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.[1]

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

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)

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[1] 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.

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.[2]

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 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

[2] 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)

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 aggregate profits that reflects economic, or opportunity costs, and consistency in cost definitions across industries. Since this study aims to model industry 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.[3] The definition of adjusted industry profits is:

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[3] 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.

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

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.[4] (For this study, data from 1955-1987 was used.) The last 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

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

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.[5]

[5] 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:

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:

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

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.[6]

In summary, aggregate profits are strongly procyclical, and macro models usually concentrate on that behavior in specifying a

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

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 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.[7] 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-

[7] 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.

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 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:

$$PROF(i) = f(IC, LC, D) \qquad (3.6)$$

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.[8] In effect, profits 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).[9]

---

[8] 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.

[9] 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.

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.[10] 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 as follows:

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

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

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

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

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

where

$p_{j,t}$ = product price j, time t,

[10] 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.

$p_{i,t}$ = 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.[11] 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.[12] 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 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

[11] 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.
[12] 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.

demand conditions. There are a number of competing theories on pricing in less than perfectly competitive industries.[13] In general, however, industries that face highly elastic demand are less willing to pass on higher costs to consumers than industries with inelastic demand.[14] 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-

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

[14] 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.

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 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.

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

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.[15]

Changes in Labor Costs

[15] 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 most likely 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.

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 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,

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

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.[16] 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 temporary 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

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

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.[17]

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.

[17] 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 equations closely resemble random walk models, where the variable deviates around a trend value in response to shocks.