Chapter 2
Profit System Models of the Firm, Industry, and Business Sector

This chapter proposes an integrated profit system model of the firm consisting of dynamic relationships among fundamental business variables. The first part of the chapter derives theoretical profit system models of production, capital stock, profit rate, profit margin, total profit, and employment for firms in the business sector, in addition to related models of employee compensation and other business variables. The second part of the chapter provides empirical profit system models that capture the relationships between these variables as a system of dynamic equations. These empirical models can be applied to individual firms, industries, and the whole business sector.

For managers of firms, these new empirical models provide a battery of methods to better understand the interrelationships between sales, fixed tangible assets, and profits. Importantly, the models can be used to not only analyze recent business decisions but forecast critical operating variables too. What production is needed by a firm to meet forecasted sales? How much investment in new capital is needed to meet forecasted capital stocks? What profit guidance is expected for the next period? On the industry and business sector levels these empirical models can be used by a wide variety of interested parties for business and economic analyses, forecasting, policy analyses, impact studies, and stock valuation. We demonstrate a number of these practical uses in forthcoming chapters.

2.1 Theoretical Foundation of Profit System Models of the Firm

We begin with the simple identity that firm output is equal to the product of the profit rate and market value of capital stock divided by the profit margin. This production identity can be rearranged to easily derive models of capital stock, profit rate, profit margin, and employment in the business sector. Together, these models constitute an integrated profit system model of firms.

There are two approaches to derive our profit system model of production: a mathematical economic approach and an accounting approach. Readers who are not interested in the mathematical economic approach can skip to the accounting approach.

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2.1.1 Mathematical Economic Approach to Obtaining a Profit System Model of Production

Output for a firm is commonly represented by the Cobb–Douglas production function:[1]

$$Y_t = A_t K_t^S H_t^{1-S}, \tag{2.1}$$

where Y is the output, A is the total factor productivity, K is the amount of capital, H is the amount of labor hired, and S is a parameter less than 1. Output can be defined as either sales or value added (e.g., dollar revenues from goods and services sold minus dollar costs of goods and services purchased). Assuming that each unit of output is priced at \$1 and that the wage rate is equal to the marginal product of labor, the *accounting profit function* (Z) conventionally computed by business firms is

$$Z_t = A_t K_t^S H_t^{1-S} - (1-S) A_t K_t^S H_t^{-S} H_t = S A_t K_t^S H_t^{1-S} = S Y_t, \tag{2.2}$$

where the dollar value of the marginal product of labor $(1-S)A_t K_t^S H_t^{-S}$ equals the wage rate. Note that S is capital's share of output or profit margin (i.e., profit divided by output).

Dividing equation (2.2) by K_t yields the profit rate R_t as

$$R_t = \frac{S Y_t}{K_t}. \tag{2.3}$$

Hence, a profit system model of production can be written as

$$Y_t = \frac{R_t K_t}{S_t}. \tag{2.4}$$

Thus, output in the Cobb–Douglas production function is equal to the product of the profit rate and capital stock divided by the profit margin for a business firm. In the Cobb–Douglas production function, the profit margin or capital's share of output S is a constant. However, as shown in equation (2.4), we assume (for practical reasons explained shortly) that the profit margin is a variable that varies over time S_t.[2] This key assumption changes equation (2.3) to a model of profit rates with time-varying S_t as follows:

$$R_t = \frac{S_t Y_t}{K_t}. \tag{2.5}$$

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[1] See Solow (1957) and Felipe and Holz (2001).

[2] In a recent paper McGratten and Prescott (2000) allow profit margins to vary in the Cobb–Douglas function.

2.1.2 Accounting Approach to Obtaining a Profit System Model of Production

The average profit rate R_t in period t commonly calculated by firms can be alternatively defined as the dollar value of nominal profit or earnings Z_t in period t generated from a stock of capital divided by the total market value of the capital stock K_t, or

$$R_t = \frac{Z_t}{K_t}. \tag{2.6}$$

Profit margin in period t is defined as nominal profit Z_t divided by the dollar value of nominal output in either sales or value-added terms:

$$S_t = \frac{Z_t}{Y_t}. \tag{2.7}$$

Solving for Z_t in equations (2.6) and (2.7), we alternatively obtain

$$Z_t = R_t K_t = S_t Y_t. \tag{2.8}$$

No matter how profit is defined (before or after charging interest costs, taxes, depreciation, etc.), the identities (2.6) and (2.7) result in equation (2.4) as long as the same figure for profit is used for computation of R_t and S_t. Derivation of the output model (2.4) from accounting identities (2.6) and (2.7) shows that it is not necessary to make any assumptions to derive the output model (2.4). In particular, it is not necessary to assume profit maximization.

