a constraint on the labor variables, the coefficients consistently sum to a negative number. In an industry characterized by labor disputes, it is not surprising to discover that labor and capital must compete for income earned by the industry.

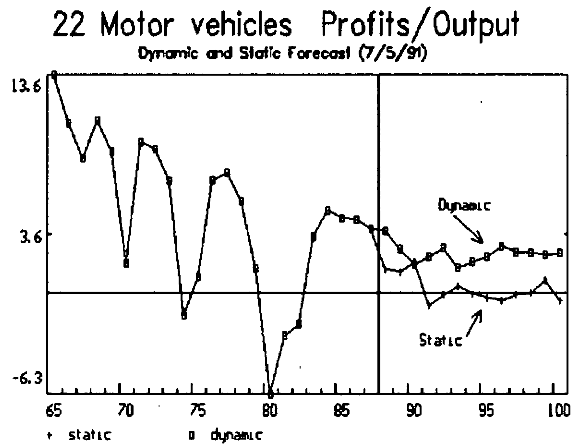
The equation captures the volatile history of the profit margin, and over 60% of the variability of the dependent variable is explained. A relatively low rho of .10 and a Durbin Watson of 1.8 indicate little

Figure 4.5: Estimation of Motor vehicles Profits

```
title First Difference Profits/Output: 22 Motor vehicles
con 99999 0.0 = a1 + a2 + a3
con 99999 0.0 = a4 + a5 + a6

:                      FD Profits/Output: 22 Motor vehicles
  SEE    =        2.43 RSQ   = 0.6301 RHO =    0.10 Obser  =   23 from 1965.000
  SEE+1  =        2.42 RBSQ  = 0.5213 DW  =    1.79 DoFree =   17 to   1987.000
  MAPE   =      190.46
    Variable name            Reg-Coef  Mexval t-value  Elas    Beta        Mean
  0 fdprat                   - - - - - - - - - - - - - - - - - - - -      -0.40
  1 pcvuc                    -0.32249     5.4  -1.371  4.32  -0.308        5.40
  2 pcvuc[1]                 -0.02277     0.0  -0.072  0.30  -0.022        5.37
  3 pcvuc[2]                  0.34523     7.3   1.600 -4.56   0.337        5.32
  4 pcwage                   -0.28157    31.1  -3.495  0.14  -0.507        0.20
  5 pcwage[1]                 0.26285    19.4   2.693 -0.39   0.470        0.60
  6 pcwage[2]                 0.01867     0.2   0.231 -0.04   0.034        0.89
```





problem of autocorrelation. After converting the predicted first differences to levels, the predicted profit rate correlates well with the actual rate (r "p" = .668, and r "a" = .879). The dynamic forecast for the profit margin indicates a fairly smooth path, compared to the more volatile historical experience. This is not surprising, since the forecast for other variables for the industry, such as labor compensation and output, are more smooth than experienced historically. As noted in Chapter 2, the original LIFT forecast for this profit margin followed a questionable pattern of constant growth from 1988 to 2000. The dynamic forecast here shows no dominant trend in the profit rate. Rather, the outlook shows a cyclical response of profits to economic slowdowns in 1990 and 1993, and an eventual flattening out of the profit rate over the long-run horizon.

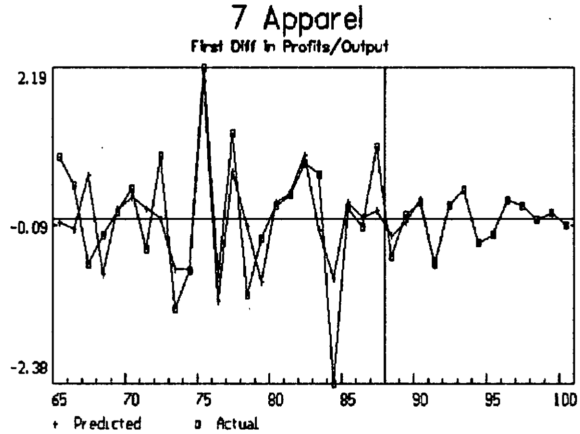
Apparel (7)

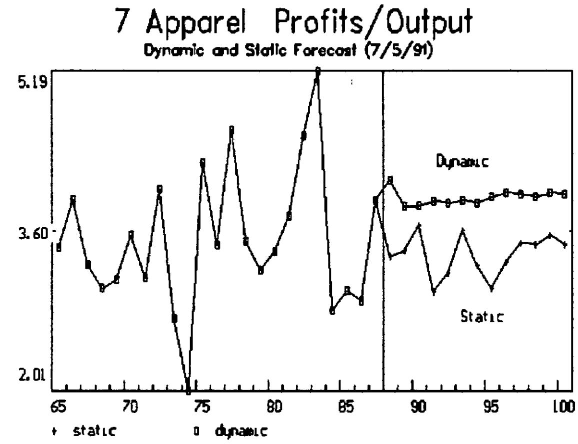
Similar to Motor vehicles, the Apparel industry is strongly sensitive to changes in costs, both material and labor. Increases in input or labor costs are absorbed initially by a fall in the profit margin. It takes two years in each case for the profit margin to recover. Without constraints on the coefficients, each set sums to approximately zero, so the effect of the constraints on the fit of the equation is minimal. Attempts were made to incorporate demand and imports in the equation, but the cost-driven equation here produced the most sensible results. The equation has an R^2 over .5 and the predicted rate correlates well with the actual rate, correlation coefficient (r "p") equals .746. The static and dynamic forecasts differ with the dynamic forecast much less volatile than the static outlook. The smoother behavior is traced to a less volatile outlook for Apparel's costs in the dynamic forecast than in the static one.

Figure 4.6: Estimation of Apparel Profits

```
title First Difference in Profits/Output  07 Apparel
con 999999 0.0 = a1 + a2 + a3
con 999999 0.0 = a4 + a5 + a6

:                     FD in Profits/Output  07 Apparel
  SEE    =       0.67 RSQ   = 0.5092 RHO =  -0.33 Obser  =   23 from 1965.000
  SEE+1  =       0.61 RBSQ  = 0.3649 DW  =   2.67 DoFree =   17 to   1987.000
  MAPE   =      83.63
    Variable name          Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                 - - - - - - - - - - - - - - - - - - - -      0.06
  1 pcwage                 -0.07261    10.7  -1.956  0.38  -0.355      -0.29
  2 pcwage[1]               0.03442     2.5   0.934 -0.05   0.169      -0.08
  3 pcwage[2]               0.03818     4.1   1.191 -0.14   0.190      -0.20
  4 pcvuc                  -0.07201     3.8  -1.140 -5.50  -0.251       4.23
  5 pcvuc[1]                0.09010     3.1   1.042  6.69   0.319       4.11
  6 pcvuc[2]               -0.01809     0.2  -0.289 -1.30  -0.065       3.99
```





Primary metal industries (17)

The Primary metal industry contains firms engaged in smelting and refining metals, as well as manufacturing some basic metal products, such as nails, spikes, and castings. Like the other industries in this group, the profit margin of Primary metals responds to changes in material input costs. Initially, an increase in material costs results in a higher profit margin, as cost changes are more than fully passed on in product prices. The effect is temporary, and, after three years, the positive effect on the profit margin is canceled. The ability to pass cost changes through to prices is consistent with the oligopolistic nature of this industry. The Primary metal industry, mostly steel and copper, is dominated by a few large firms. According to the 1982 Census of Manufacturers, the four largest firms in the Blast furnace and steel mill industry accounted for 42% of the industry's total value of shipments, while the eight largest firms accounted for 64%. A common theory on pricing strategy in oligopolies (and one often applied to the American steel industry) is the kinked demand model and its implication of price leadership. The concept of a kinked demand curve, introduced by Sweezy (1939), is based on the idea that a firm in an oligopoly faces more elastic demand if it raises prices than if it lowers prices. Because of the kink in the demand curve and discontinuity in marginal revenue, several different levels of costs are consistent with a given price-level. Firms will be reluctant to adjust prices in response to cost changes, unless there is some reason to believe that all other firms will raise prices also. In industries dominated by a few large firms, a price leader may therefore emerge. The leader firm will raise prices, which will serve as a signal to other firms to do so also. In discussion of oligopolies, U.S. Steel or Bethlehem Steel are often cited as examples of price leaders.[39] An implication of the price leadership

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[39] See Nicholson, and Browning and Browning, for examples.

strategy is that price changes will be relatively infrequent, but of substantial magnitude. The results here suggest that the lag on price response is no more than one year, and that the price response is substantial.[40]

The Primary metal industry mostly sells its output to the Motor vehicle industry, and profits are tied to overall demand for motor vehicles as well as overall macroeconomic activity. An increase in production of Motor vehicles increases the profit margin for Primary metals. In addition, Metal industries are also tied to other manufacturing activities, and therefore are sensitive to overall changes in demand. The inverse of the unemployment rate is used as a demand measure in the equation, and an increase in unemployment leads to a fall in the profit margin for Metals.

Although the equation fits only fairly well, with an R^2 of .385, the correlation between the predicted and actual profit margins is a high .837% (r "p"). The profit margin for Metals shows much cyclical activity and an especially volatile response to the 1982 recession. The dynamic forecast shows the margin dipping in response to the recessionary period 1990-1991, followed by a strong recovery. The margin stabilizes for three years until dropping again in response to the 1995 slowdown. In the last five years of the forecast, the profit margin stabilizes, as the economy moves along its long-run trend growth path.

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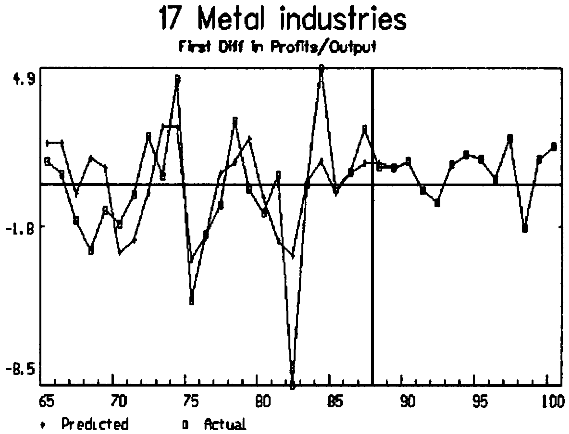
[40] The results are consistent with findings by Carlton (1986) in his study on price rigidities by industry using Stigler-Kindahl data. The average duration of price rigidity for the Steel industry was close to one year (thirteen months), and Steel was the second most rigid industry in the study. In addition, Carlton concluded "There is a positive correlation between price rigidity and average absolute price change. The more rigid are prices, the greater is the price change when prices do change." (p. 638)

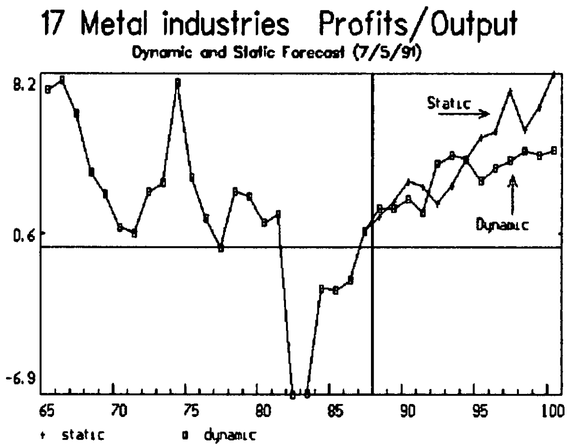
Figure 4.7: Estimation of Metal industries Profits

```
title First Difference Profits/Output for 17 Metal Industries
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4 + a5
```

```
:                    FD Prof/Output for 17 Metal Industries
  SEE    =       2.18 RSQ   = 0.3850 RHO =  -0.13 Obser  =   23 from 1965.000
  SEE+1  =       2.16 RBSQ  = 0.2041 DW  =   2.26 DoFree =   17 to   1987.000
  MAPE   =     225.47
```

Variable name	Reg-Coef	Mexval	t-value	Elas	Beta	Mean
0 fdprat	- -					-0.28
1 pccars	0.00111	0.0	0.038	-0.01	0.006	3.73
2 pccars[1]	-0.00110	0.0	-0.038	0.01	-0.006	3.82
3 pcvuc	0.14931	8.7	1.753	-2.75	0.347	5.21
4 pcvuc[1]	-0.01682	0.1	-0.170	0.32	-0.039	5.35
5 pcvuc[2]	-0.13249	7.0	-1.575	2.50	-0.305	5.32
6 fduninv	41.04452	12.8	2.148	0.20	0.442	-0.00





Metal products (18)

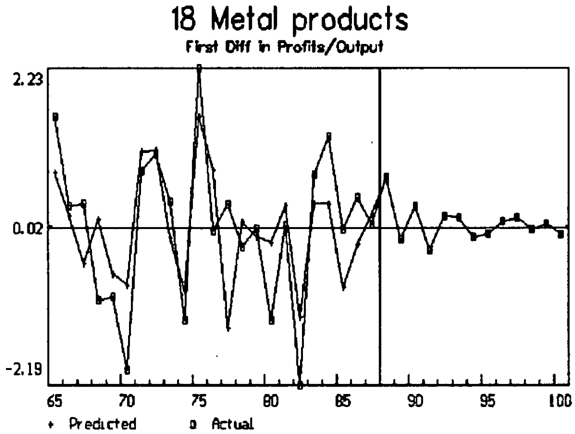
Firms in this industry manufacture metal products such as automobile body parts, food containers, and nuts and bolts, and the largest sources of demand are Motor vehicles, Machinery, and Food and tobacco processing. The profit margin in the industry responds to changes in demand, as captured by industry-specific output, where an increase in demand initially increases the profit margin. Profits from manufacturing Metal products also depend on the cost of metal inputs. As with the Primary metal industry, an increase in input costs is passed on to consumers of metal products at first, and the profit margin rises for the two years after the increase. The effect eventually is overridden, and after the third year, the increase is entirely offset. Like the Primary metal industry, this is an oligopolistic industry with high concentration ratios. In 1982, the four largest firms in the Automotive stampings industry, for instance, accounted for 61% of total shipments, and the eight largest accounted for 66%. The price response to cost changes suggested by this equation for the profit margin is consistent with the oligopolistic structure of the industry.

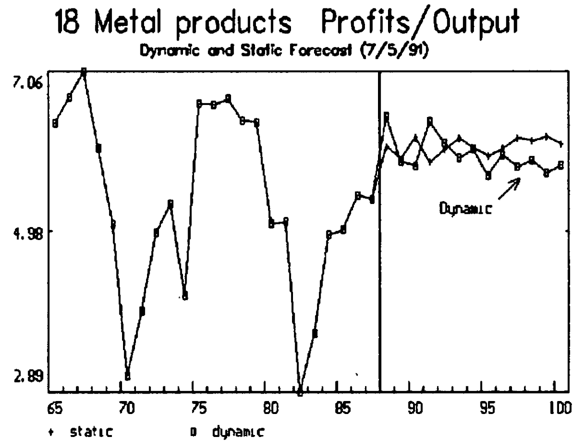
The static and dynamic forecasts show a first-year increase in the profit margin that is the result of an increase in output forecast for the industry. The static and dynamic forecasts differ only slightly, and both show the profit margin hovering around a rate moderately greater than its average value from 1965 to 1987. The dynamic forecast shows an expected drop in the margin during the slowdown through 1991, followed by a modest recovery.

Figure 4.8: Estimation of Metal products Profits

```
title First Difference Profits/output: 18 Metal products
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4 + a5

:                      FD Prof/output: 18 Metal products
  SEE   =        0.76 RSQ   = 0.4928 RHO =  -0.07 Obser  =   23 from 1965.000
  SEE+1 =        0.75 RBSQ  = 0.3801 DW  =   2.15 DoFree =   18 to   1987.000
  MAPE  =      342.52
    Variable name            Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                   - - - - - - - - - - - - - - - - - - -        0.01
  1 pcout                     0.09758    30.3   3.545  23.57   0.678      2.21
  2 pcout[1]                 -0.09757    30.3  -3.545 -24.93  -0.682      2.34
  3 pcvuc                     0.02428     0.7   0.515  14.37   0.114      5.42
  4 pcvuc[1]                  0.13003    15.4   2.442  77.24   0.608      5.44
  5 pcvuc[2]                 -0.15430    24.3  -3.132 -91.81  -0.720      5.45
```





Chemicals (10)

The Chemical industry is the largest of the manufacturing sectors, with a share of 5.5% of total profits in 1987. Like the other industries in this group, Chemical profits are sensitive to industry-specific costs. Materials for this industry include mostly intra-industry trade and petroleum. Initially, an increase in the cost of materials increases the profit margin, implying that cost changes are passed more than fully into prices. In the two years following the cost increase, the profit margin absorbs the excess cost pass-through. The Chemical industry is dominated by a few large firms and exhibits the pricing behavior of an oligopoly. The 1982 four-firm concentration ratio for Soaps and detergents, a large part of Chemicals, was 60%, while the eight-firm ratio was 73%.

Changes in labor costs also affect the profit margin for the Chemical industry, but, unlike material costs, they are not passed through immediately to prices. Rather, increases in labor costs are absorbed temporarily by the profit margin, which recovers after one year. The different response of the profit margin to changes in labor and material costs suggests an interesting implication for theories of oligopoly pricing. In general, oligopoly pricing models do not distinguish different types of cost increases, but consider only a change in overall marginal costs. The results for the Chemical industry (and also for Medicine and education and Air transportation) suggest that price response to cost changes may differ by type of cost, and by industry.

The profit margin for the Chemical industry also responds to demand. The industry includes firms that manufacture intermediate products, such as organic and inorganic chemicals and plastic resins, as well as end-use products, such as soaps, fertilizer, drugs and paint. Profits are sensitive to the overall business cycle, therefore, and the inverse of the unemployment rate is used in the equation to measure demand for the industry.

The equation captures most of the volatility of the profit margin over the estimation period. When the predictions are summed to calculate a predicted profit rate, the correlation coefficient between the predicted profit rate and the actual rate is greater than 70% (r "p" = .713). The correlation coefficient between the one-step ahead prediction and the actual rate is a reassuring 93% (r "a" = .927).

The profit margin for Chemicals has a volatile history, with a significant drop in the margin from 1975 to 1980. From 1985 to 1987, however, the margin grew strongly and recovered to its level prior to the oil shocks of the late 1970's and the 1980-1981 recession. The dynamic forecast for Chemicals shows that the level of the margin achieved since 1987 is maintained through 2000, with only minor oscillations in response to economic slowdowns in 1991 and 1995.

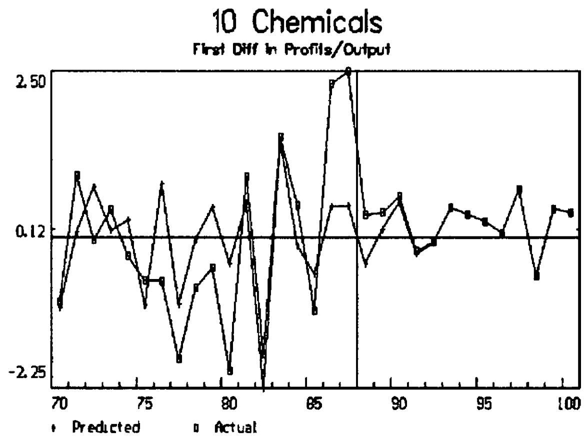
Food and tobacco processing (5)

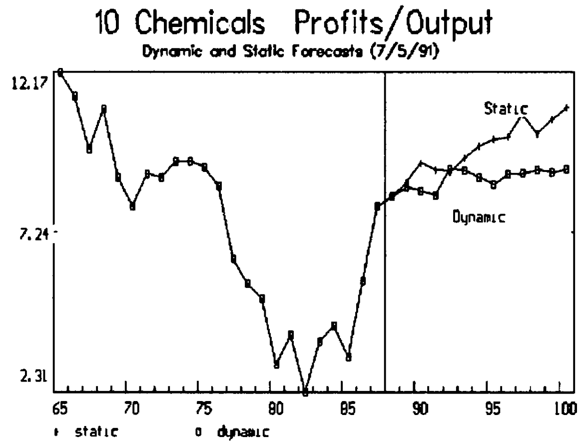
Although Food processing is included in this first group of industries, the measure of input costs in this equation differs from most of the other equations. Since agricultural prices dominate the costs for this industry, the price of agricultural inputs was used rather than the price of all inputs. In estimating the equation, agriculture prices were statistically important in describing movements in the profit margin, both in terms of t-statistics, and mexvals. Without a constraint on the coefficients, they consistently summed to a positive number, indicating that input costs were more than fully passed on as higher prices in this industry. In choosing an equation to be used in the model, the coefficients were constrained to sum to zero, and demand variables were also included. The high Mexval's on material costs support the hypothesis that profits in this industry provide a vehicle to prevent full and immediate pass through of higher costs.

Figure 4.9: Estimation of Chemicals Profits

```
title First Difference in Profits/Output  10 Chemicals
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4 + a5

:                     FD in Profits/Output  10 Chemicals
 SEE    =        0.98 RSQ   = 0.4288 RHO =   0.36 Obser  =   18 from 1970.000
 SEE+1  =        0.94 RBSQ  = 0.1908 DW  =   1.28 DoFree =   12 to   1987.000
 MAPE   =      196.07
   Variable name            Reg-Coef  Mexval t-value  Elas    Beta       Mean
 0 fdprat                  - - - - - - - - - - - - - - - - - - - - -    -0.08
 1 pcwage                  -0.10403    23.8  -2.528  -0.47  -0.509      -0.35
 2 pcwage[1]                0.10404    23.8   2.528   0.30   0.512      -0.23
 3 pcvuc                    0.08792    11.0   1.669  -7.34   0.489       6.61
 4 pcvuc[1]                -0.12542     8.2  -1.433  10.35  -0.704       6.53
 5 pcvuc[2]                 0.03749     2.0   0.699  -3.17   0.206       6.69
 6 fduninv                 12.50622     6.2   1.241   1.09   0.296      -0.01
```





Even with constraints on the coefficients, the equation fits fairly well (R^2 equals .6665). The correlation coefficient between the predicted and actual profit rate of .688 shows that the series are almost 70% correlated. The equation captures the effects of the drought in 1973-74 and the static forecast shows the effect of the 1987 drought, with the profit margin falling and remaining at a low level for two years. The margin recovers from the drought-induced decline through 1992. Over the long-run forecast horizon, the profit margin stabilizes in both the dynamic and static forecasts, as demand and cost changes reach a constant growth rate.

Group 2: Lagged costs: input and labor

The industries in this group depend on current and lagged input costs, as well as labor's share of income. The group includes two manufacturing industries, Miscellaneous manufacturing and Instruments, and three service industries, Medicine and education, Movies and amusements, and Wholesale and retail trade. The Railroad industry also falls into this group, but is discussed in the section on regulated industries.

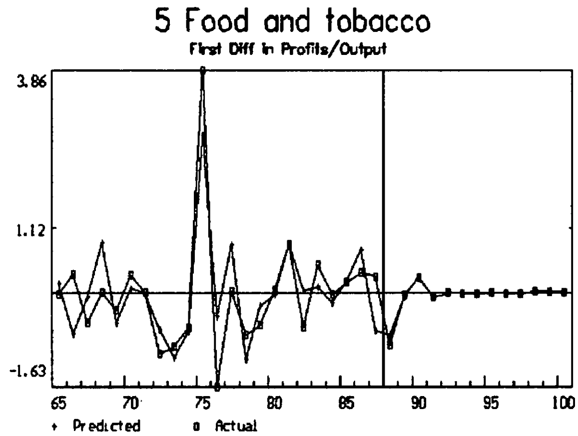
Miscellaneous manufacturing (24)

This industry includes firms that manufacture items such as umbrellas, musical instruments, toys, and artificial Christmas trees, and it is a relatively small share of total profits (.3% in 1987). Profits initially absorb increases in either input or labor costs. The coefficients on the cost variables have been constrained to cancel out, so the net effect on the profit margin of an increase in either type of cost is zero. The profit margin also responds to changes in industry output, where again, the coefficients have been constrained to sum to zero. Without the constraint, the demand coefficients have a net

Figure 4.10: Estimation of Food Profits

```
title First Difference in Profits/Output of 05 Food
con 99999 0.0 = a1 + a2
con 99999 0.0 = a3 + a4 + a5
```

```
:                    FD in Profits/Output of 05 Food
 SEE   =       0.57 RSQ   = 0.6665 RHO =  -0.19 Obser  =   23 from 1965.000
 SEE+1 =       0.56 RBSQ  = 0.5923 DW  =   2.38 DoFree =   18 to   1987.000
 MAPE  =    3244.47
   Variable name            Reg-Coef  Mexval t-value  Elas    Beta       Mean
 0 fdprat                   - - - - - - - - - - - - - - - - - - - -     -0.01
 1 pcout                    -0.09612   17.7  -2.632  15.37  -0.222       1.85
 2 pcout[1]                  0.09612   17.7   2.632 -15.79   0.225       1.90
 3 pcvuc                    -0.03094   17.0  -2.579  11.76  -0.327       4.38
 4 pcvuc[1]                 -0.02347    5.7  -1.459   8.50  -0.250       4.18
 5 pcvuc[2]                  0.05441   50.5   4.772 -20.74   0.570       4.40
```



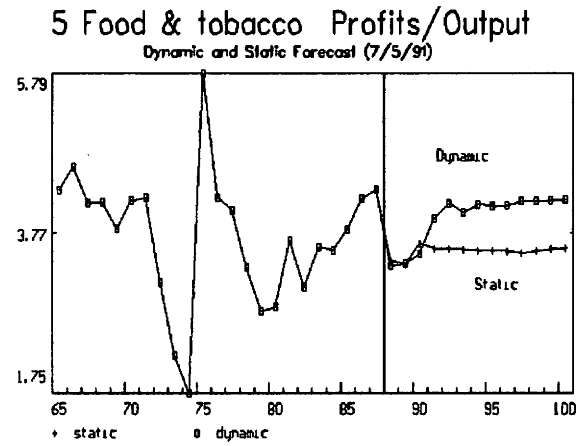
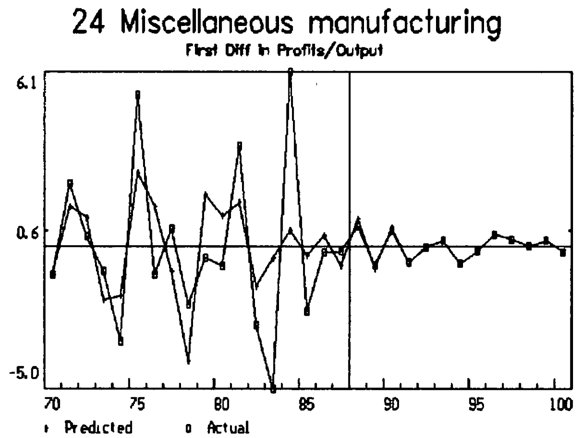
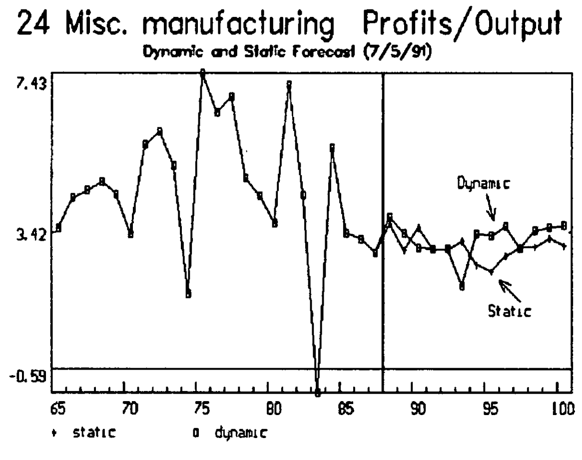


Figure 4.11: Estimation of Miscellaneous manufacturing Profits

```
title First Difference in Profits/output: 24 Misc. Manufacturing
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4
con 999999 0.0 = a5 + a6

:                 FD in Prof/output: 24 Misc. Manufacturing
  SEE    =        2.28 RSQ   = 0.3270 RHO =   -0.53 Obser  =    18 from 1970.000
  SEE+1  =        1.93 RBSQ  = 0.0465 DW  =    3.06 DoFree =    12 to   1987.000
  MAPE   =      154.04
    Variable name          Reg-Coef  Mexval t-value  Elas    Beta        Mean
  0 fdprat                 - - - - - - - - - - - - - - - - - - - -      -0.09
  1 pcout                  -0.00917    0.0  -0.107   0.09  -0.024        0.90
  2 pcout[1]                0.00918    0.0   0.107  -0.10   0.024        1.08
  3 pcvuc                  -0.03794    0.2  -0.224   2.40  -0.070        5.99
  4 pcvuc[1]                0.03794    0.2   0.224  -2.39   0.070        5.97
  5 pcwage                 -0.17104   13.7  -1.877   1.13  -0.418        0.63
  6 pcwage[1]               0.17104   13.7   1.877  -0.88   0.416        0.49
```





positive effect on the profit margin. The static and dynamic forecasts move similarly and show the profit margin oscillating in response to cyclical activity, but with no pronounced trend.

Instruments (23)

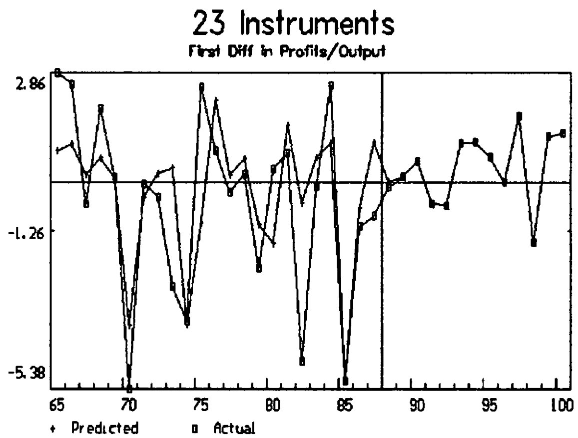
This industry manufactures medical instruments, scientific instruments, industrial control equipment, and navigation instruments, such as radar. Its profits are determined by a triumvirate of demand, labor costs, and material costs. In addition, reported profits for the industry in 1985 inexplicably dropped. Since no relevant economic reason for the drop could be found, a dummy variable was used in the equation. Although it imparts an upward bias to the forecast of the margin, the dummy variable resulted in reasonable coefficients on the cost and demand variables, so it was kept in the equation. Increases in material costs and labor costs are absorbed partially by the profit margin initially, and recover in the following year. The profit margin responds more to overall demand in the economy, captured by the unemployment rate, than to an industry-specific measure of demand.

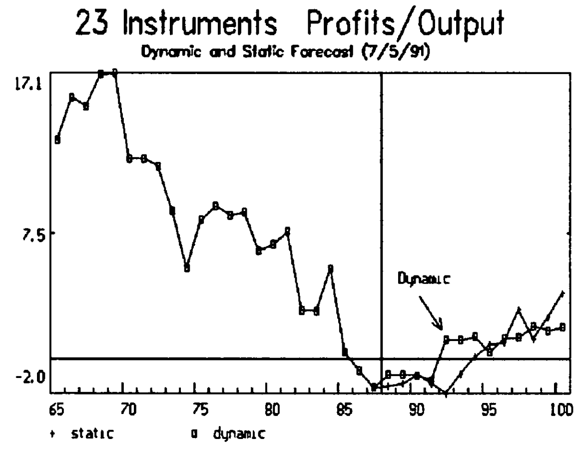
The equation fits fairly well, R^2 equals .5, and there is a strong correlation between the cumulated predictions and the actual profit rate (r "p" = .91), in part due to the dummy variable. Unlike most industries, Instrument's profit margin exhibits an underlying trend throughout the historical period. Since 1970, the margin has been on a downward trend, and it is negative in the last two years of historical data (1986 and 1987). The forecast for the profit margin shows the margin hovering around zero throughout the forecast. The margin does not recover to a positive value until 1992, when the economy is recovering from the overall slowdown through 1991. During the rest of the forecast, the margin remains relatively flat and barely positive. (Given the low value of the margin throughout the forecast, any upward bias from the dummy variable explaining the 1985 decline, is tolerable.)

Figure 4.12: Estimation of Instruments Profits

```
title First Difference in Profits/output: 23 Instruments
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4

:                      FD in Prof/output: 23 Instruments
  SEE   =         1.69 RSQ   = 0.5000 RHO =   0.08 Obser  =   23 from 1965.000
  SEE+1 =         1.69 RBSQ  = 0.3530 DW  =   1.85 DoFree =   17 to   1987.000
  MAPE  =       185.25
    Variable name           Reg-Coef  Mexval t-value  Elas    Beta      Mean
  0 fdprat                  - - - - - - - - - - - - - - - - - - - -    -0.55
  1 pcvuc                   -0.22346     7.0  -1.569  2.04  -0.382      4.99
  2 pcvuc[1]                 0.22346     7.0   1.569 -2.00   0.390      4.89
  3 pcwage                  -0.04408     0.7  -0.498 -0.02  -0.072     -0.30
  4 pcwage[1]                0.04408     0.7   0.498  0.03   0.074     -0.41
  5 fduninv                 36.85572    19.4   2.693  0.09   0.463     -0.00
  6 dum85                   -5.59905    20.0  -2.735  0.45  -0.479      0.04
```





Motion pictures and amusements (37)

The Motion picture industry and Medicine and education share similar equation specifications. Both depend on input and labor costs. In addition, they also depend on changes in consumer demand in the economy, as measured by changes in total Personal Consumption Expenditures (PCE). In the equation for Motion pictures, an increase in either material or labor costs initially is passed on in higher prices, and the profit margin rises. In the following year, that temporary increase is entirely offset. The coefficients on the cost variables were constrained to cancel each other out; without that constraint material costs had a large positive relationship with the profit margin, and labor costs had a negative relationship. The Motion picture industry is another example of an oligopoly in the U.S. economy that exhibits a price leadership strategy in reacting to changes in costs. The equation also depends on a dummy variable to account for the Hollywood writer's strike which decreased profits in 1984. The dynamic forecast shows profits remaining flat during the slow period through 1991. Profits then fall in response to the economic slowdown in 1994, characterized by slow growth in consumption expenditures. As the economy approaches a steady growth path, and PCE grows at a stable rate, the profit margin for motion pictures likewise stabilizes.

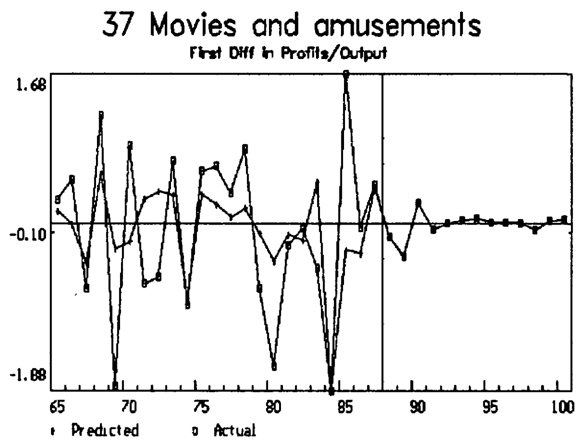
Medicine, education, and npo (38)

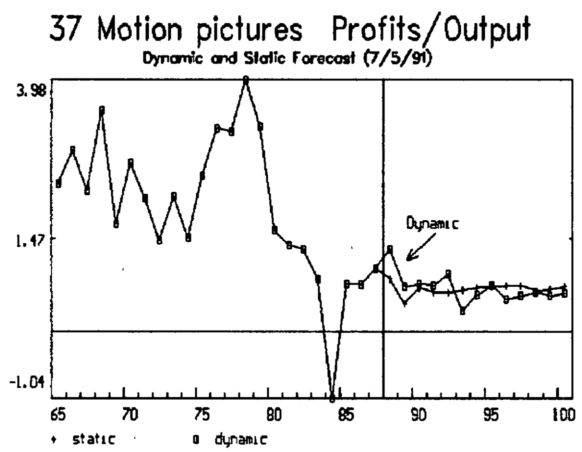
This industry includes Medical and Educational institutions, as well as Non-profit organizations, such as professional membership organizations. As noted, changes in PCE measure demand for this industry, where an increase in demand initially increases the profit margin. An increase in input costs initially implies an increase in the profit margin for this industry as well, as cost changes are passed more than fully into prices. Although this industry includes private schools and membership organizations, such as the American Economic Association,

Figure 4.13: Estimation of Movies Profits

```
title First Difference in Profits/Output: 37 Movies & amusements
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4
con 999999 0.0 = a5 + a6

:              First Diff in Prof/Output: 37 Movies & amusements
  SEE    =        0.78 RSQ   = 0.3073 RHO =  -0.15 Obser  =   23 from 1965.000
  SEE+1  =        0.77 RBSQ  = 0.0475 DW  =   2.31 DoFree =   16 to   1987.000
  MAPE   =      106.55
    Variable name           Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                  - - - - - - - - - - - - - - - - - - -       -0.08
  1 pcpce                    0.17884    8.5   1.689  -8.27   0.342       3.56
  2 pcpce[1]                -0.17884    8.5  -1.689   8.55  -0.348       3.69
  3 pcvuc                    0.14128    3.2   1.027 -10.33   0.323       5.64
  4 pcvuc[1]                -0.14128    3.2  -1.027  10.15  -0.338       5.54
  5 pcwage                   0.02909    0.7   0.491   0.21   0.095      -0.55
  6 pcwage[1]               -0.02909    0.7  -0.491  -0.39  -0.064      -1.03
  7 dum84                   -2.01827   13.4  -2.141   1.14  -0.441       0.04
```





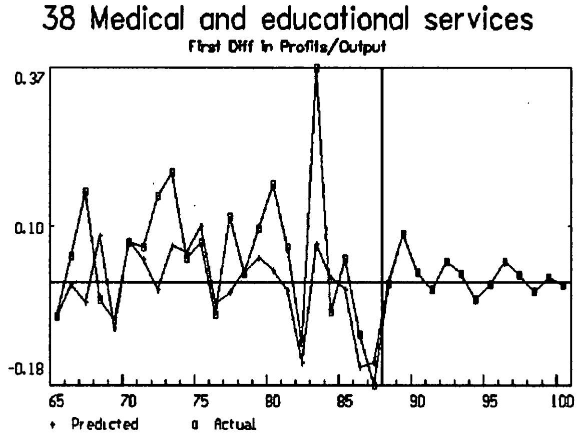
it is dominated by the health sector. It is not surprising that when the constraint on the material cost coefficients is removed, the net effect of costs on the profit margin is positive. The price of medical care has grown more rapidly than any other price in the U.S. economy in the last decade, and this is reflected in the relationship between material costs and the profit margin for the industry. Labor costs also affect the profit margin, but, unlike material costs, an increase in labor's share of output decreases the profit margin at first. This result again suggests the importance of distinguishing between types of costs when studying pricing strategies by industry.

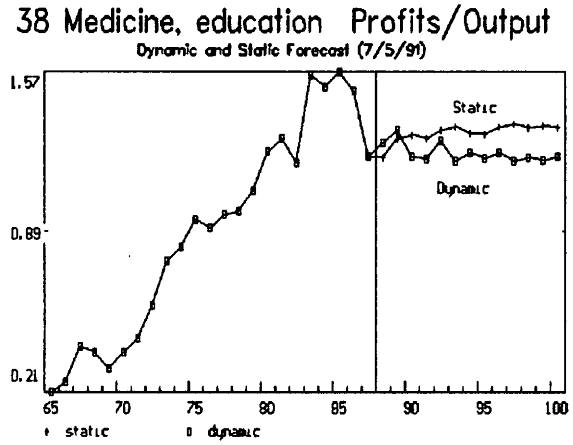
From 1965 to 1983, the profit margin for Medical and educational industries grew almost continuously, declining only four times in eighteen years. After stabilizing somewhat from 1983 to 1986, the margin declined in 1987. The forecast for the margin in this industry is mostly flat, as overall consumption demand and input costs stabilize. Given the strong upward trend in the profit margin for much of the historical period, the lack of any such trend in the forecast is open to question. However, the last five observations indicate a change in that upward trend. Rather than include a trend that may or may not exist in the future, the equation models changes in the profit margin around some average level in response to changes in demand or costs.

Figure 4.14: Estimation of Medical/educational Profits

```
title First Difference in Profits/Output: 38 Medical,education,npo
con 99999 0.0 = a1 + a2
con 99999 0.0 = a3 + a4
con 99999 0.0 = a5 + a6

:              First Diff in Prof/Output: 38 Medical,education,npo
  SEE   =        0.10 RSQ   = 0.2079 RHO =   0.08 Obser  =   23 from 1965.000
  SEE+1 =        0.10 RBSQ  = -0.0251 DW  =   1.84 DoFree =   17 to   1987.000
  MAPE  =       77.88
    Variable name            Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                   - - - - - - - - - - - - - - - - -            0.04
  1 pcpce                     0.02085     3.2   1.045   1.73   0.321      3.56
  2 pcpce[1]                 -0.02085     3.2  -1.044  -1.78  -0.327      3.69
  3 pcwage                   -0.01470     9.5  -1.835  -0.38  -0.424      1.10
  4 pcwage[1]                 0.01470     9.5   1.835   0.20   0.381      0.58
  5 pcvuc                     0.03398    12.0   2.080   4.87   0.986      6.17
  6 pcvuc[1]                 -0.03397    12.0  -2.080  -4.78  -1.020      6.05
```





Group 3: Inputs costs and demand

In this third group of industries, input costs are the only cost that affect the profit margin. Supplementing the cost variable in these equations are some measures of demand. The group includes mostly services industries: Finance and insurance, Business services, Automobile repair, and Utilities. (Communication services also falls into this group, but is discussed in the section for regulated industries below.) In addition, three manufacturing industries are represented: Electrical machinery, Printing, and Metal products.

Finance and Insurance Services (32)

The Finance and insurance industry is the second-largest domestic sector in terms of corporate profits, comprising 11.5% of the total in 1987. The profit margin for this industry depends on two demand variables, the unemployment rate and industry output, as well as on input costs. Because this service industry is sensitive to overall demand in the economy, the inverse of the unemployment rate was used as a measure of demand. As the economy worsens, profits in Finance and insurance slow. In addition, the profit margin is responsive to changes in industry activity beyond overall changes in the macroeconomy. An increase in input costs initially increases profits for the industry, although the effect is entirely canceled out by lagged costs.

A dummy variable was included to account for the structural changes that occurred in the banking industry between 1979 and 1982 due to deregulation. One effect of deregulation was increased competition for banks and thrift institutions. That increased competition led, in part, to a large fall in the overall profit margin for the industry. From 1979 to 1982, the profit margin fell from a value of 20% to 4.5%. To the extent that excess profits existed due to lack of competition,

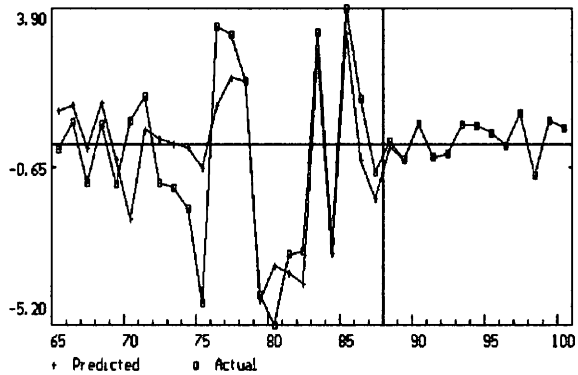
Figure 4.15: Estimation of Finance Profits

```
title First Difference in Profits/Output: 32 Financial, insurance
con 99999 0.0 = a1 + a2
con 99999 0.0 = a3 + a4

:                 FD in Profits/Output: 32 Financial, insurance
  SEE    =         1.46 RSQ   = 0.6794 RHO =    0.20 Obser  =   23 from 1965.000
  SEE+1  =         1.44 RBSQ  = 0.5850 DW  =    1.59 DoFree =   17 to   1987.000
  MAPE   =       105.19
    Variable name            Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                   - - - - - - - - - - - - - - - - - - - -     -0.47
  1 pcout                     0.46962     8.6   1.743  -4.12   0.245      4.09
  2 pcout[1]                 -0.46962     8.6  -1.743   4.14  -0.242      4.11
  3 pcvuc                     0.42703    32.9   3.612  -6.16   0.470      6.74
  4 pcvuc[1]                 -0.42703    32.9  -3.612   6.05  -0.486      6.62
  5 fduninv                  13.71246     2.3   0.895   0.04   0.159     -0.00
  6 dummy                    -2.66191    22.4  -2.907   0.99  -0.391      0.17
```

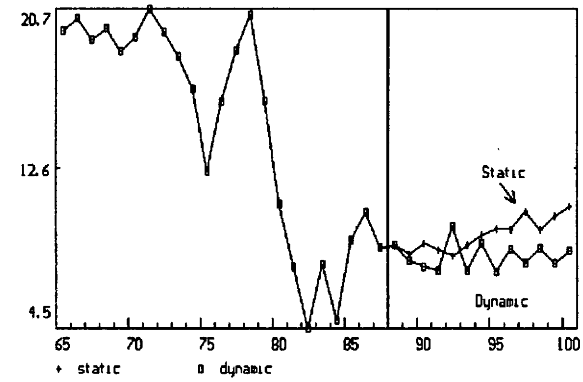
32 Financial and insurance services

First Diff in Profits/Output



32 Finance and insurance Profits/Output

Dynamic and Static Forecast (7/5/91)



then deregulation certainly worked.[41] As the industry adjusted to deregulation, and to the recovery from the 1982 recession, the profit margin recovered from its low of 4.5% to a level close to 9% by 1987.

Other specifications that were tried for this industry included using labor costs and interest rates, but the equation presented here showed the best combination of statistical fit and reasonable forecasting properties.

The dynamic forecast for Finance and insurance shows a gradual decline in the margin through the economic slowdown until 1991. The rest of the forecast follows a damped oscillating pattern of growth, where the margin responds to cyclical activity, but as the economy's turnarounds become less dramatic, the growth in the margin also stabilizes.