Equation (2.4) can be viewed as a profit system model of managers' production behavior in the business sector. Consider a firm that has capital stock K. The firm's capital stock is the bundle of investment goods selected by the firm in the past based on expected hurdle profit rates. The firm's management is expected to attain the profit rate R used for selecting investment projects, which means that R is the target profit rate. Multiplying the expected target profit rate by the amount of capital stock gives the expected target total profit, or $Z_t = R_t K_t$. In order to attain the expected target profit, the firm must achieve a target level of sales or output derived by multiplying the expected target profit ($Z_t = R_t K_t$) and expected sales to profit ratio ($1/S_t = Y_t/Z_t$) to get $Y_t = R_t K_t / S_t$, namely, equation (2.4). While ex post realized profit rates and profit margins can be negative on a firm basis or even on an industry basis, expected target profit rates and profit margins are positive, due to the fact that firms do not embark on production activities unless they anticipate positive profits in the future.

Equation (2.4) shows that higher output depends on a higher profit rate and a smaller profit margin (or larger labor share of output). Also, equation (2.4) reveals that a falling profit rate does not necessarily lead to falling output. The adverse impact on output of falling profit rates in the numerator of equation (2.4) can be offset by a smaller profit margin in the denominator of equation (2.4), which means a growing share of labor. These observations are important for two reasons. First, falling profit rates have been considered as a prelude to the collapse of the capitalist system due to Marx's assertion that falling profit rates would eventually lead to the collapse of the capitalist system.[3] This assertion does not take into account declining profit margin effects that can boost output. Second, many economists have assumed that the impacts on output of changes in profit margins and profit rates are the same. The profit system model of production shows that *both* profit rates and profit margins are key determinants of output with distinctly different impacts on output.

2.1.3 Profit System Model of Capital Stock

Solving for K in terms of the other variables in equation (2.4) gives the value of the stock of capital as the discounted value of profit, or

$$K_t = \frac{S_t Y_t}{R_t}, \tag{2.9}$$

where the numerator shows profit as the product of output and the profit margin, and the denominator is the discount rate equal to the average profit rate. Similar to the accelerator theory of investment,[4] which posits that changes in capital stock (i.e., investment) depend on changes in output, equation (2.8) likewise shows that capital stock is a function of output. Investment in neoclassical theories depends on the required profit rate.[5] The capital stock in equation (2.8) depends on both the profit rate and the profit margin. While our model shares similarities to these well-known investment theories, it proposes that both output and profitability drive capital investment via the functional relation defined in equation (2.9).

2.1.4 Profit System Model of Profit Margins

By solving equation (2.4) for the profit margin, we obtain

$$S_t = \frac{R_t K_t}{Y_t}. \tag{2.10}$$

This equation implies that S_t can be viewed as a variable related to R_t, K_t, and Y_t in any period t. Measurement of the actual time series of S_t for the USA confirms that capital's share of output (as well as labor's share) is a variable. Willis and Wrobleski

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[3]For example, see Marx (1894), Gillman (1957), Duménil and Lévy (1993), Shaikh and Tonak (1994), Wolff (2003), and Mohun (2003, 2006).

[4]See Clark (1917) and Chenery (1952).

[5]See Jorgenson and Yun (2001).

(2007) report that, in the US nonfinancial corporate business sector, capital (labor) shares fluctuate within a range of 16 percent (84 percent) to 22 percent (78 percent). The authors offer some potential explanations for this variability, including delayed adjustments in wages and salaries over time, business cycle uncertainty, and changing risk-sharing arrangements between workers and firms throughout the business cycle. In this regard, former Federal Reserve Bank Chairman Alan Greenspan once observed that profit margins vary over time with the business cycle: "... in the U.S., profit margins ... have begun to stabilize, which is an early sign we are in the later stages of a cycle."[6] Finally, relevant to Section 2.2 on the empirical application of the above equations, the assumption that the profit margin is not a constant per equation (2.10) allows more accurate forecasts of not only S_t but Y_t, R_t, and K_t, as defined in equations (2.4), (2.5), and (2.9), respectively.