Business services (35) and Automobile repair services (36)

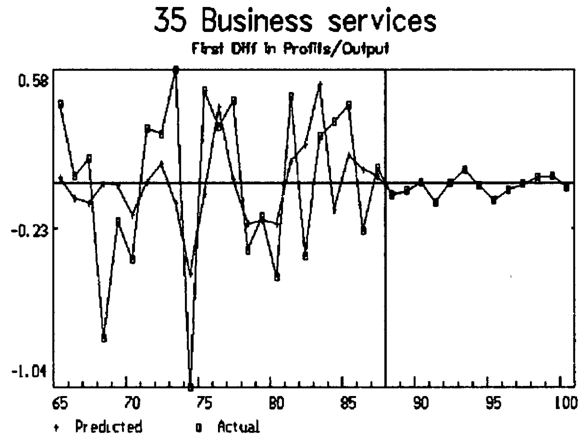
Business services and Automobile repair services share the same equation specification. The profit margin depends on changes in input costs, current and lagged once, as well as changes in output, current and lagged. In each equation, an increase in costs implies an initial fall in the profit margin, which is then offset in the following year. The profit margin for both service industries responds positively to changes in demand, and the effect is reversed in the following year. Both industries also share the characteristic that they were extremely difficult equations to estimate. For some of the service industries, an overall measure of demand in the economy, such as the unemployment

[41] This fall in profits is interesting given that the call for deregulation came, in part, from within the industry itself. Although, as noted in the Economic Report of the President, 1980, "Even as they sought innovative ways to bypass the regulatory structure and to maintain their markets, some depository institutions urged regulatory agencies to loosen their restrictions. The call for deregulation was less than unanimous, however, since many institutions believed that the regulatory structure still protected their profitable markets from encroachment by competitors." (p. 109)

Figure 4.16: Estimation of Business services Profits

```
title First Difference in Profits/Output: 35 Misc Business Services
con 9999 0.0 = a1 + a2
con 9999 0.0 = a3 + a4

:             First Diff in Prof/Output: 35 Misc Business Services
  SEE   =        0.37 RSQ   = 0.2194 RHO =  -0.26 Obser  =   23 from 1965.000
  SEE+1 =        0.36 RBSQ  = 0.0962 DW  =   2.53 DoFree =   19 to   1987.000
  MAPE  =       98.99
    Variable name            Reg-Coef  Mexval t-value  Elas    Beta      Mean
  0 fdprat                  - - - - - - - - - - - - - - - - - - - -      0.01
  1 pcout                    0.00303     0.0   0.126   1.42   0.022      5.13
  2 pcout[1]                -0.00301     0.0  -0.125  -1.41  -0.022      5.13
  3 pcvuc                   -0.10123     9.6  -1.960 -53.25  -0.721      5.77
  4 pcvuc[1]                 0.10123     9.6   1.961  52.68   0.738      5.71
```



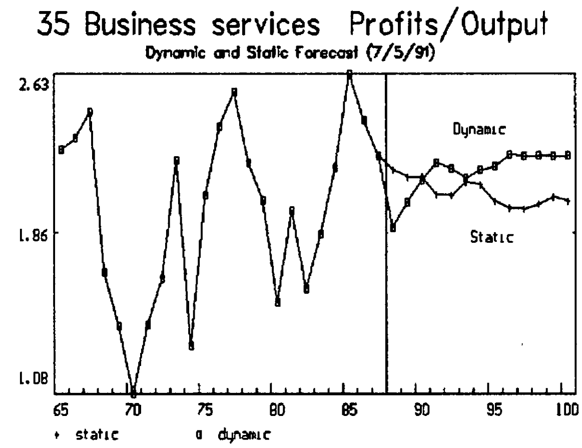
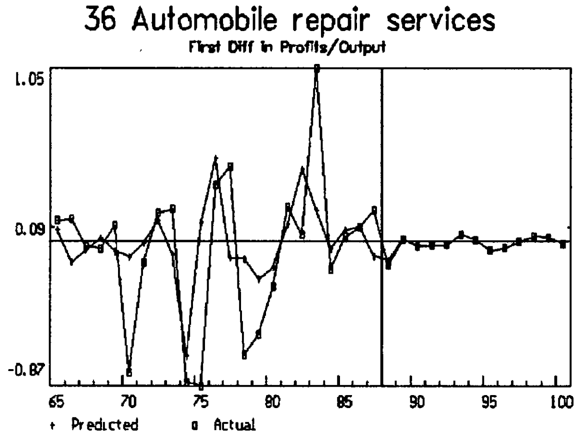
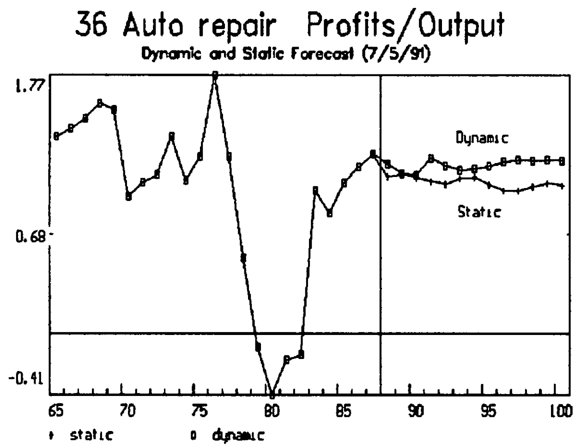


Figure 4.17: Estimation of Auto repair Services

```
title First Difference in Profits/Output:  36 Auto Repair
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4

:                First Diff in Prof/Output:  36 Auto Repair
 SEE    =        0.39 RSQ   = 0.2388 RHO =  -0.10 Obser  =   23 from 1965.000
 SEE+1  =        0.39 RBSQ  = 0.1186 DW  =   2.21 DoFree =   19 to   1987.000
 MAPE   =      123.94
   Variable name            Reg-Coef  Mexval t-value  Elas    Beta       Mean
 0 fdprat                   - - - - - - - - - - - - - - - - - - - -     -0.06
 1 pcout                     0.00450     0.5   0.446  -0.35   0.066      4.31
 2 pcout[1]                 -0.00450     0.5  -0.446   0.34  -0.066      4.26
 3 pcvuc                    -0.07194    11.8  -2.184   7.24  -0.607      5.65
 4 pcvuc[1]                  0.07193    11.8   2.184  -7.17   0.615      5.59
```





rate or PCE, was found to be helpful. No type of macro variable was helpful for these industries, however. In addition, labor costs did not help the statistical fit of the equations, or yield reasonable coefficients, even when constraints were used. Neither equation has a particularly outstanding statistical fit, with R^2's less than .24 in each case. However, the combination of the input costs and demand resulted in reasonable static and dynamic forecasts for the industries. The forecast for Business services shows sensitivity of profits to the economy's business cycle. The margin oscillates around its average value in the previous twenty years. The forecast for the profit margin of Automobile repair services shows only a slight response to the downturn of 1990. Thereafter, the profit margin remains relatively flat, only barely exceeding its average value from 1965 to 1987.

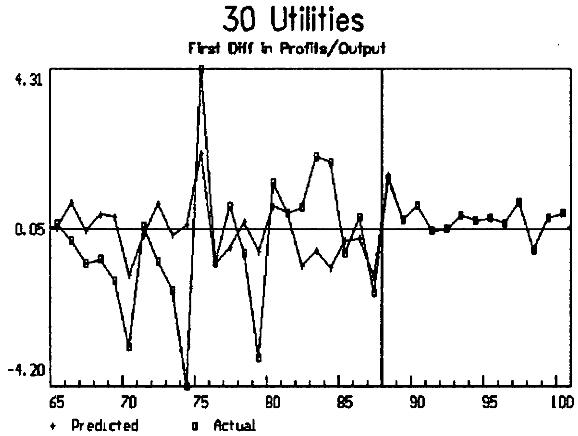
Electric, gas, and sanitary services (30)

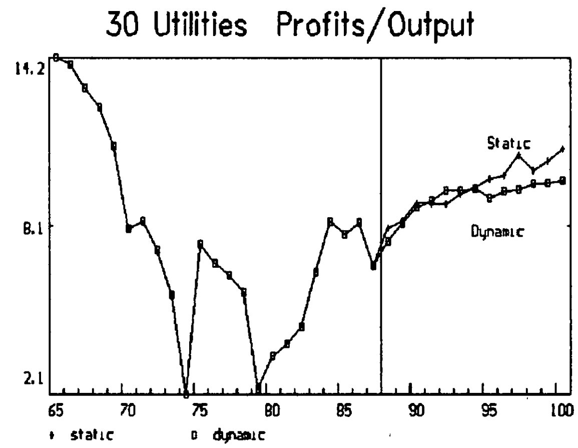
The profit margin for Electric, gas, and sanitary services, or Utilities, depends only on input costs and one demand variable, changes in the unemployment rate. Attempts were made to incorporate oil prices, the deregulation of the natural gas industry, labor costs, and other variables in this equation with no success. Initially, an increase in material costs is passed on in prices and results in a temporary rise in the profit margin. In the following year, however, that increase is reversed. Without constraints on the cost coefficients, the net effect of a cost increase on the profit margin is positive. This positive relationship between costs and profits indicates another oligopoly industry that is able to exercise market power to pass on cost changes. This positive relationship is also consistent with inelastic demand for electric, gas, and water utilities. In general, demand for utilities depends on overall growth in the economy, and the profit margin is partially explained by the unemployment rate. As the economy grows

Figure 4.18: Estimation of Utilities Profits

```
title First Difference Profits/Output: 30 Utilities
con 99999 0.0 = a1 + a2

:                       First Diff Prof/Output: 30 Utilities
  SEE    =         1.69 RSQ   = 0.1254 RHO =    0.22 Obser  =   23 from 1965.000
  SEE+1  =         1.65 RBSQ  = 0.0380 DW  =    1.56 DoFree =   20 to   1987.000
  MAPE   =       122.81
    Variable name             Reg-Coef  Mexval t-value  Elas    Beta        Mean
  0 fdprat                    - - - - - - - - - - - - - - - - - - - -       -0.40
  1 pcvuc[1]                   0.15012     9.4   1.986 -2.91   0.710        7.71
  2 pcvuc[2]                  -0.15010     9.4  -1.986  3.14  -0.633        8.31
  3 fduninv                   12.83520     1.9   0.873  0.04   0.212       -0.00
```





during an expansion, and unemployment falls, the profit margin for the Utilities industry rises.

Electrical machinery (21)

This industry manufactures household and industrial appliances, communication equipment, lighting and wiring equipment, and radios, televisions, and other electronic goods. Profits in the industry are explained well with a relatively simple equation that depends only on input costs and two measures of demand. Costs are not passed on to consumers fully, and an increase implies an initial fall in the profit margin. In the following year, that increase is offset, partially due to a constraint on the coefficients that ensure they sum to zero. (Without the constraint, the coefficients implied a permanent negative effect on profits.) The profit margin responds to both an industry-specific measure of demand, changes in output, and a measure of overall economic activity, the unemployment rate. The profit margin appears to be less responsive to the business cycle over time, as the response to the 1974 recession was more drastic than to the 1982 recession. There are no major differences between the static and dynamic forecasting properties of this equation. The forecast shows the profit margin declining slightly to 1991, recovering modestly in 1992, and then stabilizing through the rest of the forecast period.

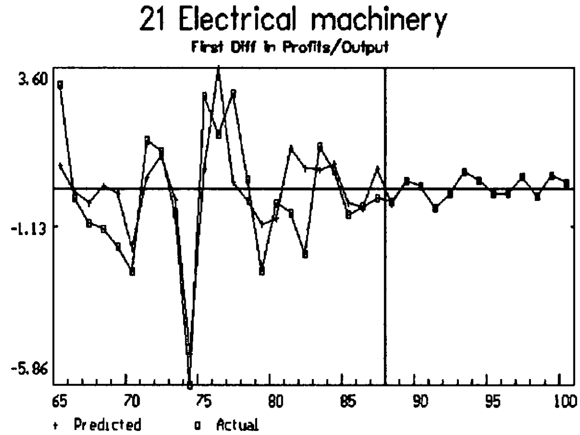
Printing and publishing (9)

Profits in the Printing industry have been extremely sensitive to downturns in the economy and have a volatile history. Changes in input costs, as well as changes in demand explain movements in the profit margin. Cost increases imply an initial fall in the profit margin, that is offset in the following year. Profits respond to demand as captured by industry output, but they also are sensitive to the overall business cycle, as measured by the unemployment rate.

Figure 4.19: Estimation of Electrical machinery Profits

```
title First Difference Profits/output: 21 Electrical Machinery
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4

:                    FD Prof/output: 21 Electrical Machinery
  SEE    =        1.37 RSQ   = 0.5231 RHO =  -0.06 Obser  =   23 from 1965.000
  SEE+1  =        1.36 RBSQ  = 0.4172 DW  =   2.12 DoFree =   18 to   1987.000
  MAPE   =       92.91
    Variable name            Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                   - - - - - - - - - - - - - - - - - - -       -0.25
  1 pcvuc                    -0.32478    20.7  -2.865  6.15  -0.601       4.66
  2 pcvuc[1]                  0.32478    20.7   2.865 -6.04   0.613       4.57
  3 pcout                     0.05612     5.0   1.357 -1.26   0.228       5.51
  4 pcout[1]                 -0.05612     5.0  -1.357  1.26  -0.228       5.53
  5 fduninv                   7.21684     0.9   0.566  0.04   0.109      -0.00
```



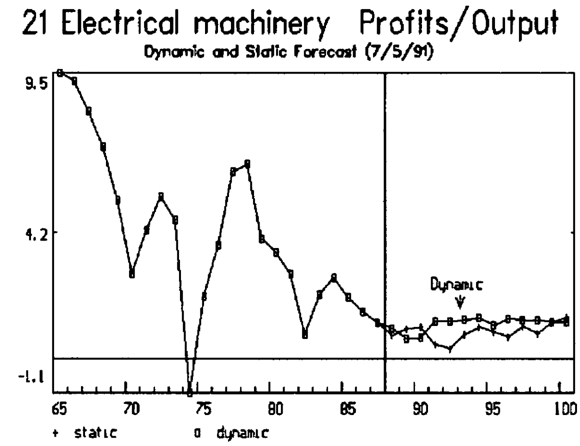
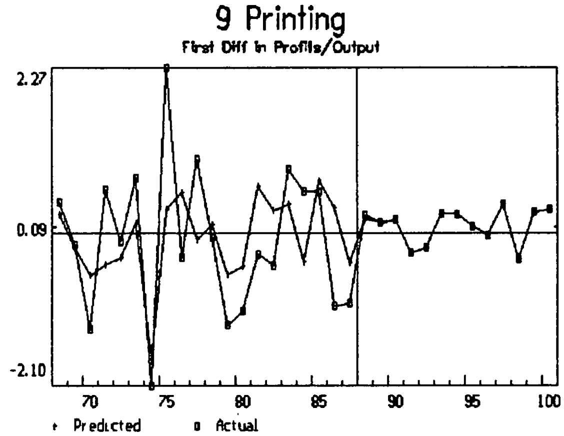
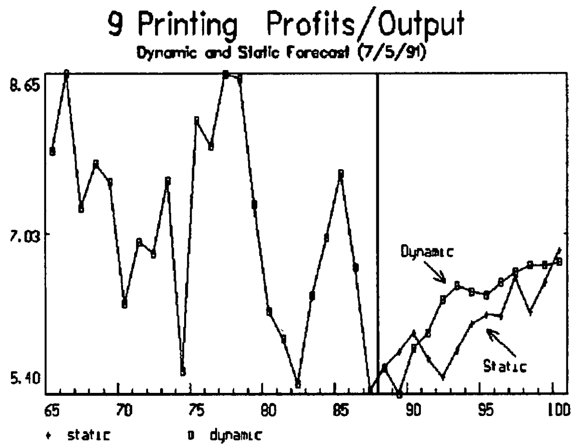


Figure 4.20: Estimation of Printing Profits

```
title First Difference Profits/Output 09.Printing
con 99999 0.0 = a1 + a2
con 99999 0.0 = a3 + a4

:                          FD Profits/Output 09.Printing
 SEE    =        0.82 RSQ   = 0.3124 RHO =  -0.09 Obser  =   20 from 1968.000
 SEE+1 =         0.82 RBSQ  = 0.1291 DW  =   2.18 DoFree =   15 to   1987.000
 MAPE  =       123.28
   Variable name             Reg-Coef  Mexval t-value  Elas    Beta      Mean
 0 fdprat                    - - - - - - - - - - - - - - - - - - - -     -0.10
 1 pcout                     -0.05552     3.4  -1.019   1.62  -0.218     2.95
 2 pcout[1]                   0.05552     3.4   1.019  -1.54   0.213     2.79
 3 pcvuc                     -0.18426    19.5  -2.537  11.51  -0.711     6.30
 4 pcvuc[1]                   0.18426    19.5   2.536 -11.41   0.719     6.25
 5 fduninv                    9.26868     4.6   1.187   0.45   0.278    -0.00
```





The dynamic forecast is slightly less volatile than the static forecast, since the overall economic outlook of the dynamic forecast is more stable than the forecast used for the static analysis. The margin dips in the slowdown through 1990, then recovers well through 1993. Even with this recovery, however, the margin remains below its average value during the historical period.

<u>Group 4: No input costs</u>

This small group consists of three industries whose profits are explained without using any measure of input costs: Textiles, Paper, and Hotels and non-auto repair services.

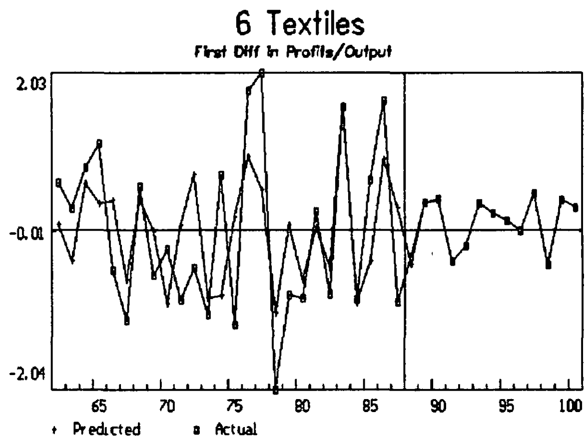
Textiles (6)

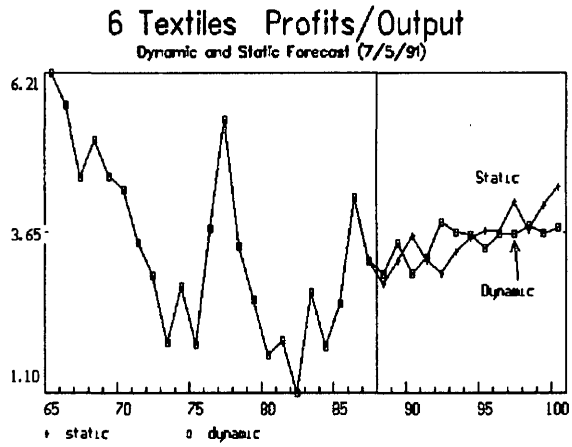
The profit margin for the Textile industry is more sensitive to changes in demand and labor than to changes in material costs. Demand is captured with an industry-specific variable, the change in output, as well as a measure of the overall business cycle, the unemployment rate. An increase in output causes an initial surge in the profit margin. In the following year, that temporary increase in profits is offset. In addition, an increase in demand, indicated by a fall in unemployment, also implies an increase in the profit rate. Although unit material costs were not found to be useful in this equation, current changes in labor costs are important. In this industry characterized by labor unions, an increase in labor's share of income implies an initial decrease in the profit margin. The equation captures much of the variability in the profit margin, and the correlation between the actual and predicted profit margin is 83% (r "p"). The static and dynamic forecasts evince no startling differences, and the outlook for the profit margin is appropriately cyclical over the forecast period.

Figure 4.21: Estimation for Textile Profits

```
title First Difference in Profits/Output for 06 Textiles
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4

:                      FD in Profits/Output for 06 Textiles
  SEE   =        0.83 RSQ   = 0.3927 RHO =  -0.08 Obser  =   26 from 1962.000
  SEE+1 =        0.83 RBSQ  = 0.2771 DW  =   2.16 DoFree =   21 to   1987.000
  MAPE  =       96.94
    Variable name           Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                  - - - - - - - - - - - - - - - - - - -       -0.02
  1 pcout                    0.09755    26.6   3.554 -11.10   0.472       2.35
  2 pcout[1]                -0.09755    26.6  -3.554  10.97  -0.470       2.32
  3 pcwage                  -0.02005     1.6  -0.812   0.18  -0.090       0.18
  4 pcwage[1]                0.02005     1.6   0.812   0.18   0.094      -0.19
  5 fduninv                  9.12467     4.2   1.335  -0.21   0.247       0.00
```





Paper and allied products (8)

Like the Textile industry, profits for the Paper industry respond more to demand changes than to changes in material input costs. Changes in demand, measured by industry output, help explain the cyclical behavior of Paper profits. In addition, the labor share of output also explains profits. In contrast to the Textile industry, an increase in labor costs initially is passed on to consumers in prices, and the profit margin rises. The underlying trend for the profit margin from the mid-1970's through 1985 was downward, and profits were hard hit by the 1982 recession. In 1987, however, the profit margin jumps significantly, regaining its peak level of 1974 in almost one year. The dynamic forecast of the margin shows cyclical response of this industry to a slowdown in demand in 1993. Thereafter, the margin remains fairly steady to the end of the forecast period.

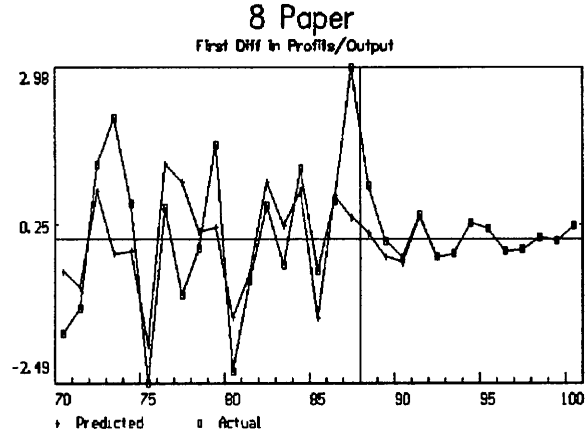
Hotels and non-automobile repair services (34)

The only service industry in this group, Hotels and repairs depend on changes in demand measured by both industry-specific and macro-economic variables. Changes in industry output have a three-year effect on the profit margin for this industry. The initial response to a demand change is an increase in profits. The lagged effect, however, is a decrease in the profit margin. Finally, in the third year, any negative effect on the profit margin is canceled out, as the change in industry output increases the profit margin. Profits react to the overall business cycle, and the unemployment rate and interest rates also are included in the equation. As might be expected with only demand variables in the equation, the dynamic forecast shows cyclical behavior for Hotel profits, not unlike historical activity. Profits remain flat through the 1990-1991 slowdown, but then grow quickly during the recovery. As the economy resumes a more stable growth rate, the profit margin for Hotels likewise stabilizes.

Figure 4.22: Estimation of Paper Profits

```
title First Difference Profits/Output 08.Paper
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4

:                        FD Profits/Output 08.Paper
 SEE    =     1.15 RSQ   = 0.3766 RHO =    0.32 Obser  =   18 from 1970.000
 SEE+1 =      1.13 RBSQ  = 0.2430 DW  =    1.36 DoFree =   14 to   1987.000
 MAPE  =     87.82
   Variable name           Reg-Coef  Mexval t-value  Elas    Beta       Mean
 0 fdprat                  - - - - - - - - - - - - - - - - - - - -      0.06
 1 pcout                    0.07326    12.7   1.944  3.35   0.269       2.74
 2 pcout[1]                -0.07326    12.7  -1.944 -3.32  -0.269       2.72
 3 pcwage                   0.16805    21.1   2.558 -1.97   0.415      -0.71
 4 pcwage[1]               -0.16805    21.1  -2.558  1.59  -0.432      -0.57
```



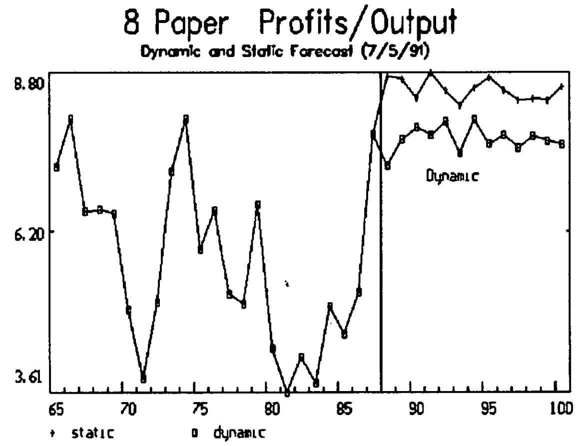
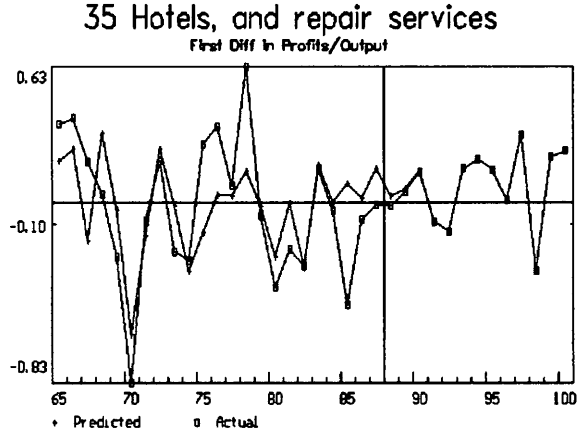
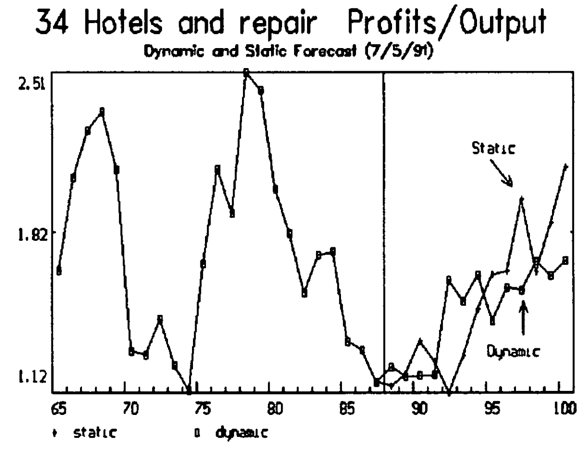


Figure 4.23: Estimation of Hotel Profits

```
title First Difference in Profits/output: 34 Hotels & repair
con 99999 0.0 = a1 + a2 + a3

:                First Diff in Prof/output: 34 Hotels & repair
  SEE    =        0.24 RSQ   = 0.4352 RHO =   0.29 Obser  =   23 from 1965.000
  SEE+1  =        0.23 RBSQ  = 0.3097 DW  =   1.42 DoFree =   18 to   1987.000
  MAPE   =      171.61
    Variable name              Reg-Coef  Mexval t-value  Elas    Beta      Mean
  0 fdprat                   - - - - - - - - - - - - - - - - - - - - -    -0.02
  1 pcout                      0.02452     3.3   1.106  -2.56   0.212      2.42
  2 pcout[1]                  -0.05310    10.7  -2.013   5.58  -0.461      2.43
  3 pcout[2]                   0.02859     4.2   1.235  -2.93   0.247      2.38
  4 fdrlint                   -0.02114     0.7  -0.512   0.11  -0.101      0.12
  5 fduninv                    6.69342    16.5   2.538   0.40   0.624     -0.00
```





Group 5: Regulated industries

The following group contains those industries who have experienced some degree of regulation, and usually de-regulation, during the historical period of estimation.

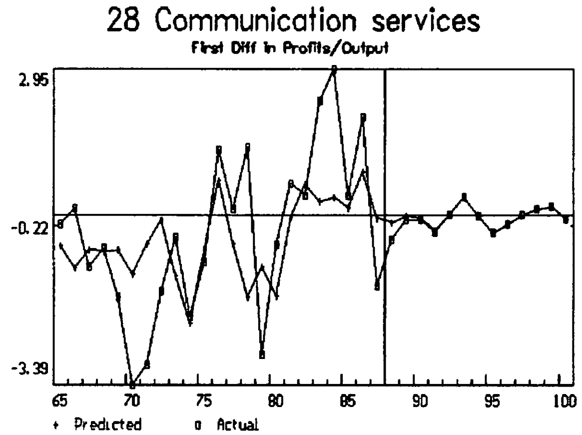
Communication services (28)

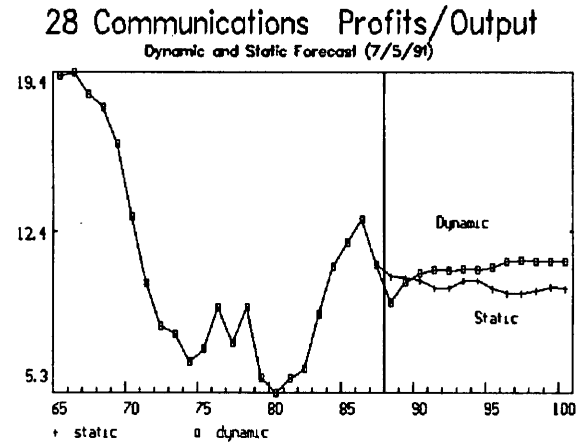
The profit margin for Communication is sensitive to changes in demand and changes in input costs. An increase in costs initially implies a decrease in the profit margin that is offset in the following year. The equation also includes a dummy variable to account for the significant restructuring that occurred in the communication industry in the early 1980's. In 1982, a U.S. district judge gave final approval to a deregulation settlement between the American Telephone and Telegraph Company (AT&T) and the Department of Justice. To account for this deregulation, a dummy variable was introduced into the equation that equals one before the break-up of AT&T, one-half in 1983, as the break-up was being phased in, and zero thereafter. The coefficient of -.6 on the regulation variable implies that regulation of the industry lowered the industry's profit margin by more than half a percentage point. Interestingly, profits in the communications industry fell consistently from 1970 to 1981. Since deregulation, the profit margin has increased at an average annual rate of 13.8% per year, although it fell in 1987. The dynamic forecast of the margin is smooth and indicates that there are no large changes in demand or input costs forecast for this industry.

Figure 4.24: Estimation of Communications Profits

```
title First Difference in Profits/Output: 28 Communication
  regul   = dummy variable = 1 before break-up of AT&T, 1955-1982
                             .5 in 1983
                              0 thereafter
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4

:                   FD in Profits/Output: 28 Communication
  SEE    =        1.39 RSQ   = 0.2755 RHO =   0.25 Obser  =   23 from 1965.000
  SEE+1  =        1.36 RBSQ  = 0.1145 DW  =   1.51 DoFree =   18 to   1987.000
  MAPE   =      147.65
    Variable name            Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                  - - - - - - - - - - - - - - - - - - - -      -0.35
  1 pcvuc                   -0.45209    11.0  -2.039   7.57  -0.741       5.94
  2 pcvuc[1]                 0.45209    11.0   2.039  -7.42   0.777       5.82
  3 pcout                   -0.01673     0.1  -0.171   0.29  -0.031       6.16
  4 pcout[1]                 0.01673     0.1   0.171  -0.29   0.031       6.24
  5 regul                   -0.57562     6.3  -1.528   1.31  -0.134       0.80
```





Air transportation services (26)

Although attempts were made to include demand variables in the equation for airline profits, the profit margin depends only on changes in material costs, largely fuel, labor costs and a variable representing deregulation of the industry. Increases in labor costs initially imply a fall in the profit margin, which is offset after a one-year lag. The initial effect of an increase in input costs is a small increase in the profit margin, but the one-year lag on costs implies a decrease in the profit margin. The decrease is not made up until the second year after the initial rise in costs. Although airline prices typically respond quickly to changes in fuel costs, rising rapidly after the Iraqi invasion of Kuwait, for example, this equation suggests that the pass-through of cost increases occurs with a delay. The initial pass-through is absorbed in the following year by a decrease in the profit margin. It takes three years for the effect of a cost change to work its way through completely to prices.

From 1979 to 1982, the Airline Deregulation Act of 1979 was being implemented, and the structure of the industry was changing. A dummy variable is used in the equation to account for the changes during this period. The coefficient on the deregulation variable is negative, but interpreting its meaning is difficult, since the restructuring also overlapped with the 1980-1982 recession.

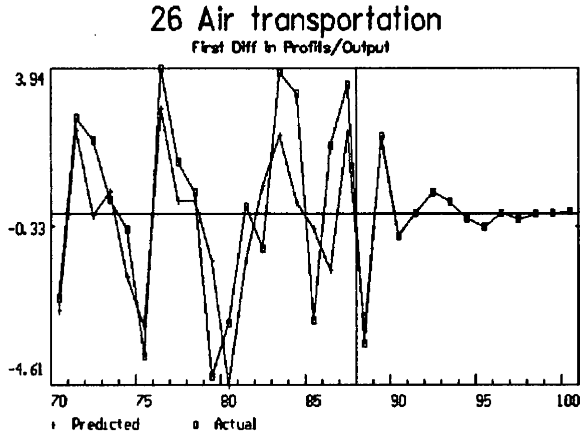
The static and dynamic forecasts differ largely due to the different oil-prices faced by the industry in each scenario. The dynamic forecast shows an expected dip in the profit margin in response to higher oil prices due to the Iraqi invasion and Desert Storm. The profit margin recovers in 1992, and the remainder of the forecast shows a stable profit margin.

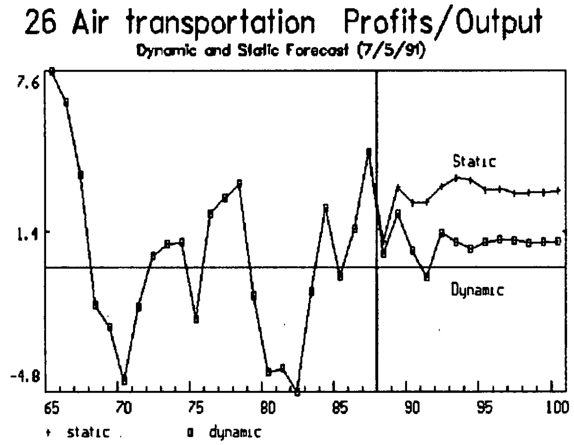
Figure 4.25: Estimation of Air transportation Profits

```
title First Difference Profits/Output: 26 Air Transportation
 dereg = dummy variable = 0 before de-regulation

con 99999 0.0 = a1 + a2
con 99999 0.0 = a3 + a4 + a5

:                First Diff Prof/Output: 26 Air Transportation
  SEE   =        1.78 RSQ   = 0.5432 RHO =  -0.25 Obser  =    18 from 1970.000
  SEE+1 =        1.71 RBSQ  = 0.3529 DW  =   2.51 DoFree =    12 to   1987.000
  MAPE  =      118.79
   Variable name            Reg-Coef  Mexval t-value  Elas    Beta        Mean
  0 fdprat                  - - - - - - - - - - - - - - - - - - - -      0.33
  1 pcwage                  -0.15041    18.8  -2.224  -0.35  -0.438      0.76
  2 pcwage[1]                0.15043    18.8   2.225   0.04   0.401      0.09
  3 pcvuc                    0.08584     6.2   1.236   2.07   0.265      7.87
  4 pcvuc[1]                -0.34183    31.8  -2.973  -8.12  -1.061      7.77
  5 pcvuc[2]                 0.25602    37.7   3.279   6.45   0.727      8.24
  6 dereg                   -1.68476     6.5  -1.269  -0.86  -0.239      0.17
```





Railroad (25)

The profit margin for the Railroad industry is determined by lagged input costs, labor costs, and changes in output. Current changes in costs were insignificant in this equation, but the margin responds to cost changes lagged one and two years. An increase in costs first implies a fall in the profit margin, as Railroads are reluctant to pass the costs on to their customers in higher prices, or, are prohibited from doing so by regulators. Likewise, an increase in the labor share of output initially implies a fall in the profit margin, rather than an immediate pass-through of the cost change into prices. The profit margin also responds to changes in demand, as measured by industry output. Finally, a dummy variable was used to account for the implementation of the Staggers Rail Act in 1981, which deregulated parts of the rail industry. After a sharp drop in profits in 1981 and 1982, due to both deregulation and the 1982 recession, the rail industry experienced a remarkable increase in the profit margin in the middle 1980's.

The static and dynamic forecasts for the profit margin differ significantly for this industry. In the static outlook, the profit margin falls in the first year of the forecast, 1988, by over 5 percentage points. In contrast, in the dynamic forecast the profit margin falls in 1988, but only by 1.8 percent points. In the static outlook, labor costs jumped significantly in the first forecast year, driving the profit margin down, while in the dynamic outlook labor costs actually fall slightly in the first year of the forecast.[42] The result is a less dramatic drop in the profit margin for the Railroad industry

---

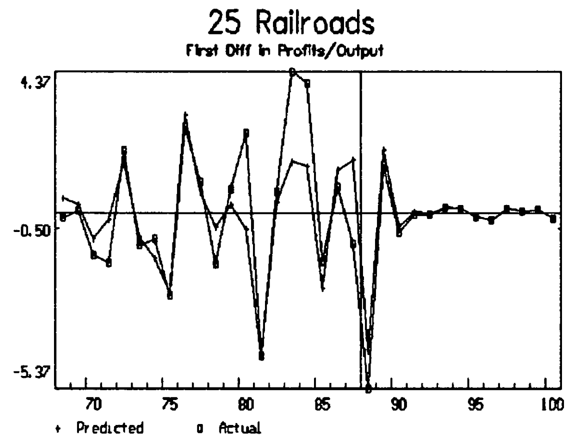
[42] It is difficult to backtrack and determine exactly why the labor cost variable jumped in the static outlook. One explanation for the jump may be that a "group fix" was applied to force total labor compensation to equal the known total for 1988, even though industry data were not available. A group fix in LIFT is applied by scaling the industry results, based on the size of each industry, to equal some given total. In some cases, that type of scaling may lead to jumps in the industry series.

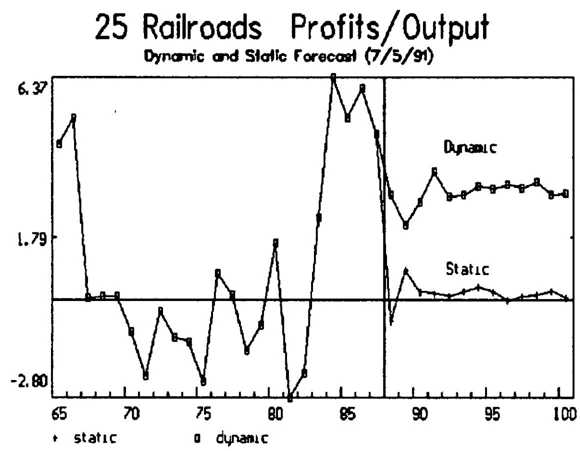
Figure 4.26: Estimation of Railroads Profits

```
title First Difference Profits/Output: 25 Railroads

  regul  = dummy variable for govt regulation of Railroad industry:
               0  before de-regulation  1955-1980
               1  in year of implementation of Staggers Rail Act '81
               0  thereafter
con 99999 0.0 = a1 + a2
con 99999 0.0 = a3 + a4
con 99999 0.0 = a5 + a6

:                        FD Prof/Output: 25 Railroads
  SEE    =       1.33 RSQ   = 0.6095 RHO =    0.43 Obser  =   20 from 1968.000
  SEE+1 =        1.24 RBSQ  = 0.4292 DW  =    1.14 DoFree =   13 to   1987.000
  MAPE   =      89.96
    Variable name            Reg-Coef  Mexval t-value  Elas    Beta        Mean
  0 fdprat                   - - - - - - - - - - - - - - - - - - - -       0.13
  1 pcout                     0.03189     0.9   0.485  0.25   0.099        1.04
  2 pcout[1]                 -0.03189     0.9  -0.485 -0.11  -0.097        0.45
  3 pcvuc[1]                 -0.15317     9.4  -1.601 -6.74  -0.473        5.90
  4 pcvuc[2]                  0.15319     9.4   1.601  7.15   0.442        6.26
  5 pcwage                   -0.10497     8.8  -1.550  0.57  -0.243       -0.73
  6 pcwage[1]                 0.10497     8.8   1.549 -0.02   0.235       -0.02
  7 regul                    -3.84363    18.8  -2.310 -1.43  -0.392        0.05
```





in the dynamic forecast than in the static outlook.

Trucking and warehousing (27)

Although Trucking is included in this group because it underwent deregulation in 1980 and 1981, no dummy variable was needed in the equation to explain the effects of regulation. Prior to the passage of the Motor Carrier Act (MCA) in 1980, the profit margin showed an underlying upward trend, although the margin oscillated around that trend in response to economic conditions. From 1980 to 1982, in response to implementation of the MCA and to the economy-wide recession, the profit margin for Trucking fell significantly, with most of the drop occurring in 1982. Recovery in 1983 was strong, and the profit margin performed well until 1987, when it dropped again.

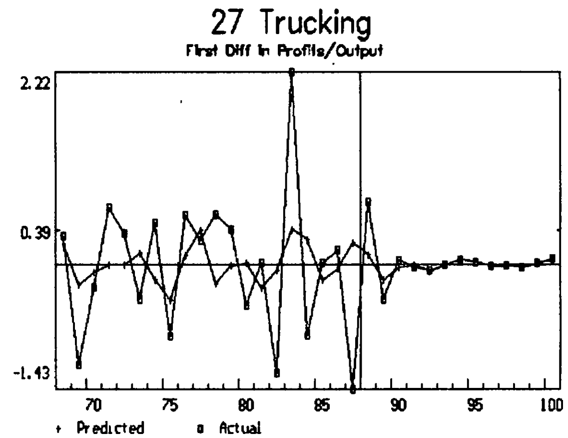
The equation determines the profit margin as a function of lagged input costs, changes in labor costs, and changes in demand as measured by the unemployment rate. An increase in material costs is absorbed (after a one-year lag) by the profit margin. The decline in the margin is offset in the following year. An increase in labor costs initially implies an increase in the profit margin, which is then offset in the next year. Without constraints on the coefficients, the labor share variable has a large negative effect on profits. Finally, trucking is sensitive to the overall business cycle, and changes in the unemployment rate affect the profit margin.

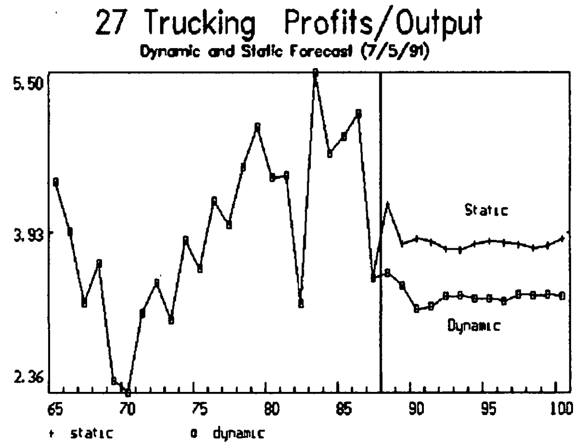
The dynamic forecast of the margin shows a decline in the profit margin due to the overall economic slowdown through 1991. The margin recovers in 1992 and 1993, and remains stable through the rest of the forecast period.

Figure 4.27: Estimation of Trucking Profits

```
title First Difference in Profits/output: 27 Trucking
con 99999 0.0 = a1 + a2
con 99999 0.0 = a3 + a4

:                    First Diff in Prof/output: 27 Trucking
  SEE    =        0.79 RSQ    = 0.0707 RHO =  -0.36 Obser  =    20 from 1968.000
  SEE+1  =        0.69 RBSQ   = -0.1771 DW  =   2.73 DoFree =    15 to   1987.000
  MAPE   =      250.33
    Variable name              Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                     - - - - - - - - - - - - - - - - - - - -     -0.03
  1 pcwage                      0.02430     0.9   0.534   0.15   0.108     -0.15
  2 pcwage[1]                  -0.02430     0.9  -0.534  -0.28  -0.107     -0.30
  3 pcvuc[1]                   -0.03067     0.8  -0.506   7.42  -0.175      6.25
  4 pcvuc[2]                    0.03067     0.8   0.506  -7.66   0.167      6.45
  5 fduninv                     0.65160     0.0   0.088   0.12   0.024     -0.00
```





Group 6: Construction related

The industries in this group share a similar demand factor: change in construction activity in the economy. The group includes: Construction, Real estate, Lumber and wood products, Furniture, and Stone, clay and glass.

Construction (4)

The profit margin for the Construction industry is responsive to changes in aggregate housing activity in the economy and to labor costs. Changes in the profit margin depend on current and lagged changes in investment in residential structures. (Attempts made to incorporate non-residential structures were unsuccessful.) The profit margin also responds to changes in the labor share of output, and an increase in labor costs initially implies a decrease in the profit rate.

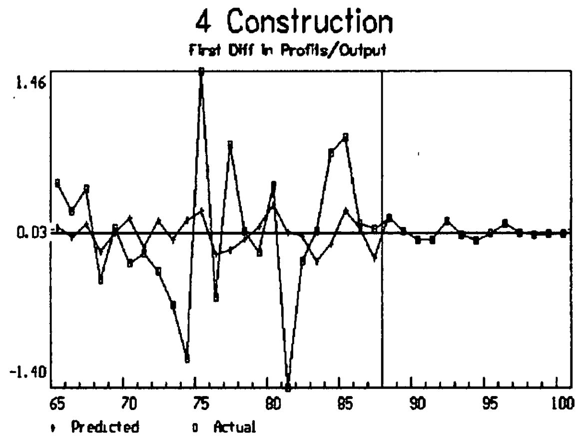
This equation was difficult to estimate, and the chosen equation fits poorly, with R^2 equal to .0488 and the correlation between the actual profit rate and cumulative predictions (r "p") only .278. (When past errors are not cumulated, and the actual profit rate is compared to a one-step ahead prediction, the correlation is a respectable .707.) The poor fit is due, in part, to the coefficient constraints. Without constraints on the coefficients, the R^2 equals .1324 r "p" equals 44.2%, and r "a" equals 75%. Efforts to include industry-specific costs, as well as other demand variables, such as interest rates and overall construction activity, did not produce any equations more reasonable than the one here.

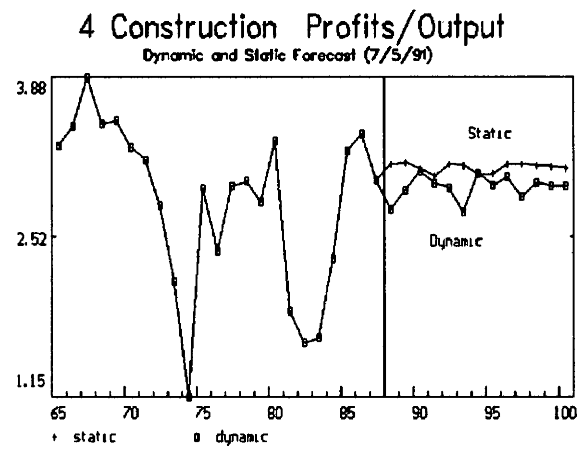
The forecast for the profit margin shows cyclical behavior in response to both demand for residential construction and the labor cost share. As labor costs increase and demand slows, there is a marked dip in the margin in 1993, and a smaller fall in 1997. Although the margin does not fluctuate in the forecast as much as it does historically, it does show a reasonable pattern of cyclical activity.

Figure 4.28: Esimation of Construction Profits

```
title First Diff Profits/Output for: 04 Construction
con 99999 0.0  = a1 + a2
con 99999 0.0  = a3 + a4

:               First Diff Profits/Output for: 04 Construction
  SEE    =      0.62 RSQ   = 0.0488 RHO =  -0.04 Obser  =   23 from 1965.000
  SEE+1  =      0.62 RBSQ  = -0.1013 DW  =   2.09 DoFree =   19 to   1987.000
  MAPE   =    226.29
    Variable name          Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                 - - - - - - - - - - - - - - - - - - -        0.00
  1 pcih                  -0.00655    1.8  -0.828  -4.83  -0.167        3.33
  2 pcih[1]                0.00657    1.8   0.830   4.96   0.167        3.41
  3 pclab                 -0.02231    2.0  -0.885  -3.79  -0.174        0.77
  4 pclab[1]               0.02231    2.0   0.885   2.58   0.164        0.52
```





Furniture (15)

Profits in the Furniture industry are determined by a combination of macroeconomic and industry-specific factors. Changes in Residential construction and changes in the mortgage rate both influence the profit margin for the Furniture industry, as do changes in the material costs for the industry. The effect of Residential construction on the profit margin is spread over three years, with the largest, positive, impact occurring with a one-year lag. Changes in the mortgage rate also affect the profit margin for this industry, where an increase in the mortgage rate implies a fall in profits for the Furniture industry. The profit margin also depends on the cost of materials, mostly the costs of wood and wood products, and an increase in material costs initially depresses the profit margin.

The equation captures most of the cyclical behavior of profits in the Furniture industry, and the correlation between the predicted and actual level of the profit margin is 81% (r "p"). The dynamic and static forecasts differ only slightly, and they both show a stable outlook for the profit margin of the Furniture industry.

Real estate services (33)

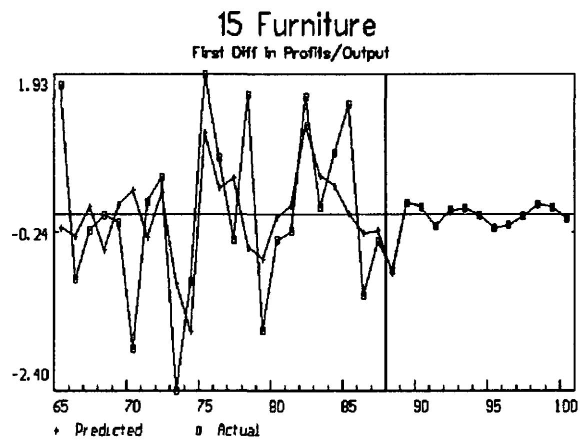
The equation for profits of Real estate services uses only macroeconomic indicators of demand. Profits respond positively to increases in Investment in residential and nonresidential construction. In addition, demand is measured by the unemployment rate. Attempts were made to include some industry-specific variables in this equation, such as industry costs, labor costs, or industry output. The equation here, however, proved to be the most reasonable. The forecast of the profit margin shows an appropriate response to slow economic activity through 1991. Industry profits recover with the rest of the economy in 1992. The profit margin dips slightly in 1995, in response to a mild downturn, and then stabilizes over the rest of the forecast.

Figure 4.29: Estimation of Furniture Profits

```
title First Difference Profits/Output: 15 Furniture
con 999999 0.0 = a1 + a2 + a3
con 999999 0.0 = a4 + a5
con 999999 0.0 = a6 + a7
```

```
:                        FD Prof/Output: 15 Furniture
  SEE    =      0.99 RSQ   = 0.2678 RHO =  -0.21 Obser  =   23 from 1965.000
  SEE+1  =      0.95 RBSQ  = -0.0068 DW  =   2.43 DoFree =   16 to   1987.000
  MAPE   =    369.33
```

Variable name	Reg-Coef	Mexval	t-value	Elas	Beta	Mean
0 fdprat	- - - - - - - - - - - - - - - - - - - -					0.02
1 pcih	0.00048	0.0	0.027	0.06	0.007	3.33
2 pcih[1]	0.01490	1.2	0.629	2.04	0.206	3.41
3 pcih[2]	-0.01538	4.1	-1.155	-2.11	-0.213	3.41
4 pcvuc	-0.17675	9.3	-1.764	-38.08	-0.531	5.36
5 pcvuc[1]	0.17675	9.3	1.764	37.35	0.543	5.26
6 fdrcmor	-0.26524	1.1	-0.606	-1.61	-0.213	0.15
7 fdrcmor[1]	0.26524	1.1	0.606	2.07	0.208	0.19



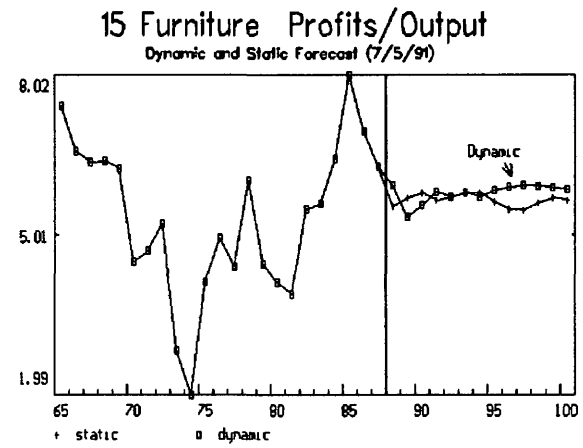
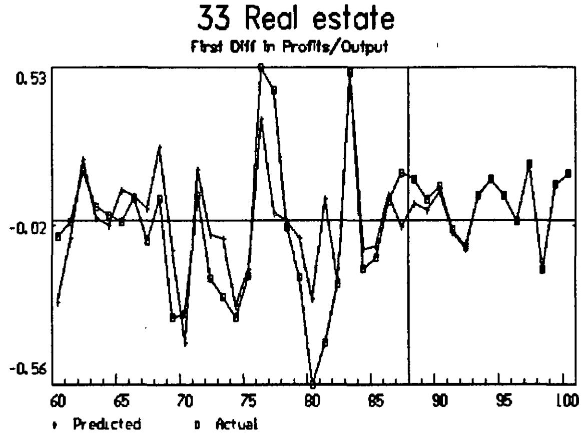
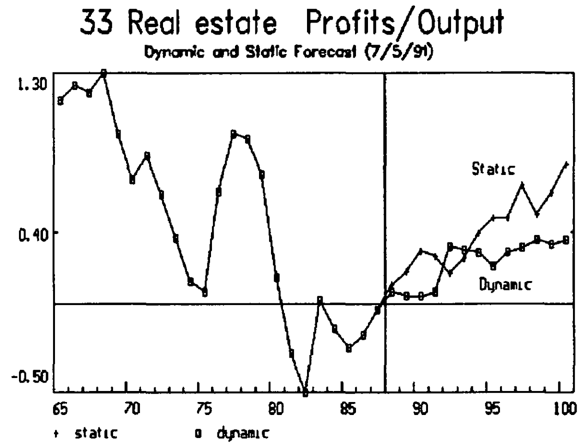


Figure 4.30: Estimation of Real estate Profits

```
title First Difference in Profits/Output: 33 Real Estate
con 99999 0.0 = a1 + a2
con 99999 0.0 = a3 + a4

:                 First Diff in Prof/Output: 33 Real Estate
  SEE   =       0.17 RSQ   = 0.5417 RHO =   0.45 Obser  =   28 from 1960.000
  SEE+1 =       0.16 RBSQ  = 0.4619 DW  =   1.09 DoFree =   23 to   1987.000
  MAPE  =     158.46
    Variable name           Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                  - - - - - - - - - - - - - - - - - - - -     -0.05
  1 pcih                     0.00838    38.4   4.591  -0.59   0.485      3.30
  2 pcih[1]                 -0.00838    38.4  -4.588   0.74  -0.501      4.19
  3 pccst                    0.00086     0.1   0.191  -0.04   0.024      2.20
  4 pccst[1]                -0.00086     0.1  -0.191   0.04  -0.024      2.45
  5 fduninv                  4.11970    16.5   2.862   0.07   0.456     -0.00
```





Lumber and wood products (14)

This industry includes activities such as cutting of timber and pulpwood, as well as the manufacturing of some wood products, excluding furniture, such as containers and plywood. The profit margin for the industry is well explained by only three variables: industry output, labor productivity, and the mortgage rate. A percent changes in output, signalling increased demand, increases the profit rate initially. The margin is negatively related to a second measure of demand, the interest rate on 30-year commercial mortgages. A 1 point increase in the mortgage rate initially decreases lumber's profit margin, but the decrease is offset in the following year. Labor productivity, measured as output per hours worked, is negatively related to the profit margin. As labor productivity increases, implying an increase in wages, the profit margin initially falls.

The equation fits fairly well, capturing most of the turning points in lumber's profit margin, including the 1982 recession and eventual recovery. The forecast shows no growth in the profit margin in the first three years of the forecast, as a result of slow demand in the economy. The margin recovers in 1992 and 1993, and follows a stable path for the rest of the forecast period.

Stone, clay, and glass (16)

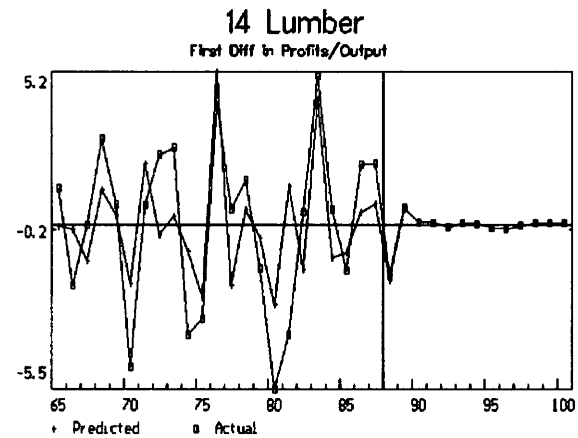
Profits in the Stone, clay, and glass industry are influenced mostly by changes in industry-specific demand and input costs. However, because the industry's activity is tied closely to construction demand in the economy, profits in Stone, clay, and glass also are influenced by the mortgage rate.

A change in demand, measured by the percent change in industry output, increases the profit margin initially. An increase in costs, on the other hand, initially decreases the profit margin. Over the next two years, however, the margin rises so the initial effect is offset.

Figure 4.31: Estimation of Lumber Profits

```
title First Difference Profits/Output for 14 Lumber
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4
con 999999 0.0 = a5 + a6

:                        FD Prof/Output for 14 Lumber
  SEE    =        2.03 RSQ   = 0.4618 RHO =    0.11 Obser  =    23 from 1965.000
  SEE+1  =        2.02 RBSQ  = 0.3035 DW  =    1.78 DoFree =    17 to   1987.000
  MAPE   =     1553.63
    Variable name             Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                   - - - - - - - - - - - - - - - - - - -         0.05
  1 pcout                     0.13015    10.5   1.936   6.41   0.285       2.50
  2 pcout[1]                 -0.13015    10.5  -1.936  -6.41  -0.285       2.50
  3 fdlprod                  -0.82035    31.8  -3.537  -8.35  -0.390       0.52
  4 fdlprod[1]                0.82035    31.8   3.537   8.82   0.387       0.55
  5 fdrcmor                  -0.12043     0.1  -0.213  -0.36  -0.041       0.15
  6 fdrcmor[1]                0.12043     0.1   0.213   0.46   0.040       0.19
```



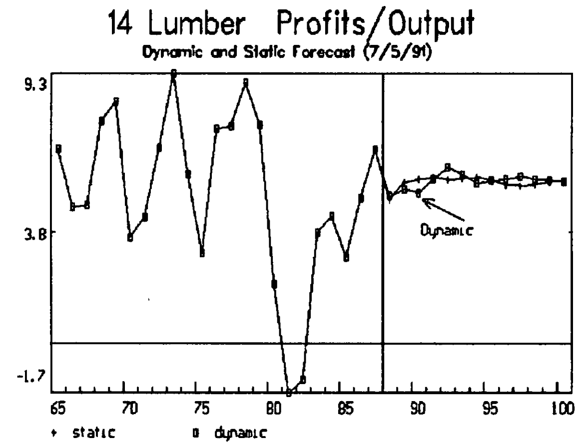
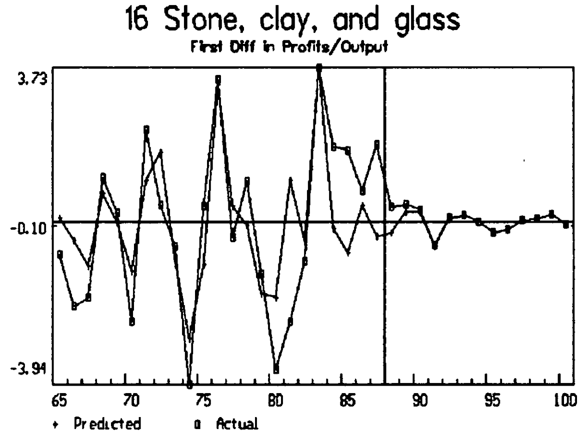
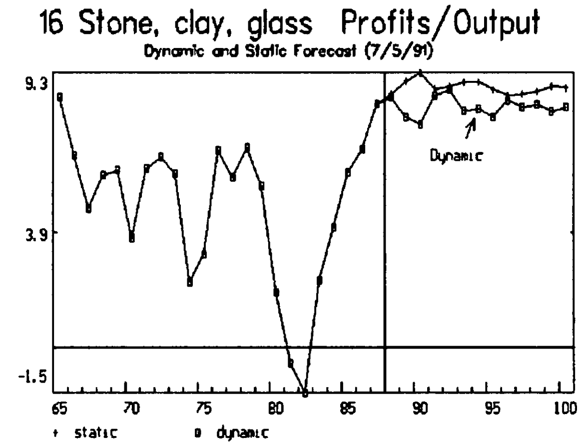


Figure 4.32: Estimation of Stone, clay, & glass Profits

```
title First Difference Profits/output: 16.Stone.clay.glass
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4 + a5
con 999999 0.0 = a6 + a7

:                    FD Prof/output: 16.Stone.clay.glass
  SEE    =       1.39 RSQ   = 0.5329 RHO =    0.29 Obser  =    23 from 1965.000
  SEE+1  =       1.35 RBSQ  = 0.3577 DW  =    1.43 DoFree =    16 to   1987.000
  MAPE   =      97.67
    Variable name           Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                  - - - - - - - - - - - - - - - - - - -       -0.07
  1 pcout                    0.15951    21.8   2.781  -2.97   0.495      1.31
  2 pcout[1]                -0.15951    21.8  -2.781   3.44  -0.500      1.52
  3 pcvuc                   -0.05928     0.8  -0.499   4.84  -0.143      5.76
  4 pcvuc[1]                 0.02640     0.1   0.180  -2.14   0.064      5.73
  5 pcvuc[2]                 0.03287     0.3   0.330  -2.66   0.080      5.72
  6 fdrcmor                 -0.20784     0.8  -0.507   0.44  -0.095      0.15
  7 fdrcmor[1]               0.20784     0.8   0.507  -0.57   0.093      0.19
```





The most important variable in the equation, according to the mexval and the t-statistic, is the change in the mortgage rate. An increase in the mortgage rate decreases the profit margin. The changes in the mortgage rate help explain the strongly cyclical behavior of profits in this industry, and close to 54% of the variability of the change in the profit margin is explained by this equation. In addition, there is a relatively strong correlation between the predicted and actual levels of the profit margin (r "p" = .721, r "a" = .853).

In the dynamic forecast for Stone, clay, and glass, profits respond to the slowdown in construction activity through 1991, but then recover as the mortgage rate again falls. The long-run outlook for the profit margin shows only slow growth in the margin after the period of recovery from the downturn. The profit margin eventually stabilizes and, in the last four years of the forecast, remains relatively flat.

Group 7: Special industry profit equations

Equations for eight industry profits have been classified as special, since they each required specifications that deviated from the general functional form chosen for profits. The first three special industries are those that are influenced strongly by changes in oil prices: Rubber and plastics, Transportation equipment, and Petroleum refining. The remaining industries are ones whose prices are set exogenously in the model. This implies that their profit equations are relatively unimportant in the overall running of the model. These industries include: Agriculture, Crude oil and natural gas, Mining, Non-electrical machinery, and Leather.

Rubber and plastic products (12)

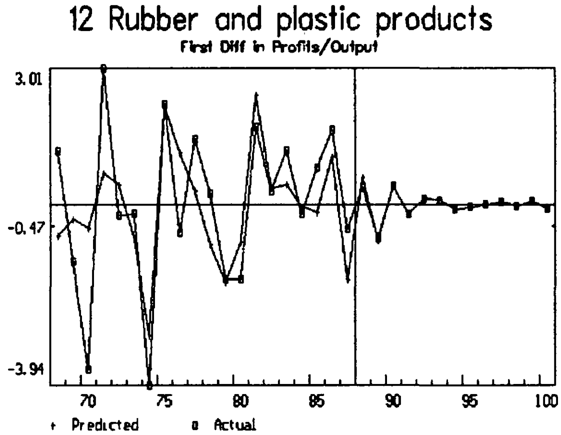
In experimenting with equations to explain this industry's profits, it became clear that profits were strongly influenced by changes in oil prices. Crude oil is an input into the production of plastic resins, and consequently represents an important cost of production. In addition, however, oil prices strongly affect the demand for rubber and plastic materials. Rubber is used chiefly for making tires, for instance, whose demand links strongly to automobile sales. Rather than using all material costs, therefore, the equation uses changes in the price of oil. An increase in oil prices is initially absorbed by the profit margin for the Rubber and plastic industry, rather than being passed on fully into prices. The equation relies not only on oil prices, however, and industry labor costs, as well as demand variables are used. Demand is measured by changes in industry output, where an increase in demand leads to an initial increase in the profit margin. In addition, an increase in labor costs initially implies a fall in the profit margin, but the decrease is offset in the following year.

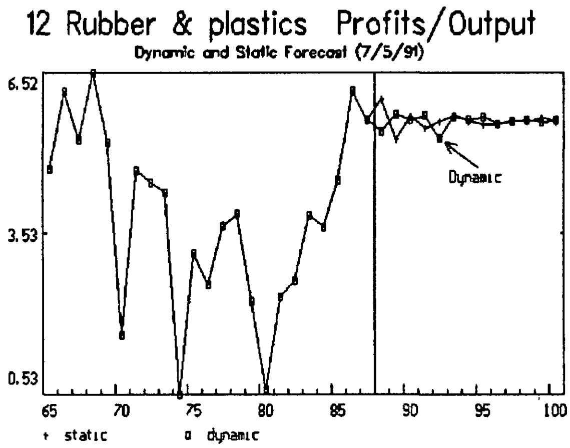
The profit margin for the industry follows two different trends over the historical period. From 1965 to 1980, the margin oscillated in response to the 1970, 1974, and 1980 recessions, but the overall trend was downward. Since 1980, however, the profit margin has increased almost continuously, with only slight pauses in 1984 and 1987. The dynamic forecast differs only modestly from the static forecast, and both show slight response to cyclical activity at the beginning of the forecast period, followed by a relatively stable profit margin to the year 2000.

Figure 4.33: Estimation of Plastic Profits

```
title First Difference Profits/Output for 12 Rubber & plastic
con 999999 0.0 = a1 + a2
con 999999 0.0 = a3 + a4
con 999999 0.0 = a5 + a6

:                    FD Prof/Output for 12 Rubber & plastic
  SEE   =        1.25 RSQ   = 0.4955 RHO =  -0.18 Obser  =   20 from 1968.000
  SEE+1 =        1.21 RBSQ  = 0.3154 DW  =   2.36 DoFree =   14 to   1987.000
  MAPE  =      121.30
    Variable name            Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                   - - - - - - - - - - - - - - - - - - - -      -0.01
  1 pcout                     0.03514     5.2   1.217 -30.01   0.194       5.18
  2 pcout[1]                 -0.03514     5.2  -1.217  33.23  -0.203       5.74
  3 pcwage                   -0.03401     2.7  -0.867  -1.89  -0.129      -0.34
  4 pcwage[1]                 0.03401     2.7   0.867   4.90   0.140      -0.87
  5 pcproil                  -0.03266    28.2  -3.004  64.38  -0.499      11.96
  6 pcproil[1]                0.03265    28.2   3.003 -59.76   0.500      11.11
```





Transportation equipment, excluding motor vehicles (19)

Transportation equipment is a disparate industry that includes Ships and boats, Aerospace, Trains and Tanks. Industry demand as well as costs are heavily influenced by the cost of oil, and profits respond to changes in oil prices. In addition, the change in demand, as measured by industry output, also influences profits. The dependent variable for this equation differs from most others in this study. The equation explains simply the change in the level of adjusted profits, rather than the profit margin. As seen in Figure 4.34, profits for this industry are much more cyclical in the last 10 years than in the prior years. The change in behavior made an equation explaining the profit margin exceedingly difficult to estimate.

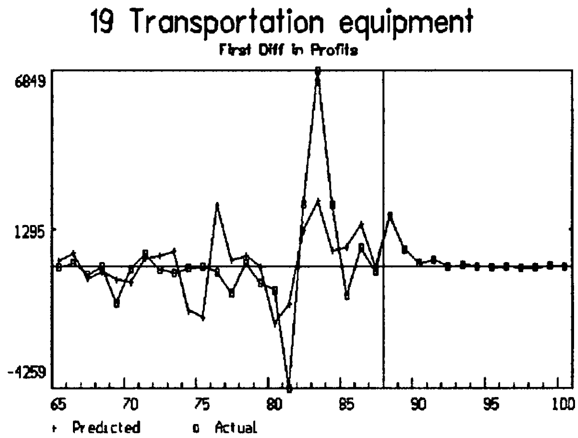
Positive and negative changes in the price of oil do not have symmetric effects on profits in the Transportation equipment industry. An increase in the price of oil initially implies an increase in operating costs for the industry. In addition, a higher price of oil can also imply a slowdown in demand for Transportation equipment. An increase in the price of oil consequently implies a fall in profits for the industry over two years. Eventually, the increase in oil prices is passed on in higher prices, and profits recover partially. A fall in oil prices, however, implying both lower costs and higher demand, results in an increase in industry profits.

The forecast of the profit margin shows a response to the Iraqi oil shock and the 1990-1991 recession that closely resembles the behavior of the profit margin after the 1979 shock and the 1980-1982 recession. In the long-run, the profit margin eventually flattens, as the overall economy stabilizes.

Figure 4.34: Estimation of Transportation equipment Profits

```
title First Difference Profits: Transp.equipment
f fdprat = acpr19 - acpr19[1]
con 9999999 0.0 = a1 + a2

:                        FD Profits: Transp.equipment
  SEE    =      1510.79 RSQ   = 0.3405 RHO =    0.08 Obser  =    23 from 1965.000
  SEE+1  =      1506.42 RBSQ  = 0.0932 DW  =    1.85 DoFree =    16 to   1987.000
  MAPE   =     13379.02
    Variable name          Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                 - - - - - - - - - - - - - - - - - - - -    105.03
  1 pcout                  44.35699     1.6   0.728   0.91   0.175      2.16
  2 pcout[1]              -44.35705     1.6  -0.728  -0.89  -0.175      2.12
  3 incpoil                -7.59202     0.5  -0.395  -0.98  -0.088     13.56
  4 incpoil[1]            -28.06789     4.7  -1.240  -3.41  -0.329     12.77
  5 incpoil[2]             33.30023     8.5   1.679   4.05   0.390     12.77
  6 decpoil               -31.35653     1.9  -0.782   0.93  -0.156     -3.11
  7 decpoil[2]            -45.49943     0.4  -0.366   0.53  -0.070     -1.22
```



Petroleum refining (11)

Petroleum refining makes a perfect transition between the industries who are related to oil prices and the following group who are affected strongly by exogenous prices in the model. Clearly, the primary input for the petroleum refining industry is Crude oil. Profits in the industry follow petroleum prices, therefore. In the model, profits consequently are determined largely by an exogenous variable, the price of crude petroleum. The equation is a simple one, therefore, that relates profits to changes in output and to changes in the prices of oil. As expected, the forecast of the profit margin shows a dip in response to the 1990 oil shock, followed by moderate growth that reflects the assumption for the price of crude oil.

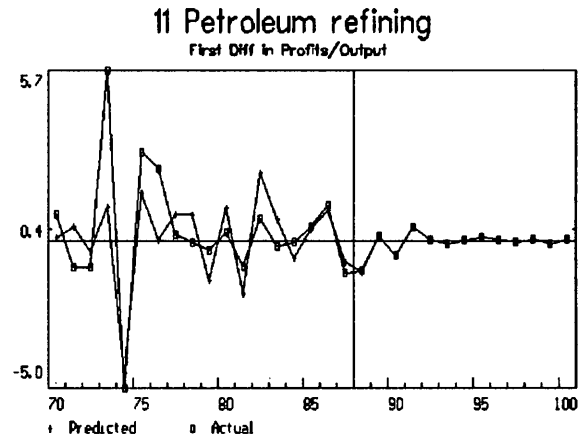
Agriculture, Forestry, Fisheries (1)

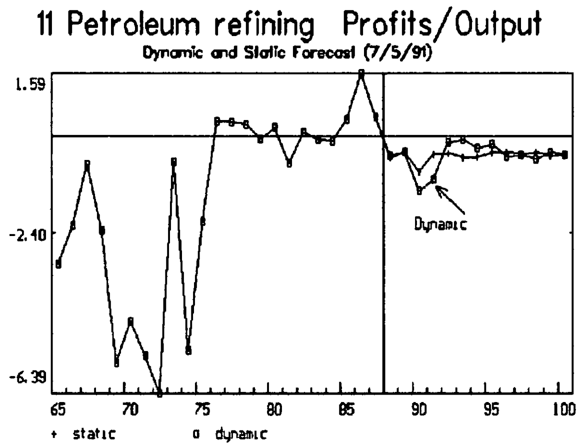
There are several reasons why profits in the Agriculture industry require special treatment. First, the Agriculture industry processes chiefly raw materials, such as food crops, lumber and fibers (such as cotton), and most of the industry's trade is intra-industry, sales from one agricultural unit to another. This large proportion of intra-industry trade implies that the cost of material inputs is mostly determined by the industry price, implying that current material costs and the industry price are highly correlated. On one hand, including the current cost of material inputs in the agriculture profit equation insures a well-fitting equation. On the other hand, the equation then has poor forecasting properties, since the equation is essentially self-determining. In addition, and most importantly for running the LIFT model, the price of agriculture is set exogenously, so profits are determined to a certain extent, by the price. As noted in Chapter 2, LIFT allows prices to be set exogenously. When a price is given as an exogenous assumption, the accounting identity implied by the dual input-

Figure 4.35: Estimation of Petroleum refining Profits

```
title First Difference Profits/Output for  11 Petroleum refining
con 9999999 0.0 = a1 + a2
con 9999999 0.0 = a3 + a4 + a5

:                  FD Prof/Output for  11 Petroleum refining
  SEE    =        1.48 RSQ    = 0.4907 RHO =   -0.16 Obser   =   18 from 1970.000
  SEE+1  =        1.46 RBSQ   = 0.3340 DW  =    2.31 DoFree  =   13 to   1987.000
  MAPE   =      275.44
    Variable name              Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                     - - - - - - - - - - - - - - - - -            0.31
  1 pcout                      -0.16880    24.8  -2.692  -0.80  -0.417      1.47
  2 pcout[1]                    0.16880    24.8   2.692   0.90   0.420      1.66
  3 pcproil                    -0.02631    14.6  -2.018  -1.09  -0.356     12.95
  4 pcproil[1]                  0.00084     0.0   0.044   0.03   0.011     12.22
  5 pcproil[2]                  0.02548     9.9   1.646   1.21   0.304     14.74
```





output equation must be enforced. In other words, given a level of labor income and a sectoral price, the remaining value added for the industry is then a residual. In LIFT, the accounting identity is imposed by spreading the difference between value added implied by the price level and value added implied by the model's equations to three components of value added: corporate profits, proprietor income, and indirect business taxes. An equation for Agricultural profits will determine the initial share of profits in value added, but the level of profits will be determined by the exogenous price assumption.

For these reasons, agricultural profits are determined by a simple equation based on a moving average of the dependent variable, changes in output, and a dummy variable for the 1973 grain deal. The dependent variable is profits, deflated by the agriculture output deflator, as a share of output. Profits depend positively on the previous year's average profits and positively on the three-year moving average of percent changes in output. This equation gives a reasonable first guess of the profit level for Agriculture, which is then scaled as needed to impose the exogenous price for Agriculture.

Crude oil and natural gas extraction (2) and Mining (3)

As with Agriculture, Oil and gas extraction and Mining require special treatment. Since both industries process raw materials that are subject to factors not easily modeled, such as weather and politics, and since profits are determined largely by an exogenous price assumption, the equations are relatively simple ones. The profit to output share depends on a three-year moving average of the profit rate, changes in output, and a dummy variable for OPEC supply shocks.

Figure 4.36: Estimation of Agriculture Profits

```
title Profit Rate (profits/output)  1 Agriculture
   ratav   =  3-year moving average of profit rate
   outav   =  3-year moving average of changes in real output
   grdeal  =  dummy variable equal 1 in 1973

:                Profit Rate (profits/output)  1 Agriculture
  SEE    =       0.20 RSQ   = 0.5220 RHO =   0.28 Obser  =   23 from 1965.000
  SEE+1  =       0.19 RBSQ  = 0.4465 DW  =   1.44 DoFree =   19 to   1987.000
  MAPE   =      70.28
    Variable name           Reg-Coef  Mexval t-value  Elas    Beta      Mean
  0 prat                    - - - - - - - - - - - - - - - - - - - -     0.50
  1 intercept                0.21110    7.1   1.672  0.42   0.000      1.00
  2 ratav                    0.30586    5.2   1.430  0.30   0.228      0.49
  3 outav                    0.04427    6.2   1.557  0.19   0.249      2.17
  4 grdeal                   0.90060   34.8   3.943  0.08   0.628      0.04
```

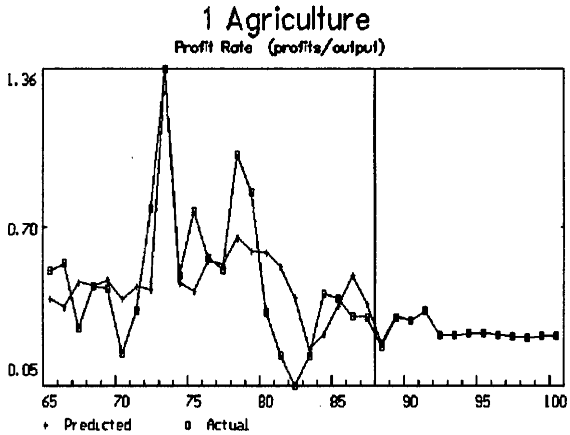


Figure 4.37: Estimation of Crude oil Profits

title Profits/output: 2 Crude oil & Natural gas extraction

```
   ratav     = 3-year moving average of profit rate
   outav     = 3-year moving average of changes in real output
   opec      = dummy variable = 1 in 1974 and 1979

:            Profits/output: 2 Crude oil & Natural gas extraction
  SEE    =       6.72 RSQ    = 0.6466 RHO =    0.15 Obser  =    23 from 1965.000
  SEE+1  =       6.65 RBSQ   = 0.5909 DW  =    1.70 DoFree =    19 to   1987.000
  MAPE   =      44.62
```

Variable name	Reg-Coef	Mexval	t-value	Elas	Beta	Mean
0 prat	- - - - - - -	- - -	- - - -	- - -	- - - -	23.88
1 intercept	-1.55305	0.2	-0.279	-0.07	-0.000	1.00
2 ratav	0.88663	41.7	4.374	0.96	0.599	25.96
3 outav	0.66097	3.2	1.120	0.02	0.154	0.74
4 opec	22.18376	36.2	4.030	0.08	0.553	0.09

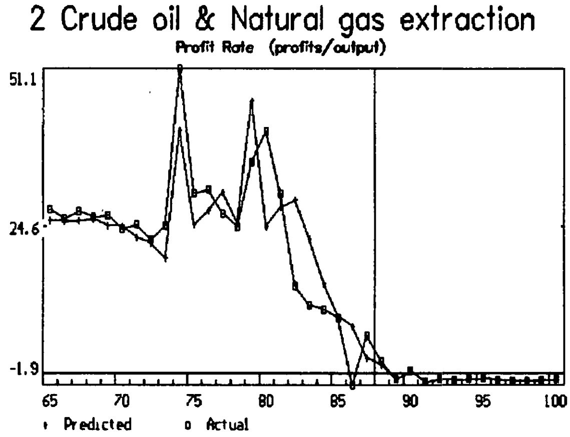
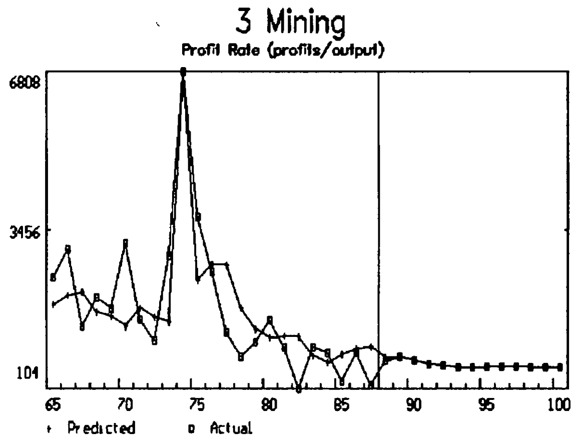


Figure 4.38: Estimation of Mining Profits

```
title Profit Rate (profits/output) for: 03 Mining
    ratav = 3-year moving average of profit rate
    outav = 3-year moving average of changes in output
    opec  = dummy variable equals 1.0 in 1974

:                 Profit Rate (profits/output) for: 03 Mining
  SEE    =      797.41 RSQ    = 0.6954 RHO =    0.08 Obser  =    23 from 1965.000
  SEE+1  =      797.01 RBSQ   = 0.6473 DW  =    1.84 DoFree =    19 to   1987.000
  MAPE   =      109.13
    Variable name            Reg-Coef  Mexval t-value  Elas    Beta      Mean
  0 prat                    - - - - - - - - - - - - - - - - - - - -   1806.49
  1 intercept              498.47080     4.0   1.238   0.28   0.000      1.00
  2 ratav                    0.49549    20.1   2.900   0.55   0.372   1998.58
  3 outav                   40.94988     0.7   0.527   0.05   0.068      2.07
  4 opec                  5354.31111    68.8   5.929   0.13   0.756      0.04
```



Non-electrical machinery (20)

The Non-electrical machinery industry manufactures specialty machinery, such as agricultural machinery, construction, mining and oilfield equipment, and metalworking machinery. This industry also includes manufacturers of computers, which is the reason for its designation as a special industry. The Department of Commerce, in an attempt to account for the changing technology of the computer industry, developed a hedonic price index for computers. This index is supposed to capture the changing price per unit of "quality", say price per unit of computing power. The price of computers measured by this hedonic index fell through most of the 1980's. Use of a special method for one industry's price calculation, and especially a method that shows a price declining, introduces several technical problems into modeling both real and income activity for the industry.[43] To avoid those problems in the model, the price of computers is assumed to be flat. As noted earlier, when a price is introduced exogenously, the implication is that value added is also exogenous to a large extent. For purposes of completeness, however, the estimated equation for profits of Non-electrical machinery will be described.

Profits are explained by two variables: demand and material costs, both of which are lagged for two years. An increase in demand implies an initial increase in the profit margin. Over the next two years, that increase is offset. An increase in material costs initially has a small negative effect on the profit margin, but in the following year, the profit margin falls as cost changes are absorbed by the industry. After the third year of the change, however, the profit margin recover.

Explaining profits with only demand and cost changes results in an equation that captures turning points in the series well, including the recessionary drops in 1974 and 1982, as well as the 1985 decrease.

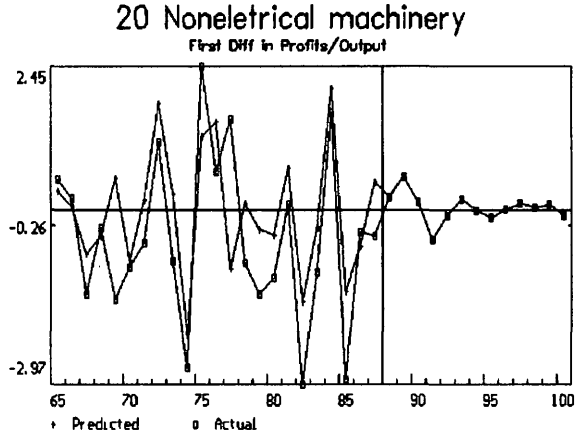
---

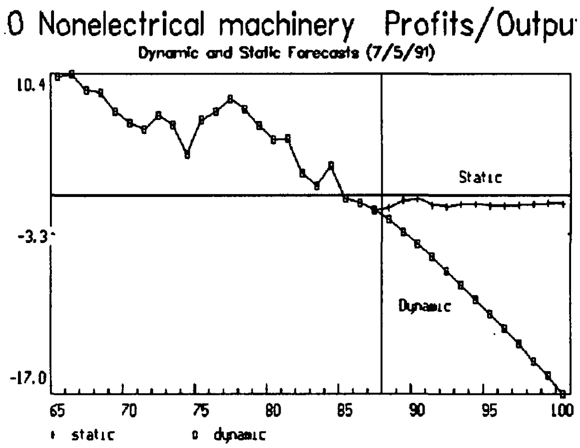
[43] See McCarthy (1991) and Meade (1990).

Figure 4.39: Estimation of Nonelectrical machinery Profits

```
title First Difference Profits/output: 20 Non-elect.machinery
con 99999 0.0 = a1 + a2 + a3
con 99999 0.0 = a4 + a5 + a6

:                    FD Prof/output: 20 Non-elect.machinery
 SEE   =       1.04 RSQ   = 0.4340 RHO =   0.02 Obser  =   23 from 1965.000
 SEE+1 =       1.04 RBSQ  = 0.2675 DW  =   1.96 DoFree =   17 to   1987.000
 MAPE  =     105.58
   Variable name            Reg-Coef  Mexval t-value  Elas    Beta      Mean
 0 fdprat                   - - - - - - - - - - - - - - - - - - - -     -0.49
 1 pcout                     0.09817   32.1   3.557  -0.63   0.612      3.18
 2 pcout[1]                 -0.08449   18.7  -2.633   0.58  -0.534      3.41
 3 pcout[2]                 -0.01369    0.8  -0.529   0.11  -0.086      3.88
 4 pcvuc                    -0.08572    3.4  -1.085   0.92  -0.256      5.32
 5 pcvuc[1]                  0.30748   17.1   2.509  -3.31   0.917      5.32
 6 pcvuc[2]                 -0.22178   16.2  -2.443   2.38  -0.665      5.30
```





The implication of a flat computer deflator can be seen in the illustration of the dynamic forecast for this industry's profit margin in Figure 4.39. The profit margin for Nonelectrical machinery falls throughout the forecast period, and it is negative. Although this negative profit margin does not look reasonable, it results from the effort to compensate for the hedonic price index for computers. It also is relatively inocuous in the model, in the sense that it has little effect on other variables. One of the main roles of profits is to determine prices, but the price in this case is given. Of course, profits also affect aggregate profit income, but this industry is relatively small, only .8% of the total in 1987, so its effect on aggregate income is small.

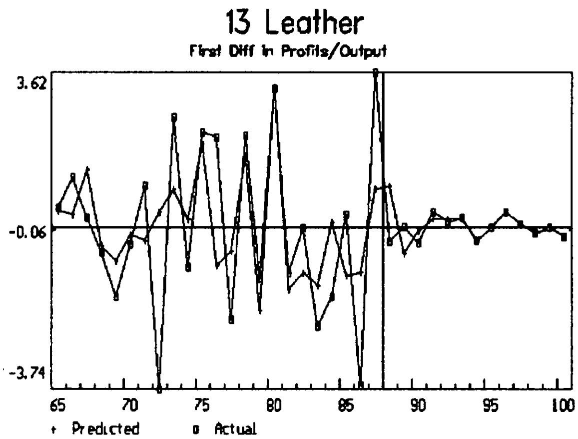
Leather and leather products (13)

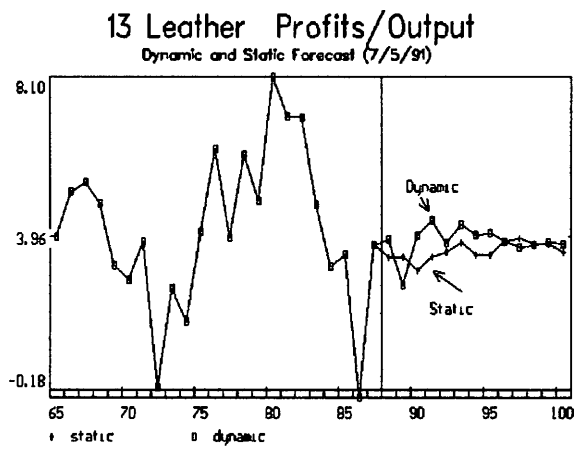
The final industry to be considered in the special category is another one whose behavior in the model is largely determined by exogenous assumptions. Although the domestic price of Leather is not set exogenously, most of the activity for this industry is. The outlook for the profit margin is affected greatly, therefore, by exogenous assumptions. Nevertheless, the estimated equation includes the response of profits to demand, imports, and input costs. The shoe industry has been highly sensitive to foreign trade, so the change in imports was used in the equation. Increases in output for the industry, indicating domestic demand, initially increase the profit margin, although that increase is offset in the following year. Finally, increases in production costs are passed on to consumers in higher prices at first, and overridden after two years. The dynamic and static forecasts for the profit margin differ modestly, with the dynamic forecast more volatile in the first few years than the static forecast. The margin stabilizes and remains relatively flat over the last nine years of the forecast.

Figure 4.40: Estimation of Leather Profits

```
title First Difference Profits/Output for 13 Leather
con 99999 0.0 = a1 + a2
con 99999 0.0 = a3 + a4
con 99999 0.0 = a5 + a6

:                         FD Prof/Output for 13 Leather
  SEE    =        1.60 RSQ   = 0.3665 RHO =  -0.48 Obser  =   23 from 1965.000
  SEE+1  =        1.32 RBSQ  = 0.1802 DW  =   2.96 DoFree =   17 to   1987.000
  MAPE   =      372.32
    Variable name            Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 fdprat                   - - - - - - - - - - - - - - - - - - -       -0.01
  1 pcout                     0.06791     4.1   1.196  16.16   0.170     -2.56
  2 pcout[1]                 -0.06791     4.1  -1.196 -14.24  -0.178     -2.26
  3 pcimp                     0.06228    13.7   2.233 -71.65   0.392     12.39
  4 pcimp[1]                 -0.06229    13.7  -2.233  73.16  -0.390     12.65
  5 pcvuc[1]                  0.40774    17.9   2.578-200.67   0.772      5.30
  6 pcvuc[2]                 -0.40773    17.9  -2.578 195.90  -0.799      5.18
```





Conclusions

This chapter has shown the development of thirty-seven equations to determine profits by industry in an Interindustry Macroeconomic model. The equations developed here are just part of the income side of an IM model. The next chapter describes equations to determine the remaining components of industry income.

Chapter 5: Non-profit Income Equations

The industry profit equations described in the preceding chapters comprise only part of total industry income in an IM model. This chapter describes equations for estimating the remaining components of capital income: Proprietor income, Net interest payments, Depreciation allowances, Inventory valuation adjustments, and Business transfer payments. The chapter also includes a brief discussion of the government portions of value added: Indirect business taxes and Government subsidies.

Proprietor Income

Proprietor income is the profits of non-corporate enterprises. In other words, it is the excess revenue that remains for a proprietorship after labor and material costs have been paid. Because proprietor income and profits are defined similarly, the functional form of the equation chosen for proprietor income closely resembles the equations for corporate profits. Changes in the profit rate, or proprietor income rate, are explained as a mark-up over labor and material costs and as a response to changes in demand.

The estimation of proprietor income equations differs from the procedure for profit equations in terms of the scope of the equations. In Chapter 2, two methods of estimating industry equations were described. In the first method, industry equations are estimated separately. A single functional form is applied to each industry, and equations differ in their parameters. In the second method, a single equation is estimated for the aggregate variable, which is then distributed to industries based on industry share equations or relative industry-to-aggregate equations. The equations for proprietor income were developed with a hybrid version of those two methods. Proprietor income for four large industries is estimated with individual equations, while the remainder is estimated as "all other proprietor income" and distributed appropriately.

Close to eighty percent of total Proprietor income is accounted for by four industries: Wholesale and Retail Trade, Construction, Business Services, and Agriculture. These industries are different enough to warrant individual equations to determine the proprietor income in each. However, the remaining twenty percent of proprietor income is spread to over thirty industries. Rather than estimating separate equations for each sector's proprietor income, a single equation for their sum is estimated. That subtotal is then distributed to the industries based on their share of that subtotal.

Because the equations for proprietor income closely resemble those for corporate profits developed in the previous two chapters, the form of the equation will be reviewed only briefly here. Changes in the "profit rate", or "proprietor income rate", are modeled as a function of changes in costs, both material and labor, and changes in demand. The equation results are summarized in Figures 5.1 and 5.2.

Business services (35)

The largest industry in terms of proprietor income is Business services, which includes such diverse activities as building management, advertising, and computer consulting. The dependent variable is defined as the change in the "proprietor income rate," where the rate is the proprietor income share of total output as defined earlier for the profit equations. The change in the rate for Business services depends on changes in material and labor costs and changes in demand, as measured by industry output. As with the profit equations, reasonable long-run properties of the equation are ensured by constraining the coefficients on a variable to sum to zero over time. Initially, an increase in material costs implies a fall in the proprietor income margin. An increase in labor costs, on the other hand, causes an initial increase in the margin.

Agriculture, forestry, fishery services (1)

The second-largest industry, in terms of proprietor income, is Agriculture. The equation uses a combination of demand and cost variables to determine first differences in the Proprietor income share of output. Costs are measured by lagged changes in input costs. Only lagged changes are used because of the high degree of intra-industry trade for the industry. The intra-industry trade implies that the cost of material inputs is highly collinear with the price of agriculture. A lagged increase in costs initially implies a fall in the proprietor income rate. That decrease is eventually offset, however. Changes in demand, on the other hand, initially are positively linked to changes in the proprietor income share. Lastly, a dummy variable is used in the equation to account for the grain deal of 1973.

As noted in Chapter 4, the price for Agriculture is set exogenously. This implies that total value added for the industry is controlled by an exogenous assumption, since the input-output price equation must hold. If the product price is determined, then value added is a residual and is determined by spreading the value-added implied by the price fix to the components of income. Even though the results of this equation are being overridden, it is included for two reasons. The first is that the equation provides an initial estimate of proprietor income for Agriculture. Since the spreading of value added implied by the price fix is based on the share of proprietor income, profits, and indirect business taxes in total value added, it is important to have a reasonable value for the initial estimate of proprietor income. In addition, proprietor income not only is used in price determination, it also is a significant part of total personal income. Since proprietor income will affect personal income, it is important that it maintain reasonable values.

Figure 5.1: Equation Estimates for Proprietor Income

title First Diff in Proprietor Income/Output: 35 Misc Business Services

SEE =	0.69	RSQ =	0.3423	RHO =	0.06	Obser =	23 from 1965.000
SEE+1 =	0.69	RBSQ =	0.1489	DW =	1.88	DoFree =	17 to 1987.000
MAPE =	92.29						

Variable name	Reg-Coef	Mexval	t-value	Elas	Beta	Mean
0 fdprat	- -					-0.03
1 pcvuc	-0.01847	0.1	-0.181	4.17	-0.066	5.77
2 pcvuc[1]	0.01846	0.1	0.181	-4.12	0.067	5.71
3 pcout	-0.04210	2.0	-0.832	8.45	-0.154	5.13
4 pcout[1]	0.04210	2.0	0.832	-8.45	0.154	5.13
5 pcwage	0.07182	12.3	2.103	-5.00	0.342	1.78
6 pcwage[1]	-0.07183	12.3	-2.103	3.72	-0.270	1.33

title First Diff in Proprietor Income/Output: 1 Agriculture

SEE =	4.23	RSQ =	0.4239	RHO =	0.13	Obser =	23 from 1965.000
SEE+1 =	4.21	RBSQ =	0.2545	DW =	1.73	DoFree =	17 to 1987.000
MAPE =	199.54						

Variable name	Reg-Coef	Mexval	t-value	Elas	Beta	Mean
0 fdprat	- -					0.15
1 pcout	0.14652	2.0	0.834	2.04	0.103	2.07
2 pcout[1]	-0.14652	2.0	-0.834	-2.05	-0.103	2.08
3 pcvuc[1]	-0.37459	10.6	-1.948	-11.76	-0.399	4.65
4 pcvuc[2]	0.15358	1.0	0.571	4.92	0.161	4.74
5 pcvuc[3]	0.22099	3.8	1.155	7.42	0.221	4.97
6 grdeal	14.92085	22.9	2.946	4.38	0.546	0.04

title First Diff Proprietor Income/Output: 4 Construction

SEE =	0.96	RSQ =	0.2733	RHO =	-0.02	Obser =	23 from 1965.000
SEE+1 =	0.96	RBSQ =	0.0595	DW =	2.04	DoFree =	17 to 1987.000
MAPE =	446.86						

Variable name	Reg-Coef	Mexval	t-value	Elas	Beta	Mean
0 fdprat	- -					0.21
1 pcih	0.02235	6.7	1.532	0.35	0.319	3.33
2 pcih[1]	-0.02232	6.7	-1.530	-0.36	-0.318	3.41
3 pcvuc	0.03764	0.7	0.486	1.02	0.168	5.80
4 pcvuc[1]	-0.03763	0.7	-0.486	-1.01	-0.170	5.72
5 pcwage	0.10694	17.5	2.547	0.38	0.467	0.77
6 pcwage[1]	-0.10694	17.5	-2.547	-0.26	-0.439	0.52

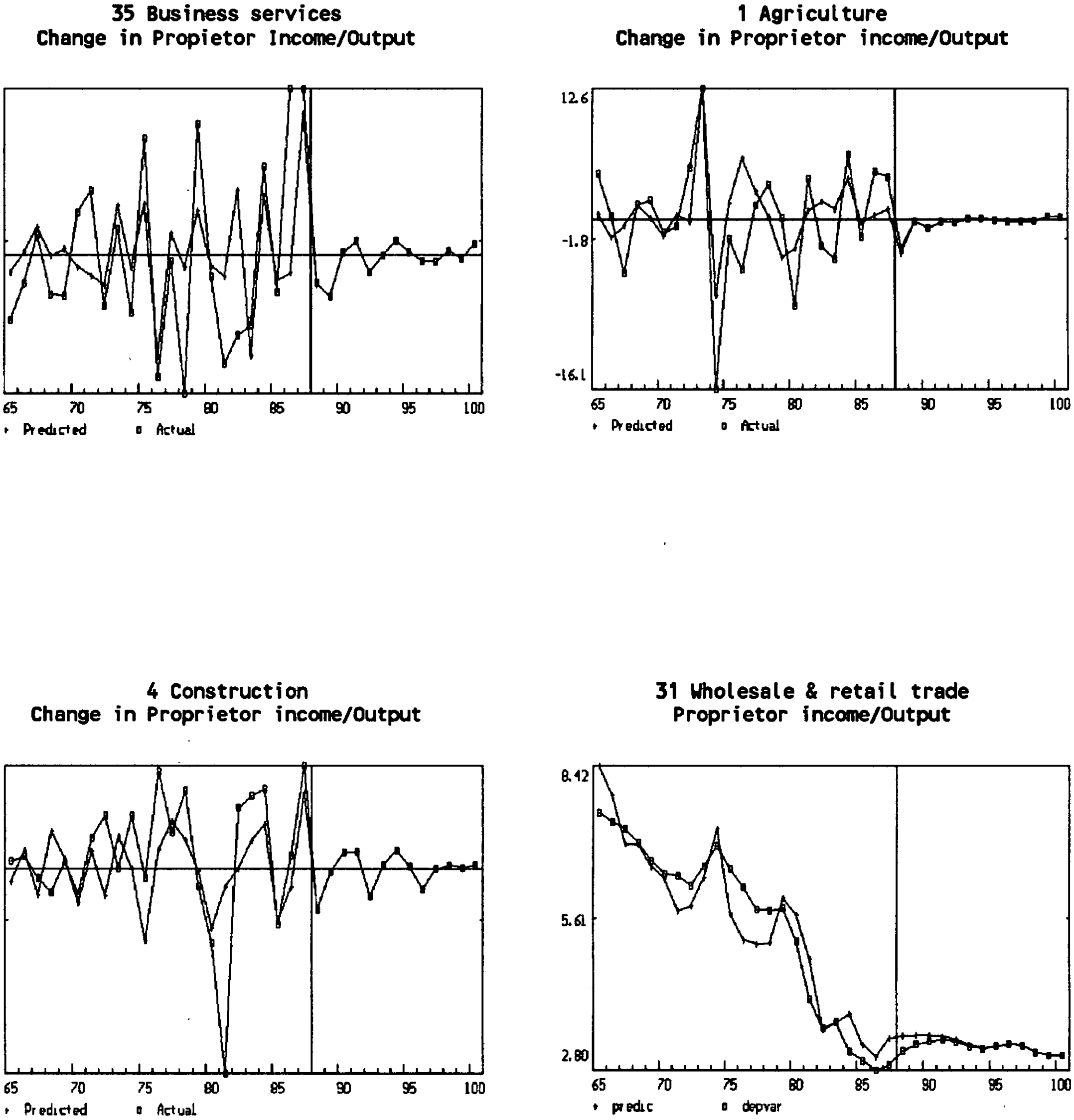
title Proprietor income/Output: 31 Wholesale & retail trade

```
f time     = @cum(time, 1.0, 0.0)
f onetime  = 1/time
```

SEE =	0.50	RSQ =	0.8965	RHO =	0.58	Obser =	23 from 1965.000
SEE+1 =	0.44	RBSQ =	0.8802	DW =	0.84	DoFree =	19 to 1987.000
MAPE =	8.20						

Variable name	Reg-Coef	Mexval	t-value	Elas	Beta	Mean
0 prat	- -					5.51
1 intercept	0.14104	0.2	0.291	0.03	0.000	1.00
2 pcvuc	0.19383	59.7	5.429	0.18	0.484	5.11
3 pcout	0.04719	2.7	1.026	0.03	0.091	3.63
4 onetime	83.42067	196.9	12.184	0.76	0.917	0.05

Figure 5.2: Equation Graphs for Proprietor Income



Construction (4)

The third-largest industry, in terms of proprietor income, is Construction. In addition, proprietor income is a large share of the total capital income for the industry, 63% in 1987. In fostering industry-specific behavior in an IM model, it is reasonable to develop an equation for proprietor income in the Construction industry. Proprietor income for Construction depends on a combination of industry-specific and macroeconomic factors. Costs are measured by industry-specific input and labor costs, while demand is measured by changes in investment in residential structures. (Investment in nonresidential structures was tried in the equation also, but with little success.) Increase in either labor costs or input costs have an initial positive effect on proprietor income. In other words, an increase in costs is not absorbed by a fall in proprietor income, but rather, is passed on to consumers. In addition, increases in demand, as measured by Residential investment, have an initial stimulative effect on proprietor earnings.