2.1.5 Profit System Model of Employment

Dividing both sides of equation (2.4) by H_t, the number of hours of employment or the number of employees hired in period t, results in the following equations:

$$\frac{Y_t}{H_t} = \frac{R_t K_t}{S_t H_t} \tag{2.11}$$

and

$$B_t = \frac{R_t K_t}{S_t H_t}, \tag{2.12}$$

where labor productivity in period t is

$$B_t = \frac{Y_t}{H_t}. \tag{2.13}$$

Solving for H_t gives employment determined by profit rates, capital stock, profit margins, and labor productivity:

$$H_t = \frac{R_t K_t}{S_t B_t}. \tag{2.14}$$

Equation (2.14) reveals a positive relationship between employment and both profit rates and capital stock in the numerator but a negative relationship between employment and both labor productivity and capital's share of output (profit margin) in the denominator.

Comparison of equations (2.4) and (2.14) shows that, while business output Y_t is determined by R_t, S_t, and K_t, employment is determined by these variables plus labor productivity.

[6] See the *Wall Street Journal*, February 28, 2007, p. C1.

2.1.6 Other Key Business Variables: Sales Tax, Depreciation, Total Employment Compensation, and Wage Rate

A number of useful relationships can be defined with the above variables. Total sales tax T_t is the product of sales tax rate τ_t and total output of the business sector Y_t:

$$T_t = \tau_t Y_t. \tag{2.15}$$

Total depreciation expense G_t is the product of depreciation rate g_t and total nominal capital stock K_t:

$$G_t = g_t K_t. \tag{2.16}$$

Total employees' compensation C_t is

$$C_t = Y_t - Z_t - G_t - T_t, \tag{2.17}$$

where output Y is measured in value-added terms. If Y is measured in sales, the cost of goods and services purchased is deducted from Y. Lastly, the wage rate per hour of employment in nominal terms is

$$W_t = \frac{C_t}{H_t}. \tag{2.18}$$

2.1.7 Profit System Channel of Inflation Transmission

Anari and Kolari (2002) have argued that home owners, when renting their houses, add expected inflation over the rental period to real rents. This inflation adjustment is similar to Fisher's (1930) famous observation that lenders add expected inflation to real interest rates when lending funds to borrowers. Since home prices are the discounted values of expected rents, higher rents containing an inflation premium lead to higher home prices. In general, the same model of transmission of inflation from profit to capital stock can be applied to other types of capital stock. Thus, equation (2.9) can be written as

$$K_t = \frac{S_t \bar{Y}_t \widehat{P_t}}{R_t}, \tag{2.19}$$

where output in real terms is

$$\bar{Y}_t = \frac{Y_t}{\widehat{P_t}} \tag{2.20}$$

and $\widehat{P_t}$ is the output price index (deflator) in period t that takes into account the general price level (i.e., inflation). In equation (2.19) owners of capital stock multiply expected profit in real terms ($S_t \bar{Y}_t$) by an index of expected inflation ($\widehat{P_t}$).

Consequently, the nominal value of K_t in equation (2.19) contains information about expected inflation. The impact of inflation on capital stock is transmitted to nominal output in equation (2.4) when firms use nominal values of capital stock to determine their target profits and output levels.

2.1.8 Profit System Models of Deflated Output, Deflated Capital Stock, and Deflated Labor Productivity

Output and capital stock in the Cobb–Douglas production function (2.1) are in real terms. By contrast, firms and market participants normally use actual (nominal) output and capital stock in equations (2.6) and (2.7) for computing profit rates and profit margins. As shown in forthcoming chapters, the distinction between real and nominal terms becomes important when the profit system model is applied to industries (or group of firms) and the whole business sector (or all firms). For these reasons we next provide profit system models in deflated terms.

Solving for real output ($\bar{Y}_t$) in equation (2.19) gives

$$\bar{Y}_t = \frac{R_t K_t}{S_t \widehat{P}_t} \tag{2.21}$$

or

$$\bar{Y}_t = \frac{R_t \bar{K}_t}{S_t}, \tag{2.22}$$

where deflated capital stock is

$$\bar{K}_t = \frac{K_t}{\widehat{P}_t} \tag{2.23}$$

and $\widehat{P}_t$ is the output price deflator. Equations (2.21) and (2.22) show that we can compute output in real terms from capital stocks deflated by the output price deflator. Note that capital stock deflated by an output price deflator in equation (2.23) is not capital stock in real terms.