Wholesale and retail trade (31)

The last industry whose proprietor income is estimated separately is Wholesale and retail trade, and its equation was estimated with a slightly different procedure than has been used so far. As seen in Figure 5.2, the proprietor income to output share has a distinct downward trend over its entire history. Unlike many profit series, or proprietor income series, this one is not volatile around that trend. Efforts to estimate the equation as the first difference of the proprietor income rate resulted in equations dominated by the effects of the negative trend. Equations that fit well usually contained a large negative intercept. Even with a negative intercept, the coefficients on behavioral variables also were negative. Although such equations fit well, their forecasting properties were unreasonable.

Rather than estimate the first difference of the proprietor income rate, therefore, the rate itself was estimated as a simple function of changes in costs, demand, and a non-linear trend.[44] The non-linear trend captures the overall downward slope of the series and its leveling off in the last few years. Movements around that trend are captured by changes in costs and demand. An increase in costs leads to a temporary increase in proprietor income, as does an increase in demand, as measured by changes in real output.

Remaining Proprietor income

The twenty percent of proprietor income not accounted for by the four previously-discussed industries is distributed among thirty industries. Since the marginal benefit of estimating thirty equations to determine each industry's proprietor income is small, the remaining proprietor income is treated as a single item. Although initial attempts were made to estimate an equation for this "Other proprietor income," few viable equations resulted. Rather than impose tenuously-established behavior on the series, a simple modeling approach was used. In the model, the "All other" portion of Proprietor income is assumed to grow at the same rate as overall labor compensation. The idea is that an individual may choose between self-employment or "regular" employment in an established enterprise. Since self-employment involves the risks associated with entrepreneurship, the returns for self-employment are assumed to be growing at least at the same rate as the returns from regular employment. After the total for these thirty industries is determined, the result is distributed among the industries based on their relative shares of proprietor income and real growth in

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[44] The nonlinear trend used in this estimation was the inverse of a time-trend. Using the inverse of a time-trend implies that the nonlinear curve depends on the starting point used to calculate the trend.

the industry. Specifically, each industry's income share is indexed by the change in the industry's real output share from a base year, as follows:

$$npr_{i,t} = \left(\frac{npr_{i,to}}{NPR_{to}} * \frac{out_{i,t}/OUT_t}{out_{to}/OUT_{to}} \right) * NPR_t \qquad 5.1$$

where

to	=	last year of historical data,
$npr_{i,t}$	=	proprietor income for industry i, time t,
NPR	=	aggregate for Proprietor income,
$out_{i,t}$	=	constant dollar output, industry i, time t.

(This method of distributing an aggregate result to industries is used for distributing several components of capital income where an aggregate equation is used to determine the total.) This distribution method allows those industries who are experiencing relatively strong growth, as measured by changes in their share of total real output, to capture an increasing share of the component of return to capital being distributed.

Non-profit capital income

This section describes the equations for the remaining components of value added: Net interest payments, Depreciation allowances, Inventory valuation adjustments, Business transfer payments, and Indirect business taxes. Most of these income components are modeled by using an aggregate equation to determine the total, which is distributed to industries based on their share of the total, and their relative growth.

Net Interest Payments

Net interest payments are the interest payments received by business, less interest paid by business.[45] As shown in Figure 5.3, Net interest as a share of GNP rose rapidly from 1972-1982, during a period of high interest rates and debt accumulation. Although the share stabilized from 1982 to 1987, it rose again through 1989, reaching a peak of 8.9% of GNP. The net interest share of GNP is modeled as a function of a cumulative business deficit, as well as interest rates. The business deficit is calculated as the sum over time of the excess of business investment purchases over the funds available to pay for that investment. The interest rate used is a four-year moving average of the AAA-bond rate. The estimation results are summarized in Figure 5.3. The dependent variable of the equation is domestic Net interest payments (Total Net interest less net payments of Rest of world) as a share of GNP. An increase in business debt as a share of GNP will increase the Net interest share, as will an increase in interest rates. The equation fits well, with R^2 equal to .9623. The rho of .3 and Durbin Watson of 1.5 indicate only a slight degree of serial correlation.

An equation for aggregate Net interest is preferred over industry equations, largely due to the importance of the variable for business debt. While it is a fairly straightforward task to calculate aggregate business debt, it is a more complicated task to construct measures of industry debt. Since business debt is an important explanatory variable for Net interest payments, the aggregate equation approach is chosen.[46]

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[45] The specification of the Net interest equation follows the work of Almon in the Quest model. (Almon, 1989, pp. 230-231.)

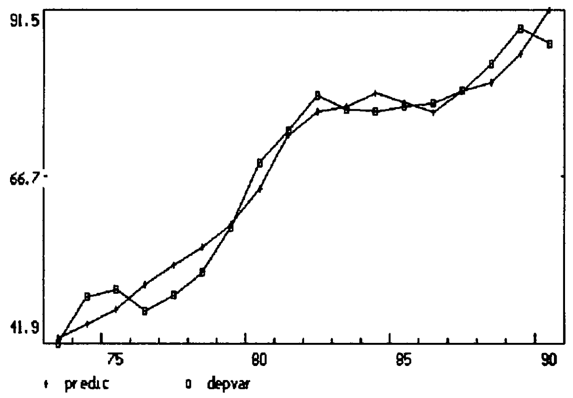
[46] Creating industry business debt is complicated by the lack of data for some business funds at the industry level. For instance, funds available equals profit income + depreciation allowances less taxes paid and dividends paid, however, neither taxes paid or dividends are available by industry. Hyle (1986) calculated a simpler measure of industry debt, but his work also used an aggregate equation to determine total Net interest payments, with industry share equations to determine detailed results.

Figure 5.3: Net interest payments

```
title Domestic net interest payments as share of GNP
f bpurch$ = ipe + struc
f bfunds  = vccc + ccadj/1000. + vcpr - tc - ydv
f bfunds$ = bfunds/pgnp
f borrow  = bpurch$ - bfunds$
f debt    = @cum(debt, .25*borrow, 0.0)
f ninsh   = nin48/gnpz
f debtsh  = debt/gnp
f smrat   = (raaa + raaa[1] + raaa[2] + raaa[3])/4

  SEE    =       2.93 RSQ   = 0.9623 RHO =   0.27 Obser  =   18 from 1973.000
  SEE+1  =       2.88 RBSQ  = 0.9542 DW  =   1.47 DoFree =   14 to   1990.000
  MAPE   =       3.97
    Variable name          Reg-Coef  Mexval t-value  Elas    Beta       Mean
  0 ninsh                  - - - - - - - - - - - - - - - - - -         67.48
  1 intercept             73.84952   203.5  10.720   1.09   0.000       1.00
  2 debtsh               354.62423   244.6  12.339  -0.34   0.891      -0.07
  3 smrat                  4.73381    42.7   3.809   0.70   0.570       9.99
  4 smrat[1]              -3.09559    18.1  -2.352  -0.45  -0.392       9.86
```

Domestic Net Interest Payments
as Share of Gross National Product



Capital Consumption Allowances

Depreciation costs, or Capital Consumption Allowances, for both Corporate and Non-corporate enterprises represent accounting depreciation as calculated for tax purposes.[47] The model currently uses equations to determine aggregate Capital Consumption Allowances, which then are distributed to industries based on shares and relative output growth.[48] Clearly, depreciation allowances should be related to the current value of depreciation of plant and equipment. In determining investment purchases on the real side of the model, replacement investment, or depreciation, is calculated for both investment in Durable Equipment and investment in Structures. The equations for depreciation allowances are:

$$corpcca = -30 + .992 * replace \qquad (5.2)$$
$$othcca = -9.7 + .445 * replace \qquad (5.3)$$

where

corpcca = Corporate Capital Consumption Allowances, billion $
othcca = Noncorporate Capital Consumption Allow, billion $
replace = Replacement investment of Producer Durable equipment plus Replacement investment of Structures, billion $

The measure of replacement investment takes into account the different rates at which equipment and structures depreciate, as well as the current and historical mix of spending on equipment and structures.

Inventory Valuation Adjustment

As noted in Chapter 3, the BEA makes an attempt to adjust for the effects of inflation on inventory costs as calculated for tax purposes. In other words, the IVA is designed to compensate the change in the

---

[47] Because these allowances do not measure "economic" depreciation, the Department of Commerce calculates an <u>aggregate</u> Capital Consumption Adjustment, as discussed in Chapter 3. There is no such adjustment calculated by industry, however.

[48] Thanks are due to Margaret McCarthy for the estimation of the Capital Consumption equations.

book value of inventories for the effects of the price changes of the items in inventory. In periods of high inflation, for example, the book value of inventory change is understated, since the goods are usually evaluated at their price upon entering inventory. The Inventory Valuation Adjustment is purely a price phenomenon, therefore, and is explained with a simple regression equation. An aggregate equation is used for Corporate IVA and one for Noncorporate IVA, and the results are then distributed to industries. The equations, summarized in Figure 5.4, simply relate the amount of IVA to inflation, where high inflation means a lower (more negative) IVA.

Figure 5.4: Inventory Valuation Adjustments

Corporate Inventory Valuation Adjustment

SEE = 7.61	RSQ = 0.6808	RHO = 0.05	Obser = 25	from 1963.000		
SEE+1 = 7.62	RBSQ = 0.6669	DW = 1.91	DoFree = 23	to 1987.000		
MAPE = 380.21						

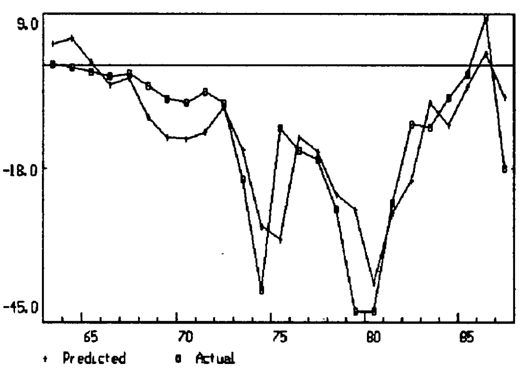
Variable name	Reg-Coef	Mexval	t-value	Elas	Beta	Mean
0 vciv	- - - - - - - -	- - - -	- - - -	- - -	- - - -	-12.35
1 intercept	10.85080	17.5	2.954	-0.88	0.000	1.00
2 infl	-4.47829	77.0	-7.004	1.88	-0.825	5.18

Noncorporate Inventory Valuation Adjustment

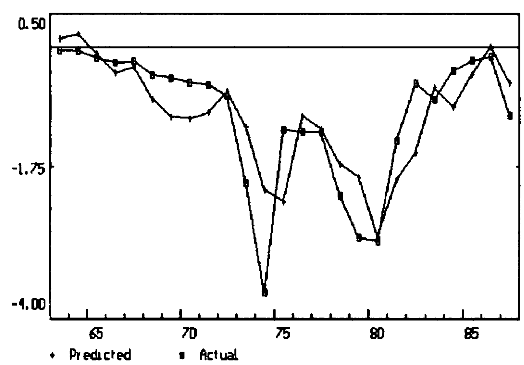
SEE = 0.57	RSQ = 0.6501	RHO = 0.16	Obser = 25	from 1963.000		
SEE+1 = 0.57	RBSQ = 0.6349	DW = 1.68	DoFree = 23	to 1987.000		
MAPE = 92.97						

Variable name	Reg-Coef	Mexval	t-value	Elas	Beta	Mean
0 vniv	- - - - - - - -	- - - -	- - - -	- - -	- - - -	-1.00
1 intercept	0.62997	10.8	2.283	-0.63	0.000	1.00
2 infl	-0.31396	69.1	-6.537	1.63	-0.806	5.18

Corporate Inventory Valuation Adjustment



Noncorporate Inventory Valuation Adjustment



Business transfer payments

Business transfer payments are mostly losses due to theft and bad debt, as well as legal settlement payments from business to persons. Total transfers are a small share of GNP (0.7% in 1987), and that share is explained as a function of lagged real interest rates and the unemployment rate. Debt losses are more likely to increase when interest rates are high, while both bad debt and thievery are counter-cyclical activities (as the economy worsens, crime and bankruptcies are more likely to occur). As the unemployment rate rises, therefore, the Business transfer payment share of GNP increases. The equation fits reasonably well, R^2 equals .8356, although the increase in Transfer payments in 1987 is underpredicted.

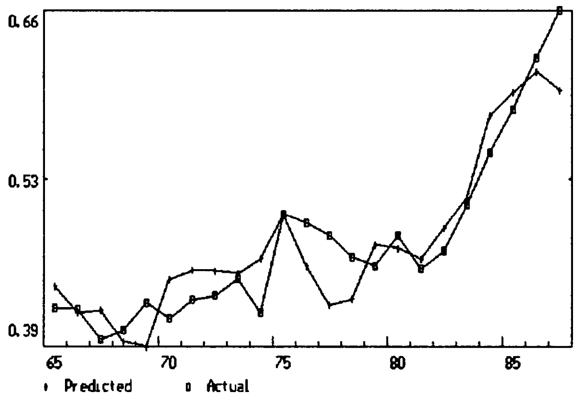
Figure 5.5: Business transfer payments

title Business Transfer Payments as share of GNP

```
SEE    =      0.03 RSQ   = 0.8356 RHO =   0.39 Obser  =   23 from 1965.000
SEE+1  =      0.03 RBSQ  = 0.7990 DW  =   1.21 DoFree =   18 to   1987.000
MAPE   =      4.63
```

Variable name	Reg-Coef	Mexval	t-value	Elas	Beta	Mean
0 vtrfsh	- -					0.48
1 intercept	0.50692	353.6	18.770	1.07	0.000	1.00
2 rlraaa[1]	0.00155	0.3	0.334	0.01	0.060	3.30
3 rlraaa[2]	0.00636	3.1	1.056	0.04	0.232	3.11
4 rlraaa[3]	0.01495	23.1	3.049	0.09	0.492	2.86
5 1/un	-0.56903	44.5	-4.427	-0.21	-0.454	0.17

Business Transfer Payments
as share of GNP



Indirect business taxes and Net government subsidies

Indirect business taxes are mostly property taxes, excises, and sales taxes. (They exclude corporate income taxes.) Since the amount collected in taxes depends largely on legislated tax rates, the equation to determine aggregate Indirect business taxes is relatively simple. Taxes as a share of GNP (roughly the indirect business tax rate), are modeled as a function of the average share of taxes in GNP, as well as current and lagged GNP growth.

Government subsidies less Current surplus of government enterprises is mostly comprised of the subsidy to agriculture through the Commodity Credit Corporation. Rather than estimate an equation for Government subsidies, the share of Net government subsidies in nominal GNP is exogenous, as are the payments to Agriculture from the CCC.

Conclusion

This chapter described equations for the non-profit components of return to capital. The equations will be included in an Interindustry Macroeconomic model of the U.S. economy that is described in the following chapter.

Chapter 6: The LIFT Model

In Chapter 2, the concept of an Interindustry Macroeconomic (IM) model was introduced. Chapters 3-5 described industry income equations that will be included in an IM model of the U.S. economy. This chapter describes that specific IM model. The model is the Long-term Interindustry Forecasting Tool (LIFT), which was developed at the University of Maryland under the direction of Clopper Almon.[49] LIFT models industry-level and macroeconomic activity of the U.S. economy using annual data, and it is designed to provide projections over the long-run, ten to fifteen years into the future. This chapter gives an overview of the model and its principal behavioral properties. The part of the model that determines real, or product, activity is described first. The second section of the chapter focuses on the price-income side of the model, and the chapter concludes with a discussion of how the "Accountant" part of the model reconciles the real and income parts of the model.

The "Real" Side of LIFT (Product determination)

As noted in Chapter 2, an IM model is structured on the input-output equations that determine output and prices based, in part, on interindustry requirements. Recall

$$q = (I-A)^{-1} * f \qquad (6.1)$$

$$p = v * (I-A)^{-1} \qquad (6.2)$$

where
- q = vector of product output,
- A = matrix of input-output coefficients,
- I = identity matrix,
- f = vector of final demand by products,
- p = vector of product prices,
- v = vector of value added per unit of output.

---

[49] The current LIFT model represents the cumulative effort of a number of researchers over the past twenty years. The description of the model here is based on descriptions by McCarthy (1991), Almon (1991, 1986a, 1986b), and Monaco, R.M. (1984).

The Real side of the model is based on equation 6.1, which determines product output as a function of interindustry demand and final demand. To forecast product output, final demand by product is calculated. Final demand consists of Personal Consumption Expenditures, Investment in Producer Durable Equipment, Investment in Residential and Nonresidential Structures, Exports, and Government Purchases of Goods and Services, less demand met by Imports and Changes in Inventories.

Table 6.1 lists the equations that comprise the Real side of LIFT. The largest component of final demand is Personal Consumption Expenditures (PCE), and it is determined by a two-step process. PCE by product is determined by a system of behavioral equations. Then, total PCE is determined as the difference between disposable income and savings.[50] The initial product results are then scaled so that total PCE sums to the solution of the income less savings identity. In practice, the degree of scaling is modest (less than one percent), indicating that the product equations give solutions consistent with the constraint that consumption equals income less savings. It also should be noted that the scaling is based on income-sensitivity of products, not merely on the share of each product in total consumption. If the income identity implies that total consumption is higher than what is predicted by the product equations, for example, the consumption of Automobiles will be affected relatively more than the consumption of Food.

PCE by product is determined by equations that combine cross-section and time-series analysis.[51] The cross-section analysis measures the effect on consumption of income distribution and demographic variables, such as age structure of the population, percent

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[50] Specifically, PCE = income - savings, where savings includes interest paid by consumers to business. The amount of savings is determined by an equation for the savings rate, which is described below.

[51] See Devine for description of estimation.

Table 6.1: LIFT Product Side

Component	Sectors	Influences
Output by product sector	78	$q = Aq + f$
Personal Consumption* by NIPA expenditure category	80	Disposable income Size distribution of income Change in disposable income Time trend Relative prices Age structure of population Other demographic variables
Equipment Investment by investing industry	55	Change in product outputs Change in relative prices of user cost of capital, labor, and energy Stock of equipment by industry
Construction by type	31	Output, Income, or Expenditure Interest rates Stocks of structures Demographic variables
Inventory Change by product sector	78	Product output Interest rates and inflation Stocks of inventories
Imports by product sector	78	Domestic demand by product Domestic/foreign product prices Exchange rates
Exports by product sector	78	Foreign demand by product Foreign/domestic product prices Exchange rates
Labor Productivity by product sector	78	Output cycles by sector Time trends
Length of Work Year by product sector	78	Change in output Time trend
Employment by product sector	78	Labor productivity, output, work year
Consumption, Equipment and Construction by product sector	78	Final demands by category are bridged to producing sectors with unique bridge matrices
Government Purchases by product sector	78	Exogenous

* Total PCE is determined as the difference between disposable income and savings. See the section below on macroeconomic equations in LIFT.

of families with two earners, and regional location of population. The cross-section results are combined with time-series analysis of relative prices, income changes, and trends. The equations are estimated as a system so that relative price effects are symmetric across goods that are substitutes and complements. The response of consumption to relative prices is one of the important behavioral links in the model between real and price activity. An increase in oil prices, for instance, will affect not only the consumption of fuel, but also the consumption of a complementary good, such as Automobiles, and a substitute good, such as Local public transportation. A change in relative prices therefore leads to a change in the structure of demand.

Investment in Producer Durable Equipment (PDE) is determined using a generalized Leontief cost function.[52] Net investment by industry is determined as a function of demand, measured by a distributed lag of changes in output, and the relative prices of capital, labor and energy. Constraints are used to insure that own-price elasticities are negative and that cross-price elasticities between labor and capital are positive and symmetric. The use of changes in output as a measure of demand implies that the equations resemble typical accelerator models. Replacement investment is then determined based on the current and lagged levels of the capital stock, as well as on assumed depreciation rates. Finally, gross investment by industry is simply the sum of replacement and net investment.

Investment in Residential Structures is determined for four types of residential construction: One-unit structures, Two-or-more unit structures, Mobile homes, and Additions and alterations to residences. The equations specify investment as a function of income or consumption, interest rates, stock of structures, and demographic variables. Investment in Nonresidential structures is divided into nineteen private

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52 See Meade (1990) for full development of the PDE equations used in LIFT.

categories and eleven public categories. Private investment, in structures such as Industrial factories, Offices, Mining exploration shafts and wells, and Petroleum pipelines, is determined by demand, measured by industry output, interest rates, and the stock of structures. For the most part, government investment in structures, such as Highways, Sewer systems, and Schools, is set exogenously and is not determined by behavioral equations.

The LIFT model is part of a linked system of IM models for seven countries.[53] Product exports and imports in LIFT are determined by exchange rates, relative foreign-to-domestic prices and other product-specific variables that result from solving the linked International System.[54] Exports depend on foreign demand by product, for example, where demand is determined by economic conditions facing our trading partners. Imports of specific products are determined by domestic demand for each product, as well as relative foreign to domestic prices. Price sensitivity of exports and imports is another important behavioral link between the real and price sides of LIFT. An increase in the price of Electrical machinery in this country, in response to higher costs of plastic and metal, for instance, not only will affect PCE of Electronics, but also the exports of Electrical machinery, and the demand for imported machinery. The sensitivity of consumption, exports, and imports to the price change will determine the net effect on the output of the Electrical machinery industry. A fall in demand for Electrical machinery implies a fall in the profit margin for the industry, which in turn means that the product price will fall (based on the definition of product price by the input-output dual equation).

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[53] The seven countries linked at the time of this work are the U.S., Japan, the Federal Republic of Germany, France, Italy, Canada, and Belgium. Models of Mexico, Austria, and South Korea have since been added to the system, while models of Spain, Poland and the United Kingdom are being prepared. See Nyhus (1991).

[54] The export and import equations were estimated by Nyhus (1975), and are described in greater detail in Chapter 7 below.

The fall in price will help stimulate demand for Electrical machinery again, both domestically and abroad, and bring about a recovery in the Electrical machinery industry.

Once final demand by product is determined, output is defined by the input-output equation. The last calculation on the Real side of the model is employment by producing sector. The demand for employment is based not only on production levels (output), but also on labor productivity (output per hour). Labor productivity by producing sector is estimated as a function of changes in output and simple trends. The equations reflect the fact that the influence of demand changes is not symmetric over the business cycle. Labor hoarding occurs at the beginning of a downturn, while hiring increases very slowly at the beginning of a recovery.[55] Since productivity is defined as output per hour worked, an equation is needed to determine the average hours worked per year. The yearly hours equations also depend on changes in output and time trends. Employment is then determined by combining labor productivity, the length of the work year, and output.

The Price-Income Side of LIFT

As noted above, forecasting product prices implies forecasting value added by industry, such as labor compensation, corporate profits, and so on. The main components of the price-income side, and their determinants in the model, are outlined in Table 6.2. Product prices are defined by the input-output identity, equation 6.2, and they depend on value added by product. Value added by product is calculated by distributing the results from the industry income equations to product

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[55] Because of these changes in productivity over the business cycle that have been observed historically, aggregate measures of employment make poor leading indicators of cycles. Employment could rather be thought of as a coincident, or even lagging, indicator of cyclical turning points.

Table 6.2 LIFT Price-Income Side

COMPONENT	Sectors	INFLUENCES
Prices by product sector	78	p = pA + v
Value added by product sector	78	Value added by industry distributed to products based on product-to-industry bridge
Value added by industry:		
Labor Compensation	46	Industry wage * employment
Manufacturing wage	1	Labor productivity 5-year lag of money growth Price shocks Unemployment rate
Nonmanufacturing wage	1	Manufacturing wage rate Unemployment rate
Relative wages industry/aggregate	46	Unemployment, inflation Industry output Industry exports,imports
Return to capital by industry (See Table 6.3)	46	Corporate profits + Proprietor income + Net interest + Depreciation allowances + Inventory value adjustment + Business transfer payments
Rental income for 1 industry	1	Average share of nominal GNP Inflation Transitory nominal GNP
Indirect business taxes Total of all industries	1	Lagged IBT as share of GNP Growth in real GNP
by industry	46	Share of total IBT Change in output share
Government subsidies (largely Agricultural susidies)	46	Exogenous

sectors using the product-to-industry bridge described in Chapter 2. The industry income equations determine the three main components of value added: labor compensation, return to capital, and returns to government.

Labor compensation in the model is determined by a combination of aggregate and industry equations. The aggregate manufacturing and non-manufacturing wage rates are calculated using equations that depend on labor productivity, demand, money growth, and price shocks. The equations embody the short-run Phillip's curve trade-off between unemployment and inflation. They also are based on long-run neutrality of money, as excess changes in the growth of the money supply eventually lead to proportional changes in nominal wages.[56] By using an aggregate equation to establish the link between monetary inflation and wages, a change in inflation does not impose a permanent change on industry relative wages. Specifically, the aggregation wage rate for manufacturing is determined by:

$$wmfg - prod - smm2 = .69 * shock + 11.33 * tight \qquad (6.3)$$

where

wmfg = percent change in manufacturing hourly labor compensation,
prod = three-year moving average of labor productivity,
smm2 = smoothed excess money growth over a five-year period:

$$smm2 = .2x_t + .3x_{t-1} + .2x_{t-2} + .1x_{t-3} + .1x_{t-4} + .1x_{t-5}$$

x = percentage change in ratio of money supply (M2) to real GNP

shock = price shock variable: inflation rate lagged one year less smoothed excess money growth lagged one year,
tight = tightness of the labor market as measured by the first difference in the two-year moving average of the inverse of the unemployment rate.

The aggregate wage rate for non-manufacturing is then a function of the manufacturing wage rate and changes in the overall unemployment rate.

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56 See Monaco, R.M. for development of the aggregate wage equations.

Table 6.3 LIFT Return to Capital by Industry

COMPONENT	#	INFLUENCES
Corporate Profits by industry	46	Change in material costs Change in labor costs Change in demand (output, unemployment, interest rates, other)
Proprietor Income 4 largest industries equaling 80% of Total	4	Change in material costs Change in labor costs Change in demand Trend
All other proprietor income	1	Change in Labor Compensation
by industry	42	Share of All other Change in output share
Net Interest Payments Total domestic payments	1	Current AAA-bond rate Smoothed average rate Business debt
by industry	45	Share of Total domestic payments Change in output share
Rest of World Payments	1	Change in net factor income
Capital Consumption Allowances Corporate & Noncorporate Totals determined by same specification, but with different equations	1	Depreciation of equipment Depreciation of structures
by industry	46	Industry share of total Change in output share
Inventory Valuation Adjustment Corporate & Noncorporate Totals determined by same specification, but with different equations	1	Inflation
by industry	46	Share of total IVA Change in output share
Business Transfer Payments Total	1	Share of nominal GNP Lagged real interest rate Unemployment rate
by industry	46	Share of total Business Transfers Change in output share

Once the aggregate wage rates are calculated, industry wage rates are calculated using relative wage equations that depend on industry-specific variables, such as output, exports, and imports, as well as macroeconomic variables such as unemployment and inflation. Labor compensation by industry then is calculated as the product of total employment and the wage rate.

After labor income, the bulk of the remaining value added consists of return to capital by industry. In this study, each type of capital income is solved for using a behavioral equation, and the results are summed to calculate total return to capital. The equations for return to capital, which were developed in Chapters 3-5, are summarized in Table 6.3.

The Accountant in LIFT

The third important section of the LIFT model is called the Accountant, since it calculates many of the aggregate variables of the National Income and Product Accounts. The three main tasks of the Accountant are (1) calculate aggregate income and product variables, as well as prices, as the sum of the industry detail provided by the Real and Price-income sides of the model; (2) determine personal disposable income; and (3) calculate interest rates and financial variables.

The first task of the Accountant involves summing the industry detail provided by the rest of the model. Total GNP is calculated in both real and nominal terms by summing product demands, as well as product demand multiplied by prices. Implicit aggregate price deflators also are calculated.

The LIFT model includes a detailed personal tax model that uses estimates of income distribution as well as legislated tax-rate schedules to calculate the amount of personal income taxes. These taxes play a role in determining not only personal disposable income, but also government revenues. After determining personal disposable income, the

Accountant side of LIFT also calculates the amount of personal savings using an equation for the savings rate. The savings rate is a function of the unemployment rate, the percent change in income, automobile purchases as a share of PCE, interest payments as a share of income, personal contributions to social insurance as a share of income, and inflation. Specifically:

$$savrat = 15.6 - 1.0 * un[1] - 1.0 * auto - 1.0 * ipbrat + .56 * pctdi + .33 * pctpri - .49 * shssc \quad (6.4)$$

where

savrat = savings as a percent of disposable income,
un[1] = unemployment rate, lagged on year,
auto = automobile purchases as a share of disposable income,
ipbrat = interest paid by consumers as a share of disposable income,
pctdi = percent change in real disposable income,
pctpri = percent change in implicit GNP deflator (inflation),
shssc = personal contributions for social insurance as a share of disposable income.

The relationship between the savings rate and the unemployment rate provides one of the key macroeconomic features of LIFT. As the unemployment rate increases, due to a slowdown in real growth, the savings rate falls. As consumers spend a relatively larger share of their income, demand is stimulated, which helps offset the initial fall in demand. As noted earlier, total PCE is determined implicitly by the savings rate equation and the identity that disposable income less savings equals consumption.

The third type of calculation performed by the Accountant involves the financial sector. Long and short-term interest rates are modeled as a function of changes in the money supply, inflation, and changes in demand. Interest rates are used by equations on the product side of the model that determine investment in structures, as well as some consumer items (such as Housing and Automobiles). In addition, interest rates affect income variables, such as Net interest payments and Personal interest income, as well as the Net interest expense of government expenditures.

Exogenous variables

In addition to the equations described for the Real, Price-income, and Accountant parts of the model, LIFT includes a number of exogenous variables. The exogenous variables can be grouped into four main categories: demographic, price, public policy, and interindustry coefficients. (See Table 6.4) The demographic assumptions include population and its age distribution, as well as the civilian labor force. Some product prices are set exogenously, especially the price of crude petroleum and some mining sectors. LIFT also uses a host of monetary and fiscal policy assumptions. The supply of money (M2) is exogenous, as are exchange rates with our trading partners. In addition, Government spending is exogenous, although the parts of spending that depend on economic conditions do respond to the model. For example, the unemployment insurance transfer payments are calculated by combining an assumed rate times the number of people unemployed as determined by the model in any year. Likewise, an assumption is made for real old-age benefits per capita, and the model determines the current-dollar level of payments in any year based on inflation and demographics.

The final type of assumption concerns the coefficient matrices in LIFT. First, of course, is the input-output coefficient matrix, or A-matrix, that describes interindustry relationships. As noted in Chapter 2, the LIFT model uses projections of input-output coefficients that reflect changes in technology and interindustry relationships that occur over time. LIFT also includes bridge matrices to convert Investment in PDE by industry to products, Construction investment by type to products, and Personal Consumption Expenditures by type to product sectors. The coefficients for the Construction matrix are estimated and projected using the same procedure as for the A-matrix coefficients, while the consumption bridge is based on coefficients from the last year of historical data and is fixed over the forecast. The bridge matrix for PDE is a special case, in that the B-matrix coefficients are designed to be endogenous to the model.[57] The coefficients are estimated as a function of a trend as well as cyclical variables. The cyclical variables capture the idea that certain products are more likely to be purchased as part of an industry's total equipment purchases during an expansion, while others are more likely to be purchased on a continuing basis. For example, total investment in PDE by the Air transportation industry is predicted by a behavioral equation. The B-matrix coefficients are used to distribute total equipment investment between Airplanes, Computers, and Furniture (among other products). Computers and Furniture are more likely to be purchased on an ongoing basis, as part of general maintenance and upkeep, while the decision to purchase Airplanes is more likely to be affected by cyclical trends in demand.

Conclusions

The purpose of this chapter was to provide an overview of the LIFT model, including the newly estimated income equations described in Chapter 3-5. In the following chapters, the properties of the LIFT model are described, by analyzing forecasts done with the model.

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[57] The B-matrix coefficients are estimated as part of the sister model to LIFT called the Detailed Output Model (DOM). DOM expands the 78 product sectors of LIFT to 430 sectors. The B-matrix is estimated at the level of detail of 430 (products) x 55 (industries). The DOM coefficients are aggregated to the 78x55 structure of LIFT and, in effect, are exogenous to the LIFT model.

```
;                       Table 6.4:   Exogenous Assumptions for the
;                       Long-term Interindustry Forecasting Tool (LIFT)
;
;
;
;Demographic Assumptions
;----------------------
;
lhtc    ; Teen-age Cilvian Labor Force
lfc     ; Civilian Labor Force
hhead   ; Percent of Household Head Age 25-35
pt      ; Population
pop1    ;  Age  0- 4 years
pop2    ;  Age  5-14 years
pop3    ;  Age 15-19 years
pop4    ;  Age 20-29 years
pop5    ;  Age 30-39 years
pop6    ;  Age 40-49 years
pop7    ;  Age 50-64 years
pop8    ;  Age 65+
sage    ; School age population
dthrat  ; Death Rate
hhld    ; Number of Households (thousands)
twoern  ; Percent of Households with Two Earners
multjb  ; Multiple Job Adjustment
domemp  ; Domestic Servants (employment)
emptim  ; Adjustment to Time for Labor Productivity
;
;
;
;Monetary Policy Assumptions
;--------------------------
;
m2                     ; Supply of M2
(m2/m2[1]-1.0)*100.    ; annual percent change
;
;(or -- if m2 is endogenous)
nbr      ; Non-borrowed reserves
reqres   ; Required Reserves Ratio
mbase    ; Monetary Base
mmult    ; Money Multiplier (m2/mbase)
;
;
;
;Federal Government Assumptions
;-----------------------------
;
;Employment/Compensation of Employees
efdent                 ; Employees of Federal Enterprises (thousands)
;
emp91m+emp91c+emp91n   ; Total Federal Employment
emp91m+emp91c          ;  Defense Employment
emp91m                 ;    Military Employment
emp91c                 ;    Civilian Employment
emp91n                 ;  Non-defense Employment
;
wndc                   ; Wages and salaries, Non-defense employees
                         (constant$)
```

```
;                              Exogenous Assumptions for the
;                       Long-term Interindustry Forecasting Tool (LIFT)
;
;Federal Government (continued)
;Purchases of Goods and Services
;Macro Fixes
gfdp+gfndp              ; Total Federal Purchases, constant$
gfdp                    ;   Defense purchases, excl COE
gfndp                   ;   Non-defense purchases, excl COE
;
;Industry Fixes
def38                   ; Defense purchases of Communication Equipment
def44                   ; Defense purchases of Aerospace
def45                   ; Defense purchases of Ships and boats
def43+def46            ; Defense purchases of Motor vehicles, Trans Equip
def71                   ; Defense purchases of Non-competitive Imports
                          (bases abroad)
;
ndf1                    ; Non-defense purchases of Agriculture
ndf70                   ; Non-defense purchases of Government Enterprises
;
gia                     ; Grants in Aid to State & Local Govt, current$
;
pctgov                  ; Percentage of Debt held by Government Accounts
doshi                   ; Domestic Share of Federal Interest Payments
floan                   ; Direct Federal Loans Outstanding
rtbf                    ; Federal Share of Indirect Business Taxes
;
;Transfer Payments
trpcoas                 ; Social Security Payments per person (constant$)
trchmi                  ; Old-age Hospital & Medical Benefits per person
                          (constant $)
uipc2                   ; Unemployment Insurance Benefits per person
                          (constant$)
;
socrat                  ; Legislated Social Security Payroll Tax Rate
rtpfi                   ; Federal Tax Rate on Personal Income
;
;
;State and Local Government Assumptions
;--------------------------------------
;
;Employment/Compensation of Employees
esdent                ; Employees of State & Local Enterprises (thousands)
;
emp94e+emp94o          ; Total State & Local Employment
emp94e                 ;   Education Employment
emp94o                 ;   Non-education Employment
;
wslec                  ; Wages and salaries, S&L Education (constant$)
wsloc                 ; Wages and salaries, S&L Non-education (constant$)
;
;Purchases of Goods and Services
gsloe                 ; S&L Expenditures (excl COE): Education
                        (constant$)
gsloo                 ; S&L Expenditures (excl COE):
                        Non-education(constant$)
;
rtcsl                 ; S&L Tax Rate on Corporate Profit Income
rtpsli                ; S&L Income Tax Rate on Personal Income
sldebt                ; State & Local Surplus  (billions $)
```

```
;                              Exogenous Assumptions for the
;                       Long-term Interindustry Forecasting Tool (LIFT)
;
;Rates for Contributions to Social Insurance and Other Labor Income
;-------------------------------------------------------------------
;
;Contributions to Federal Insurance Fund by:
rcofp      ; Private Employers
rcoffe     ; Federal Enterprises
rcoffi     ; Federal Industry
rcofse     ; State & Local Enterprises
rcofsi     ; State & Local Industry
;
;Contributions to State & Local Insurance Fund by:
rcolp      ; Private Employers
rcolse     ; State and Local Enterprises
rcolsi     ; State and Local Industry
;
;Contributions to Other Labor Income by:
rcoop      ; Private Employers
rcoofe     ; Federal Enterprises
rcoofi     ; Federal Industry
rcoose     ; State & Local Enterprises
rcoosi     ; State & Local Industry
;
;Income Assumptions
;------------------
;
cayf    ; Capital Consumption Adjustment: Farm Proprietor Income
caybp   ; Capital Consumption Adjustment: Non-Farm Proprietor Income
;
cayc    ; Capital Consumption Adjustment: Corporate Profit Income
cayri   ; Capital Consumption Adjustment: Rental Income
;
trpfrn  ; Net Personal Transfer Payments to Foreigners
;
;Foreign Trade Assumptions
;-------------------------
;
exscl     ; Exchange Rate Scalar  (and 7 exchange rates by country)
fdm1-fdm75; Foreign demand by product
;
caninc ; Canadian Income
gerinc ; German Income
japinc ; Japan Income
;
;Rest of World Sector
rowemp ; Employment (macro variable)
wag46  ; Relative Wage
pdm75  ; Domestic Price
fpe75  ; Foreign Export Price
fpi75  ; Foreign Import Price
gco    ; Gross Capital Outflows
;
exp6   ; Exports of Crude Petroleum
;
pdm71  ; Domestic Price of Non-competive Imports
;
fpe21  ; Foreign Export Price: Shoes
fpe35  ; Foreign Export Price: Computers
fpe49  ; Foreign Export Price: Non-merchandise (sectors 49-78)
```

```
;
;Foreign trade (continued)
;
fpi21  ; Foreign Import Price: Shoes
fpi35  ; Foreign Import Price: Computers
fpi6   ; Foreign Import Price: Crude Petroleum
pdm6   ; Domestic Price:       Crude Petroleum
fpi49  ; Foreign Import Price: Non-merchandise  (sectors 49-78)
;
;
;
;Investment-Related Assumptions
;------------------------------
;
;Producer Durable Equipment
rraaa   ; Real Interest Rate (raaa)
tlife   ; Investment Depreciation Lifetime for Tax purposes
ctax    ; Corporate Tax Rate
vtaxcr  ; Investment Tax Credit
;
cap56   ; PDE for Personal Automobiles
cap57   ; PDE for Sales of Used Equipment
;
;Construction
difscl  ; Disintermediation Scalar (construction)
disint  ; Disintermediation Dummy
;
cst20   ; Public Construction: Highways and Streets
cst21   ; Public Construction: Military Facilities
cst22   ; Public Construction: Conservation
cst23   ; Public Construction: Sewer Systems
cst24   ; Public Construction: Water Supply Facilities
cst25   ; Public Construction: Residences
cst26   ; Public Construction: Industrial
cst27   ; Public Construction: Educational
cst28   ; Public Construction: Hospitals
cst29   ; Public Construction: Other Public Buildings
cst30   ; Public Construction: Miscellaneous
;
;
;
;Personal Consumption Expenditures Assumptions
;---------------------------------------------
;
pce49   ; Domestic servants
;
;
;
;Inventory Change Assumptions
;----------------------------
;
ven1    ; Agriculture
ven43   ; Motor Vehicles
ven9    ; Food and Tobacco
ven41   ; Electrical Equipment
ven44   ; Aerospace
ven47   ; Instruments
ven48   ; Misc Manufacturing
;
;
```

```
;                                    Exogenous Assumptions for the
;                            Long-term Interindustry Forecasting Tool (LIFT)
;
;
;Prices and Income by Industry Assumptions
;----------------------------------------
;
;Crude Petroleum
pdm6    ; Domestic Price
fpi6    ; Foreign Import Price
;
;Computers
pdm35   ; Domestic Price
fpi35   ; Foreign Import Price
fpe35   ; Foreign Export Price
;
;Shoes
fpi21   ; Foreign Import Price
fpe21   ; Foreign Export Price
;
;Non-merchandise Trade
fpi49   ; Foreign Import Price (sectors 49-78)
fpe49   ; Foreign Export Price (sectors 49-78)
;
pdm71   ; Domestic Price of Non-competitive Imports
pdm74   ; Domestic Price of Scrap & Used
;
;
;
```

Chapter 7: Properties of the LIFT Model

The previous chapter described the structure of the Long-term Interindustry Forecasting Tool (LIFT), an Interindustry Macroeconomic model of the U.S. economy. In this chapter, five forecasts are done with the model, to examine its overall forecasting properties, and especially the properties of the industry profit equations developed in Chapter 4. After describing the Base forecast with LIFT, the chapter analyzes four alternate scenarios: a change in the price of oil, a change in labor productivity, a change in monetary policy, and a change in exchange rates.

Base Forecast with LIFT

Given the equations described in Chapters 4-6, and assumptions for the exogenous variables of the model, what does LIFT forecast for the U.S. economy? To some extent, the macroeconomic and industry results of a LIFT forecast arise out of the model's assumptions, so a brief summary of key assumptions is in order. In terms of the demographic outlook for the economy, LIFT uses Department of Census projections of population growth and projections of labor force participation from the Bureau of Labor Statistics.[58] The two principal features that define the future demographic profile of the economy are a slowdown in the rate of growth of the labor force, and the gradual aging of the population as the percent of the population aged 50 and over increases. Figure 7.1 illustrates the historical and projected growth rate of the Civilian Labor Force. From 1965 to 1980, the labor force grew at an average rate of 2.3% per year, due, in part, to increased participation in the labor force of women and minorities. The following decade, from 1980-1990, saw a marked slowdown in that growth rate, to 1.6% per year. The BLS

[58] See Current Population Reports, and Monthly Labor Review.

Figure 7.1: Labor Force Growth Rate
9/91 Assumptions

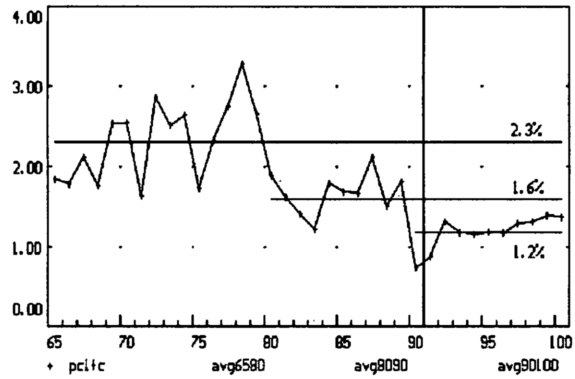
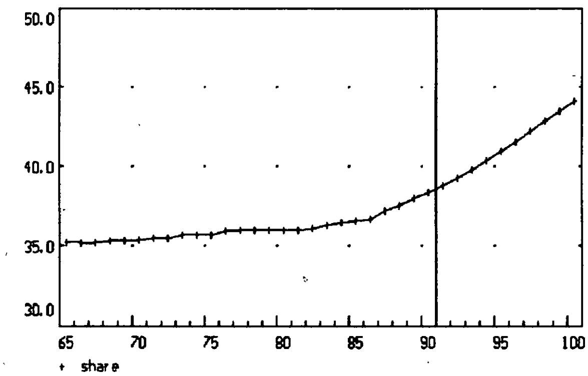


Figure 7.2: Age Mix of Population
Age 40+ as Percent of Total



"medium-range" projection shows the 1990-2000 decade as an even slower decade, in terms of labor force growth, with average growth of 1.2% per year. The slowdown in the rate of growth of the labor force is due to a projected decline in the rate of growth of the population, as well as to a projected slowdown in labor-force participation rates.

The second key demographic assumption is illustrated in Figure

7.2. As the growth rate of the population slows, life-expectancies increase, and so-called "baby-boomers" age, the share of elderly people in the overall population is projected to increase through the year 2000. The age structure of the population defines potential demand for items such as Health care (which is positively related to an older population), and New homes (negatively related). The age structure of the population also affects Government spending on transfer payments, such as Old-age benefits and Medicare.

The second key group of assumptions, summarized in Table 7.1, concerns monetary and fiscal policy. The exogenous variable for monetary policy in LIFT is the supply of money, M2.[59] The forecast for M2 growth assumes that the Federal Reserve will be aiming for low inflation by allowing the money supply to grow modestly. The growth rate of M2 slows from an average annual rate of 5.7% per year from 1985-1990, to an average rate of 4.6% from 1990 through 2000. Fiscal policy is defined by recent legislation limiting growth of Federal spending.[60] Defense spending is projected to decline by 3.7% per year, in real terms, through 1995, and then remain relatively unchanged for the last five years of the forecast. Although not declining in real terms, Nondefense spending grows only slowly through the year 2000, .4% per year from 1990 to 1995, and 1.4% from 1995 to 2000. As spending by the Federal government declines, spending by State and Local governments grows modestly, averaging 1.6% per year from 1990-2000. The trend toward a falling share of Federal spending in total government spending continues through the 1990's, as the Federal share of total government spending falls from 42% in 1990 to 33% in 2000.

There are several assumptions for the model concerning the U.S.

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[59] The supply of money can be endogenous in LIFT by specifying, instead, the monetary base. The base, plus endogenous results for the money multiplier, then determines the supply of money.

[60] See the Congressional Budget Office's <u>An Analysis of the President's Budgetary Proposals for Fiscal Year 1992</u>, for example.

Table 7.1: Government Assumptions for LIFT
Purchases of Goods and Services

	1980	1990	2000	1980-85	1985-90	1990-95	1995-00
	billions of 1977 $			average annual exponential growth			
Government	377.3	531.1	543.5	4.7	2.1	-0.4	0.9
Federal	160.1	221.0	181.1	5.4	1.1	-3.7	-0.3
Defense	108.3	161.9	116.2	6.4	1.6	-5.4	-1.2
Nondefense	51.8	59.1	64.9	3.1	-0.4	0.4	1.4
State & Local	217.2	310.1	362.5	4.2	2.9	1.7	1.5
Education	108.6	128.0	141.0	1.1	2.2	0.9	1.0
Other	108.7	182.1	221.5	6.9	3.5	2.2	1.8
Share of total:							
Federal	42.4	41.6	33.3				
State & Local	57.6	58.4	66.7				
Quantity of M2	1566.7	3293.5	5253.8	9.2	5.7	4.8	4.5

economy's interaction with the world economy. First, exchange rates by country are assumed for any country for which there is a model in the linked International System of IM models. Figure 7.3 illustrates the assumed exchange rate for three large trading partners with the U.S.: Canada, and Japan, and West Germany. The dollar depreciates modestly against the yen over the forecast horizon, while it remains fairly stable with the Canadian dollar and the German mark. The implication of the exchange rate assumptions is summarized in Figure 7.4, where the average effective relative price of exports is shown. Given the assumption of no appreciation in the dollar, the price of U.S. goods abroad will be relatively low throughout the forecast. The relative price of U.S. goods falls every year through 1995. In the last five years of the forecast, the effective price of exports rises slightly, but remains at a level lower than any value prior to 1990. The exchange rate assumptions are combined with specific product deflators by country to calculate the assumed relative foreign to domestic prices by product for both exports and imports. The product deflators by country are the result of forecasting with the International System of IM models.

Figure 7.3: Exchange Rate Assumptions currency/U.S. dollar; index 1985=1.0

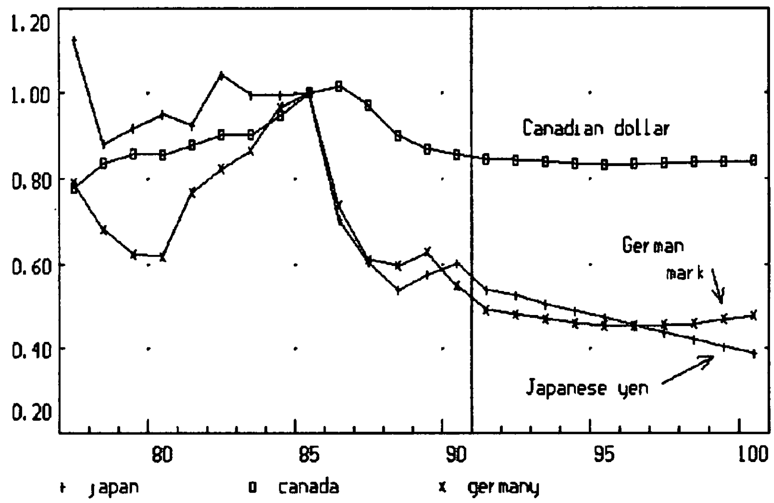
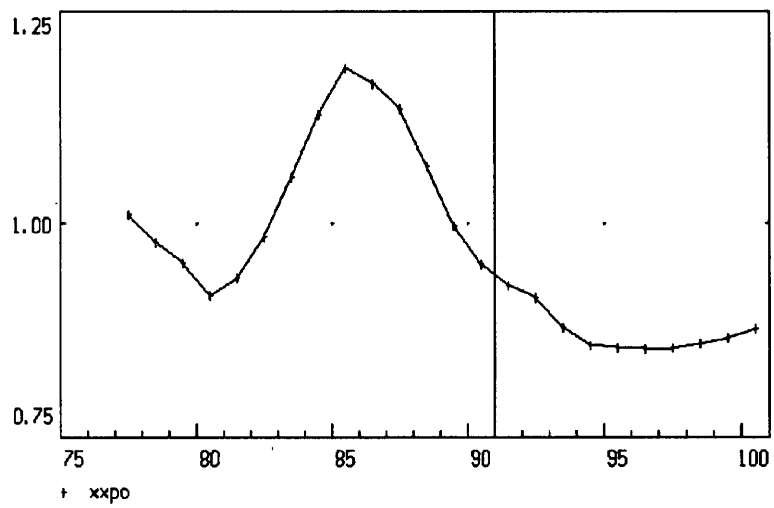
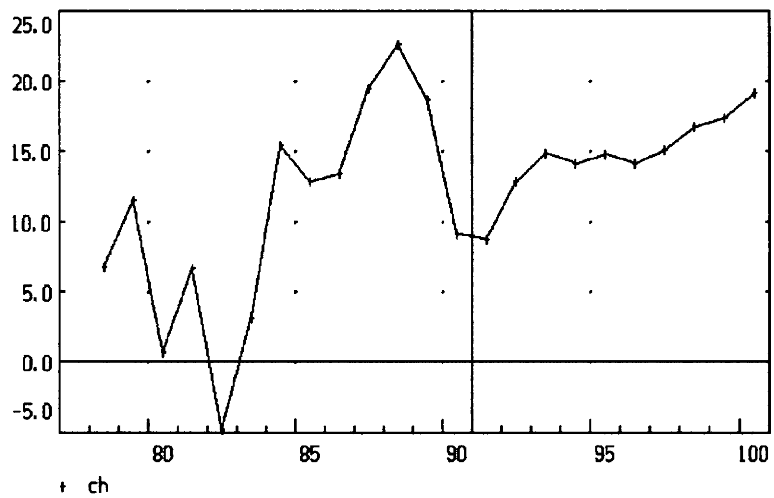


Figure 7.4: Average Effective Price of Exports U.S. prices/foreign prices; index 1977=1.0



Lift's import and export equations rely not only on foreign prices and exchange rates, but also on foreign demand by product. Figure 7.5 illustrates the change in average foreign demand for U.S. exports. This measure of foreign demand is the average of demand for U.S. exports of 78 different products, from the countries who import those products. Foreign demand grows throughout the 10-year forecast horizon, at an average rate slightly less than the average growth from 1985 to 1990.

Figure 7.5: Growth in Foreign Demand
(change in index; 1977=100)



In summary, the assumptions for the forecast show an economy characterized by a slower growing labor force, implying slower growth in potential GNP. In addition, the Government is a smaller source of demand than in previous decades, while foreign countries represent a significant market for U.S. products.

The macroeconomic results of the Base forecast are summarized in Table 7.2 and Figure 7.6. The model is using actual data available

Table 7.2: Base Forecast with LIFT Model

	1991	1992	1993	1994	1995	1996	1997	1998	2000
billions of 1977 $									
Gross national product	2810.0	2885.1	2937.9	2994.6	3017.4	3087.2	3140.1	3211.7	3323.9
Consumption	1854.7	1902.1	1913.8	1946.3	1965.4	2010.6	2041.4	2083.8	2161.6
Investment	467.8	487.7	501.0	508.6	497.7	518.5	531.2	552.0	572.8
Fixed	451.2	470.2	483.3	491.2	482.9	502.3	515.2	535.7	557.2
Nonresidential	336.3	352.0	366.0	374.8	367.8	385.8	397.5	417.8	440.4
Structures	80.4	87.4	90.5	90.9	88.4	91.3	94.5	97.8	101.7
Equipment	255.9	264.5	275.6	284.0	279.4	294.6	303.1	320.0	338.7
Residential structures	114.9	118.2	117.3	116.4	115.1	116.4	117.7	117.8	116.8
Change in inventory	16.6	17.5	17.6	17.4	14.8	16.3	16.0	16.4	15.7
Exports	408.1	431.7	463.6	492.3	511.9	529.7	545.6	561.9	592.8
Imports	450.3	461.6	462.7	473.3	478.5	495.2	505.1	518.0	547.0
Disposable income (1972$)	1421.2	1455.0	1480.2	1500.2	1517.0	1544.1	1577.2	1609.9	1678.7

	1991	1992	1993	1994	1995	1996	1997	1998	2000
annual percent change									
Gross national product	2.4	2.7	1.8	1.9	0.8	2.3	1.7	2.3	1.7
Consumption	1.6	2.6	0.6	1.7	1.0	2.3	1.5	2.1	1.9
Investment	8.5	4.2	2.7	1.5	-2.1	4.2	2.4	3.9	1.7
Fixed	7.9	4.2	2.8	1.6	-1.7	4.0	2.6	4.0	1.8
Nonresidential	9.8	4.7	4.0	2.4	-1.9	4.9	3.0	5.1	2.6
Structures	6.3	8.8	3.5	0.4	-2.7	3.2	3.5	3.5	2.2
Equipment	10.9	3.4	4.2	3.1	-1.6	5.4	2.9	5.6	2.8
Residential structures	2.7	2.9	-0.8	-0.8	-1.2	1.2	1.1	0.2	-1.2
Exports	3.7	5.8	7.4	6.2	4.0	3.5	3.0	3.0	2.6
Imports	3.1	2.5	0.2	2.3	1.1	3.5	2.0	2.5	2.9
Disposable income (1972$)	2.3	2.4	1.7	1.4	1.1	1.8	2.1	2.1	2.0

	1991	1992	1993	1994	1995	1996	1997	1998	2000
billions of $									
Gross national product	5750.5	6103.6	6459.6	6851.6	7187.3	7619.0	8032.9	8511.4	9552.8
Labor compensation	3433.3	3629.8	3837.5	4044.9	4241.9	4447.7	4687.6	4942.1	5511.7
Return to capital	1798.9	1936.7	2060.8	2211.1	2322.2	2510.6	2656.9	2841.5	3232.6
Corporate profits	304.9	332.8	344.1	367.2	354.7	392.9	400.7	424.1	452.5
Proprietor income	402.3	437.8	459.2	483.1	502.4	537.3	563.0	599.3	667.1
Corp Capital Consumption Allo	397.9	422.2	449.0	480.7	513.1	546.2	576.3	608.7	683.4
Non-corp CCA	195.5	205.6	216.9	230.3	244.1	258.2	271.0	284.8	316.8
Corp Iventory Valuation Adjus	-0.7	-3.8	-6.4	-6.9	-7.1	-4.8	-5.1	-4.8	-7.6
Non-corp IVA	-0.2	-0.4	-0.6	-0.6	-0.6	-0.5	-0.5	-0.5	-0.7
Business Transfer Payments	30.3	29.6	32.1	34.4	36.5	37.7	40.2	42.6	48.7
Net interest payments	469.0	513.0	566.4	622.9	679.1	743.5	811.2	887.4	1072.3
Rental income	67.1	67.7	69.4	73.5	76.2	77.4	80.7	83.3	91.6
Indirect business taxes	465.7	484.6	508.1	539.2	565.2	602.4	627.8	665.8	740.8
Government subsidies	-14.5	-15.2	-16.2	-17.1	-18.2	-19.0	-20.2	-21.3	-23.9
Inflation (% ch in GNP dfl)	2.7	3.4	3.9	4.0	4.1	3.6	3.6	3.6	4.2
Inflation (% ch in PCE dfl)	2.5	3.5	3.9	4.2	4.1	4.0	3.7	4.0	4.3
Unemployment rate	5.5	4.6	4.5	4.5	5.0	4.9	4.8	4.6	4.7
Interest rate on AAA-rated bond	9.3	9.3	9.5	9.9	10.1	10.2	10.4	10.4	11.0
Interest rate on 3-month Treasu	7.4	7.8	8.1	8.6	8.8	8.9	9.5	9.6	10.6

as of May, 1990, so its forecast horizon is from 1991 through 2000.[61] The economy slows considerably in 1990, and then recovers with growth in real GNP of 2.5% for the next two years, 1991 and 1992. Another cyclical slowdown begins in 1993, as demand for fixed investment reacts to a slowing down of the rate of growth of overall demand. The recovery from the slowdown is modest, and GNP growth averages 2% per year from 1995 through 2000. The relatively modest rate of real growth is due to the assumed slow growth of the labor force and its implication of less potential GNP. Even with growth of only 2% per year, a large percent of the available labor force is employed, and the unemployment rate reaches a low of 4.7% by 2000. Given the slow growth of the money supply, as well as modest demand growth, inflation averages 3.7% per year over the forecast.

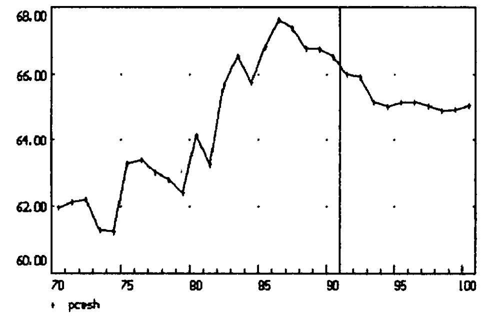
Figures 7.6(a)-(f) illustrate the changing share of the composition of GNP during the 1990's. As labor-force growth slows, Personal consumption expenditures and Residential structures comprise a smaller share of total GNP than in the preceding decade. Likewise, Government expenditures become a smaller share of the total economy. On the other hand, business investment in plant and equipment, as well as net exports increase in relative importance in terms of the composition of GNP. In the next decade, the U.S. undergoes a transition to a less consumer-oriented and more business- and foreign-market oriented economy.

The macroeconomic results of the forecast simply summarize the myriad industry-level interactions of the model. Table 7.3 shows growth rates of real output by product for the 78 product sectors in the model. The products are ranked according to their growth from 1990 to 2000. Products whose demand is driven by business investment and export growth

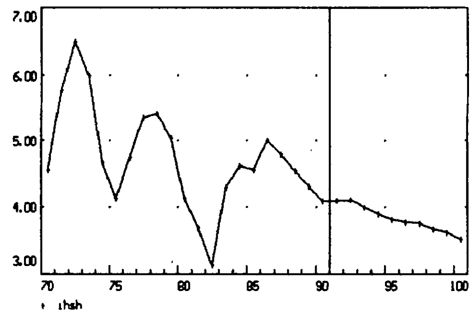
[61] Some variables are controlled through 1991, so the first true forecast year of the model is 1992. The forecast horizon for LIFT has since been extend to the year 2025, but for this study, the last year of the forecast will be 2000.

Figure 7.6: Composition of GNP in Base Forecast

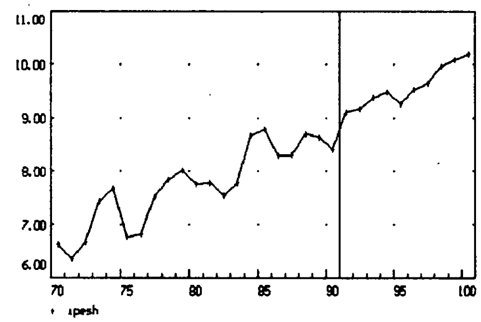
(a) Personal Consumption share of GNP



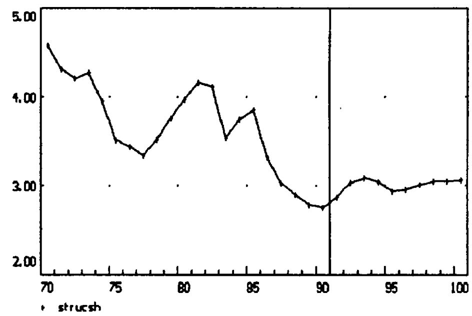
(b) Residential Structures share of GNP



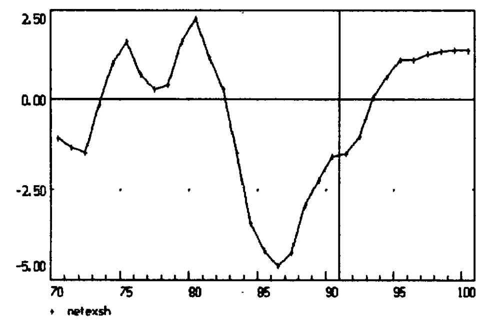
(c) Equipment Investment share of GNP



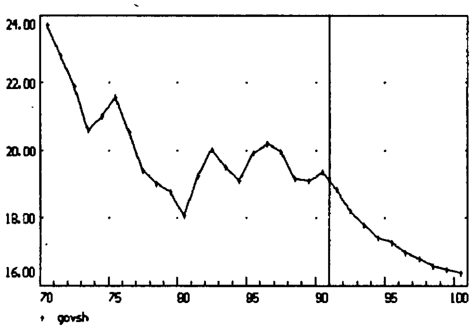
(d) Nonresidential Structures as share of GNP



(e) Net Exports share of GNP



(f) Government share of GNP



lead the list of top performers in the 1990's. The top ten fastest growing products include Engines and turbines, Electrical equipment, and Nonelectrical machinery. Six of the ten fastest growing products are among the top ten fastest growing exports for 1990-2000 (see Table 7.4). In addition, fifteen of the top twenty fastest growing products are included in the top twenty exporters, or are industries strongly related to foreign trade, such as Water and Air transportation, and Transportation services.

Another factor in achieving strong growth in the next decade involves changes in technology, as summarized by the assumptions for the input-output coefficients. Plastic products are in the top ten list of fast-growing items, while Ferrous metals are in the bottom ten, due, in part, to the substitution of plastic for steel in many products. The coefficients for plastics and steel reflect trends toward increased demand for plastic in products such as Motor vehicles, Computers, and Instruments, and decreased use of steel in those products.

Items that are consumer-driven, such as Retail trade, Food and tobacco, Owner-occupied housing, and Televisions are found at the bottom of the list. Other products that grow slowly over the 1990-2000 decade include those whose primary source of demand is the federal government, such as Aerospace and Other transportation equipment, which includes tanks.

The consumer-driven economy of the 1980's is replaced by an export and business-led economy from 1990 to 2000. Those industries that performed well in the 1980's are not likely to be the leaders of the next decade. When the products are ranked according to their growth from 1980 to 1990, and that ranking is compared to the ranking for 1990-2000, the rank correlation coefficient is -.18.[62]

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[62] The correlation coefficient of the sectoral ranks was computed. This is equivalent to calculating Spearman's rank correlation coefficient. See Moroney, Chapter 18.

Table 7.3: BASE: OUTPUT BY PRODUCING SECTOR (1977$)

summary of exponential annual growth rates
Ranked According To: 90-100

		80- 90	90- 95	95-100	90-100
(1)	Engines and turbines	-1.08	7.81	4.17	5.99
(2)	Computers	8.60	6.06	5.91	5.98
(3)	Construct, mining, oilfield equip	-3.36	8.78	1.78	5.28
(4)	Communic equip, electronic comp	4.26	6.27	4.13	5.20
(5)	Misc non-electrical machinery	1.24	5.54	3.45	4.50
(6)	Elec lighting & wiring equip	3.20	5.01	3.77	4.39
(7)	Elec indl apparatus & distrib	0.91	5.17	3.43	4.30
(8)	Transportation services	5.36	4.49	4.10	4.30
(9)	Plastic products	8.03	4.95	3.40	4.18
(10)	Agricultural machinery	-3.01	6.86	1.15	4.00
(11)	Air transportation services	5.01	4.05	3.86	3.96
(12)	Metalworking machinery	-0.48	5.05	2.86	3.96
(13)	Instruments	3.63	4.03	3.64	3.84
(14)	Household appliances	1.22	4.31	2.84	3.57
(15)	Other nonferrous metals	-0.06	4.02	2.81	3.41
(16)	Communication services	5.50	3.41	3.38	3.39
(17)	Water transportation services	1.46	3.82	2.86	3.34
(18)	Other office equipment	0.08	7.20	-0.66	3.27
(19)	Motor vehicles	3.77	3.39	3.14	3.26
(20)	Business services	4.93	3.18	3.16	3.17
(21)	Wholesale trade	4.22	3.29	2.79	3.04
(22)	Metal products	1.97	3.31	2.45	2.88
(23)	Furniture	2.92	2.85	2.87	2.86
(24)	Movies and amusements	5.72	2.59	2.99	2.79
(25)	Special industry machinery	-0.20	4.18	1.36	2.77
(26)	Unimportant industry	2.63	3.10	2.44	2.77
(27)	Service industry machinery	3.55	3.04	2.47	2.75
(28)	Natural gas utility	-2.96	2.62	2.77	2.70
(29)	Pipeline	0.67	2.79	2.60	2.69
(30)	Stone, clay, and glass	0.24	3.13	2.25	2.69
(31)	Trucking, hwy passenger transit	2.45	2.78	2.45	2.61
(32)	Lumber	1.93	3.13	2.09	2.61
(33)	Automobile repairs	5.04	2.37	2.63	2.50
(34)	Other chemicals	2.98	3.12	1.84	2.48
(35)	Textiles, excluding knits	1.01	2.98	1.94	2.46
(36)	Finance and insurance	3.68	2.35	2.49	2.42
(37)	Natural gas extraction	-1.26	2.30	2.51	2.41
(38)	Paper	3.09	2.36	1.99	2.17
(39)	Rubber products	3.39	2.35	1.93	2.14
(40)	Real estate	2.77	2.15	2.06	2.11

Table 7.3: BASE: OUTPUT BY PRODUCING SECTOR (1977$)

summary of exponential annual growth rates
Ranked According To: 90-100

(continued)

		80- 90	90- 95	95-100	90-100
(41)	Electric utilities	2.12	2.08	2.14	2.11
(42)	Medicine, education, npo	4.32	1.79	2.42	2.11
(43)	Misc. manufacturing	0.59	2.92	1.18	2.05
(44)	Railroads	0.96	2.41	1.66	2.03
(45)	Hotels; non-auto repairs	2.85	1.87	2.19	2.03
(46)	Printing and publishing	4.49	1.91	2.05	1.98
(47)	Eating and drinking places	0.78	1.84	2.02	1.93
(48)	Agriculture, forestry, fishery	0.86	2.27	1.56	1.91
(49)	Non-metallic mining	1.40	2.30	1.51	1.91
(50)	Retail trade	3.18	1.71	2.07	1.89
(51)	Water and sanitation	2.06	1.81	1.93	1.87
(52)	Agricultural fertilizers	0.52	2.30	1.27	1.79
(53)	Construction	1.96	1.75	1.82	1.79
(54)	Coal mining	1.69	1.84	1.63	1.73
(55)	Nonferrous metals mining	1.68	1.67	1.15	1.41
(56)	Apparel, household textiles	1.08	1.83	0.91	1.37
(57)	Knitting	1.45	1.34	1.39	1.37
(58)	Copper	0.18	1.82	0.85	1.34
(59)	Federal & S&L Govt enterprises	1.41	1.14	1.45	1.29
(60)	Aerospace	3.05	1.02	1.47	1.25
(61)	Food and tobacco	1.83	1.33	1.08	1.21
(62)	Petroleum refining	0.22	1.39	0.93	1.16
(63)	TV sets, radios, phonographs	3.76	2.24	0.08	1.16
(64)	Owner-occupied housing	1.91	0.99	0.96	0.98
(65)	Other transportation equipment	-5.78	-3.56	5.43	0.94
(66)	Crude petroleum	-2.19	0.68	0.13	0.41
(67)	Ferrous metals	-3.09	1.11	-0.30	0.41
(68)	Domestic servants	2.52	0.23	0.14	0.19
(69)	Shoes and leather	-4.37	-0.16	0.29	0.06
(70)	Non-competitive imports				
(71)	Government industry	2.67	-0.35	0.30	-0.02
(72)	Ships, and boats	-0.36	0.36	-0.42	-0.03
(73)	Iron ore mining	-0.96	0.34	-0.61	-0.13
(74)	Fuel oil	-1.63	0.39	-1.16	-0.38
(75)	Rest of the world industry	-8.35	-11.61	-9.60	-10.60

Table 7.4: BASE: EXPORTS BY PRODUCING SECTOR (billions of 1977$)

summary of exponential annual growth rates
Ranked According To: 90-100

		80- 90	90- 95	95-100	90-100
(1)	Construct, mining, oilfield equip	-6.25	18.85	2.08	10.47
(2)	Lumber	2.02	13.40	5.37	9.38
(3)	Furniture	6.07	11.98	6.46	9.22
(4)	Engines and turbines	0.62	12.09	5.38	8.74
(5)	Gas utilities	1.10	11.15	4.24	7.70
(6)	Electric indl appl & distrib equip	3.55	10.39	5.00	7.70
(7)	Plastic products	8.49	11.84	2.88	7.36
(8)	Misc non-electrical machinery	2.89	9.49	4.99	7.24
(9)	Electric lighting & wiring equip	6.98	8.67	5.28	6.98
(10)	Communication equip, electronics	12.14	9.05	4.88	6.96
(11)	Metal products	2.65	8.88	3.59	6.24
(12)	Trucking, highway passenger transit	2.68	8.26	4.19	6.23
(13)	Medicine, education, npo	7.32	6.78	5.61	6.20
(14)	Wholesale trade	3.24	8.24	4.15	6.19
(15)	Computers	11.64	5.94	5.43	5.68
(16)	Other office equipment	4.86	8.57	2.78	5.67
(17)	Instruments	5.37	6.81	4.30	5.56
(18)	Railroads	3.76	7.35	3.59	5.47
(19)	Household appliances	4.29	8.42	2.32	5.37
(20)	Motor vehicles	4.59	7.20	3.14	5.17
(21)	Service industry machinery	1.69	7.20	2.75	4.97
(22)	Metalworking machinery	0.48	7.34	2.60	4.97
(23)	Air transportation services	6.97	5.74	4.07	4.90
(24)	Finance and insurance	5.26	6.20	3.50	4.85
(25)	TV sets, radios, phonographs	9.71	5.78	3.82	4.80
(26)	Rubber products	5.52	6.24	3.25	4.75
(27)	Water transportation services	3.86	6.01	3.32	4.66
(28)	Paper	3.36	5.67	3.53	4.60
(29)	Agricultural machinery	-1.09	6.24	2.74	4.49
(30)	Scrap and used	1.72	5.67	3.30	4.49
(31)	Stone, clay, and glass	4.23	5.98	2.85	4.42
(32)	Other chemicals	3.37	6.25	2.32	4.29
(33)	Communications services	4.67	4.96	3.49	4.22
(34)	Printing and publishing	2.91	5.17	3.26	4.22
(35)	Aerospace	4.13	5.13	3.15	4.14
(36)	Real estate	3.54	4.85	3.29	4.07
(37)	Water and sanitation services	3.27	4.82	3.06	3.94
(38)	Other transportation equipment	1.89	3.60	3.92	3.76
(39)	Business services	3.25	4.05	3.02	3.53
(40)	Hotels, non-auto repairs	3.61	4.00	2.96	3.48

Table 7.4: BASE: EXPORTS BY PRODUCING SECTOR (billions of 1977$)

summary of exponential annual growth rates
Ranked According To: 90-100

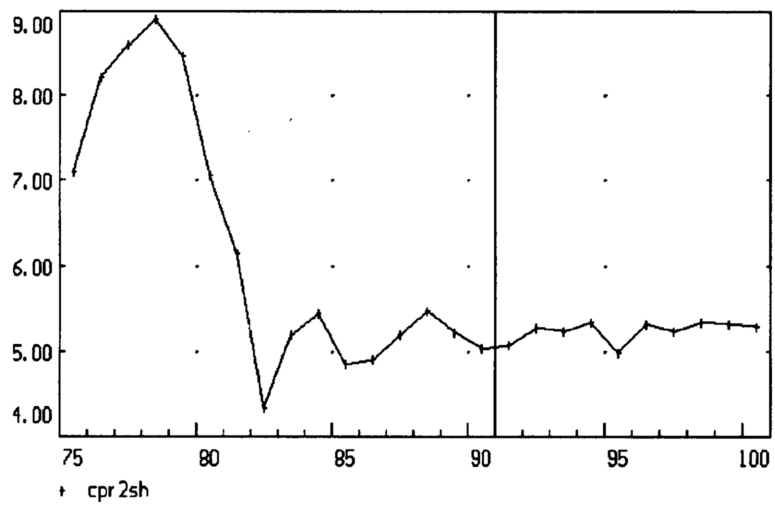
(continued)

		80- 90	90- 95	95-100	90-100
(41)	Federal & S&L govt enterprises	3.09	4.03	2.92	3.48
(42)	Misc. manufacturing	5.75	4.89	1.93	3.41
(43)	Construction	3.49	3.90	2.87	3.39
(44)	Agricultural fertilizers	1.27	4.68	1.97	3.32
(45)	Non-metallic mining	0.20	3.81	2.78	3.29
(46)	Food and tobacco	1.50	4.25	2.17	3.21
(47)	Movies and amusements	4.02	3.35	3.00	3.17
(48)	Textiles, excluding knits	0.78	4.25	1.68	2.96
(49)	Special industry machinery	0.95	6.14	-0.27	2.93
(50)	Apparel, household textiles	5.20	5.02	0.69	2.86
(51)	Agriculture, forestry, fishery	0.71	3.13	2.57	2.85
(52)	Other nonferrous metals	8.28	2.92	2.20	2.56
(53)	Ships and boats	-2.92	2.93	1.95	2.44
(54)	Petroleum refining	4.63	2.72	1.99	2.36
(55)	Knitting	1.69	3.58	1.01	2.29
(56)	Transportation services	2.27	1.76	2.20	1.98
(57)	Coal mining	0.72	1.72	1.68	1.70
(58)	Pipelines	-0.28	1.76	1.58	1.67
(59)	Electric utilities	3.76	0.79	2.26	1.53
(60)	Shoes and leather	4.26	0.85	1.24	1.05
(61)	Nonferrous metals mining	11.21	1.20	0.70	0.95
(62)	Crude petroleum	-14.53	0.00	0.00	0.00
(63)	Iron ore mining	-3.41	0.47	-0.48	-0.01
(64)	Rest of the world industry	2.55	0.04	-0.38	-0.17
(65)	Fuel oil	11.80	-0.18	-0.18	-0.18
(66)	Copper	4.59	-1.67	-1.74	-1.71
(67)	Ferrous metals	-9.66	-16.47	-6.19	-11.33

Industry Profits in the Base Forecast

The forecast of profits by industry reflects the changes in demand and costs that occur over the business cycles in the overall forecast. The industry profit margins are summarized in Figures 7.7(a)-(aj), which illustrate the margins from 1970 to 2000.[63] As expected, those industries whose profits are sensitive to demand changes show a relatively cyclical response of profits over the forecast period. Some of the most cylical industries include: Construction; Paper; Stone, clay and glass; Motor vehicles; Miscellaneous manufacturing; Wholesale and retail trade; Finance and insurance; and Movies and amusements. In general, no industry profit margin exhibits any signifcant trend over the forecast, and total Corporate profits retain a reasonable share of nominal GNP. (See Figure 7.8)

Figure 7.8: Profits as share of GNP
Domestic before-tax profits (less computer industry) as share of nominal GNP



[63] The profit margin is the ratio of Before-tax corporate profits, adjusted for Capital Consumption Allowances and Inventory Valuation, as a share of nominal output.

Figure 7.7: Forecast of profit margins in Base forecast

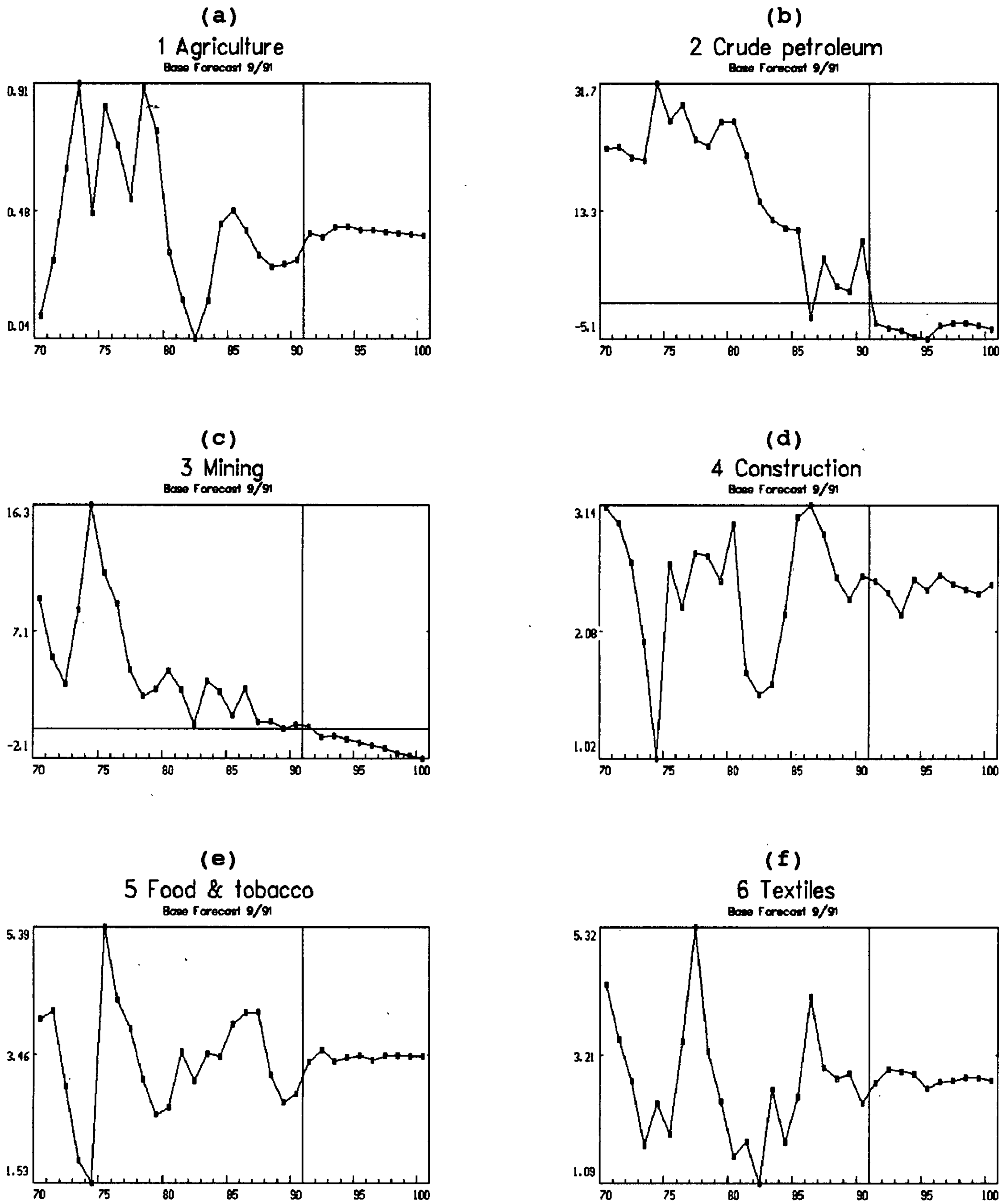
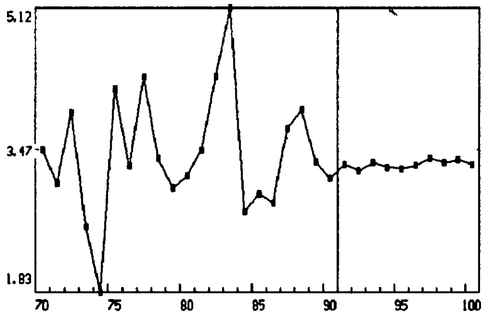


Figure 7.7 (continued)

(g)

7 Apparel

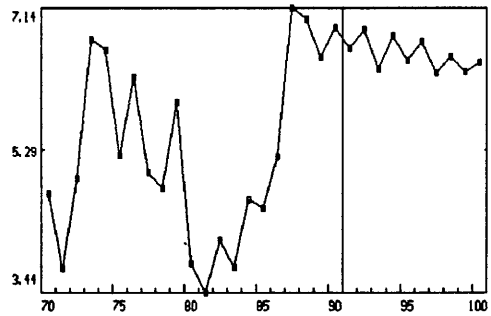
Base Forecast 9/91



(h)

8 Paper

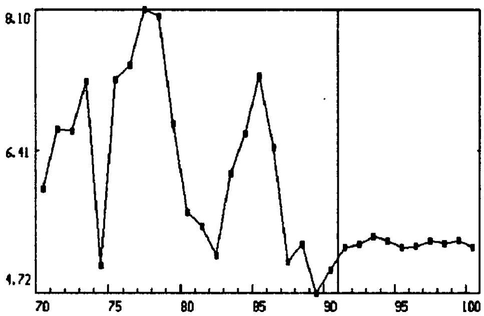
Base Forecast 9/91



(i)

9 Printing

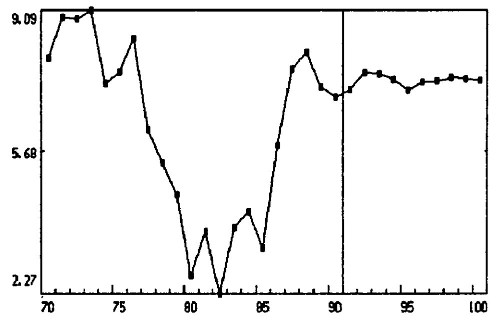
Base Forecast 9/91



(j)

10 Chemicals

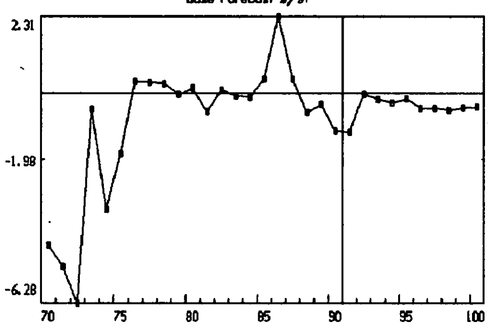
Base Forecast 9/91



(k)

11 Petroleum refining

Base Forecast 9/91



(l)

12 Rubber & plastics

Base Forecast 9/91

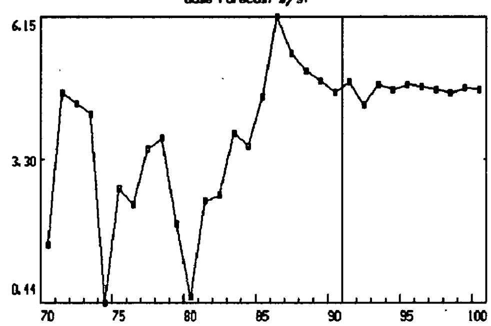


Figure 7.7 (continued)

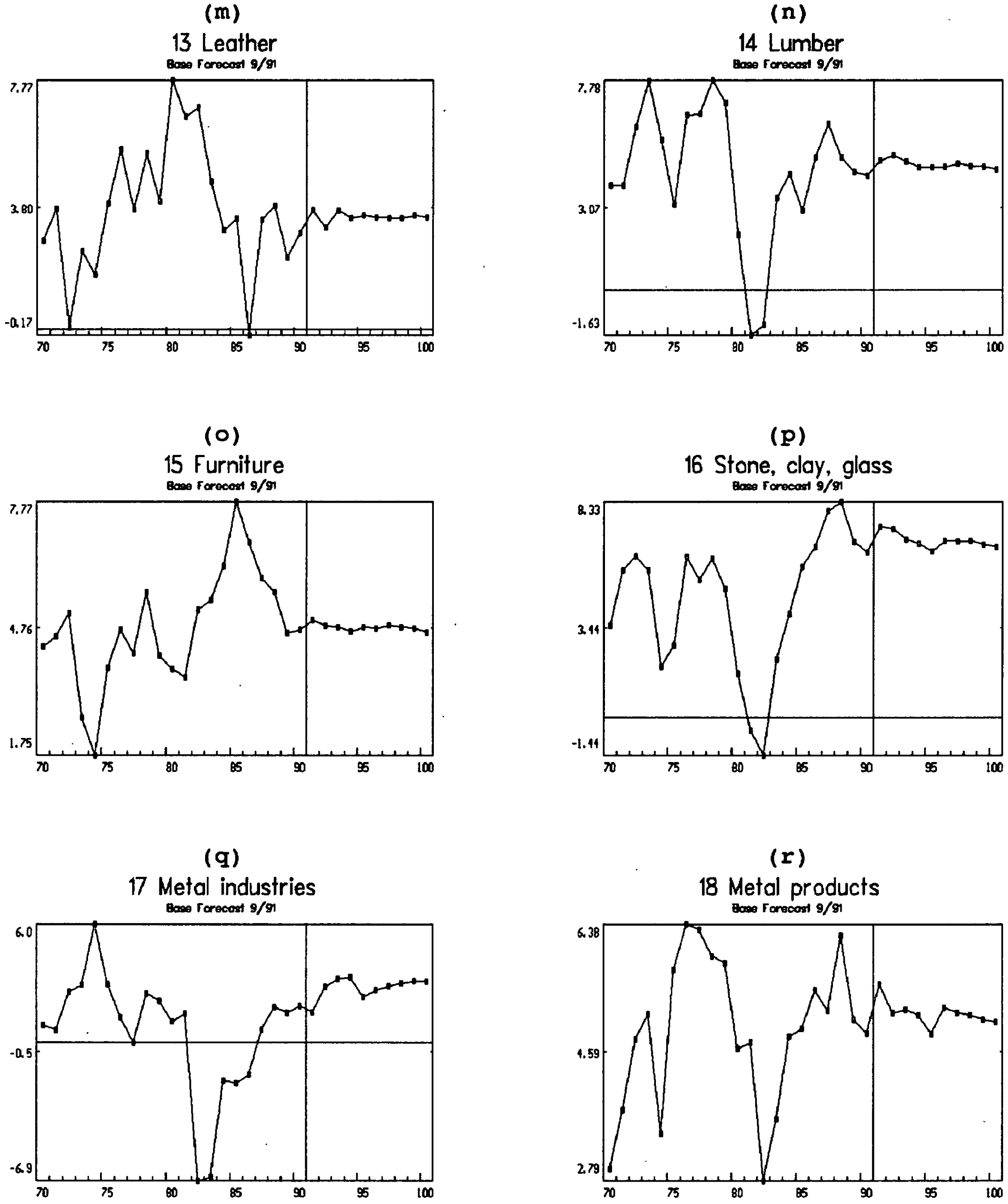


Figure 7.7 (continued)

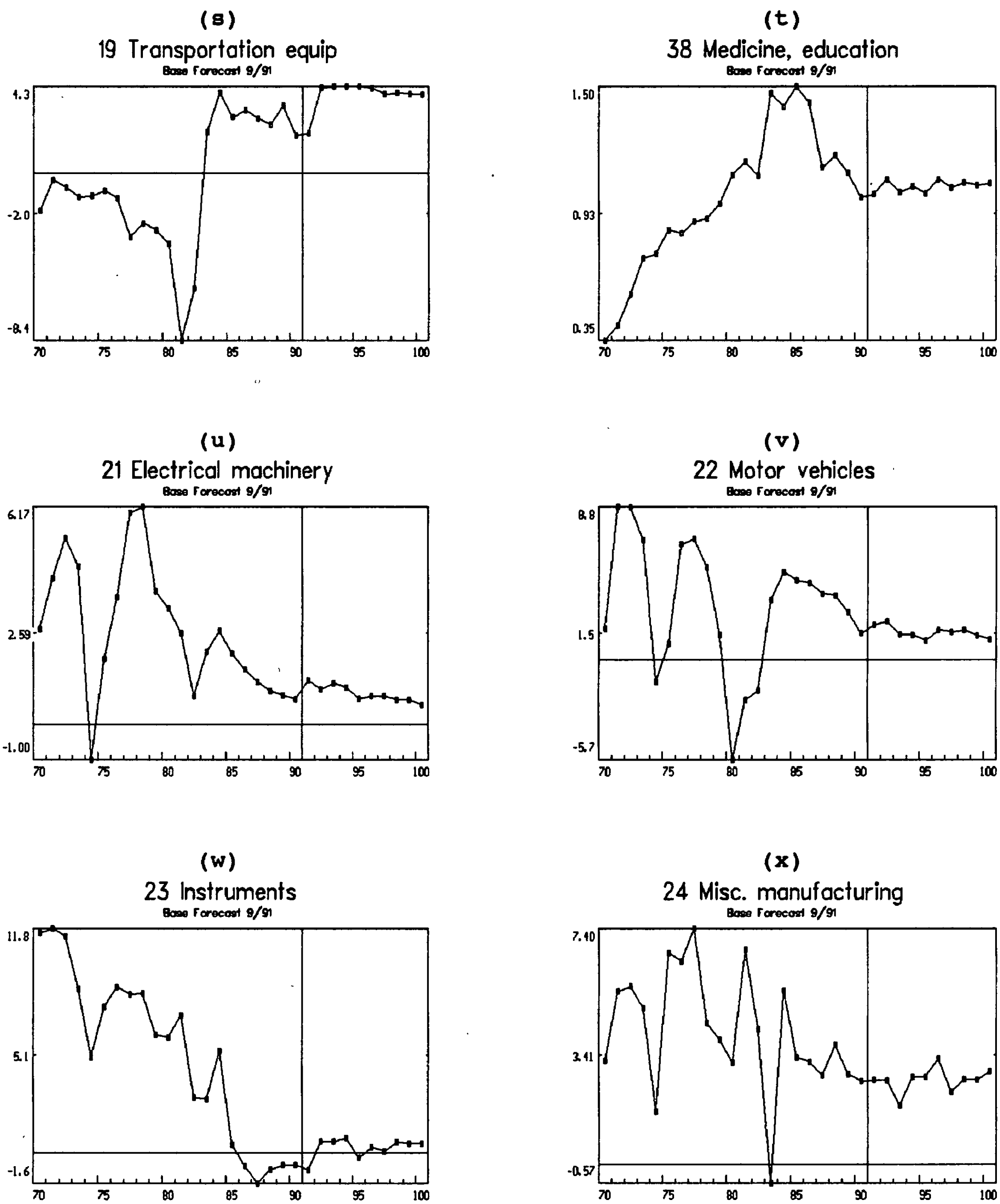
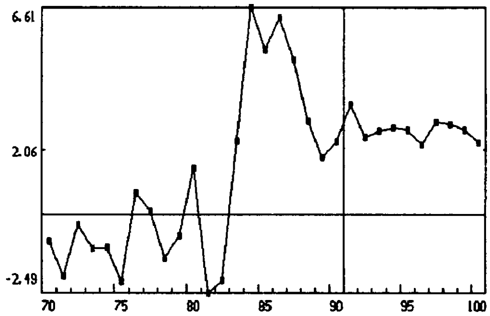


Figure 7.7 (continued)

(y)

25 Railroads

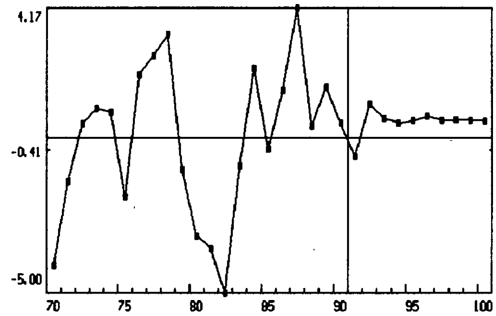
Base Forecast 9/91



(z)

26 Air transportation

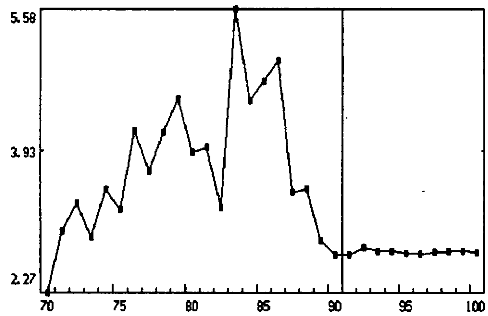
Base Forecast 9/91



(aa)

27 Trucking

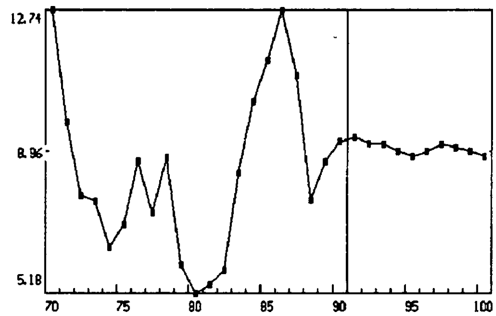
Base Forecast 9/91



(ab)

28 Communications

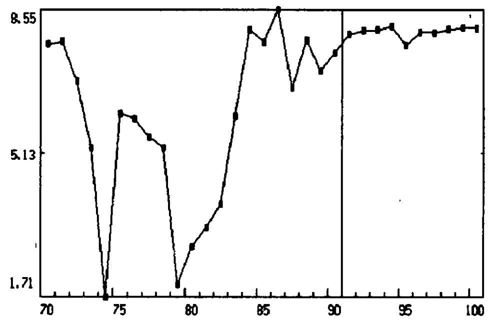
Base Forecast 9/91



(ac)

30 Utilities

Base Forecast 9/91



(ad)

31 Wholesale and retail

Base Forecast 9/91

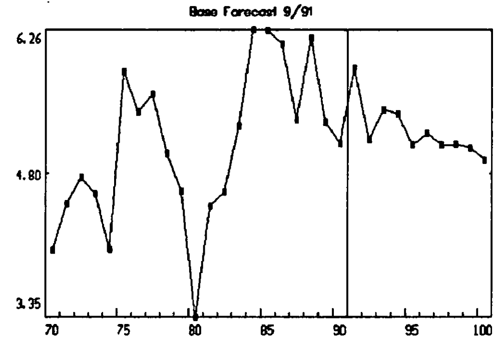
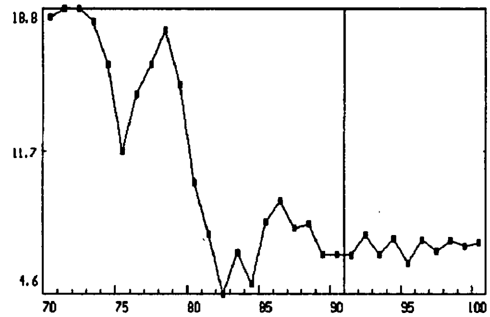


Figure 7.7 (continued)

(ae)

32 Finance and insurance

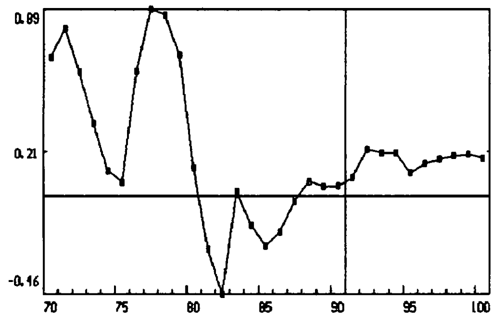
Base Forecast 9/91



(af)

33 Real estate

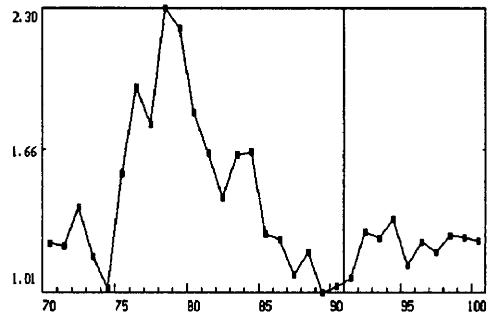
Base Forecast 9/91



(ag)

34 Hotels and repair

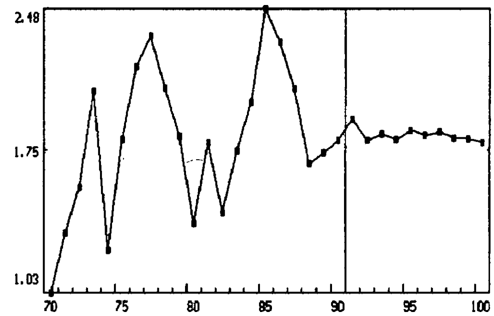
Base Forecast 9/91



(ah)

35 Business services

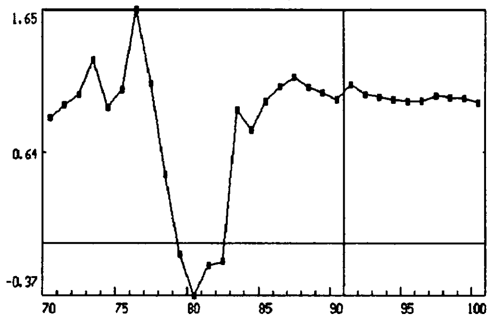
Base Forecast 9/91



(ai)

36 Auto repair

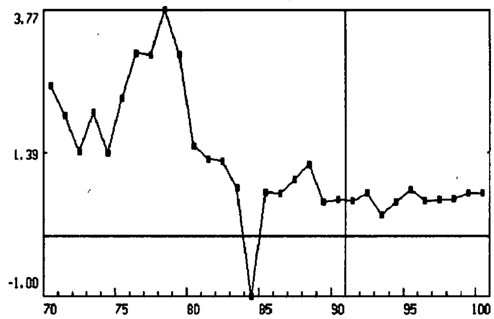
Base Forecast 9/91



(aj)

37 Motion pictures

Base Forecast 9/91



Oil-price Shock in LIFT

The oil-price shocks of the 1970's had a major impact on the U.S. economy, and on the way economists think about the economy. The combination of high inflation and high unemployment that occurred after the oil-price shock in 1973 led to a breakdown in the consensus views on macroeconomic policy, since it contradicted the Keynesian trade-off between inflation and unemployment.[64] Although interest in oil-price shocks waned in recent years, as oil prices stabilized, the Iraqi invasion of Kuwait in August 1990 again sparked interest in the effects of oil-price shocks on the U.S. economy. LIFT is an especially appropriate model for analyzing an industry-level supply shock, such as an increase in the price of oil, because of its focus on industry behavior and inter-industry relationships. In LIFT, increased oil prices will have an effect on the Motor vehicle industry different from the effect on the Food and tobacco industry, for example. In addition, analyzing an oil-price shock in LIFT tests the properties of the industry profit equations developed for this study, since profits are responsive to changes in input costs, such as petroleum.