Equation (2.22) results in the following three equations for deflated capital stocks, profit rates, and profit margins, respectively, when deflated output and capital stock are used:

$$\bar{K}_t = \frac{S_t \bar{Y}_t}{R_t} \tag{2.24}$$

$$R_t = \frac{S_t \bar{Y}_t}{\bar{K}_t} \tag{2.25}$$

$$S_t = \frac{R_t \bar{K}_t}{\bar{Y}_t}. \tag{2.26}$$

For transforming output in nominal terms to real terms, we need a price model for the good or service under consideration – that is, a price function which shows the relationship between price levels and a number of variables. In the second part of this chapter, we present a model of prices based on Wicksell's (1898) theory of the relationships between prices and interest rates and then employ this price model in applications of our profit system model to the aggregate business sector in the Chapter 3 and the corporate sector in Chapter 4. When this model is applied on the microlevel to an individual firm, it can be augmented by adding the firm's specific variables determining the prices of outputs, such as unit labor cost, unit material cost, unit energy cost, and so on.

Using equation (2.22) and relationships (2.11), (2.12), (2.13), and (2.14) results in the following employment equation when employment is determined by deflated capital stock, profit rate, profit margin, and labor productivity in real terms:

$$H_t = \frac{R_t \bar{K}_t}{S_t \bar{B}_t}. \tag{2.14a}$$

2.1.9 Total Profit Equations

Equation (2.8) shows that total profit in current dollars is given by

$$Z_t = S_t Y_t \tag{2.8a}$$

or

$$Z_t = R_t K_t. \tag{2.8b}$$

Dividing both sides of equation (2.8a) and (2.8b) by a price index for output gives deflated total profit:

$$\bar{Z}_t = S_t \bar{Y}_t \tag{2.8c}$$

or

$$\bar{Z}_t = R_t \bar{K}_t. \tag{2.8d}$$

2.1.10 Profit System Economic Equilibrium

Since capital formation projects are expected to generate output and profit over the useful economic lives of projects, the variables R_t, S_t, and Y_t in equation (2.9) are expected values wherein expectations are formed at the initial stage of project evaluation. Consequently, equation (2.9) can be written as

$$K_t = \frac{E_t(S) E_t(Y)}{E_t(R)}, \tag{2.27}$$

where $E_t(S)$,$E_t(Y)$, and $E_t(R)$are expected values or steady states of S_t, Y_t, and R_t as of time t over the useful economic lives of projects, respectively.

Substituting K_t from equation (2.27) into equation (2.4) gives

$$Y_t = \frac{R_t E_t(S) E_t(Y)}{S_t E_t(R)}, \tag{2.28}$$

where R_t and S_t are the realized values of the profit rate and profit margin, respectively. Equation (2.28) shows that output in the steady state wherein $E_t(Y) = Y_t$ (i.e., expected output is equal to realized output) occurs when the expected profit rate and profit margin are equal to their realized values or $E_t(R) = R_t$ and $E_t(S) = S_t$. In a competitive economy, if realized profit rates are higher than expected profit rates, higher output by existing firms and entering firms that seek profit opportunities will lead to reduced profit rates, while lower than expected profit rates will lead to reduced output and abandonment of business activities.

The speed of attaining equilibrium, at which realized profit rate and profit margins are equal to their expected values when business investment projects were selected, depends on the gestation period of capital formation projects. Over the past three centuries, industrialization of formerly agrarian economies has resulted in the selection and implementation of business investment projects with long gestation periods. For instance, it takes 7 years to build a nuclear power station, which means that it may take more than 7 years to find out whether the realized profit rate on a nuclear power plant is greater than the expected profit rate when the investment project was selected.

In the capitalist system profit rates not only determine the level of capital formation activity but also the level of production activity *after* capital formation projects come on stream. As Schumpeter (1942) has argued, selection of investment projects is a gamble with results only known in the future. Sometime after projects are implemented, entrepreneurs realize that some projects should not have been selected. The realization that the realized profit rates are lower than expected hurdle rates leads to abandonment of unprofitable or less profitable activities and the release of resources locked up in these activities, a process he famously dubbed "creative destruction."