The effect of an oil-price shock in LIFT is determined, in part, by the interindustry relationships of the petroleum industry with the rest of the economy. Figure 7.9 illustrates some of the direct and indirect channels by which petroleum is linked to other industries. The largest user of Crude petroleum is the Petroleum refining industry, as shown in the first column of the figure. As the second and third columns show, the output of Petroleum refining is then used as an input by the producing sectors in LIFT. In addition, its output is

---

[64] Mankiw asserts that the breakdown in a consensus was the result of two flaws, both of which were crucial. The empirical flaw was the failure of the consensus view to cope adequately with the high inflation and high unemployment of the 1970s. In addition, the consensus embodied a wide gap between microeconomic principles and macroeconomic principles, which was "too great to be intellectually satisfying." (page 5)

Figure 7.9: Interindustry Flows for Crude petroleum

Output of Crude petroleum
27,579 million 1977$

↓

Sales to Intermediate Demand:	
Crude petroleum	2,391
Chemicals	539
Petroleum refining	48,877
Total to intermed	51,685

→

Output of Petroleum refining
99,483

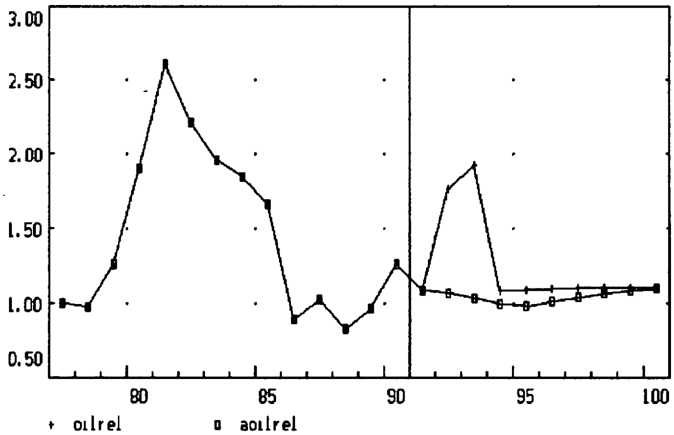
→

Sales to Intermediate Demand:	
Agriculture	2,273
Coal mining	207
Construction	1,910
Food & tobacco	246
Paper	280
Printing	333
Chemicals	8,594
Petroleum refin	6,189
Fuel oil	18,990
Lumber	254
Nonferrous metals	331
Trucking	1,334
Air transport	6,073
Communications	336
Electric utilit	376
Water/sanitation	519
Wholesale trade	2,597
Retail trade	2,377
Eating & drink	279
Finance, insur	611
Real estate	452
Hotels, repairs	277
Business services	1,315
Auto repairs	1,037
Medicine,educat	1,655
Total intermed	62,926
Sales to Final demand:	
<u>Construction</u>	
1 unit residential	929
2 or more unit	223
Additions/alterations	342
Stores,restuarants	278
Highways & streets	1,362
Total Construction	4,802
<u>Personal Consumption</u>	
Gasoline & oil	26,583
Fuel oil & coal	906
Total PCE	27,489
<u>Other final demand</u>	
Defense	3,500
State & local	1,975
Exports	4,401
Imports	-6,956
Total Other	1,411

sold directly to several types of Construction sectors, as well as to two major PCE categories. The indirect effects of an increase in the price of Crude petroleum are quite widespread. The links illustrated in this figure are, of course, only a partial picture of the complex interindustry relationships that comprise the LIFT model.

Figure 7.10 illustrates the assumption for the Oil-price shock. The graph shows the implicit deflator for Crude petroleum relative to the GNP deflator in the Base forecast and in the Oil shock scenario.[65] In the shock forecast, the relative price of oil is assumed to double over two years, 1992 and 1993. The oil crisis ends in the following year, and the relative price returns to its pre-shock level. From 1995 to 2000, the relative price of oil remains stable, as in the Base forecast.

Figure 7.10: Assumption - Oil-price Shock
deflator for Crude petroleum/ GNP deflator



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[65] The domestic price of Crude petroleum and the price of imported petroleum are assumed to be equal to each other in both the Base forecast and in the Shock scenario. See also Table 7.5.

Table 7.5 summarizes the macroeconomic results of the Oil-price shock. As inflation rises, implying not only higher prices but also a relative decline in real income, Personal consumption expenditures decline (compared to the Base forecast). Most of the $15 billion decline in GNP in the first year of the shock is attributable to a reduction in Consumption. In response to lower demand in the economy, investment in Producer durable equipment likewise is lower after the oil-price shock than in the Base forecast. As inflation rises domestically, relative domestic to foreign prices also rise, hurting exports slightly. Imports, on the other hand, are more affected by the slowdown in real disposable income than by changes in relative foreign to domestic prices, and imports are lower after the oil-price shock than in the Base forecast. The decline in demand is reflected in the desire of firms to hire workers, and unemployment increases by .3% in the first year of the shock, and by .5% and .7% in the following two years.

The economy responds slowly to the fall in the oil-price in 1994, when the price returns to its pre-shock level (roughly equal to its value in the Base forecast for that year). The rate of inflation falls in 1994, and demand for Personal consumption and Equipment investment responds in 1995. One of the main differences between the Base forecast and the Oil-price shock scenario is in the pattern of growth. The Base forecast includes a growth recession, where growth slows from 2.7% in 1992 to 0.8% in 1995. In contrast, the year 1995 in the Oil-price scenario marks a recovery from the oil-price shock and a year of an increase in GNP growth compared to prior years. As expected, the temporary Oil-price shock does not affect the long-run growth potential of the economy, and in the Oil-price scenario the average growth of GNP from 1996-2000 is close to 2% per year: the average growth in the Base forecast. Likewise, the change in total GNP is not permanent, and by 2000 the difference between GNP in the two scenarios is only one tenth of a percent. (See Figure 7.11, as well as Table 7.5).

Table 7.5: Macroeconomic Results of Oil-price Shock

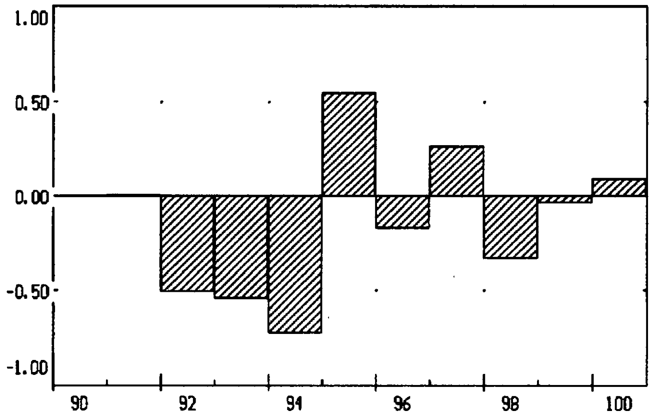
result for Base forecast
and difference = value in Oil-shock forecast - value in Base forecast
% difference = difference as a percent of value in Base forecast

Billions of 1977$	1992	1993	1994	1995	1996	1997	1998	2000
Gross national product	2885.1	2937.9	2994.6	3017.4	3087.2	3140.1	3211.7	3323.9
Difference	-14.6	-15.8	-21.6	16.4	-5.2	8.3	-10.5	2.9
% difference	-0.5	-0.5	-0.7	0.5	-0.2	0.3	-0.3	0.1
Personal consumption	1902.1	1913.8	1946.3	1965.4	2010.6	2041.4	2083.8	2161.6
Difference	-14.5	-20.6	-23.5	2.6	-12.0	-1.7	-8.3	0.7
% difference	-0.8	-1.1	-1.2	0.1	-0.6	-0.1	-0.4	0.0
Fixed investment	470.2	483.3	491.2	482.9	502.3	515.2	535.7	557.2
Difference	-4.4	0.5	-0.6	17.6	3.4	8.7	-6.6	0.6
% difference	-0.9	0.1	-0.1	3.6	0.7	1.7	-1.2	0.1
Durable equipment	264.5	275.6	284.0	279.4	294.6	303.1	320.0	338.7
Difference	-5.9	-5.7	-5.9	9.4	0.6	5.8	-4.9	-0.3
% difference	-2.2	-2.1	-2.1	3.4	0.2	1.9	-1.5	-0.1
Nonresid structures	87.4	90.5	90.9	88.4	91.3	94.5	97.8	101.7
Difference	2.2	5.4	3.3	4.6	1.2	2.5	-0.8	-0.2
% difference	2.5	6.0	3.6	5.3	1.4	2.7	-0.8	-0.1
Residential structures	118.2	117.3	116.4	115.1	116.4	117.7	117.8	116.8
Difference	-0.6	0.8	2.0	3.6	1.6	0.4	-0.9	1.0
% difference	-0.5	0.7	1.7	3.1	1.3	0.3	-0.8	0.8
Exports	431.7	463.6	492.3	511.9	529.7	545.6	561.9	592.8
Difference	-0.3	-0.5	-0.9	-0.7	0.3	1.2	1.4	0.8
% difference	-0.1	-0.1	-0.2	-0.1	0.1	0.2	0.3	0.1
Imports	461.6	462.7	473.3	478.5	495.2	505.1	518.0	547.0
Difference	-5.4	-5.0	-3.7	5.0	-3.1	0.6	-4.1	-0.8
% difference	-1.2	-1.1	-0.8	1.0	-0.6	0.1	-0.8	-0.1
Disposable income (72$)	1455.0	1480.2	1500.2	1517.0	1544.1	1577.2	1609.9	1678.7
Difference	-17.1	-30.8	-19.6	-5.1	-1.7	-3.0	-2.6	0.5
% difference	-1.2	-2.1	-1.3	-0.3	-0.1	-0.2	-0.2	0.0

Percent:	1992	1993	1994	1995	1996	1997	1998	2000
Inflation (GNP deflator)	3.4	3.9	4.0	4.1	3.6	3.6	3.6	4.2
Oil-price scenario	3.7	3.3	3.5	3.8	3.9	4.0	3.9	4.3
Inflation (PCE deflator)	3.5	3.9	4.2	4.1	4.0	3.7	4.0	4.3
Oil-price scenario	4.8	4.1	2.5	3.6	3.8	4.2	4.1	4.2
Unemployment rate	4.6	4.5	4.5	5.0	4.9	4.8	4.6	4.7
Oil-price scenario	4.9	5.0	5.2	4.9	4.9	4.7	4.8	4.6
Growth of real GNP	2.7	1.8	1.9	0.8	2.3	1.7	2.3	1.7
Oil-price scenario	2.1	1.8	1.7	2.0	1.6	2.2	1.7	1.8

Assumption:	1992	1993	1994	1995	1996	1997	1998	2000
Price of oil $/bl	19.25	19.33	19.42	19.50	20.00	21.40	22.80	25.60
Oil-price scenario	32.00	36.00	21.00	22.00	23.00	24.00	25.00	27.00
difference	12.75	16.67	1.58	2.50	3.00	2.60	2.20	1.40
Growth rate	1.3	0.4	0.4	0.4	2.6	7.0	6.5	5.8
Oil-price scenario	68.4	12.5	-41.7	4.8	4.5	4.3	4.2	3.8

Figure 7.11
% Difference in GNP due to Oil Shock
real GNP in Oil shock - real GNP in Base



The macroeconomic results summarized so far reflect the interaction of the industry responses in LIFT to the oil-price shock. Table 7.6 summarizes the effect of the oil price shock on industry output by listing the percent difference in output between the Base forecast and the Oil-price scenario for each product. The differences are ranked from largest decrease to smallest in the first year of the shock, 1992. Those industries hardest hit by the oil-price shock are those that are affected directly by an increase in oil prices, such as Petroleum refining, and Pipelines. For these products, an increase in the cost of oil increases their price and lowers demand. In addition, however, there are several products at the top of the list which are affected indirectly by the oil-price change. These are products which may not be linked directly to oil, but that are affected by changes in real income. The higher inflation caused by the oil-price shock leads to a decrease in demand for income-sensitive products, such as Motor vehicles, Transportation equipment, Furniture, and Office equipment. (Demand for Motor vehicles also is affected directly by a change in oil prices, since cars and gasoline are complementary goods.) Products listed at the bottom of the list benefit from the increase in oil prices. Demand for Construction, mining, and oilfield equipment increases, for example, as an increase in oil prices stimulates exploration and drilling for oil.

In the long run, as the oil price returns to its Base forecast level and changes in real income dissipate, output for most industries is little changed due to the oil-price shock. The percent change in output ranges from -3.1% to .59% in 1992, with only six industries where output is greater after the oil price increase. In contrast, the percent change in output ranges from -2.9% to 1.9% in 2000, and fifty-eight industries experience a small increase in output. A rank correlation coefficient computed for the ranking of output differences in 1992 and 2000 shows that the industries most affected by the shock initially, are not likely to be affected most in the long run. The rank correlation coefficient equals -.119.

The industry profit equations developed in Chapter 4 explicitly consider changes in input costs in determining profit margins. Since petroleum is a pervasive input in production, a change in the price of oil should affect profits by industry. Table 7.7 illustrates the difference in profit margins by industry between the Oil price shock and the Base forecast. As input costs rise in 1992, the profit margin for most industries falls. The exceptions are those industries in which an increase in input costs is passed more than fully into prices, temporarily, through an increase in the profit margin, such as Rubber and plastic products, Air transportation, Electric, gas, and sanitary utilities, and the Medical and education industry.

Table 7.6: Industry Effects of Oil-price Shock

Percent difference in Output: Oil price shock - Base Forecast ranked according to difference in 1992

And rank in the year 2000

		1992	1995	2000	Rank 2000
(1)	Motor vehicles	-3.122	2.917	0.091	(35)
(2)	Crude petroleum	-2.660	-0.083	0.034	(21)
(3)	Metalworking machinery	-2.522	4.697	-0.323	(4)
(4)	Fuel oil	-2.511	-0.644	-0.041	(8)
(5)	Other transportation equipm	-2.446	4.525	-2.851	(1)
(6)	Office equipment	-2.238	3.275	0.574	(68)
(7)	Petroleum refining	-2.122	-0.122	0.014	(16)
(8)	Pipeline	-1.961	0.018	0.023	(19)
(9)	Service industry machinery	-1.693	2.621	0.176	(49)
(10)	Furniture	-1.389	1.910	-0.036	(9)
(11)	Computers	-1.389	2.163	-0.084	(6)
(12)	Copper	-1.254	1.940	0.116	(37)
(13)	Nonelect machinery	-1.155	1.932	0.066	(29)
(14)	Retail trade	-1.109	0.454	-0.056	(7)
(15)	Spec ind machinery	-0.979	1.708	0.271	(61)
(16)	Textiles	-0.930	0.545	0.209	(55)
(17)	Shoes	-0.927	-2.088	1.924	(71)
(18)	Instruments	-0.914	1.217	0.297	(65)
(19)	Rubber	-0.914	1.021	0.107	(36)
(20)	Lumber	-0.881	2.057	0.496	(77)
(21)	Plastic	-0.877	0.905	0.253	(60)
(22)	Elec lighting and wiring	-0.872	1.069	0.297	(64)
(23)	Wholesale trade	-0.855	0.859	0.073	(31)
(24)	Ships boats	-0.851	0.854	-2.845	(2)
(25)	Other nonferrous metals	-0.847	1.199	0.031	(20)
(26)	Air transport	-0.834	-0.462	-0.001	(13)
(27)	Communic equipment	-0.828	1.290	0.251	(59)
(28)	Metal products	-0.799	1.465	0.047	(24)
(29)	Engines and turbines	-0.789	0.707	-0.026	(11)
(30)	Knitting	-0.784	-0.131	0.135	(40)
(31)	Electrical appliances	-0.769	1.351	0.212	(56)
(32)	Water transport	-0.759	0.528	0.059	(28)
(33)	Chemicals	-0.749	0.103	0.202	(53)
(34)	Water and sanitation	-0.740	0.541	0.154	(46)
(35)	Ferrous metals	-0.713	2.619	0.021	(17)
(36)	Transportation services	-0.698	-0.144	0.040	(22)
(37)	Household appliances	-0.668	0.645	-0.220	(5)
(38)	Apparel	-0.663	0.009	0.198	(52)
(39)	TVs radios phonographs	-0.654	1.276	0.800	(70)
(40)	Railroads	-0.651	0.743	0.088	(34)

Table 7.6: Industry Effects of Oil-price Shock

Percent difference in Output: Oil price shock - Base Forecast
ranked according to difference in 1992

continued

		1992	1995	2000	Rank 2000
(41)	Stone, clay, glass	-0.649	1.868	0.192	(50)
(42)	Hotels	-0.641	0.752	0.153	(45)
(43)	Govt enterprises	-0.627	0.781	0.135	(41)
(44)	Paper	-0.563	0.365	0.135	(42)
(45)	Movies and amusements	-0.547	1.160	0.194	(51)
(46)	Medicine, education, npo	-0.523	-0.368	0.042	(23)
(47)	Nonmetallic mining	-0.510	0.961	0.171	(48)
(48)	Misc manufacturing	-0.508	0.325	0.286	(63)
(49)	Nonferrous metals mining	-0.506	0.490	0.058	(27)
(50)	Business services	-0.482	0.559	0.066	(30)
(51)	Real estate	-0.472	0.468	0.133	(39)
(52)	Aerospace	-0.467	-0.038	-0.820	(3)
(53)	Auto repairs	-0.461	0.729	0.057	(26)
(54)	Printing	-0.451	0.309	0.078	(32)
(55)	Communication services	-0.445	0.383	0.012	(15)
(56)	Trucking	-0.426	0.782	0.083	(33)
(57)	Finance and insurance	-0.403	0.244	-0.035	(10)
(58)	Iron mining	-0.315	0.788	0.053	(25)
(59)	Gas utilities	-0.166	1.146	0.250	(58)
(60)	Agric fertilizers	-0.145	-0.036	0.229	(57)
(61)	Natural gas extraction	-0.130	-0.275	0.276	(62)
(62)	Eating and drinking	-0.122	-0.483	0.160	(47)
(63)	Coal mining	-0.096	0.372	0.011	(14)
(64)	Agric machinery	-0.029	0.500	0.479	(66)
(65)	Construction	-0.013	1.761	0.147	(44)
(66)	Rest of world	0.022	-0.004	-0.002	(12)
(67)	Agriculture	0.042	0.139	0.139	(43)
(68)	Food and tobacco	0.213	0.012	0.128	(38)
(69)	Owner occupied housing	0.221	-0.513	0.583	(69)
(70)	Electric utilities	0.307	0.331	0.022	(18)
(71)	Const mining oilfield equip	0.590	1.265	0.204	(54)

The magnitude of the change in the profit margin depends on the sensitivity of the margin to changes in input costs, as well as on the relative importance of oil as an input into the production process, both directly and indirectly, for each industry. For example, the profit margin for Instruments ranks fourth in the list of margins with the largest decrease in 1992, while Wholesale and retail trade ranks eighth. The equation for each industry depends on input costs, labor costs, and demand, as measured by the change in the inverse of the unemployment rate. The profit margin for Instruments has a larger response to a one percent change in input costs (-.22) than does the profit margin for Wholesale and retail trade (-.05), so it is not surprising that Instruments ranks above Trade in terms of the initial effect of the oil-price shock on profits. On the other hand, Petroleum represents a much larger percent of material costs for Trade than for Instruments. In 1985, for instance, the constant-dollar cost of petroleum inputs was 3% of the total cost of material inputs for Trade, while only 0.7% of the cost of inputs for Instruments. Given this difference in the importance of Petroleum as a direct input into production, the stronger response of Instruments may seem unreasonable. However, Petroleum also affects the costs of production for Instruments indirectly. Since prices are defined by the input-output equation, based on the Leontief inverse, both the direct and indirect costs are accounted for in deterimining prices. One of the largest costs for producing Instruments are Rubber and plastic products, for example, which were 11% of total costs in 1985. (Rubber and plastic products are less than .2% of costs for Wholesale and retail trade.) As noted, the profit margin for Rubber and plastic increases due to the oil price shock, and an increase in costs is more than fully passed through to prices. The price of Rubber and plastic components for Instruments therefore increases due to the oil shock, leading to a substantial increase in the unit costs of production and a fall in the profit margin for Instruments.

Table 7.7: Effect of Oil-price shock on Profit Margins

Difference between profit margin in Oil-price scenario and Profit margin in Base forecast

Profit margin equals Before-tax profits, adjusted for CCA and IVA as percent of nominal output

ranked by difference in 1992

	1992	1993	1994	1995	1996	1997	1998	2000
(1) Transport equip	-1.111	-4.079	0.130	2.756	2.737	2.915	2.976	2.876
(2) Petroleum refining	-0.976	-1.768	0.613	0.837	0.079	0.014	0.155	0.073
(3) Railroads	-0.954	-0.042	0.993	-0.396	0.663	-0.153	-0.366	0.501
(4) Instruments	-0.710	-0.651	-0.974	0.505	-0.287	0.243	-0.444	-0.038
(5) Motor vehicles	-0.536	-0.022	0.820	0.737	-0.319	-0.138	-0.427	0.087
(6) Financial insurance	-0.437	-0.222	-0.812	0.881	-0.756	0.588	-0.449	0.037
(7) Electrical machiner	-0.357	-0.160	0.316	0.252	0.043	-0.073	-0.114	0.039
(8) Wholesale retail tr	-0.309	0.122	-0.000	-0.219	-0.003	0.081	-0.073	0.002
(9) Stone clay glass	-0.303	-0.045	0.217	0.463	-0.162	-0.026	-0.291	0.063
(10) Printing	-0.302	-0.149	0.110	0.036	0.030	-0.058	-0.061	0.024
(11) Communications	-0.285	-0.090	0.224	0.443	0.256	-0.186	-0.135	0.037
(12) Primary metal	-0.259	-0.500	-1.341	-0.128	-0.144	0.066	-0.203	0.101
(13) Furniture	-0.208	0.015	0.435	0.029	-0.037	-0.159	-0.088	0.010
(14) Textile mills	-0.208	-0.184	-0.140	0.112	-0.022	0.014	-0.086	0.024
(15) Misc manufacturing	-0.170	0.231	-0.327	-0.057	-0.963	0.456	-0.076	-0.301
(16) Apparel	-0.153	0.106	0.216	-0.134	0.001	-0.032	0.022	0.042
(17) Auto repair	-0.121	-0.037	0.170	0.051	0.017	-0.028	-0.017	0.011
(18) Lumber	-0.119	0.010	0.199	0.109	0.003	-0.164	-0.057	0.071
(19) Chemicals	-0.109	-0.033	-0.178	-0.161	-0.153	-0.005	-0.157	0.013
(20) Leather	-0.098	0.359	0.048	-0.707	-0.175	0.167	0.268	0.027
(21) Food	-0.097	-0.082	0.162	0.017	-0.005	0.011	0.022	-0.005
(22) Hotels repair	-0.091	-0.127	-0.184	0.113	-0.064	0.065	-0.082	0.010
(23) Metal products	-0.076	0.158	0.048	0.010	-0.229	0.014	-0.079	0.062
(24) Paper	-0.067	-0.159	-0.034	0.350	-0.209	0.286	-0.158	-0.147
(25) Real estate	-0.050	-0.066	-0.103	0.037	-0.014	0.001	-0.045	0.022
(26) Construction	-0.050	0.145	0.070	0.019	-0.184	0.016	-0.051	-0.092
(27) Trucking	-0.048	-0.164	-0.010	0.158	0.055	0.008	-0.014	0.008
(28) Business services	-0.042	0.009	0.110	-0.012	0.032	-0.032	0.004	-0.011
(29) Motion pictures	-0.037	-0.023	0.103	-0.183	-0.057	0.057	0.098	-0.010
(30) Agriculture	-0.005	0.002	0.001	-0.003	-0.001	0.007	-0.004	0.003
(31) Mining	0.007	0.396	-0.020	-0.590	-0.126	-0.033	0.181	0.036
(32) Electric gas sanita	0.009	0.749	0.614	0.677	-0.967	0.115	0.045	0.189
(33) Medical educational	0.010	0.017	-0.043	0.023	-0.045	0.024	-0.015	0.003
(34) Rubber plastic	0.044	0.078	0.212	-0.260	-0.017	-0.068	0.132	-0.047
(35) Nonelect machinery	0.049	0.046	0.166	0.033	0.266	0.139	0.278	0.157
(36) Air transportation	0.684	-1.756	-1.330	1.889	0.178	-0.104	-0.068	0.049
(37) Crude oil	13.213	4.125	-6.855	-1.966	-1.946	-1.697	-1.660	-1.013

Sensitivity to demand also affects the response of the profit margins to the oil-price shock. For instance, the profit margin for Finance and insurance has the sixth-largest drop in the first year of the oil shock, even though the coefficient for an increase in costs is positive. Profits in the Finance and insurance industry are sensitive to demand changes, measured by changes in industry output and changes in the unemployment rate. As real income falls, due to higher inflation, Personal consumption expenditures on income-sensitive products fall. The income elasticity of Brokerage and investment counseling is 1.3, for example, while the elasticity for Bank services is 1.1. A reduction in disposable income therefore leads to a decrease in demand for Financial and insurance services. (Figure 7.12 shows the percent difference in output for the Finance industry between the Oil-price forecast and the Base forecast.) The low demand leads to a drop in the profit margin (relative to the Base forecast) and reduces the price of Financial and insurance services, which helps stimulate demand again. (The price deflator for the Finance industry in the Base forecast and the Oil-price scenario is illustrated in Figure 7.13.)

If profits did not respond directly to changes in input costs, then all product deflators would rise after an oil-price shock, based on the share of petroleum costs in the industry's costs of production. In other words, given the definition of prices from the dual input-output equation, an increase in input costs, *ceteris paribus*, implies a proportional increase in price. Since profits respond to input costs, however, not all prices will rise by the petroleum-weighted change in costs in the first year of the shock. Figure 7.14 illustrates relative prices for four products in the Base forecast and in the Oil-shock alternative. For some industries, the increase in oil prices is more than fully passed on to prices initially, and the price of the product rises significantly. Chemicals and Air transportation services are two industries who illustrate such an increase. On the other hand, in some

Figure 7.12: Output for Finance and insurance
% difference Oil-shock - Base

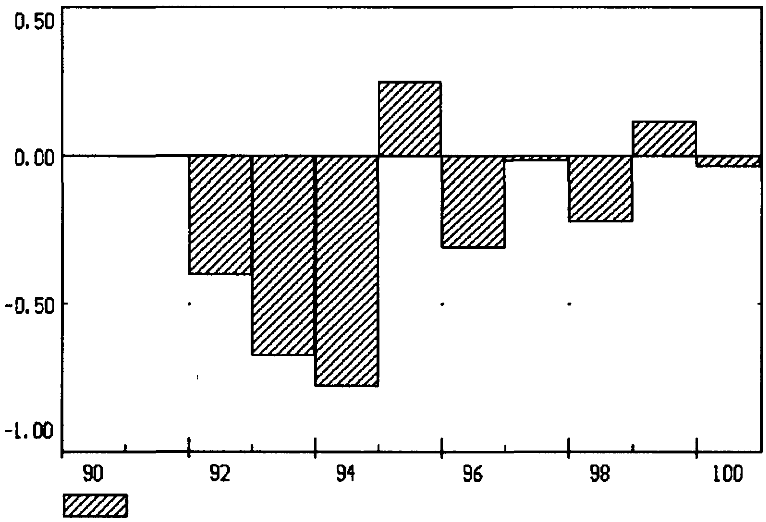
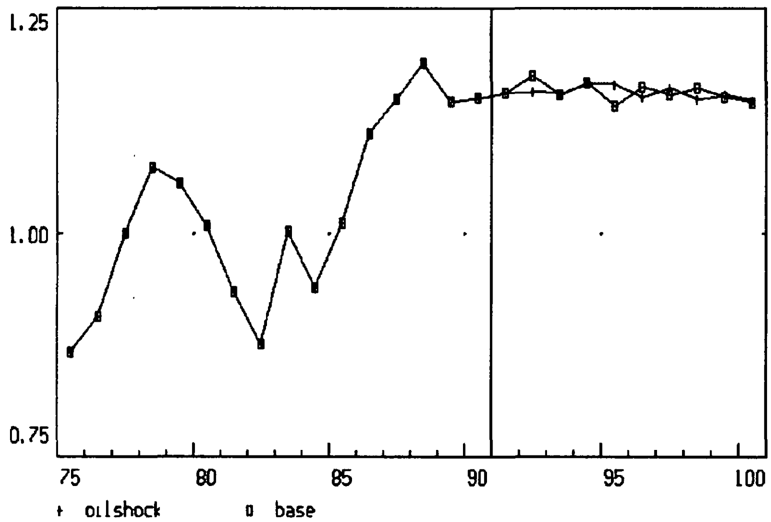


Figure 7.13: Price of Finance and insurance
deflator for Finance relative to GNP deflator
Oil-price shock and Base forecast

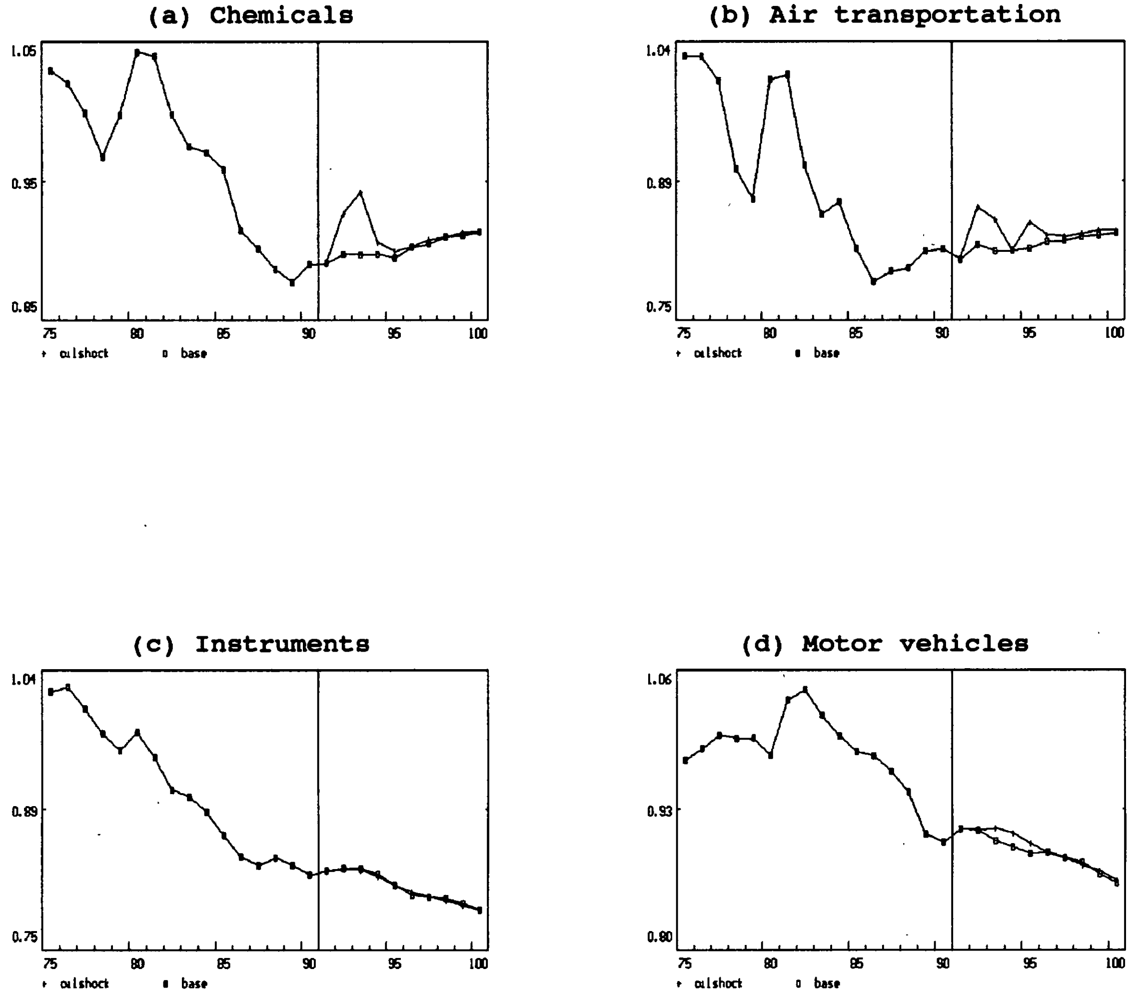


cases, the profit margin absorbs changes in input costs, and there is almost no effect of cost changes on the product price. The price of Instruments, for example, is little changed in the two scenarios. In the case of Finance, as seen in Figure 7.13, the fall in the profit margin more than compensates for the increase in costs, and the price is actually lower after the oil shock than in the Base forecast. For an industry such as Motor vehicles, the increase in costs is partially absorbed by the profit margin, and the price rises after the oil-shock, but by less than if the profit margin did not respond to the cost change.

Over the long run, the effects of the oil-price shock dissipate, and neither industry profits nor product prices differ significantly in 2000 between the Base and Oil-price scenarios.

Figure 7.14: Price Effects of Oil-price Shock

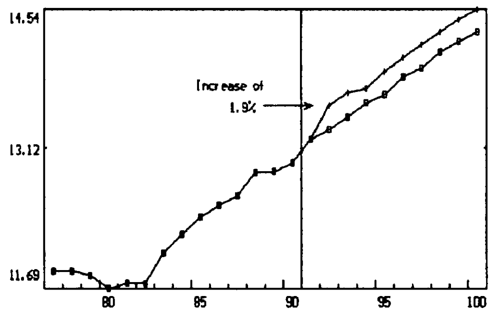
(output deflator/GNP deflator)



Productivity shock

Like an energy price shock, the second experiment conducted with the model also can be considered a supply shock. This scenario considers the effect of a permanent increase in labor productivity, or an outward shift in the aggregate supply curve. The facility exists in LIFT to conduct experiments on industry-level labor productivity: increase some sectors' productivity and keep others unchanged, or decreased. However, for this simulation, an economy-wide increase in productivity was assumed. Namely, nine months' of growth in productivity is added to the productivity of each industry, beginning in 1992.[66] The shock is therefore distributed among industries in proportion to their productivity growth rates. The net result of the assumption is that labor productivity is increased by 1.9% in 1992. (See Figure 7.15.)

Figure 7.15:
Labor Productivity Shock



The macroeconomic results of the simulation are consistent with expected results in an aggregate supply/aggregate demand framework. (See Table 7.8.) An increase in productivity increases real output and

[66] The labor productivity equations depend on two time trends: one to capture the trend from 1960 to the present, and one to capture the trend from 1970 to the present. The productivity shock is imposed by adding .75 to the first trend in each year of the forecast, where adding 1.0 to the trend is equivalent to adding one year's worth of productivity growth.

Table 7.8: Macroeconomic Results of Productivity Shock

result for Base forecast
and difference = value in Productivity shock forecast - value in Base forecast
% difference = difference as a percent of value in Base forecast

Billions of 1977$	1992	1993	1994	1995	1996	1997	1998	2000
Gross national product	2885.1	2937.9	2994.6	3017.4	3087.2	3140.1	3211.7	3323.9
Difference	27.3	64.9	10.7	31.6	20.7	42.0	24.6	35.0
% difference	0.9	2.2	0.4	1.0	0.7	1.3	0.8	1.1
Personal consumption	1902.1	1913.8	1946.3	1965.4	2010.6	2041.4	2083.8	2161.6
Difference	16.1	41.5	0.8	19.3	15.7	25.2	13.3	21.4
% difference	0.8	2.2	0.0	1.0	0.8	1.2	0.6	1.0
Fixed investment	470.2	483.3	491.2	482.9	502.3	515.2	535.7	557.2
Difference	14.4	31.1	3.4	10.6	-0.1	15.3	5.6	8.7
% difference	3.1	6.4	0.7	2.2	-0.0	3.0	1.1	1.6
Durable equipment	264.5	275.6	284.0	279.4	294.6	303.1	320.0	338.7
Difference	10.0	22.2	-1.0	5.1	-3.0	9.3	2.0	4.3
% difference	3.8	8.1	-0.3	1.8	-1.0	3.1	0.6	1.3
Nonresid structures	87.4	90.5	90.9	88.4	91.3	94.5	97.8	101.7
Difference	2.0	4.0	0.4	1.5	-0.4	3.2	0.5	0.5
% difference	2.3	4.5	0.5	1.7	-0.4	3.4	0.5	0.4
Residential structures	118.2	117.3	116.4	115.1	116.4	117.7	117.8	116.8
Difference	2.4	4.9	3.9	4.0	3.3	2.8	3.2	4.0
% difference	2.0	4.1	3.3	3.5	2.8	2.4	2.7	3.4
Exports	431.7	463.6	492.3	511.9	529.7	545.6	561.9	592.8
Difference	0.7	1.6	2.7	3.9	4.3	4.3	4.7	5.2
% difference	0.2	0.4	0.5	0.8	0.8	0.8	0.8	0.9
Imports	461.6	462.7	473.3	478.5	495.2	505.1	518.0	547.0
Difference	5.9	12.5	-4.8	2.6	-1.5	4.1	-1.3	0.5
% difference	1.3	2.7	-1.0	0.5	-0.3	0.8	-0.2	0.1
Disposable income (72$)	1455.0	1480.2	1500.2	1517.0	1544.1	1577.2	1609.9	1678.7
Difference	9.3	19.6	8.5	1.5	5.8	9.3	10.2	8.6
% difference	0.6	1.3	0.6	0.1	0.4	0.6	0.6	0.5

Percent	1992	1993	1994	1995	1996	1997	1998	2000
Inflation (GNP deflator)	3.4	3.9	4.0	4.1	3.6	3.6	3.6	4.2
Productivity scenario	1.9	3.1	4.4	4.1	3.5	3.4	3.8	4.1
Inflation (PCE deflator)	3.5	3.9	4.2	4.1	4.0	3.7	4.0	4.3
Productivity scenario	1.9	3.6	4.2	4.5	3.7	3.6	3.9	4.1
Unemployment rate	4.6	4.5	4.5	5.0	4.9	4.8	4.6	4.7
Productivity scenario	5.3	4.0	4.8	5.5	5.4	4.9	5.0	4.9
Interest rate 3-mo T-bill	7.8	8.1	8.6	8.8	8.9	9.5	9.6	10.6
Productivity scenario	7.4	8.0	7.8	7.9	8.7	9.0	9.3	10.3
Growth of real GNP	2.7	1.8	1.9	0.8	2.3	1.7	2.3	1.7
Productivity scenario	3.6	3.1	0.1	1.5	1.9	2.4	1.7	1.7

Assumption	1992	1993	1994	1995	1996	1997	1998	2000
Productivity (GNP/Hours)	13.3	13.4	13.6	13.7	13.8	13.9	14.1	14.3
Difference	0.2	0.3	0.1	0.2	0.2	0.2	0.2	0.2
% difference	1.9	1.9	1.1	1.7	1.5	1.8	1.5	1.6
Productivity growth rate	0.8	0.9	1.1	0.6	1.3	0.7	1.2	0.7
Productivity scenario	2.7	1.0	0.3	1.3	1.1	1.0	0.9	0.7

Productivity equals (GNP less government)/(Private hours worked) lowers the price level. The peak effect on GNP occurs one year after the increase in productivity, when GNP is 2.2% greater in the alternate forecast than in the Base.

Higher demand and lower prices stimulate investment in both Durable equipment and Structures. In the year after the initial productivity increase, Investment in Producer Durable Equipment (PDE) is 8% higher than in the Base forecast. As the rate of change of overall growth slows, demand for Equipment investment also slows, and the long-run effect of the productivity shock is a 1.3% increase in PDE compared to the Base forecast. Investment in Residential structures responds positively to higher income and lower interest rates, and in 1993 investment in residences is 4.1% higher in the Productivity scenario than in the Base forecast. Because the effect of income occurs with a lag, Residential structures continue to respond strongly over the entire forecast, and by the year 2000, Residential structures are 3.4% higher in the Productivity scenario.

The lower level of domestic prices, with fixed exchange rates, stimulates exports. Since exports respond to price changes with a lag, the impact of the productivity shock on exports increases over the simulation horizon. Exports are .2% higher in 1992 in the Productivity scenario than in the Base forecast, .8% higher in 1995, and .9% higher in 2000. Since Imports are more responsive to income changes than to price changes, Imports are higher in the Productivity shock forecast than in the Base forecast. The peak effect occurs in the year after the shock, where Imports are 3% higher. Thereafter, the price and income effects balance out, and Imports remain fairly close to their level in the Base scenario. By the year 2000, Imports are .1% higher in the Productivity shock forecast than in the Base.

None of the assumptions for the exogenous variables were explicitly changed for the Productivity scenario, which means that the growth rate of M2, as well as the value of the exchange rate are unchanged in the Base and Productivity forecasts. Since the money supply growth is not changed to accommodate faster growth in the economy, the result is a relatively tighter monetary policy in the Productivity scenario than in the Base forecast.[67] This relatively tight money growth helps keep the price level lower in the Productivity scenario. In addition, the exchange rate (and foreign prices) do not respond to any of the changes in domestic demand, prices, or interest rates that occur in the Productivity scenario. Since the exchange rate does not change, relative foreign to domestic prices are permanently affected by the change in domestic productivity.

The short-run effects of increased productivity are mostly seen in Personal consumption expenditures and Producer durable equipment investment. As shown in Table 7.9, the increase in Consumption accounts for 64% of the initial change in GNP, while the change in Equipment investment accounts for 34% of the change. Over the long run, the lagged effect of income changes on Residential structures, as well as the lagged effect of price changes on Exports increase in importance. The change in Exports accounts for only 2.5% of the increase in GNP in 1993 and 15% by the year 2000. Likewise, Residential structures accounts for 8% of the GNP change in 1993 and 11% in 2000.

Table 7.9: Long and Short-run Effects of Productivity Shock
Difference between Productivity Shock and Base forecast
(billions of 1977 $ and %)

	1993		2000	
	difference	% of GNP	difference	% of GNP
Gross national product	64.9	100%	35.0	100%
Personal consumption	41.5	63.9	21.4	61.1
Producer durable equip	22.2	34.2	4.3	12.3
Nonresidential structures	4.0	6.2	0.5	1.4
Residential structures	4.9	7.6	4.0	11.4
Exports	1.6	2.5	5.2	14.9
Imports	-12.5	-19.3	-0.5	-1.4
Inventory change	3.2	4.9	0.1	0.3

[67] Although the price level is lower, which increases the real money supply, the ratio of the money supply to real GNP is lower in the Productivity scenario than in the Base forecast.

In the first year of the shock, the unemployment rate increases because the change in aggregate demand is not sufficient to absorb the labor released by the productivity increase. As real income continues to increase, more of the labor force is employed, and the unemployment rate is only slighter higher (.2%) in the Productivity scenario than in the Base forecast by the year 2000. The fact that the unemployment rate remains higher after the productivity shock may be attributable to two factors. First, there is no assumed change in the labor force in this scenario. It may be that as real income increases, labor force participation rates would fall. Part of the increase in labor-force participation in the 1970s is attributable to an increase in the number of families with two earners. If real income were to increase, the number of families requiring two earners would fall. Assuming no change in the work force implies a possible upward bias in the size of the labor force, which keeps the unemployment rate high.

The macroeconomic results of the Productivity shock in the current version of LIFT are consistent with experiments done with earlier versions of the model. Pollock, for example, showed that an increase in productivity growth led to higher real GNP, higher real income, as well as a slightly higher unemployment rate.[68] The LIFT results contrast with the results from the Federal Reserve Board MPS model, especially in terms of the dynamic effects of the shock.[69] Figure 7.16 illustrates the multipliers for real GNP, the unemployment rate, the

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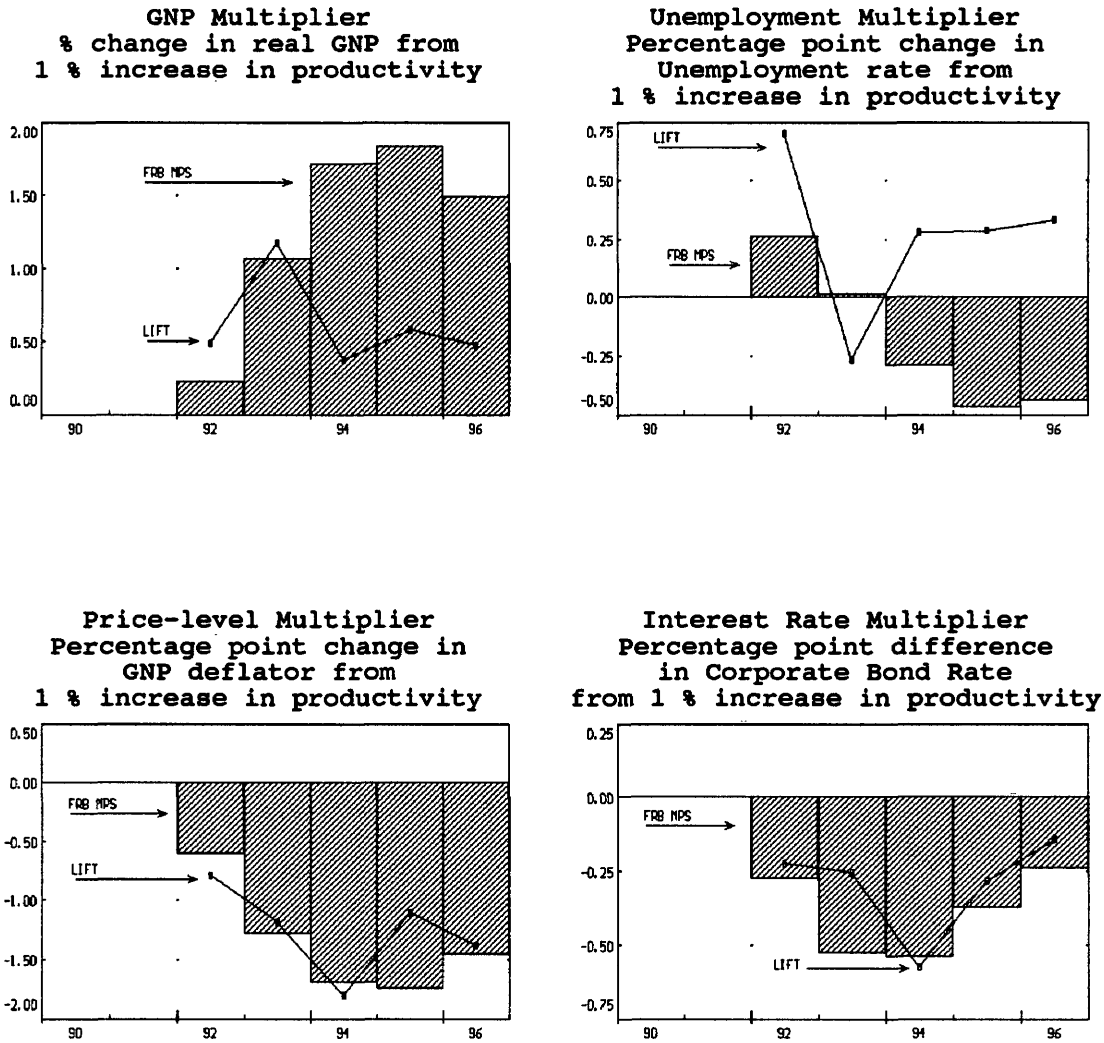
[68] INFORUM staff reports by Pollock (1986), and McCarthy (1989).