In the for-profit sector, the price system can equilibrate supply and demand to the extent that price movements reflect profit rate movements. Changes in prices may have no effect on the supply of and demand for goods and services if price changes do not lead to changes in profit rates – for instance, when higher costs of energy inputs are offset by lower labor costs due to higher labor productivity.

2.1.11 Profit System Theory of Economic Growth

There is a vast literature on the subject of economic growth that is beyond the scope of this book.[7] Here we seek to focus on applying our profit system model to the problem of understanding economic growth. To do this we rewrite equation (2.5) as

[7] For example, see Schumpeter (1934), Solow (1956), Swan (1956), Barro (1997), Foley (1999), Charles (2002), Lucas (2004), Aghion and Durlauf (2005), and many others.

follows:

$$R_t = S_t A_t K_t^{S-1} H_t^{1-S} = S_t A_t \left(\frac{H_t}{K_t} \right)^{1-S}. \tag{2.5a}$$

Together, the set of equations for output Y_t, capital stock K_t, profit rate R_t as represented by equation (2.5a), profit margin S_t, employment H_t, and wage rate W_t can be viewed as a profit system theory of economic growth. Equation (2.5a) shows that higher total factor productivity A_t results in higher profit rates for a given level of capital and labor. Higher profit rates lead to higher output in equation (2.4). Higher output in equation (2.17) implies higher employee compensation and higher wages in equation (2.18). Higher labor productivity B_t in equation (2.14) is associated with less labor employed for a given level of output, which increases the availability of labor inputs for new economic activities. Thus, the set of equations for Y_t, K_t, R_t, S_t, H_t, and W_t represents a growth process that has taken place over the past two centuries in industrialized economies. As an example, productivity growth in the agrarian sector resulted in more agricultural goods produced with less labor, thereby releasing more labor to be employed in the manufacturing and services sectors accompanied by growing real wage rates. Economic growth in our profit system model is driven by profit and attained by the selection of more profitable projects and abandonment of less profitable activities making entrepreneurship an important factor in economic growth. This Schumpeterian creative destruction has been described by former Federal Reserve Chairman Alan Greenspan as "... the process by which the cash flow from obsolescent, low-return capital is invested in high-return, cutting-edge technology."[8]

2.1.12 Profit System Theory of Business Cycles

According to equations (2.4) and (2.9), fluctuations in both profit rates and profit margins generate fluctuations in output per equation (2.4) and capital stock per equation (2.9). Note that changes in profit rates and profit margins have opposing effects on output and capital stock, as the profit rate is in the numerator of output equation but the denominator of capital stock equation, while profit margin is in the denominator of output but the numerator of capital stock. Thus, a change in profit could generate a business cycle through the interaction between output and capital stock in response to a change in profit. According to Samuelson (1939a), interactions between multiplier effects and accelerator effects may generate business cycles. Increases in investment are expected to result in higher output (the multiplier effect), whereas increases in output are expected to result in higher investments (the accelerator effect). Relating these concepts to our profit system model of business activity, the interactions between output per equation (2.4) and capital stock per

[8] Swan (1956).

equation (2.9) are due to changes in profit rates and profit margins, whose changes are due to simultaneous changes in output and capital stock also. To demonstrate the effects of these interactions, Chapter 3 applies our profit system model to business cycle analysis in the US economy.

2.1.13 Financial Sector Variables: Interest Rate and Credit

So far we derived all the components of a profit system model of the firm as if the economy consisted of a goods and services market plus a labor market. But advanced market economies have another important component – namely, the financial sector. Before proceeding to the next section's empirical representations of our model, it is worthwhile to look at the relationship between its key variables and the financial sector. When an economy has a financial system in which consumption and capital stocks can be financed by borrowing loanable funds, then the cost and availability of credit become important variables affecting profit rate, profit margin, capital stock, and output. Higher (lower) interest rate charges on borrowed funds decrease (increase) total profits in the numerator of equations (2.6) and (2.7) and, in turn, lead to lower (higher) profit rate and profit margin. Changes in the cost of capital or interest rate affect output and capital stocks through their impacts on profit rate and profit margin on the supply side. On the demand side higher (lower) interest rates on consumer loans result in lower (higher) demand for goods and services.