[69] See Brayton and Mauskopf, page 181. The results for the MPS model are quarterly, and have been averaged to approximate the annual results.

Figure 7.16: Multipliers for Productivity Shock

FRB MPS model and LIFT



price level, and the interest rate on Corporate bonds in response to a one percent increase in productivity in the LIFT model and in the FRB/MPS model. The effect of the productivity shock on the price level and on interest rates are similar in the two models. The interest rate does not fall as much in the second year of the shock in LIFT as it does in the MPS model, but the multipliers are otherwise quite similar. In terms of real activity, LIFT and the MPS model are similar only for the first two years of the shock. In both models, real GNP increases gradually in response to higher labor productivity. In addition, the unemployment rate rises in both models, although the increase is almost half a percentage point higher in LIFT than in the MPS model. In the second year of the shock, the unemployment rate in LIFT falls, as the increase in aggregate demand offsets the increase in labor productivity, and firms again need to increase employment. In the third year after the shock, however, the results from the two models are quite different. In the MPS model, GNP continues to expand in response to higher productivity, and the unemployment rate falls. In LIFT, the cyclical response of demand and labor productivity cause a slowdown in real growth in the economy. With higher productivity, real GNP grows by 3.6% in 1992 and by 3.1% in 1993. Demand for investment, especially Producer Durable Equipment, responds to a slowdown in the rate of growth of demand, and PDE falls in 1994 in the Productivity scenario. (PDE is not only lower than its 1993 level in the Productivity scenario, it is also lower than PDE in 1994 in the Base forecast.) The labor productivity equations also respond to a slower rate of growth, and productivity barely changes in 1994, growing by only .3%. In addition, the savings rate in LIFT responds to the drop in the unemployment rate that occurs from 1992 to 1993, and the savings rate increases in 1994. A higher savings rate implies lower consumption, which falls in 1994 in the Productivity scenario. The response to a labor productivity shock in LIFT is strongly affected by the cyclical behavior of demand in the model. Even with a lower price level and lower interest rates, a slowdown in the rate of growth in the model leads to a cyclically slow year. As the model recovers from the slow growth year of 1994, growth in real GNP resumes and the increase in GNP in the Productivity scenario compared to the Base forecast is sustained. As noted, however, the higher level of demand is not sufficient, given the higher level of labor productivity, to employ a higher percent of the work force than in the Base forecast.

The effect of higher labor productivity on the industry composition of output reflects the across-the-board increase in aggregate demand that occurs over the forecast horizon. Those industries most demand-sensitive are the ones most benefitted by the productivity shock. For instance, Table 7.10 lists the change in output by industry due to the shock, ranked from largest to smallest increase in 1992. Consumption of durable goods is income elastic, and items such as Motor vehicles, Ships and boats, and Furniture are high on the list. Machinery-related industries whose primary source of demand is PDE, such as Metalworking machinery and Service industry machinery, also are at the top of the list. Because LIFT explicitly models interindustry relationships, those industries which supply the demand-affected industries also are greatly affected by the productivity shock. Output of Ferrous metals, for instance, is responsive to changes in demand for Motor vehicles and machinery, and consequently is one of the top ten most-affected industries.

In the long run, industries affected by residential construction, personal consumption, and exports lead the list of most-affected industries. (See Table 7.11) The industries most affected by the productivity shock in the short run are not likely to be most affected in the long run. The rank correlation coefficient between the changes in output in 1992 and the changes in output in 2000 is -.08613.

Table 7.10: Industry Effects of Productivity Shock

Percent difference in Output: Productivity shock - Base Forecast
ranked according to difference in 1992

	1992	1995	2000
(1) Other transportation e	5.729	5.355	2.337
(2) Metalworking machinery	4.194	2.294	1.480
(3) Office equipment	3.310	3.744	3.194
(4) Motor vehicles	2.957	3.035	1.431
(5) Service industry machi	2.810	2.082	1.377
(6) Ferrous metals	2.676	2.823	1.862
(7) Ships boats	2.609	3.035	1.310
(8) Spec ind machinery	2.512	2.267	1.712
(9) Nonelect machinery	2.504	2.113	1.447
(10) Copper	2.379	2.297	2.044
(11) Furniture	2.373	1.630	1.305
(12) Computers	2.063	0.997	0.488
(13) Lumber	2.001	2.565	2.159
(14) Stone, clay, glass	1.985	1.902	1.506
(15) Agric machinery	1.916	1.685	1.407
(16) Electrical appliances	1.788	1.521	1.799
(17) Metal products	1.725	1.772	1.183
(18) Instruments	1.640	1.323	1.679
(19) Other nonferrous metal	1.614	1.711	1.513
(20) Household appliances	1.599	1.610	1.344
(21) Movies and amusements	1.574	1.553	1.453
(22) Communic equipment	1.528	1.789	2.123
(23) Plastic	1.508	1.793	1.773
(24) Elec lighting and wiri	1.472	1.285	1.513
(25) Rubber	1.456	1.609	1.088
(26) Const mining oilfield	1.441	3.251	2.597
(27) Engines and turbines	1.416	2.248	1.474
(28) TVs radios phonographs	1.384	3.681	4.241
(29) Construction	1.331	1.436	1.163
(30) Shoes	1.297	3.979	5.462
(31) Nonmetallic mining	1.291	1.466	1.263
(32) Wholesale trade	1.290	1.193	1.073
(33) Gas utilities	1.289	1.184	1.055
(34) Textiles	1.283	1.340	1.526
(35) Hotels	1.259	1.670	1.509
(36) Railroads	1.135	1.278	1.064
(37) Retail trade	1.119	1.199	0.925
(38) Iron mining	1.109	1.381	0.862
(39) Paper	1.028	0.981	1.102
(40) Trucking	1.019	1.135	0.999

Table 7.10: Industry Effects of Productivity Shock

Percent difference in Output: Productivity shock - Base Forecast
ranked according to difference in 1992

continued

	1992	1995	2000
(41) Nonferrous metals mini	1.008	0.962	1.001
(42) Chemicals	0.988	1.288	1.424
(43) Crude petroleum	0.946	1.087	0.952
(44) Water transport	0.943	0.995	0.858
(45) Business services	0.922	1.040	0.989
(46) Natural gas extraction	0.920	0.712	1.031
(47) Finance and insurance	0.907	0.866	0.819
(48) Govt enterprises	0.883	0.683	0.748
(49) Auto repairs	0.858	1.038	0.840
(50) Misc manufacturing	0.823	1.625	1.915
(51) Eating and drinking	0.813	0.975	1.665
(52) Electric utilities	0.799	0.870	0.920
(53) Coal mining	0.776	0.924	0.892
(54) Water and sanitation	0.760	0.704	0.779
(55) Knitting	0.756	0.947	1.266
(56) Communciation services	0.742	0.778	0.763
(57) Real estate	0.737	0.950	0.990
(58) Printing	0.728	0.808	0.918
(59) Pipeline	0.708	0.824	0.710
(60) Apparel	0.704	0.928	1.250
(61) Fuel oil	0.697	0.843	0.809
(62) Petroleum refining	0.695	0.813	0.695
(63) Aerospace	0.686	0.939	0.830
(64) Agriculture	0.572	0.626	0.766
(65) Transportation service	0.561	0.684	0.872
(66) Agric fertilizers	0.550	0.805	0.966
(67) Medicine, education, n	0.545	0.713	1.098
(68) Food and tobacco	0.507	0.546	0.738
(69) Air transport	0.394	0.589	0.861
(70) Owner occupied housing	0.183	0.736	1.922

Table 7.11: Industry Effects of Productivity Shock: 2000

Percent difference in Output: Productivity shock - Base forecast
ranked according to difference in 2000

		1992	1995	2000
(1)	Shoes	1.297	3.979	5.462
(2)	TVs radios phonographs	1.384	3.681	4.241
(3)	Office equipment	3.310	3.744	3.194
(4)	Const mining oilfield	1.441	3.251	2.597
(5)	Other transportation e	5.729	5.355	2.337
(6)	Lumber	2.001	2.565	2.159
(7)	Communic equipment	1.528	1.789	2.123
(8)	Copper	2.379	2.297	2.044
(9)	Owner occupied housing	0.183	0.736	1.922
(10)	Misc manufacturing	0.823	1.625	1.915
(11)	Ferrous metals	2.676	2.823	1.862
(12)	Electrical appliances	1.788	1.521	1.799
(13)	Plastic	1.508	1.793	1.773
(14)	Spec ind machinery	2.512	2.267	1.712
(15)	Instruments	1.640	1.323	1.679
(16)	Eating and drinking	0.813	0.975	1.665
(17)	Textiles	1.283	1.340	1.526
(18)	Other nonferrous metal	1.614	1.711	1.513
(19)	Elec lighting and wiri	1.472	1.285	1.513
(20)	Hotels	1.259	1.670	1.509
(21)	Stone, clay, glass	1.985	1.902	1.506
(22)	Metalworking machinery	4.194	2.294	1.480
(23)	Engines and turbines	1.416	2.248	1.474
(24)	Movies and amusements	1.574	1.553	1.453
(25)	Nonelect machinery	2.504	2.113	1.447
(26)	Motor vehicles	2.957	3.035	1.431
(27)	Chemicals	0.988	1.288	1.424
(28)	Agric machinery	1.916	1.685	1.407
(29)	Service industry machi	2.810	2.082	1.377
(30)	Household appliances	1.599	1.610	1.344
(31)	Ships boats	2.609	3.035	1.310
(32)	Furniture	2.373	1.630	1.305
(33)	Knitting	0.756	0.947	1.266
(34)	Nonmetallic mining	1.291	1.466	1.263
(35)	Apparel	0.704	0.928	1.250
(36)	Metal products	1.725	1.772	1.183
(37)	Construction	1.331	1.436	1.163
(38)	Paper	1.028	0.981	1.102
(39)	Medicine, education, n	0.545	0.713	1.098
(40)	Rubber	1.456	1.609	1.088

Table 7.11: Industry Effects of Productivity Shock: 2000

Percent difference in Output: Productivity shock - Base forecast
ranked according to difference in 2000

continued

	1992	1995	2000
(41) Wholesale trade	1.290	1.193	1.073
(42) Railroads	1.135	1.278	1.064
(43) Gas utilities	1.289	1.184	1.055
(44) Natural gas extraction	0.920	0.712	1.031
(45) Nonferrous metals mini	1.008	0.962	1.001
(46) Trucking	1.019	1.135	0.999
(47) Real estate	0.737	0.950	0.990
(48) Business services	0.922	1.040	0.989
(49) Agric fertilizers	0.550	0.805	0.966
(50) Crude petroleum	0.946	1.087	0.952
(51) Retail trade	1.119	1.199	0.925
(52) Electric utilities	0.799	0.870	0.920
(53) Printing	0.728	0.808	0.918
(54) Coal mining	0.776	0.924	0.892
(55) Transportation service	0.561	0.684	0.872
(56) Iron mining	1.109	1.381	0.862
(57) Air transport	0.394	0.589	0.861
(58) Water transport	0.943	0.995	0.858
(59) Auto repairs	0.858	1.038	0.840
(60) Aerospace	0.686	0.939	0.830
(61) Finance and insurance	0.907	0.866	0.819
(62) Fuel oil	0.697	0.843	0.809
(63) Water and sanitation	0.760	0.704	0.779
(64) Agriculture	0.572	0.626	0.766
(65) Communciation services	0.742	0.778	0.763
(66) Govt enterprises	0.883	0.683	0.748
(67) Food and tobacco	0.507	0.546	0.738
(68) Pipeline	0.708	0.824	0.710
(69) Petroleum refining	0.695	0.813	0.695
(70) Computers	2.063	0.997	0.488

Profits are affected by a productivity shock through their response to changes in labor costs, unit material costs, and demand. Initially, an increase in labor productivity implies a lower total wage bill for an industry, since more output can be produced with fewer workers. Although the nominal wage rate eventually responds to an increase in labor productivity, the effect occurs with a three-year distributed lag, so the initial effect on an industry's wage bill is negative. Lower labor costs in an industry imply a lower price for the products made in that industry, given the definition of prices in the input-output dual equation. However, in some industries, that pass-through of lower labor costs to prices is muted by the effect of labor costs on industry profits. In twelve of the industries whose profits are determined by labor costs, a fall in labor allows a temporary increase in the profit margin. In other words, the product price falls by less than the total decrease in labor costs, as income in the industry is transferred from labor to profits. The change in profits is temporary, however, and the cost decrease is eventually passed through entirely to the product price.

Since prices are lower after the productivity shock, the cost of material inputs falls. For most industries, a reduction in the cost of materials implies a temporary rise in the profit margin, as the cost savings are not passed entirely through to prices. After one to two years, the temporary increase in profits fades.

The productivity shock induces changes in profits through the effect of demand changes on industry profits. Since the profit margin for most industries responds positively to increased demand, profits tend to increase after the productivity shock.

The effect on profit margins indicates that most industries benefit from increased labor productivity in the short run. (See Table 7.12.) Profits in industries such as Motor vehicles, Furniture, Wholesale and retail trade, and Rubber and plastic products share in at least some of the benefits of an increase in labor productivity. In some industries, however, the initial effect of a productivity shock is a fall in the margin. Several of these industries respond to changes in the unemployment rate as a signal of economy-wide demand. Since the unemployment rate increases in the first year of the shock, profits fall temporarily in industries such as Financial and insurance services, Motion pictures, Chemicals, and Lumber.

In the long run, most industries' profits are little changed in the two scenarios, as the profit margin adjusts to a generally higher level of demand and lower prices. The mean value of the absolute value of the difference between the shock and the base in 2000 is .089, while in the first year of the shock it is .270.

Table 7.12: Effect on Industry Profit Margins of Productivity Shock

Difference between profit margin in Productivity scenario and Profit margin in Base forecast

Profit margin equals Before-tax profits, adjusted for CCA and IVA as percent of nominal output

ranked by difference in 1992

		1992	1993	1994	1995	1996	1997	1998	2000
(1)	Motor vehicles	0.945	0.532	-0.729	-0.084	0.125	0.442	-0.207	0.033
(2)	Communications	0.730	0.285	0.106	-0.181	0.090	0.111	0.009	0.056
(3)	Crude oil	0.652	1.045	0.544	0.449	0.236	0.413	0.134	0.233
(4)	Stone clay gla	0.577	0.378	-0.333	-0.003	-0.190	0.204	-0.154	-0.008
(5)	Furniture	0.535	0.069	0.105	-0.154	-0.016	-0.013	-0.009	-0.006
(6)	Railroads	0.447	-0.021	-0.196	-0.668	0.324	0.053	0.079	0.286
(7)	Rubber plastic	0.339	-0.277	0.086	0.033	0.061	-0.132	0.126	-0.010
(8)	Apparel	0.295	-0.077	-0.075	-0.074	0.107	0.004	-0.024	0.070
(9)	Air transportat	0.247	0.281	-0.135	-0.081	0.042	0.073	-0.025	0.022
(10)	Metal products	0.244	-0.181	-0.310	0.149	-0.026	0.121	-0.149	0.053
(11)	Wholesale retai	0.214	-0.009	-0.222	0.042	-0.098	-0.041	-0.166	-0.048
(12)	Business servic	0.180	0.030	0.045	-0.027	0.024	-0.005	0.018	0.003
(13)	Leather	0.154	-0.499	-0.103	-0.021	0.199	-0.015	-0.108	0.106
(14)	Non elect machi	0.149	0.258	0.671	0.467	0.631	0.532	0.760	0.749
(15)	Printing	0.139	0.220	-0.027	-0.170	-0.078	-0.081	-0.117	-0.051
(16)	Auto repair	0.132	0.039	-0.016	-0.021	0.021	0.011	0.002	0.014
(17)	Construction	0.126	0.050	-0.222	0.166	-0.031	0.078	-0.147	-0.057
(18)	Misc manufactur	0.121	0.144	-0.881	0.458	-0.485	0.011	-0.501	-0.308
(19)	Food	0.042	0.020	0.081	-0.014	0.016	0.017	0.022	-0.007
(20)	Electrical mach	0.033	0.009	0.011	0.008	0.014	0.010	0.005	0.008
(21)	Trans equip	0.030	-0.044	-0.068	-0.027	-0.020	0.008	-0.043	-0.022
(22)	Textile mill	0.026	0.316	-0.263	-0.136	-0.131	-0.025	-0.156	-0.082
(23)	Agriculture	0.013	0.018	0.009	0.003	-0.004	0.008	-0.000	0.002
(24)	Medical educati	0.011	0.005	-0.073	0.033	-0.013	0.022	-0.029	0.001
(25)	Mining	-0.003	-0.292	0.088	0.097	0.141	0.029	0.049	0.099
(26)	Trucking	-0.010	0.096	0.030	-0.032	-0.011	-0.009	0.013	-0.007
(27)	Chemicals	-0.061	0.318	-0.333	-0.251	-0.213	-0.020	-0.243	-0.134
(28)	Real estate	-0.079	0.130	-0.066	-0.057	-0.076	-0.025	-0.059	-0.033
(29)	Petroleum ref	-0.117	-0.161	0.267	-0.126	0.054	-0.076	0.076	0.007
(30)	Lumber	-0.128	0.209	-0.002	-0.153	0.040	-0.048	0.003	0.036
(31)	Hotels repair	-0.136	0.192	-0.187	0.005	-0.150	-0.013	-0.128	-0.069
(32)	Electric gas	-0.171	0.204	-0.247	-0.095	-0.197	-0.028	-0.263	-0.048
(33)	Paper	-0.176	0.503	-0.189	0.331	-0.267	0.169	-0.123	-0.140
(34)	Motion picture	-0.177	0.264	-0.164	0.012	0.022	-0.082	0.055	-0.012
(35)	Financial insu	-0.491	0.983	-1.783	0.806	-0.651	0.301	-0.720	-0.197
(36)	Instruments	-0.662	1.341	-0.841	-0.433	-0.882	-0.100	-0.751	-0.534
(37)	Primary metal	-1.275	0.812	-0.550	-0.532	-0.639	-0.298	-0.631	-0.405

Fast Growth of Money Supply

Most empirical analysis of monetary policy is done using macroeconomic models that have a common theoretical basis: changes in money growth may have real effects in the short run, but eventually will lead to a proportional increase in inflation and no change in real variables.[70] Although few empirical models are suited to analyzing the long-run and industry-level implications of monetary policy, a money model was designed for LIFT with just that purpose in mind.[71] In LIFT, the effects of money growth on interest rates and inflation trace through the economy based on the response of different industries to those changes. The macroeconomic effects of a change in monetary policy can be analyzed, therefore, as the cumulative effect of money growth on industries.

An alternate forecast was done with LIFT that assumes money growth increases from 4.8% in 1993 to 5.8%, and then from 4.5% a year from 1994 to 2000, to 6.5% a year.[72] (See Figure 7.17 and Table 7.13) The most striking result of the simulation is that the macroeconomic impact of the different money supply growth is remarkably small. (Table 7.13) The

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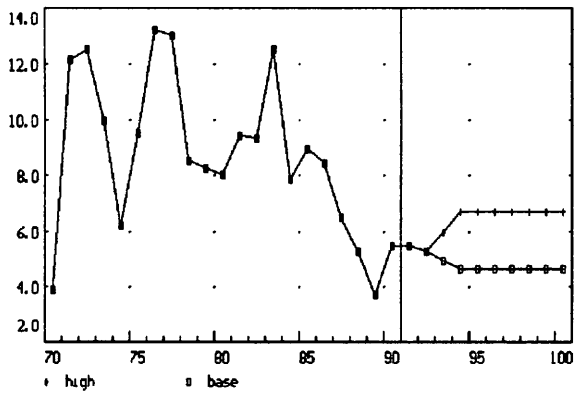
[70] This general agreement includes debate on how short the short run is, as well as on how large the real effect will be. The general agreement also is challenged by the real business cycle theorists. (See Long and Plosser (1983), Barro and King (1984), and Prescott (1986).) As Mankiw summarizes, "Before real business cycle theory entered the debate in the early 1980s, almost all macroeconomists agreed on one proposition: money matters. Although there was controversy about whether systematic monetary policy could stabilize the economy, it was universally accepted that bad monetary policy could be destabilizing. Real business cycle theorists have challenged that view using the old Keynesian argument that any correlation of money with output arises because the money supply is endogenous (King and Plosser 1984). They also give little weight to anecdotal evidence on the effects of monetary policy - like the Volcker disinflation of the early 1980s - that seem to shape the views of many other economists." (page 21)

[71] See Monaco, R.M. (1984), who states "The purpose of this (work) is to provide a framework for analyzing the long-term, interindustry effects of monetary policy. This is accomplished by incorporating a simple monetary policy model into an interindustry model designed for long-term forecasting." (page 2)

[72] Note that exchange rates remain fixed at their level in the Base forecast in this simulation.

Figure 7.17: Assumption
Percent change in M2



percent change in GNP is less than .05% for the first four years of the forecast. What change does occur is partly in response to lower interest rates. The interest rate on AAA-rated Corporate bonds is 8.8% in 1993, compared to 9.5% in the Base forecast. Investment in Residential structures responds most strongly to the lower interest rates (.4% higher than in the Base forecast), while Investment in Producer Durable Equipment (PDE) and Nonresidential structures also increase (by .1% and by .3%). Although investment responds positively to lower interest rates, the stimulus to GNP is almost entirely canceled by the negative effects of higher inflation on personal consumption and exports. In LIFT, the savings rate depends positively on current inflation; higher levels of inflation increase savings and decrease consumption. The fall in consumption offsets most of the gains from increased investment demand.

Over the long run, the results are dominated by the effect of changing relative foreign to domestic prices on Exports and Imports. As faster money growth leads to higher domestic inflation, Exports fall compared to the Base forecast, while Imports increase. By 2000, GNP is slightly lower in the High money scenario (-.2%), largely due to a 1.6% decrease in Exports and a 2.0% increase in Imports. Since this simulation was run with fixed exchange rates, it exaggerates the

Table 7.13: Macroeconomic Results of Fast Money Growth

result for Base forecast
and difference = value in Fast money growth forecast - value in Base forecast
% difference = difference as a percent of value in Base forecast

Billions of 1977$	1992	1993	1994	1995	1996	1997	1998	2000
Gross national product	2885.1	2937.9	2994.6	3017.4	3087.2	3140.1	3211.7	3323.9
Difference	0.0	0.7	0.9	-0.8	-1.5	-7.7	-5.1	-5.8
% difference	0.0	0.0	0.0	-0.0	-0.0	-0.2	-0.2	-0.2
Personal consumption	1902.1	1913.8	1946.3	1965.4	2010.6	2041.4	2083.8	2161.6
Difference	0.0	-0.3	-1.4	-3.0	-2.8	-5.8	-1.7	2.8
% difference	0.0	-0.0	-0.1	-0.2	-0.1	-0.3	-0.1	0.1
Fixed investment	470.2	483.3	491.2	482.9	502.3	515.2	535.7	557.2
Difference	-0.0	1.1	2.6	3.3	4.5	3.0	6.4	11.1
% difference	-0.0	0.2	0.5	0.7	0.9	0.6	1.2	2.0
Durable equipment	264.5	275.6	284.0	279.4	294.6	303.1	320.0	338.7
Difference	-0.0	0.3	0.5	0.2	0.5	-1.2	0.9	3.5
% difference	-0.0	0.1	0.2	0.1	0.2	-0.4	0.3	1.0
Nonresidential struct	87.4	90.5	90.9	88.4	91.3	94.5	97.8	101.7
Difference	0.0	0.2	0.2	-0.2	-0.4	-1.1	-1.0	-1.2
% difference	0.0	0.2	0.2	-0.2	-0.5	-1.1	-1.0	-1.2
Residential structures	118.2	117.3	116.4	115.1	116.4	117.7	117.8	116.8
Difference	-0.0	0.5	1.9	3.3	4.4	5.3	6.5	8.8
% difference	-0.0	0.4	1.6	2.9	3.8	4.5	5.5	7.6
Exports	431.7	463.6	492.3	511.9	529.7	545.6	561.9	592.8
Difference	0.0	-0.0	-0.2	-0.7	-1.6	-3.0	-4.8	-9.4
% difference	0.0	-0.0	-0.0	-0.1	-0.3	-0.6	-0.9	-1.6
Imports	461.6	462.7	473.3	478.5	495.2	505.1	518.0	547.0
Difference	-0.0	0.2	0.4	0.6	1.8	1.8	5.1	10.8
% difference	-0.0	0.0	0.1	0.1	0.4	0.4	1.0	2.0
Disposable income (72$)	1455.0	1480.2	1500.2	1517.0	1544.1	1577.2	1609.9	1678.7
Difference	0.0	0.3	0.8	0.6	-0.7	-0.5	0.0	-0.9
% difference	0.0	0.0	0.1	0.0	-0.0	-0.0	0.0	-0.1

Percent	1992	1993	1994	1995	1996	1997	1998	2000
Inflation (GNP deflator)	3.4	3.9	4.0	4.1	3.6	3.6	3.6	4.2
Fast money growth	3.4	4.0	4.4	4.7	4.3	4.7	4.6	5.2
Inflation (PCE deflator)	3.5	3.9	4.2	4.1	4.0	3.7	4.0	4.3
Fast money growth	3.5	4.0	4.6	4.6	4.7	4.5	4.9	5.3
Unemployment rate	4.6	4.5	4.5	5.0	4.9	4.8	4.6	4.7
Fast money growth	4.6	4.5	4.5	5.1	4.9	4.9	4.8	4.8
Interest rate 3-mo T-bill	7.8	8.1	8.6	8.8	8.9	9.5	9.6	10.6
Fast money growth	7.8	7.8	8.0	7.8	7.7	8.0	7.9	8.4
Growth of real GNP	2.7	1.8	1.9	0.8	2.3	1.7	2.3	1.7
Fast money growth	2.7	1.9	1.9	0.7	2.3	1.5	2.4	2.1

Assumption	1992	1993	1994	1995	1996	1997	1998	2000
Growth of M2	5.2	4.8	4.5	4.5	4.5	4.5	4.5	4.5
Fast money growth	5.2	5.8	6.5	6.5	6.5	6.5	6.5	6.5
difference	0.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0

negative impact of fast money growth in the long run. It does show, however, the underlying pressures that would occur with faster money growth. Eventually, the change in domestic inflation and interest rates would lead to a depreciation in the value of the dollar, which should help improve the trade balance.

Half of the two-percentage-point increase in money growth translates into higher inflation. By the year 2000, inflation in the GNP deflator rises from 4.2% a year to 5.2%. Because of the small effect on real GNP, the unemployment rate is basically unchanged in the two scenarios.

The overall small effect of faster money growth on GNP masks significant differences in industry-level effects of the change. Although most industries benefit from fast money growth in the short run, the majority of industries have lower output in the long run with faster money growth. In 1993, industries linked to investment enjoy some of the largest increases in output. (See Table 7.14.) Steel, Lumber, Copper, Construction, and Construction equipment are in the top-ten most improved industries. The top ten also includes Other transportation equipment and Ships and boats, because Consumption expenditures for these items depends positively on lower interest rates. In the long run, output of fifty-three of the seventy industries is lower due to fast money growth. The industries which reap any benefit from fast money growth are those linked strongly to Construction activity, such as Stone, clay and glass, Lumber, and Furniture. However, most industries suffer from the worsening trade position of the U.S., as the relative price of exports rises, and the relative price of imports falls. For some industries, even a tie to Investment activity does not guarantee immunity from the long-run negative trade effects. Output of Ferrous metals, for example, initially benefits from increased levels of Investment, but by the year 2000, its output is 1.7% lower than in the Base forecast because of increased competition from Imports.

The effect of fast money growth on profits comes through three channels, working in opposite directions. First, initial increases in demand work to increase the profit margins. This increase in response to demand is part of the stabilizing response profits play in the model. In what has become standard macroeconomic analysis, faster money growth leads to lower interest rates, which stimulate demand.[73] Increases in demand lead to upward pressure on prices, however, which works to choke off demand. Eventually, real activity returns to its original level, and the price level rises proportionately. Since the profit margin rises temporarily in response to demand, an increase in demand will be passed on in higher prices. In addition, however, the profit margins respond to changes in labor costs and unit material costs, both of which rise in response to an increase in the money supply. The wage equation in LIFT expressly considers the effect faster money growth has on nominal wages, and passes excess money growth through to wages with a five-year distributed lag. For most industries whose profit margins respond to changes in labor costs, an increase in labor is absorbed partially by a temporary fall in the profit margin. Likewise, an increase in material costs for most industries implies a temporary fall in the profit margin.

As shown in Table 7.15, the profit margin for most industries falls in response to faster money growth, as a consequence of higher labor and material costs. In the long run, as output in many industries falls because of a worsening trade position, the demand effects of fast money growth reinforce the effects of higher labor and material costs, and the profit margin for most industries is slightly lower than in the Base forecast.

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[73] Mauskopf (1990) refers to this relationship as the "Keynesian" paradigm, in describing the structure of the FRB MPS model.

Table 7.14: Industry Effects of Fast Money Growth Scenario

Percent difference in Output: Fast Money - Base Forecast
ranked according to difference in 1993

		1993	1995	2000
(1)	Other transportation e	0.309	0.448	1.488
(2)	Ships boats	0.244	0.536	1.750
(3)	Ferrous metals	0.208	0.222	-1.657
(4)	Stone, clay, glass	0.189	0.472	0.524
(5)	Lumber	0.178	0.812	1.212
(6)	Construction	0.177	0.541	1.187
(7)	Shoes	0.149	0.230	-5.075
(8)	Const mining oilfield	0.142	0.182	-4.526
(9)	Metalworking machinery	0.114	-0.232	-1.838
(10)	Copper	0.106	0.037	-1.525
(11)	Nonmetallic mining	0.101	0.225	-0.216
(12)	Service industry machi	0.101	0.073	0.422
(13)	Metal products	0.087	-0.021	-0.875
(14)	Iron mining	0.086	0.076	-1.223
(15)	Nonelect machinery	0.085	-0.103	-1.395
(16)	Other nonferrous metal	0.085	0.032	-1.536
(17)	Furniture	0.075	-0.135	0.287
(18)	Spec ind machinery	0.074	-0.071	-1.395
(19)	Electrical appliances	0.064	-0.058	-1.464
(20)	Rubber	0.059	-0.002	-0.209
(21)	Office equipment	0.054	-0.257	-2.620
(22)	Crude petroleum	0.051	0.087	0.290
(23)	Elec lighting and wiri	0.046	0.043	-0.115
(24)	Nonferrous metals mini	0.045	-0.003	-1.065
(25)	Computers	0.041	-0.012	0.780
(26)	Wholesale trade	0.036	0.020	0.024
(27)	Real estate	0.034	0.157	0.452
(28)	Railroads	0.034	0.001	-0.369
(29)	Plastic	0.033	-0.088	-1.022
(30)	Coal mining	0.031	-0.005	-0.612
(31)	Gas utilities	0.030	-0.005	0.572
(32)	Engines and turbines	0.030	-0.179	-2.363
(33)	Business services	0.029	-0.009	-0.068
(34)	Instruments	0.028	-0.102	-0.312
(35)	Trucking	0.028	-0.022	-0.151
(36)	Pipeline	0.028	0.048	0.199
(37)	Petroleum refining	0.025	0.044	0.194
(38)	Fuel oil	0.022	-0.008	-0.097
(39)	Natural gas extraction	0.021	0.001	0.253
(40)	Communic equipment	0.021	-0.196	-1.978

Table 7.14: Industry Effects of Fast Money Growth Scenario

Percent difference in Output: Fast Money - Base Forecast
ranked according to difference in 1993

continued

	1993	1995	2000
(41) Water transport	0.020	-0.032	-0.245
(42) Auto repairs	0.019	0.003	0.379
(43) Electric utilities	0.017	-0.056	-0.317
(44) Transportation service	0.016	-0.030	-0.259
(45) Chemicals	0.015	-0.115	-1.097
(46) Aerospace	0.015	-0.141	-1.315
(47) Household appliances	0.015	-0.130	-1.055
(48) Textiles	0.015	-0.095	-0.725
(49) Motor vehicles	0.014	-0.163	-0.420
(50) Communciation services	0.014	-0.041	-0.091
(51) Printing	0.013	-0.048	-0.117
(52) Air transport	0.009	-0.056	-0.509
(53) Water and sanitation	0.007	-0.164	-0.532
(54) Agric machinery	0.006	-0.133	-0.776
(55) Paper	0.003	-0.152	-0.747
(56) Retail trade	0.002	-0.048	0.597
(57) Owner occupied housing	-0.002	-0.164	-0.582
(58) Agriculture	-0.005	-0.070	-0.151
(59) Misc manufacturing	-0.006	-0.217	-1.286
(60) Agric fertilizers	-0.008	-0.131	-0.856
(61) Finance and insurance	-0.010	-0.107	-0.047
(62) Eating and drinking	-0.010	-0.176	-0.416
(63) Hotels	-0.012	-0.212	-0.043
(64) Medicine, education, n	-0.013	-0.177	-0.238
(65) Food and tobacco	-0.015	-0.109	-0.209
(66) Movies and amusements	-0.015	-0.327	-0.425
(67) Apparel	-0.016	-0.204	-0.968
(68) Knitting	-0.016	-0.174	-0.214
(69) Govt enterprises	-0.022	-0.326	-0.713
(70) TVs radios phonographs	-0.042	-0.619	-6.399

Table 7.15: Effect of Fast Money Growth on Profit Margins

Difference between profit margin in Fast money scenario and Profit margin in Base forecast

Profit margin equals Before-tax profits, adjusted for CCA and IVA as percent of nominal output

ranked by difference in 1993

	1993	1994	1995	1996	1997	1998	2000
(1) Financial insurance	0.046	0.112	0.147	0.231	0.064	0.376	0.666
(2) Primary metal	0.040	0.096	0.098	0.128	-0.063	0.007	-0.015
(3) Stone clay glass	0.032	0.019	-0.058	-0.098	-0.159	-0.130	-0.064
(4) Paper	0.024	0.045	0.046	0.036	-0.001	0.047	0.049
(5) Lumber	0.013	0.030	0.020	-0.000	-0.027	-0.041	-0.056
(6) Instruments	0.009	-0.033	-0.134	-0.187	-0.413	-0.378	-0.439
(7) Motion pictures	0.008	0.039	0.079	0.099	0.130	0.141	0.125
(8) Leather	0.007	0.044	0.125	0.211	0.235	0.223	0.307
(9) Hotels repair	0.007	0.013	0.009	0.007	-0.028	-0.009	0.005
(10) Real estate	0.007	0.014	0.007	0.002	-0.021	-0.015	-0.013
(11) Electric gas sanita	0.006	0.008	-0.006	0.010	-0.056	-0.042	0.006
(12) Metal products	0.006	0.003	0.019	0.055	0.039	0.089	0.187
(13) Mining	0.000	0.014	0.047	0.077	0.085	0.058	0.033
(14) Trucking	0.000	-0.003	-0.018	-0.031	-0.043	-0.050	-0.063
(15) Medical educational	-0.000	0.000	0.002	0.009	0.007	0.022	0.042
(16) Agriculture	-0.000	-0.001	-0.003	-0.003	-0.005	-0.005	-0.004
(17) Textile mill	-0.001	-0.011	-0.037	-0.046	-0.098	-0.088	-0.093
(18) Furniture	-0.002	-0.038	-0.091	-0.131	-0.140	-0.195	-0.243
(19) Food	-0.003	-0.016	-0.036	-0.055	-0.066	-0.093	-0.129
(20) Petroleum refining	-0.004	-0.004	0.002	-0.003	0.020	-0.020	-0.059
(21) Trans equip	-0.004	-0.017	-0.029	-0.031	-0.030	-0.023	-0.003
(22) Crude oil	-0.005	-0.059	-0.221	-0.356	-0.464	-0.506	-0.523
(23) Auto repair	-0.006	-0.023	-0.042	-0.051	-0.069	-0.073	-0.077
(24) Chemicals	-0.009	-0.046	-0.085	-0.090	-0.141	-0.138	-0.135
(25) Business services	-0.009	-0.031	-0.053	-0.069	-0.076	-0.099	-0.125
(26) Construction	-0.010	-0.038	-0.039	0.004	-0.069	0.009	0.063
(27) Railroads	-0.011	-0.045	-0.161	-0.185	-0.337	-0.217	0.031
(28) Wholesale retail tr	-0.015	-0.055	-0.100	-0.107	-0.184	-0.180	-0.182
(29) Misc manufacturing	-0.016	-0.054	-0.031	0.024	-0.007	0.062	0.141
(30) Printing	-0.018	-0.070	-0.128	-0.166	-0.220	-0.262	-0.306
(31) Non elect machinery	-0.019	-0.080	-0.203	-0.392	-0.581	-0.914	-1.682
(32) Rubber plastic	-0.019	-0.036	-0.010	-0.067	-0.001	-0.082	-0.169
(33) Air transportation	-0.023	-0.079	-0.130	-0.163	-0.170	-0.196	-0.193
(34) Electrical machiner	-0.023	-0.103	-0.176	-0.228	-0.265	-0.283	-0.285
(35) Apparel	-0.023	-0.068	-0.098	-0.093	-0.094	-0.115	-0.092
(36) Communications	-0.034	-0.142	-0.266	-0.355	-0.439	-0.498	-0.546
(37) Motor vehicles	-0.078	-0.316	-0.559	-0.651	-0.707	-0.719	-0.636

Exchange Rate Simulation

There is little debate that changes in the value of the dollar can have a substantial impact on the U.S. economy. Although most empirical analysis of exchange rates is done using macroeconomic models, the net effect of a change in the value of the dollar is due to the response of specific industries to changes in relative foreign to domestic prices. Since LIFT models exports and imports by industry, it is well-suited to analyzing a change in the value of the dollar. LIFT's trade flows are determined by product-specific demand and price data. In addition, LIFT considers not a single weighted exchange rate, but rather, the value of the dollar against the specific currencies of our trading partners.

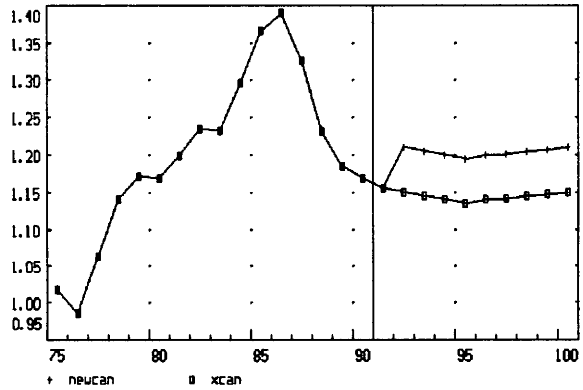
In this simulation with LIFT, a one-time appreciation of the dollar was assumed to occur in 1992. Specifically, each exchange rate changed by 5% in 1992, compared to its value in the Base forecast. From 1993 to 2000, each exchange rate follows the same growth as in the Base forecast, but it remains at the higher level. Figure 7.18 illustrates some of the implications of the exchange rate assumption. The first panel illustrates the value of the Canadian dollar relative to the U.S. dollar in the two alternatives. In 1992, the U.S. dollar equals 1.15 Canadian dollars in the Base forecast, and 1.21 Canadian dollars in the Alternate forecast. The second panel illustrates the average effective relative price of imports. Imports immediately become cheaper, and the effect continues throughout the forecast. Likewise, U.S. goods become relatively expensive abroad, and the relative price of exports rises.

The impact of exchange rates on exports and imports in LIFT depends on the equations that determine product exports and imports.[74] First, merchandise exports depend on product-specific demand from different countries, as well as on relative domestic to foreign prices.

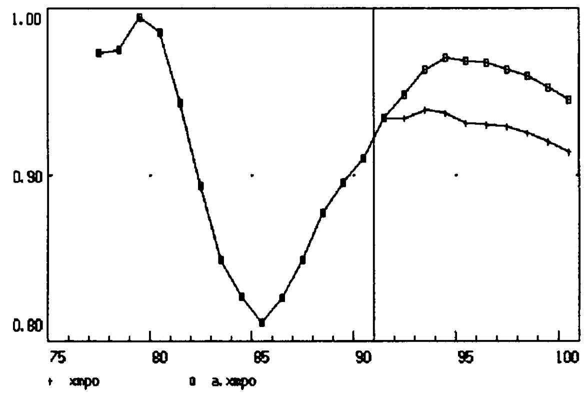
[74] The export and import equations were originally estimated by Nyhus (1975), and this section draws on Nyhus (1991).

Figure 7.18: Exchange Rate Assumption and Implications

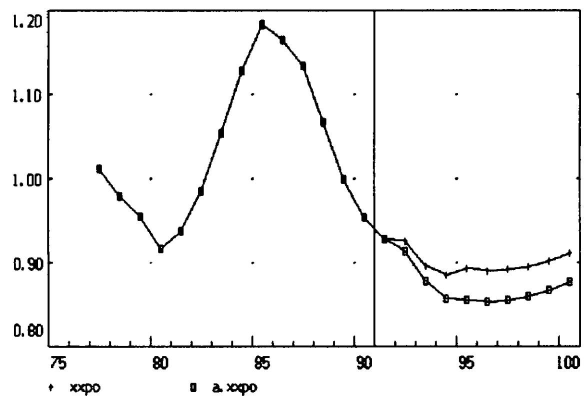
(a) Canadian dollar / U.S. dollar



(b) Relative Price of Imports



(c) Relative price of exports



Specifically, the equation to determine product exports is:

$$e_{i,t} = \left(b_0 + b_1\sum_{k=1}^{K-1} w_k \frac{m_{k,i,t}}{m_{k,i,0}}\right)(rp_{i,t})^n \tag{7.1}$$

where

$e_{i,t}$	=	volume of exports of product i, in year t,
w_k	=	U.S. exports of product i to country k as share of total U.S. exports of product i, in the base year of the model, year 0,
$m_{k,i,t}$	=	imports into country k of product i, in year t,
$rp_{i,t}$	=	relative domestic to foreign price of product i, in year t (see below),
b_0, b_1, n	=	estimated parameters specific to product i.

The price term is a four-year distributed lag on relative domestic to foreign prices, where the lag weights are product-specific.[75] Specifically, the relative price term is defined:

$$rp_{i,t} = \sum_{j=0}^{3} d_{i,j}\left(\frac{p_{i,t-j}}{f_{i,t-j}}\right) \tag{7.2}$$

where

$p_{i,t}$	=	domestic price of product i, in year t,
$f_{i,t}$	=	foreign price of competing exports of product i, in year t (see below)
$d_{i,j}$	=	distributed lag weight on prices at time t-j, for product i.

The foreign price is a trade-weighted, exchange-rate-adjusted price of competing exporters, defined as follows:

[75] See Nyhus (1975) for the estimation of these distributed lags.

$$f_{i,t} = \sum_{k=1}^{K-1} s_k \frac{(p_{k,i,t}\, r_{k,t})}{(p_{k,i,0}\, r_{k,0})} \qquad (7.3)$$

where

$f_{i,t}$	=	competing foreign price of product i, in year t, (expressed in U.S. dollars),
s_k	=	country k's share of world exports of product i in base year,
$p_{k,i,t}$	=	price index of product i in country k, in year t, (expressed in currency of country k),
$r_{k,t}$	=	exchange rate with country k (U.S. dollars per unit of foreign currency; the currency of country k), in year t.

An appreciation of the dollar, implying that $r_{k,t}$ falls, causes the foreign price, $f_{i,t}$, to fall (equation 7.3). A fall in $f_{i,t}$ will increase the current relative price for the product based on the distributed lag pattern in equation 7.2. For a product such as Textiles, the current-year weight is relatively strong, while for capital goods, such as Electrical machinery, the current-year weight is small compared to the lagged weights. An increase in the relative domestic to foreign price of a product will decrease exports based on the product-specific price elasticity, η in equation 7.1.

Merchandise imports also are determined by a combination of demand and relative prices. Specifically, the equation for product imports is

$$m_{i,t} = (b_0 + b_1 d_{i,t})\left(rp^m_{i,t}\right)^{\eta} \qquad (7.4)$$

where

$m_{i,t}$	=	volume of imports of product i, in year t,
$d_{i,t}$	=	domestic demand for product i, in year t (domestic demand equals domestic production plus imports less exports),
$rp^m{}_{i,t}$	=	relative foreign to domestic price of imports of product i, in year t (see below),
b_0, b_1, η	=	estimated parameters specific to product i.

As with export prices, the price term in the equation is a four-year distributed lag on relative foreign to domestic prices, where the weights are product-specific (and different from the weights used to determine export prices).

$$rp^m_{i,t} = \sum_{j=0}^{3} d_{i,j} \left(\frac{p^m_{i,t-j}}{p_{i,t-j}} \right) \tag{7.5}$$

where

$rp^m_{i,t}$ = relative foreign to domestic price of imports of product i, in year t,

$p^m_{i,t}$ = price of imports of product i, in year t (see below),

$p_{i,t}$ = domestic price of product i, in year t

$d_{i,j}$ = distributed lag weight on prices at time t-j, for product i.

The price of imports is a trade-weighted, exchange-rate-adjusted price, calculated as follows:

$$p^m_{i,t} = \sum_{k=1}^{K-1} v_k \left(\frac{p_{k,i,t} r_{k,t}}{p_{k,i,0} r_{k,0}} \right) \tag{7.6}$$

where

$p^m_{i,t}$ = price of imports of product i, in year t, (expressed in U.S. dollars),

$v_{k,t}$ = imports of product i from country k as share of total imports of product i, in base year,

$p_{k,i,t}$ = price in country k of product i, in year t, (expressed in currency of country k)

$r_{k,t}$ = exchange rate with country k (U.S. dollars per unit of foreign currency; the currency of country k), in year t.

An appreciation of the dollar, implying a decrease in $r_{k,t}$, causes a decrease in the import price of the product, $p^m_{i,t}$. A fall in the import price implies that the relative foreign to domestic price ratio in equation 7.5 also falls. Given a fall in import prices, the demand for imports will rise based on the estimated price elasticity for each product, ^{n}.

When LIFT is run as part of the International System of models, the product prices in each foreign country are endogenous (the $p_{k,i,t}$ terms in equations 7.3 and 7.6). However, when LIFT is run as a separate model, as it is in this study, the product prices in each other country's own currency are exogenous. Changes in relative foreign to domestic prices occur because of changes in U.S. prices or the exchange rate, but foreign prices do not respond to any of the exchange-rate changes. Moreover, foreign demand for product exports are exogenous when LIFT is run as a separate model. (Equation (7.1))

It should be noted that the export and import equations described in equations (7.1)-(7.6) are for merchandise trade only. Imports and exports of non-merchandise trade are determined using simple equations that relate non-merchandise trade to merchandise trade. There are no direct relative-price effects on non-merchandise trade.

As seen in equations (7.1)-(7.6), the initial effect of an appreciation of the dollar is to decrease the relative price of imports and increase the relative price of exports. Although U.S. consumers are clear winners from the dollar appreciation, the net effect on total GNP is negative. (See Table 7.16 and Figure 7.19.) By 1993, the year after the initial appreciation, Personal consumption expenditures are .9% higher because of lower prices (and higher real income) resulting from the rise in the value of the dollar; PCE inflation is 2.9% in 1992, compared to 3.5% in 1992 in the Base forecast. The increased consumer demand is met mostly by imported goods, however, rather than from goods produced domestically. Imports are 2.7% higher in 1993 than in the Base forecast. In addition, domestic firms are less competitive in the world market, and Exports are 2.5% lower than in the Base forecast in 1994. Faced with import competition at home and price competition abroad,

Table 7.16: Macroeconomic Results of Exchange Rate Alternative

result for Base forecast
and difference = value in Exchange rate forecast - value in Base forecast
% difference = difference as a percent of value in Base forecast

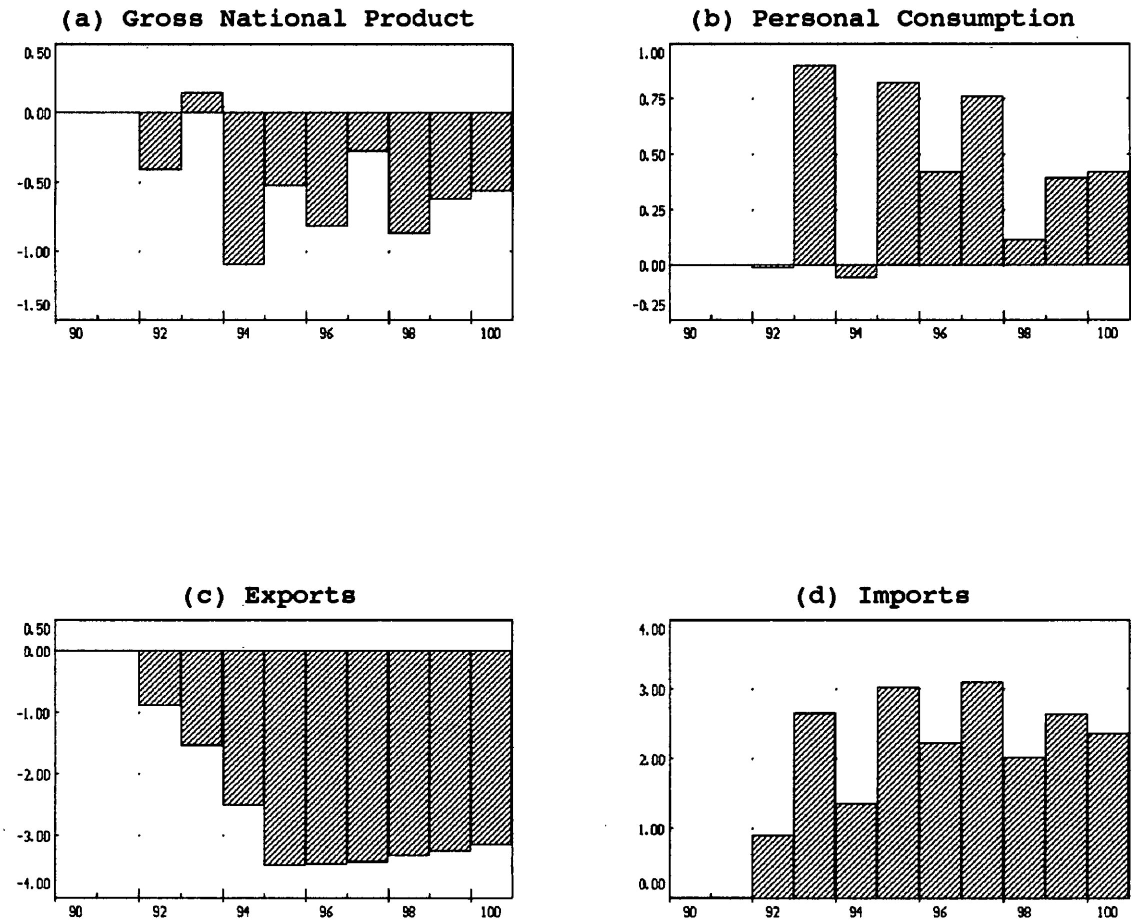
Billions of 1977$	1992	1993	1994	1995	1996	1997	1998	2000
Gross national product	2885.1	2937.9	2994.6	3017.4	3087.2	3140.1	3211.7	3323.9
Difference	-11.7	4.3	-32.8	-15.8	-25.2	-8.5	-28.0	-18.5
% difference	-0.4	0.1	-1.1	-0.5	-0.8	-0.3	-0.9	-0.6
Personal consumption	1902.1	1913.8	1946.3	1965.4	2010.6	2041.4	2083.8	2161.6
Difference	-0.2	17.2	-1.1	16.2	8.5	15.5	2.4	9.1
% difference	-0.0	0.9	-0.1	0.8	0.4	0.8	0.1	0.4
Fixed investment	470.2	483.3	491.2	482.9	502.3	515.2	535.7	557.2
Difference	-3.0	6.3	-10.9	0.8	-3.6	9.4	-0.6	3.8
% difference	-0.6	1.3	-2.2	0.2	-0.7	1.8	-0.1	0.7
Durable equipment	264.5	275.6	284.0	279.4	294.6	303.1	320.0	338.7
Difference	-2.3	4.0	-9.4	-1.7	-5.7	3.5	-3.8	-1.1
% difference	-0.9	1.5	-3.3	-0.6	-1.9	1.2	-1.2	-0.3
Nonresid structures	87.4	90.5	90.9	88.4	91.3	94.5	97.8	101.7
Difference	-1.1	-0.0	-2.7	-0.6	-1.8	1.1	-1.1	-0.6
% difference	-1.2	-0.0	-3.0	-0.7	-2.0	1.1	-1.1	-0.6
Residential structures	118.2	117.3	116.4	115.1	116.4	117.7	117.8	116.8
Difference	0.4	2.2	1.2	3.1	3.9	4.8	4.3	5.6
% difference	0.3	1.9	1.1	2.7	3.4	4.1	3.6	4.8
Exports	431.7	463.6	492.3	511.9	529.7	545.6	561.9	592.8
Difference	-3.8	-7.1	-12.3	-17.8	-18.3	-18.6	-18.6	-18.6
% difference	-0.9	-1.5	-2.5	-3.5	-3.4	-3.4	-3.3	-3.1
Imports	461.6	462.7	473.3	478.5	495.2	505.1	518.0	547.0
Difference	4.1	12.3	6.4	14.5	11.0	15.6	10.4	12.9
% difference	0.9	2.7	1.4	3.0	2.2	3.1	2.0	2.4
Disposable income (72$)	1455.0	1480.2	1500.2	1517.0	1544.1	1577.2	1609.9	1678.7
Difference	2.2	6.7	1.9	-3.2	-1.3	-0.4	-1.5	-2.9
% difference	0.2	0.5	0.1	-0.2	-0.1	-0.0	-0.1	-0.2

Percent:	1992	1993	1994	1995	1996	1997	1998	2000
Inflation (GNP deflator)	3.4	3.9	4.0	4.1	3.6	3.6	3.6	4.2
Exchange rate scenario	3.4	3.7	4.3	3.7	3.2	3.3	3.6	3.9
Inflation (PCE deflator)	3.5	3.9	4.2	4.1	4.0	3.7	4.0	4.3
Exchange rate scenario	2.9	3.8	4.2	3.9	3.6	3.5	3.7	3.9
Unemployment rate	4.6	4.5	4.5	5.0	4.9	4.8	4.6	4.7
Exchange rate scenario	4.9	4.4	5.0	5.4	5.3	5.0	5.1	5.0
Interest rate 3-mo T-bill	7.8	8.1	8.6	8.8	8.9	9.5	9.6	10.6
Exchange rate scenario	7.6	7.9	8.3	8.1	8.5	8.7	8.9	9.8
Growth of real GNP	2.7	1.8	1.9	0.8	2.3	1.7	2.3	1.7
Exchange rate scenario	2.3	2.4	0.7	1.3	2.0	2.3	1.7	1.7

Figure 7.19: Summary of Macroeconomic Effects of Appreciation of Dollar

Difference in variable due to Appreciation

as Percent of value in Base Forecast



domestic firms cut back on investment and employment. In 1994, Producer Durable Equipment investment is 3.3% lower than in the Base forecast, and investment in Nonresidential structures is 3% lower. Likewise, the unemployment rate is .5 percentage points higher after the dollar appreciation than in the Base forecast.

As shown in Figure 7.19, price changes affect trade flows with a lag, and the peak effect on exports occurs four years after the initial change (-3.5%), while the peak effect on imports occurs six years after the change (+3.1%). The fall in GNP is worse in the third year of the change, where GNP is 1.1% lower than in the Base forecast. Over the long run, lower inflation and lower interest rates stimulate some sectors of the economy. In particular, Investment in Residential Structures responds positively to lower interest rates, and investment is 4.8% higher in 2000 than in the Base forecast. Any stimulus from lower inflation and low interest rates is far outweighed, however, by the negative effect of the change in relative prices on exports and imports, and GNP is .6% lower in the year 2000 than in the Base forecast.

The industry effects of an appreciation of the dollar reflect the strong impact of price changes on exports and imports. (Table 7.17) Industries hurt most by the appreciation are those most sensitive to foreign trade competition. In 1992, the first year of the appreciation, almost all industries suffer reductions in domestic output because of the appreciation. The only exceptions are Retail trade and Ships and boats. Increased consumer spending on imports benefits Retail trade, while consumption of Ships and boats responds strongly to an increase in real Disposable income. The industries in which output decreases the most, relative to other industries, include those with high export price elasticities, such as Metalworking machinery (-1.3), TV's, radios, and phonographs (-1.4), and Nonelectrical machinery (-1.2). Industries sensitive to import competition also suffer reductions in output, such as Ferrous metals (import price elasticity -1.6), Communication equipment (-1.8), and Electrical appliances (-1.3).[76]

The initial negative effect on product outputs worsens over time, as the lagged impact of changing relative foreign to domestic prices more fully affects demand. In 1994, the effect on industry output is worse than in 1992 for all but four industries. The exceptions are industries that benefit from higher disposable income and/or lower interest rates, and that have little foreign competition, such as Eating and drinking places, Owner-occupied housing, and Medicine, education and non-profit organizations. Curiously, the fourth exception is Shoes and leather which typically is considered a trade-sensitive industry. The foreign trade results for this industry are set exogenously, however, because the estimated equation for the industry produced anomalous results. The long-run results do not differ substantially from the short-run and medium-run effects of the appreciation. The rank correlation coefficient between the 1992 effects and the 2000 effects is a positive .03096. Output for most industries is lower in the year 2000 than in the Base forecast. Some exceptions are those industries linked to Residential construction, such as Owner-occupied housing, Construction, and Gas utilities. In addition, industries where demand is income-sensitive and there is little foreign competition also benefit in the long run, such as Eating and drinking places, Medicine, education, and npo, and Hotels. Retail trade output also is higher, because of increased consumer spending.

[76] The elasticities are those reported in Wilson and Nyhus, 1987.

Table 7.17: Industry Effects of Appreciation of Dollar

Percent difference in Output: Dollar Appreciation - Base Forecast
ranked according to difference in 1992

		1992	1994	2000
(1)	Metalworking machinery	-3.031	-7.340	-3.038
(2)	TVs radios phonographs	-2.483	-7.588	-7.286
(3)	Nonelect machinery	-1.638	-4.215	-2.730
(4)	Communic equipment	-1.579	-4.181	-4.130
(5)	Spec ind machinery	-1.575	-5.021	-2.459
(6)	Agric machinery	-1.549	-3.520	-2.196
(7)	Ferrous metals	-1.460	-4.598	-3.087
(8)	Copper	-1.374	-4.330	-3.146
(9)	Electrical appliances	-1.326	-3.453	-3.740
(10)	Aerospace	-1.218	-2.404	-2.325
(11)	Other nonferrous metal	-1.199	-3.675	-2.939
(12)	Apparel	-1.144	-2.036	-2.412
(13)	Motor vehicles	-1.115	-3.946	-1.905
(14)	Service industry machi	-1.078	-2.816	-0.710
(15)	Textiles	-1.036	-2.295	-1.930
(16)	Instruments	-1.016	-2.250	-1.453
(17)	Misc manufacturing	-1.014	-3.126	-3.162
(18)	Plastic	-0.955	-2.766	-2.085
(19)	Lumber	-0.950	-2.148	-0.647
(20)	Office equipment	-0.935	-8.083	-7.517
(21)	Household appliances	-0.897	-1.938	-2.381
(22)	Chemicals	-0.852	-2.320	-1.987
(23)	Stone, clay, glass	-0.847	-2.229	-0.889
(24)	Metal products	-0.817	-2.868	-1.689
(25)	Nonmetallic mining	-0.781	-2.158	-1.291
(26)	Agric fertilizers	-0.749	-1.435	-1.311
(27)	Engines and turbines	-0.728	-5.517	-5.108
(28)	Nonferrous metals mini	-0.728	-2.162	-2.036
(29)	Rubber	-0.695	-1.994	-1.222
(30)	Owner occupied housing	-0.669	-0.550	0.865
(31)	Const mining oilfield	-0.657	-6.120	-8.796
(32)	Furniture	-0.654	-1.857	-1.016
(33)	Iron mining	-0.654	-2.626	-2.380
(34)	Other transportation e	-0.552	-5.968	-0.096
(35)	Fuel oil	-0.539	-1.944	-2.120
(36)	Agriculture	-0.537	-1.002	-0.690
(37)	Movies and amusements	-0.525	-1.498	-0.081
(38)	Railroads	-0.521	-1.716	-1.302
(39)	Paper	-0.518	-1.533	-1.050
(40)	Shoes	-0.481	0.217	3.857

Table 7.17: Industry Effects of Appreciation of Dollar

Percent difference in Output: Dollar Appreciation - Base Forecast
ranked according to difference in 1992

continued

	1992	1994	2000
(41) Hotels	-0.461	-0.957	0.066
(42) Computers	-0.436	-1.940	-0.243
(43) Water and sanitation	-0.422	-1.352	-0.453
(44) Coal mining	-0.406	-1.167	-0.939
(45) Trucking	-0.394	-1.169	-0.595
(46) Wholesale trade	-0.388	-1.351	-0.721
(47) Food and tobacco	-0.376	-0.856	-0.636
(48) Eating and drinking	-0.364	-0.188	0.150
(49) Business services	-0.335	-0.944	-0.422
(50) Crude petroleum	-0.325	-1.390	-1.109
(51) Construction	-0.321	-0.716	0.758
(52) Electric utilities	-0.306	-0.791	-0.395
(53) Govt enterprises	-0.277	-1.142	-0.412
(54) Knitting	-0.269	-0.433	-0.098
(55) Printing	-0.266	-0.744	-0.417
(56) Communciation services	-0.257	-0.693	-0.373
(57) Petroleum refining	-0.255	-1.035	-0.822
(58) Gas utilities	-0.237	-0.822	0.036
(59) Pipeline	-0.208	-0.861	-0.592
(60) Transportation service	-0.205	-0.479	-0.400
(61) Finance and insurance	-0.202	-0.362	-0.334
(62) Real estate	-0.202	-0.535	0.054
(63) Elec lighting and wiri	-0.201	-1.248	-1.573
(64) Natural gas extraction	-0.196	-0.381	-0.032
(65) Water transport	-0.193	-1.103	-0.857
(66) Medicine, education, n	-0.154	0.016	0.186
(67) Air transport	-0.097	-0.207	-0.427
(68) Auto repairs	-0.037	-0.664	-0.131
(69) Retail trade	0.117	-0.036	0.428
(70) Ships boats	0.419	-2.516	-0.486

The effect of an appreciation of the dollar on profit margins is determined by the response of profits to changes in input costs and to changes in demand. In general, a fall in costs is passed on in lower product prices through the definition of prices in the input-output dual equation. That pass-through of cost changes is delayed to the extent that industry profits absorb the cost change. As shown in Table 7.18, almost half of the industries initially experience an increase in the profit margin as a result of the dollar appreciation. In these industries, a fall in costs temporarily implies an increase in the profit margin, as profits reap some of the benefits of lower costs. Motor vehicles, Furniture, Apparel, and Communications benefit from the dollar appreciation in the short run. On the other hand, several industries are affected strongly by a fall in demand, and the profit margin for those industries falls. Primary metal industries, Instruments, Finance and insurance services, and Chemicals, for example, respond to a slowdown in overall demand.

In the long run, as demand in most industries falls, relative to the Base forecast, the profit margins likewise decline. This response of the profit margins is part of the stabilizing reaction of the model to a change in the exchange rate. A fall in the profit margin implies a fall in the product price, leading to generally lower inflation. Lower inflation helps stimulate demand, and prevents the dollar appreciation from sending the economy into a downward spiral. Because the scenario was designed to examine the effects of an exchange-rate change on only the LIFT model, the long-run negative effects of the appreciation are exaggerated. In particular, foreign demand for U.S. exports is exogenous for this simulation and does not change in response to changing prices and trade flows. As U.S. imports increase, foreign income would increase, leading to an increase in demand for imported goods by our trading partners. This increase in demand would help to offset the negative price effects on U.S. exports.

Table 7.18: Effect on Profit Margins of Exchange Rate Alternative

Difference between profit margin with Dollar Appreciation and Profit margin in Base forecast

Profit margin equals Before-tax profits, adjusted for CCA and IVA as percent of nominal output

ranked by difference in 1992

	1992	1993	1994	1995	1996	1997	1998	2000
(1) Primary metal	-0.456	0.091	-0.863	-0.554	-0.633	-0.400	-0.786	-0.535
(2) Instruments	-0.367	0.321	-0.957	-0.347	-0.735	-0.167	-0.764	-0.594
(3) Financial insurance	-0.365	0.539	-1.186	0.345	-0.709	0.196	-0.844	-0.307
(4) Chemicals	-0.160	0.050	-0.324	-0.160	-0.157	-0.052	-0.249	-0.135
(5) Misc manufacturing	-0.150	0.224	-0.380	0.470	-0.577	-0.034	-0.350	-0.355
(6) Textile mills	-0.124	0.045	-0.274	-0.115	-0.128	-0.042	-0.178	-0.098
(7) Electric gas sanita	-0.099	0.061	-0.330	-0.061	-0.237	-0.064	-0.315	-0.091
(8) Metal products	-0.068	-0.075	-0.241	0.118	-0.034	0.063	-0.168	0.030
(9) Hotels repair	-0.067	0.071	-0.193	-0.024	-0.142	-0.012	-0.142	-0.078
(10) Stone clay glass	-0.065	0.143	-0.257	0.166	0.010	0.286	-0.087	0.090
(11) Wholesale retail tr	-0.053	-0.004	-0.236	0.046	-0.168	-0.002	-0.154	-0.056
(12) Motion pictures	-0.053	0.161	0.007	-0.071	-0.041	-0.075	0.001	-0.048
(13) Real estate	-0.035	0.033	-0.091	-0.041	-0.057	-0.020	-0.076	-0.038
(14) Air transportation	-0.028	0.082	-0.023	-0.037	0.086	0.080	0.005	0.059
(15) Leather	-0.024	-0.144	-0.064	0.058	-0.054	-0.103	-0.156	0.059
(16) Medical educational	-0.014	0.019	-0.042	0.027	-0.026	0.013	-0.036	-0.005
(17) Crude oil	-0.013	0.220	-0.173	0.110	-0.016	0.144	-0.118	0.011
(18) Lumber	-0.007	-0.028	-0.041	-0.047	0.088	0.062	0.050	0.092
(19) Agriculture	-0.005	-0.003	-0.014	-0.004	-0.009	0.003	-0.004	0.000
(20) Mining	-0.005	-0.077	0.007	0.005	-0.002	-0.062	-0.028	0.020
(21) Trucking	0.001	0.016	0.006	-0.017	0.014	0.009	0.014	0.005
(22) Paper	0.014	0.155	-0.145	0.248	-0.213	0.166	-0.085	-0.113
(23) Printing	0.016	0.045	-0.125	-0.044	-0.051	-0.039	-0.083	-0.029
(24) Construction	0.017	0.057	-0.143	0.140	-0.045	0.085	-0.075	-0.061
(25) Business services	0.034	-0.002	0.023	0.040	0.040	0.015	0.048	0.024
(26) Electrical machiner	0.039	0.013	-0.178	-0.080	0.033	0.094	-0.015	0.024
(27) Auto repair	0.039	0.004	-0.007	0.015	0.034	0.020	0.016	0.030
(28) Petroleum refining	0.043	-0.057	0.188	-0.072	0.056	-0.066	0.077	0.009
(29) Food	0.068	0.003	0.086	-0.010	0.039	0.028	0.052	0.014
(30) Transport equip	0.070	0.006	0.026	0.091	0.078	0.085	0.051	0.067
(31) Non elect machinery	0.078	0.011	0.209	0.068	0.197	0.101	0.299	0.300
(32) Apparel	0.081	-0.033	-0.019	0.049	0.078	0.011	-0.002	0.086
(33) Communications	0.100	0.070	0.001	0.106	0.222	0.179	0.139	0.173
(34) Rubber plastic	0.110	-0.154	0.100	0.034	0.044	-0.088	0.144	-0.007
(35) Furniture	0.155	0.039	0.095	0.079	0.128	0.130	0.126	0.110
(36) Motor vehicles	0.162	0.155	-0.370	0.330	0.157	0.440	-0.067	0.170
(37) Railroads	0.176	-0.019	0.075	-1.194	0.440	0.106	0.011	0.347

Conclusions

The purpose of this chapter was to examine the simulation properties of the LIFT model by comparing four alternate forecasts to a base forecast. In each case, the profit equations responded in the expected direction and contributed to the stable properties of LIFT. One of the principal motivations for this work on estimating income-by-industry equations was to generate equations that were reasonable not only as an independent set of equations, but also as part of a dynamic forecasting model. Earlier attempts at estimating income-by-industry resulted in equations that were econometrically sound and reasonable in terms of economic theory.[77] The equations were not robust when included in the LIFT model, however. The simulations in this chapter illustrate that the equations developed in Chapters 3 through 5 perform well as part of a dynamic model.

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[77] See Hyle. The Hyle equations passed numerous tests of reasonableness and accuracy. In addition, more emphasis was placed on estimating industry-specific behavior for more of the components of income (Net interest, Depreciation, etc.) than in this study.

Chapter 8: Interindustry Macroeconomic Modeling and Social Accounting Matrices: An Application to Agriculture

In the quest to integrate interindustry relationships in econometric models of the macroeconomy, two different paths have been followed. One path, described in detail in Chapter 2 and the basis for this thesis, has been called the Interindustry Macroeconomic modeling approach. A second approach, recently made popular by Sherman Robinson, Jamie de Melo and others, is based on a Social Accounting Matrix (SAM). The SAM-based models include simple multiplier models, as well as Computable General Equilibrium (CGE) models.[78] Although IM models and SAM's were conceived with similar goals and approaches in mind, they have evolved into different tools. The following chapter introduces SAM-based models and outlines the differences between the two approaches by comparing the results of an experiment conducted in a SAM framework and in the LIFT model. The scenario considers a change in Agricultural policy that directly affects income in the sector.

SAM Modeling

Developed, in part, to reconcile input-output accounts with national income and product accounts, a Social Accounting Matrix (SAM) summarizes the full circular flow of goods and services in the economy. Its cornerstone is a traditional input-output table that captures intersectoral flows of intermediate inputs. In addition, a SAM includes flows from producing activities to factors of production and final demand, and then from factors back to activities.

The foundation of SAM accounting is a square matrix in which each row sum equals the corresponding column sum. It is illustrated by a SAM

[78] For development of multiplier models, see Stone and Pyatt and Round. CGE's in developing economies are surveyed in Dervis, de Melo and Robinson. For survey of CGE's of developed economies, see Scarf and Shoven.

using 1982 data for the U.S. economy shown in Figure 8.1.[79] The top left-hand corner of the matrix, showing flows from one Activity to another, is the traditional input output table. It illustrates that in 1982, for instance, the Agriculture industry purchased $71 billion of goods from Agriculture-related activities. In addition, the SAM shows income flows from Activities to Value added, in the second block in the first column. For instance, workers in Agriculture-related activities earned $1314 billion in labor income in 1982. The SAM framework also depicts the flow of income in the economy among different Institutions (namely, labor, firms, and government). Total labor income (the sum of Row 4: Labor income) equals $1864 billion. The distribution of that labor income between Labor ($1613) and Government ($251) is shown in Column 4 of the SAM. The SAM further illustrates the flow of total Labor income to Households, based on the size distribution of income. For instance, the richest 20 percent of Households earned $725 billion in 1982, while the poorest 40 percent earned $145 billion. The SAM includes a block illustrating not only the sources of income for Households, but also the disposition of that income. (In other words, it shows the consumption expenditures of households.) The block containing rows 1-3 and columns 10-12 shows that the Middle 40% of Households spent $692 billion on Agriculture-related activities, while the poorest 40% of Households spent $389 billion. Finally, the SAM shows the sources and disposition of income for three remaining institutions: Capital, Government and Rest of world. The row for the Capital account (13) shows that most of its income comes from Enterprises ($388 billion), while the column shows that most of its

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[79] The SAM is reproduced from Adelman and Robinson (1986), and highlights the agriculture sector. The following description of SAM's draws on Adelman and Robinson.

Figure 8.1: Social Accounting Matrix[80]

	Activities (1)	(2)	(3)	Value added (4)	(5)	(6)	Institutions (7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Activities															
1 Agriculture	50	94	10							5	9	7	-.2	8	19
2 Ag-related	71	1120	443							389	692	634	41	452	97
3 Othr activity	8	453	645							45	102	103	374	190	232
Sum	128	1667	1097							439	803	744	415	651	348
Value added															
4 Labor income	19	1314	531												
5 Capital income	45	701	200												
6 Ind. bus. tax	4	217	38												
Sum	68	2233	769												
Institutions															
7 Labor				1613											
8 Proprietors					112										
9 Enterprises					835									53	
Sum				1613	947									53	
Households															
10 Low 40%							145	10	81					205	-.2
11 Mid 40%							742	34	133					107	-.5
12 High 20%							725	68	225					50	-.5
Sum							1613	112	439					362	- 1
13 Capital accnt									388	-19	57	97		-115	7
14 Government				251		259			61	21	156	227		180	-24
15 Rest of world	5	38	286												
TOTALS	201	3937	2152	1864	947	259	1613	112	888	441	1016	1068	415	1130	329

80 Data for U.S. economy in 1982, billions of dollars. Source: A&R, page 1197, data provided by Engineering Economics Associates.

purchases are of non-agricultural commodities ($375 billion purchased from Other activities). The expenditure accounts for Households, Capital, Government, and Rest of world are simply the product accounts of the National Income and Product Accounts: Personal consumption expenditures, Investment, Government spending, and Net exports. The SAM summarizes flows between activities (the input-output matrix), as well as income distribution and transfers between institutions (capital account to government, for example).

As shown here, the SAM is not a model in itself, but rather is an accounting framework for depicting the interrelationships in the economy. Its usefulness as a model is developed by computing coefficients and using those coefficients to derive multipliers. The first step is to compute SAM coefficients by dividing each element in a column by the column sum. The result is called the A matrix. Since each row total equals the corresponding column total, a vector of row or column totals can be written

$$x = A x \tag{8.1}$$

where

x = vector of row or column totals,
A = matrix of SAM coefficients.

Because equation 8.1 represents a homogenous-equation system, the multipliers for analyzing a change in any column sum are equal to 1.0. In order to calculate more meaningful multipliers, the SAM A-matrix first must be partitioned into endogenous and exogenous columns, with a corresponding interchange of rows. Then, equation 8.1 becomes:

$$\begin{pmatrix} y \\ z \end{pmatrix} = \begin{pmatrix} B & C \\ D & E \end{pmatrix} \begin{pmatrix} y \\ z \end{pmatrix} \tag{8.2}$$

where
- y = endogenous column sums,
- z = exogenous column sums,
- B,C,D,E = partitions of A matrix based on y and z vectors.

The solution for the endogenous column sums can be written as:

$$y = (I-B)^{-1} Cz \tag{8.3}$$

The components of $(I - B)^{-1}$ C are then the SAM multipliers, and the following equation for the vector of exogenous column sums is simply ignored:

$$z = (I-E)^{-1} Dy \tag{8.4}$$

The multiplier matrix summarizes the relationships among activities, among institutions, and from activities to institutions. One of the important steps in setting up a SAM multiplier matrix is choosing the accounts to make exogenous. Standard practice is to choose some combination of the Capital account, Government, and the Rest of world sector. (p. 1200) The computed multipliers then can be derived to analyze a shock to the model, where the shock is defined as a change in one of the exogenous variables.

Value-added Shock to Agriculture

Recent work by Adelman and Robinson (A&R) points out the importance of analyzing a change to agriculture in a general equilibrium framework. The authors point out that partial equilibrium analysis ignores many important feedbacks between agriculture and the rest of the economy. The Agriculture sector purchases Fertilizers, for example, while the income earned in Agriculture is spent on consumer goods, among other items, and therefore affects non-agricultural sectors of the economy. In analyzing changes in agricultural policy, A&R use a SAM multiplier model to avoid the shortcomings of partial equilibrium analysis, which would ignore Agriculture's links to the rest of the economy. The SAM is based on 1982 data, and the multiplier model is derived by assuming Government and Rest of world are exogenous.[81]

Using a SAM-based multiplier model, A&R show the beneficial effects, to both the agricultural and non-agricultural sectors of the economy, of a ten billion dollar increase in agriculture's value added. It is assumed that the increase in value added does not change agricultural production, but rather is a strict transfer of income.[82] The results of the A&R analysis are summarized in Table 8.1. Non-agricultural value added rises by $19 billion, while agricultural value added rises by $10.4 billion. In addition, non-agricultural production increases by $38 billion, and non-agricultural income increases by $19 billion. The increase in agriculture's value added increases demand in the system, and yields positive leakages to the rest of the economy.

As noted by the authors, the multiplier model is completely demand driven. The multipliers are strictly fixed-price multipliers, and do not consider effects induced by changes in relative prices. Also, the multiplier model gives the comparative static results for a shock to the

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[81] In the A&R paper, it is not clear exactly how the multipliers for an increase in agriculture's value added are computed. The authors state that their model "focuses on the adjustment of the economy to shocks arising from changes in government expenditures and exports" (page 1200). Four shocks are analyzed with the SAM model, including a $10 billion increase in agriculture's value added. Presumably, the increase results from a transfer from the Government to Agriculture (as a reduction in Indirect business taxes of Agriculture, for example.) Alternatively, SAM multipliers could have been computed by creating a separate, exogenous, row/column for Agriculture, and computing the multipliers using the new exogenous column.

[82] A&R point out that price support programs that keep quantities unchanged, for example, result in direct increases in value added, with no change in input demand. In addition, input subsidies, such as the Farm Credit Program, combined with output controls also result in an effective subsidy to value added. (page 1203)

system, but does not specify the dynamic path taken to achieve the static solution. It may well be that an increase in agricultural value added of $10 billion leads to a $38 billion increase in nonagricultural output, but how and when that increase occurs may be just as important as the amount of the increase.

Table 8.1: Results of Value added Shock to Agriculture Using SAM Multiplier Model[83]

billions of dollars and percentages

	1982 value	Change	% change
Producing activities			
Agriculture	201.43	1.171	0.581
Food & tobacco	310.03	2.114	0.682
Chemicals	464.51	2.657	0.572
Utilities	525.83	3.285	0.625
Wholesale/retail	564.27	4.149	0.735
Finance,insur,re	720.12	5.471	0.760
Services	1352.65	7.240	0.535
Other	2152.19	13.242	0.615
Nonagriculture Sum	6089.61	38.159	0.627
Value added: Agriculture			
Employee compensation	18.79	3.054	16.258
Proprietor income	45.13	7.297	16.168
Indirect business tax	3.64	0.021	0.583
Sum	67.56	10.373	15.353
Value added: Nonagriculture			
Employee compensation	1845.43	11.252	0.610
Proprietor income	901.13	5.971	0.663
Indirect business tax	255.12	1.776	0.696
Sum	3001.69	18.999	0.633

Value-added Shock to Agriculture in LIFT

The accounting framework of a SAM is similar to the accounting framework of an Interindustry Macroeconomic model. As noted in Chapter 2, the cornerstone of an IM model is the A matrix of input-output coefficients, but the model also reconciles input-output data with National Income and Product Account data. The IM model includes the relationships between production activities, factor income, and final

[83] Adelman and Robinson, page 1204.

demand. Since the IM model is a closed system, like the SAM, all inter-institutional flows in the economy are accounted for.

The IM model differs from a simple SAM multiplier model, however, in three respects important for this analysis. First, the IM model is not based on fixed-prices, but rather includes the response of prices to changes in costs and demand. Second, behavior in the IM model is determined based on estimated parameters that are consistent with historical behavior of producers, consumers, and institutions. In the SAM model, relationships between institutions are determined by fixed coefficients which are based on data for one particular year. In determining the amount of Household income spent on Agriculture-related activities, for example, the SAM model uses a fixed coefficient based on 1982 data. In LIFT, on the other hand, the amount spent by persons (Households) on Agriculture-related activities is determined by the price of Agriculture-related products, the price of those products relative to Other commodities, as well as by the level of personal income. Third, the IM model projects economic variables over time and explicitly allows for lags in response to changes in the economy. The multiplier analysis, on the other hand, gives only the comparative static solution.

In the following exercise, the LIFT model is used to analyze the effects of an increase in value added for Agriculture. Because the model is based on the input-output equations for output and prices, an increase in value added corresponds to an increase in price. A concurrent increase in price and value added can occur in the following manner. Consider an increase in the world price of grain due to a crop failure abroad. An increase in the world price of grain, with no concurrent increase in costs of production for American farmers, implies that the surplus of farmers increases. The income shock introduced to LIFT assumes that agricultural value added is increased by $10 billion, and that the increase corresponds to an increase in agricultural prices.

The scenario therefore includes the stimulatory income effects of an increase in value added, as does the A&R multiplier analysis. In addition, however, it includes the negative effects of a price shock, which the fixed-price multiplier model omits.

The macroeconomic effects of the agriculture shock are summarized in Table 8.2. (The shock scenario is compared to the Base forecast described in Chapter 7.) In the shock scenario, agricultural value added was permanently increased by $10 billion, starting in 1992. By 1992, GNP is almost $3 billion lower, or .097%, than it would have been without the shock. Although agriculture's real income is $9.4 billion higher than in the Base forecast, overall labor compensation is $4.4 billion lower than in the Base. Lower income reduces personal consumption expenditures, which are $1.6 billion (.08%) lower due to the shock. Higher inflation also leads to higher interest rates, which, combined with lower output, decreases investment expenditures. Fixed investment is $1.6 billion lower than in the Base forecast in 1992.

In the long run, the positive income effects of the shock help the economy recover almost completely. By 1998, the decrease in GNP is less than $100 million dollars, or just .003%. Employment likewise recovers partially from the shock, with the drop in employment cut in half by 1998. The increase in agricultural income leads to an increase in disposable income, which stimulates consumption expenditures. In addition, fixed investment recovers partially, and is only $400 million lower than in the Base forecast by 1998.

The deleterious short-run effects of the shock are caused by the price shock implied by an increase in value added. Higher prices increase costs throughout the economy. An increase in agricultural prices raises costs for the Food and tobacco industry, for example. Higher costs lead to further price increases and reductions in demand.

Table 8.2: Macroeconomic Effects of Agriculture Value Added Shock in LIFT

	1991	1992			1998		
	base	base	diff	% diff	base	diff	% diff
billions of 1977$ and %							
Gross national product	2810.0	2885.1	-2.8	-0.0971	3211.7	-0.1	-0.0031
Personal consumption	1854.7	1902.1	-1.6	-0.0841	2083.8	2.0	0.0960
Producer durable equipment	255.9	264.5	-1.2	-0.4483	320.0	0.1	0.0347
Structures (Nonresidential)	80.4	87.5	-0.2	-0.2527	97.8	0.3	0.3303
Residential structures	114.9	118.2	-0.2	-0.2038	117.8	-0.8	-0.6432
Inventory change	16.6	17.5	-0.1	-0.7779	16.4	.03	0.1893
Exports	408.1	431.7	-0.0	-0.0088	561.9	-0.6	-0.1125
Imports	450.3	461.6	-0.6	-0.1200	518.0	1.2	0.2239
Disposable income, 1972$	1421.2	1455.0	-0.6	-0.0412	1609.9	1.3	0.0807
Unemployment rate	5.53	4.65	0.06	-	4.64	.03	-
Inflation rate	2.66	3.42	0.10	-	3.60	.06	-
Corporate bond rate	9.27	9.30	0.04	-	10.42	.14	-
Non-Agricultural income, 1992$							
Labor compensation	3410.9	3606.2	-4.40	-0.1220	3885.3	-8.77	-0.2260
Proprietor income	315.7	341.5	-0.34	-0.0980	363.4	-0.62	-0.1710
Agricultural income, 1992$							
Labor compensation	22.35	23.59	-0.00	-0.0190	23.62	-0.12	-0.4920
Proprietor income	86.61	96.29	9.41	9.7670	110.60	17.77	16.0660

Higher prices also imply that real income falls, which further reduces demand.

The effect of the shock on sectoral outputs, summarized in Table 8.3, highlights the contrasting impact of the shock in the short and long run. In the short run, 1992, output falls in almost all producing sectors of the economy. Higher prices induced by the increase in agricultural prices decrease demand. The sectors that use agricultural products as inputs, such as Food and tobacco, Eating and drinking places, and Lumber, suffer some of the largest percentage decreases in output. Likewise, those sectors that supply agriculture, such as Agricultural machinery and Agricultural fertilizers, also see relatively large reductions in output. As the stimulatory effects of increased demand emerge, demand for income-sensitive products increases. In the long-run, output of sectors such as Movies and amusements, Ships and

Table 8.3: Industry Effects of Agricultural Value Added Shock in LIFT

billions of 1977$ and percent

diff = output in Agriculture shock - output in Base Forecast
% diff = diff as percent of output in Base forecast

	1991	1992			1998		
	base b 77$	base b 77$	diff b 77$	% diff percent	base b 77$	diff b 77$	% diff percent
Agriculture, forestry, fishery	160.15	164.45	-0.72	-0.4366	183.02	-1.29	-0.7044
Agriculture-linked: buyers	1084.60	1116.73	-2.96	-0.2651	1253.55	-3.45	-0.2751
Food and tobacco	272.69	276.96	-1.45	-0.5239	296.11	-2.67	-0.9031
Eating and drinking places	112.02	114.92	-0.53	-0.4585	127.59	-0.82	-0.6416
Textiles	40.46	42.19	-0.02	-0.0412	48.10	0.01	0.0235
Lumber	53.20	55.75	-0.12	-0.2174	63.01	-0.26	-0.4133
Wholesale trade	321.77	334.18	-0.62	-0.1842	395.29	-0.27	-0.0689
Retail trade	284.45	292.72	-0.23	-0.0782	323.46	0.57	0.1750
Agriculture-linked: suppliers	595.04	614.28	-0.65	-0.1062	684.10	-0.19	-0.0282
Agricultural fertilizers	13.50	13.83	-0.03	-0.2444	15.36	-0.06	-0.4140
Agricultural machinery	9.47	10.20	-0.12	-1.1779	11.64	-0.09	-0.8044
Trucking, highway transp	77.20	79.85	-0.12	-0.1454	91.79	-0.05	-0.0594
Chemicals	156.00	162.38	-0.06	-0.0397	186.60	-0.01	-0.0034
Construction	149.56	154.56	-0.22	-0.1400	168.03	-0.09	-0.0537
Electric utilities	87.03	89.47	-0.06	-0.0672	100.69	0.00	0.0036
Petroleum refining	102.28	103.98	-0.04	-0.0398	110.00	0.11	0.1015
All other industries	3309.87	3413.99	-2.30	-0.0674	3922.97	2.86	0.0729
Mining	81.39	83.31	-0.06	-0.0767	89.43	0.02	0.0263
Nondurables	297.99	307.40	-0.21	-0.0675	350.33	0.10	0.0273
Apparel	46.84	47.97	0.01	0.0117	51.57	0.05	0.0950
Other nondurables	251.14	259.43	-0.21	-0.0821	298.76	0.05	0.0156
Durables	879.87	916.65	-1.33	-0.1448	1103.13	0.77	0.0694
Nonelectric machinery	184.59	193.62	-0.42	-0.2188	255.40	0.00	0.0001
Electrical machinery	164.97	172.54	-0.11	-0.0658	227.97	0.10	0.0420
Transportation equip	201.79	208.36	-0.30	-0.1464	230.14	0.62	0.2687
Other durables	328.52	342.13	-0.49	-0.1418	389.61	0.05	0.0131
Transportation	118.19	122.57	-0.06	-0.0510	148.07	0.03	0.0232
Utilities	202.96	210.99	-0.12	-0.0583	252.76	0.18	0.0704
Services	827.78	856.45	-0.32	-0.0377	993.18	1.28	0.1287
Hotels; non-auto repair	65.17	67.25	0.00	0.0045	74.71	0.22	0.2942
Automobile repairs	76.61	79.29	-0.01	-0.0145	90.88	0.21	0.2321
Movies and amusements	53.39	56.01	-0.06	-0.1021	65.26	0.13	0.2003
Other services	632.61	653.90	-0.26	-0.0394	762.34	0.72	0.0941
Miscellaneous	901.69	916.62	-0.19	-0.0210	986.07	0.48	0.0490

boats, and Other services benefit from the income effects of the shock.

The analysis of an agricultural value added shock in LIFT contrasts with the results from the SAM multiplier analysis in several respects. Interestingly, in the SAM analysis, a $10 billion increase in agriculture value added has a positive multiplier on its own income, and value added increases by an additional $.4 billion dollars. In the LIFT analysis, the $10 billion increase corresponds to an increase in price, which reduces demand for agricultural products, and the net effect on agricultural income is slightly less than the original $10 billion increase. The largest difference between the SAM analysis and the LIFT results centers on the price effects of an increase in value added. In the fixed-price analysis, an injection of income to agriculture has uniformly positive leakages on the rest of the economy. In LIFT, the initial effect of the shock is uniformly negative, in response to higher inflation and lower real income. Eventually, as the effects of higher income for agricultural workers and proprietorships affect aggregate income, there are some positive leakages to other sectors of the economy. Unlike in the multiplier analysis, however, the effects are not unanimous. Some industries are more affected by the price effects, even in the long run, than by the positive income effects. In addition, industries where there are positive long-run effects of the change generally have a smaller increase from the shock in the LIFT model than in the SAM multiplier analysis. For instance, the long-run percentage increase for Services in the LIFT analysis is .129%, while in the SAM multiplier analysis it is .535%.

Conclusions

Two conclusions on the effect of an agricultural value added shock are evident from the analysis with the LIFT model. First, LIFT highlights not only the stimulatory income effects of the shock, but also the deleterious effects of the implied price shock. These results contrast strongly with the results of a similar experiment with a SAM multiplier model that illustrates only the stimulatory income effects of the shock. The two experiments can best be seen as representing two extreme types of changes in agriculture. It is possible to define an income shock to agriculture that would have little or no effect on agricultural prices, as implied by the SAM analysis. It is highly unlikely, however, that such an initial change would not eventually affect prices in the rest of the economy. The fixed-price analysis is only appropriate, therefore, for quantifying one aspect of an income shock. As defined in this experiment, the income shock in the IM model corresponds to an equivalent price shock. Although the experiment may overstate the price effects of the agriculture shock, it provides a more complete picture of the income change because it includes price changes for the rest of the economy as well.

Analysis with the IM model also highlights the importance of the timing of the different effects of the change in value added. The negative effects of the price shock are felt immediately, while the offsetting stimulus from the change in income occurs with a lag. The SAM-based multiplier model gives no such insight into the dynamic effects of an income shock to agriculture. In analyzing a policy decision that involves a change in Agricultural income, the IM analysis shows that the time-horizon chosen to analyze the shock is crucial in evaluating the its overall impact. The ability to specify the dynamics of a policy change makes the IM model preferable to SAM multiplier models as a tool for policy analysis, when the timing of the effects of the policy change are important.

Chapter 9: Conclusions and Suggestions for Further Work

The purpose of this dissertation was to estimate equations for the price-income side of an Interindustry Macroeconomic model of the U.S. economy. Since prior attempts to develop the price-income side of the model had resulted in equations that performed well only in limited cases, one goal of this dissertation was to estimate equations that would be robust with respect to changes in exogenous and endogenous variables in the model. As shown in Chapters 7 and 8, the estimated equations are successful in meeting that goal, since the results of the model from six different simulations are reasonable. In each case, the income equations, especially profits, responded in the expected direction and contributed to the stable properties of the model.

The approach for estimating income by industry equations in this study focused on two areas. First, rather than estimate an aggregate measure of capital income by industry, equations for the specific components of capital income were estimated. Second, the immediate pass-through of cost changes to prices traditional in IM models was relaxed. Each of these was implemented successfully. Estimating profits directly, rather than estimating total return to capital, resulted in equations that capture the cyclical response of profits to both supply and demand changes. In addition, the relaxation of cost pass-through enriches the industry-specific behavior of the model. For example, since the Metals industry is oligopolistic, cost changes are passed more than fully through to prices initially, while in a more competitive industry, such as Wholesale and retail trade, complete pass-through of cost changes occurs with a lag.

One clear area for future research in developing the income by industry equations in the model is to expand the industry-specific behavioral equations for the non-profit components of capital income.

For instance, recent advances in availability of investment data by industry should allow for estimation of industry-level equations for Capital Consumption Allowances.[84] Since Net interest payments are a large part of return to capital, the industry-level behavior of the model also would be enhanced by equations for net interest payments that are specific to each industry.

A second area for future research concerns the question of debt and equity financing that is not addressed by the profit equations in this study. Since the focus of this work was the role of profits in price determination, the effect of increased debt financing of capital spending on profits was not addressed. It is possible, however, to identify trends in the industry profit margins, and these underlying trends may be explained by taking into account the ratio of debt to equity financing in each industry. The equation specification could be modified so that the trend of the profit margin depends on the split between debt and equity financing, while differences around the trend would depend on changes in costs and demand. A related issue concerns the relationship between capital utilization and profits. The present equation specification allows changes in demand to affect profits, but does not take into account whether the demand change occurs at high or low levels of capacity utilization. Future research on profits by industry could use industry-level investment data to determine capacity and capacity utilization for use in determining profits.

Another area for future research concerns the overall structure of the LIFT model and its behavior with respect to exchange rates. At present, LIFT assumes fixed exchange rates when alternate scenarios are run. It would be more realistic to make exchange rates endogenous. An alternative to making exchange rates endogenous would be to include a mechanism for insuring that <u>relative</u> foreign to domestic prices remain

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[84] See Meade (1990) for description of investment data by industry.

constant from one scenario to another. Alternatively, a mechanism introduced by Ralph Monaco (1984) could be re-activated in the model. The purpose of this mechanism was to move exchange rates by some scaler in response to changes in the trade balance from some pre-specified target balance. When running alternate simulations, the target trade balance was defined as the trade balance from the Base forecast. The exchange rate scaler then moved to appreciate or depreciate the dollar against all currencies in response to the deviation of the trade balance from the target. This approach had the advantage of allowing short-run response of foreign trade to a shock, but a long-run return to the relative trade position of the Base forecast.

A final area for future research concerns the role of money in the LIFT model and its effect on inflation. In the scenarios in Chapter 7, especially the money supply shock, changes in the money supply do not turn completely into inflation. In including a money model in LIFT and examining the properties of the model, Ralph Monaco (1984) noticed that changes in money did not turn completely into inflation. Rather, the change in money supply growth resulted in large changes in the velocity of money. According to the Keynesian paradigm, increases in the money supply lead to lower interest rates, which stimulate demand and put upward pressure on prices. Monaco noted that the link between demand and prices was weak in LIFT and was partly responsible for the gap in money growth and inflation.

> This suggests that more of the price-income side equations should be re-estimated to assure that velocity behaves in a more reasonable fashion when the money supply changes. (p. 264)

This dissertation has improved the response of the price-income side of the model to demand changes, but changes in money supply still do not turn completely into inflation. Part of the explanation for this behavior concerns the relatively strong response of the demand side of the model to changes in prices, coupled with a weak response to changes in interest rates. An increase in the money supply leads to higher prices in the model through the wage equation (which depends on money balances), as well as through some small increases in demand from lower interest rates. As changes in the money supply lead to higher prices, however, demand is weakened almost immediately. The price response overshadows any positive stimulus from lower interest rates, and cuts off the behavioral chain of events described by the Keynesian paradigm. One weak link in that chain of events is the effect of interest rates on real spending. Traditionally, it is difficult to find significant interest-rate effects in determining investment or consumption, and the equations in LIFT are not interest-rate sensitive. An alternative to including interest rate effects might be to follow the path of Almon (1989) and use the concept of the availability of money. Including an interest rate effect, or the availability of money in the savings rate equation, for example, would insure that some positive stimulus from lower interest rates would increase demand and put upward pressure on prices, as described by the Keynesian paradigm.

General Conclusions

The viability of the IM modeling approach in general, and the income-by-industry equations specifically, is demonstrated well by the comparison of a SAM multiplier model and LIFT in Chapter 8. The best use of an econometric model is as a simulation tool for conducting policy experiments or analyzing exogenous shocks to the economy. In two important respects, the IM approach is preferred to a SAM-based model that provides the same industry detail and accounting structure as the IM. First, the IM model clearly specifies the dynamic path for the reaction to a shock to the model. In analyzing policy simulations, the timing of the response may be the most important factor in evaluating the overall impact of the change. Second, the IM model includes the response of prices to changes in supply or demand in the model, and then the response of demand to those price changes. Since the SAM multipliers are based on fixed-prices, the simulation results give only a partial, demand-driven, picture of the policy change. Overall, the IM model compares favorably to the SAM approach.

No model of the size and scope of the current LIFT model could have been undertaken by a single person, and its development is due to the cumulative effort of a number of economists over the past twenty-five years. Just as one small stream gains strength when it reaches a river comprised of water from numerous streams, this dissertation contributes to a twenty-five year flow of econometric work. The work on improving and extending the LIFT model, in particular, and IM modeling in general, will continue, and it is hoped that the contributions made here will prove useful to future researchers.

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