The important roles played by the cost and availability of credit in the financial system necessitate their inclusion in the empirical profit system model of the firm discussed in Section 2.2.

2.2 Empirical Profit System Models in the Form of Dynamic Equations

Profit system models of output, capital stock, profit rate, and profit margin can be used by an individual firm for planning, forecasting, and research on business output, capital stock, total profit, profit rate, and profit margin. The dependency of these fundamental variables on one another in the profit system models derived above means that in the real world the magnitudes of these variables are determined simultaneously. For this reason systems of dynamic equations containing five equations for the five variables (i.e., output, capital stock, total profit, profit rate, and profit margin) are the most appropriate and potentially useful empirical representation of profit system models.

2.2.1 General Approach

As an initial step to developing empirical versions of our theoretical profit system models, we take the logarithms of both sides of capital stock equation (2.9), output equation (2.4), profit rate equation (2.5), profit margin equation (2.10), and total profit equation (2.8), resulting in the following simple contemporaneous relationships (i.e., relationships in the same period) between the logarithms of Y_t, K_t, R_t, S_t, and Z_t:

$$k_t = y_t - r_t + s_t \tag{2.29}$$

$$y_t = r_t - s_t + k_t \tag{2.30}$$

$$r_t = y_t + s_t - k_t \tag{2.31}$$

$$s_t = -y_t + r_t + k_t \tag{2.32}$$

$$z_t = r_t + k_t = y_t + s_t, \tag{2.33}$$

where the coefficients of the principle variables in the model (y_t, r_t, s_t, k_t) are either ± 1 as posited by theory, and there is no residual error. Note that we have two alternative specifications for total profit in (2.33).

Next, it is reasonable to assume that, given the profit system models represented by equations (2.9), (2.4), (2.5), (2.10), and (2.8) and their log-linear versions (2.29), (2.30), (2.31), (2.32), and (2.33), firms and market participants use lagged values of the profit rate, profit margin, capital stock, and output to form conditional expectations or forecasts of their current and future values. The simplest approach to modeling expectations when forecasting each variable in period t is to use the values of other variables in the previous period $t - 1$ as follows:

$$k_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 r_{t-1} + \alpha_3 s_{t-1} \tag{2.34}$$

$$y_t = \beta_0 + \beta_2 r_{t-1} + \beta_3 s_{t-1} + \beta_4 k_{t-1} \tag{2.35}$$

$$r_t = \theta_0 + \theta_1 y_{t-1} + \theta_3 s_{t-1} + \theta_4 k_{t-1} \tag{2.36}$$

$$s_t = \eta_0 + \eta_1 y_{t-1} + \eta_2 r_{t-1} + \eta_4 k_{t-1} \tag{2.37}$$

$$z_t = v_0 + v_1 r_{t-1} + v_2 k_{t-1} = v_0 + v_1 y_{t-1} + v_2 s_{t-1}, \tag{2.38}$$

where the left-hand-side variables are expected values or forecasts of capital stock, output, profit rate, profit margin, and total profits, respectively, for period t using the values of the other variables in the previous period $t - 1$. A constant term is added to each equation for econometric estimation of the equations. Note that, when lags of the variables are used for forming expectations, the coefficients on the lagged variables are no longer equal to plus or minus unity and residual error exists. To minimize residual errors in these equations, other variables can be included in the set of variables used for forecasting the fundamental business variables.

Equations (2.34), (2.35), (2.36), (2.37), and (2.38) can provide estimates of expectations or forecasts of capital stock, output, profit rate, profit margin, and total profit. Different econometric methods can be applied to their estimation. When using a system approach for estimating all the equations, we can reduce the number of equations (and hence coefficients) to be estimated by using the forecasts of the variables generated in the model based on a priori information that contemporaneous relationships between the logarithms of the principle variables in the model (y_t, k_t, r_t, s_t, z_t) are either ±1, as shown in equations (2.29), (2.30), (2.31), (2.32), and (2.33). For instance, equations (2.37) and (2.38) can be derived from estimates of equations (2.34), (2.35), and (2.36). Instead of estimating equation (2.37), we can compute equation (2.37) by using the forecast of k_t from equation (2.34), forecast of y_t from equation (2.35), and forecast of r_t from equation (2.36). In turn, this forecast of profit margin s_t can then be used for forecasting total profit z_t per equation (2.33) as the sum of the forecast of profit margin s_t and forecast of output from equation (2.35). Alternatively, the forecast of total profit z_t per equation (2.33) can be computed as the sum of the forecast of capital stock k_t from equation (2.34) and forecast of profit rate r_t from equation (2.36). These specifications result in the following system of equations:

$$k_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 r_{t-1} + \alpha_3 s_{t-1} \tag{2.39.1}$$

$$y_t = \beta_0 + \beta_2 r_{t-1} + \beta_3 s_{t-1} + \beta_4 k_{t-1} \tag{2.39.2}$$

$$r_t = \theta_0 + \theta_1 y_{t-1} + \theta_3 s_{t-1} + \theta_4 k_{t-1} \tag{2.39.3}$$

$$s_t = k_t + r_t - y_t \tag{2.39.4}$$

$$z_t = r_t + k_t = y_t + s_t, \tag{2.39.5}$$

The empirical representation of these profit system models of the firm in system equations (2.39) can be extended to include more lags of the fundamental variables as well as other variables which may improve the forecasts of the fundamental variables.

2.2.1.1 Profit System Models of the Goods and Services Market

Profit system models of the goods and services market can be specified in either nominal (current dollar) or deflated (constant dollar) terms. Table 2.1 provides a simple model specification with output and capital stock variables in nominal terms. System equations (2.39) are augmented with financial sector variables. As already noted, our fundamental business variables can be affected by financial sector variables, such as the interest rate and total nonfinancial debt outstanding. In empirical application of the model to the US economy, we conducted variable addition tests and found that these variables are influential with respect to capital stock, output, and profit rate. Consequently, we included these variables in the profit system model. Lag orders for these financial sector variables are determined empirically.

Table 2.1 Basic profit system model of the goods and services market with output and capital stock in current dollars

The following system of equations provides a profit system model of the goods and services market in current dollars. Financial sector variables (i.e., the Federal funds rate and growth rate of nonfinancial debt outstanding in nominal terms) are included in the model with lag (*L*) structures determined empirically.

Capital stock model

$$k_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 r_{t-1} + \alpha_3 s_{t-1} + \alpha_5 \dot{D}_{t-L} + \alpha_6 F_{t-L} \quad (2.1.1)$$

Output model

$$y_t = \beta_0 + \beta_2 r_{t-1} + \beta_3 s_{t-1} + \beta_4 k_{t-1} + \beta_5 \dot{D}_{t-L} + \beta_6 F_{t-L} \quad (2.1.2)$$

Profit rate model

$$r_t = \theta_0 + \theta_1 y_{t-1} + \theta_3 s_{t-1} + \theta_4 k_{t-1} + \theta_5 \dot{D}_{t-L} + \theta_6 F_{t-L} \quad (2.1.3)$$

Profit margin model

$$s_t = r_t + k_t - y_t \quad (2.1.4)$$

Total profit model

$$Z_t = R_t \times K_t = Y_t \times S_t \quad (2.1.5)$$

Variables are defined as follows:

$Y(y)$ = sales or output in current dollars (log)
$K(k)$ = capital stock in current dollars (log)
$R(r)$ = profit rate (log)
$S(s)$ = profit margin (log)
Z = total profit
F = Federal funds rate in percent (financial sector variable)
$\dot{D}$ = growth rate of nonfinancial debt outstanding in percent (financial sector variable),
where K_t = antilog k_t, Y_t = antilog y_t, R_t = antilog r_t, and S_t = antilog s_t

This basic profit system model can be used when we are interested only in the goods and services market and seek to analyze and forecast the fundamental variables in nominal terms. Empirical applications of this model to individual firms are presented in Chapter 7. There the model is estimated for two large US corporations (namely, IBM and Johnson & Johnson), and the resultant historical simulations of these firms' profits are used for valuing their stock prices.

Table 2.2 simplifies the model in Table 2.1 by using the forecast of log capital stock from equation (2.2.1) in equation (2.2.2)'s forecast of log output. Also, the forecast of log capital stock from equation (2.2.1) and log output from equation (2.2.2) are used in equation (2.2.3)'s forecast of log profit margin. The advantage of this alternative model is that the number of coefficients to be estimated is reduced by two; consequently, the model may be useful when the number of observations in the sample period is small. The disadvantage of the model is that error in forecasting capital stock from equation (2.2.1) may lead to errors in forecasting output

Table 2.2 Alternative basic profit system model of the goods and services market with output and capital stock in current dollars

The following system of equations provides a profit system model of the goods and services market in current dollars. Financial sector variables (i.e., the Federal funds rate and growth rate of nonfinancial debt outstanding in nominal terms) are included in the model with lag structure (L) determined empirically.

Capital stock model

$$k_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 r_{t-1} + \alpha_3 s_{t-1} + \alpha_5 \dot{D}_{t-L} + \alpha_6 F_{t-L} \quad (2.2.1)$$

Output model

$$y_t = \beta_0 + \beta_2 r_{t-1} + \beta_3 s_{t-1} + k_t + \beta_5 \dot{D}_{t-L} + \beta_6 F_{t-L} \quad (2.2.2)$$

Profit rate model

$$r_t = \theta_0 + y_t + \theta_3 s_{t-1} - k_t + \theta_5 \dot{D}_{t-L} + \theta_6 F_{t-L} \quad (2.2.3)$$

Profit margin model

$$s_t = r_t + k_t - y_t \quad (2.2.4)$$

Total profit model

$$Z_t = R_t \times K_t = Y_t \times S_t \quad (2.2.5)$$

Variables are defined as follows:

$Y(y)$ = sales or output in current dollars (log)
$K(k)$ = capital stock in current dollars (log)
$R(r)$ = profit rate (log)
$S(s)$ = profit margin (log)
Z = total profit
F = Federal funds rate in percent (financial sector variable)
$\dot{D}$ = growth rate of nonfinancial debt outstanding in percent (financial sector variable),
where K_t = antilog k_t, Y_t= antilog y_t, R_t = antilog r_t, and S_t = antilog s_t

in equation (2.2.2) and likewise in forecasting profit margin in equation (2.2.3). In Chapter 5 we apply this alternative model to 12 US industries.

Firms and market participants normally use local-currency-denominated, or nominal, values of output and capital stocks for making business decisions. For this reason we use nominal values of these variables in the basic profit system models in Tables 2.1 and 2.2. However, it is essential to distinguish between local-currency-denominated (nominal) and deflated or constant dollar (real) values when the model is applied to the aggregate national economy, aggregate business sector, and aggregate corporate sector.

Table 2.3 presents the basic profit system model of the goods and services market with output and capital stock deflated using an output price index. Derivation of this model is similar to the model presented in Table 2.1. Taking logarithms of both sides of capital stock equation (2.24), output equation (2.22), profit rate equation (2.25), profit margin equation (2.26), and total profit equations (2.8c) and (2.8d) results in the following contemporaneous relationships (i.e., relationships in the same period)

Table 2.3 Basic profit system model of the goods and services market with output and capital stock in constant dollars

The following system of equations provides a profit system model of the goods and services market in which output, capital stock, and total profit are deflated (i.e., values are deflated for changes in the general price level due to inflation). Financial sector variables (i.e., the Federal funds rate and growth rate of nonfinancial debt outstanding in deflated terms) are included in the model with lag structure (L) determined empirically.

Deflated capital stock model

$$\bar{k}_t = \alpha_0 + \alpha_1 \bar{y}_{t-1} + \alpha_2 r_{t-1} + \alpha_3 s_{t-1} + \alpha_5 \dot{\bar{D}}_{t-L} + \alpha_6 F_{t-L} \quad (2.3.1)$$

Deflated (real) output model

$$\bar{y}_t = \beta_0 + \beta_2 r_{t-1} + \beta_3 s_{t-1} + \beta_4 \bar{k}_{t-1} + \beta_5 \dot{\bar{D}}_{t-L} + \beta_6 F_{t-L} \quad (2.3.2)$$

Profit rate model

$$r_t = \theta_0 + \theta_1 \bar{y}_{t-1} + \theta_3 s_{t-1} + \theta_4 \bar{k}_{t-1} + \theta_5 \dot{\bar{D}}_{t-L} + \theta_6 F_{t-L} \quad (2.3.3)$$

Profit margin model

$$s_t = \bar{k}_t + r_t - \bar{y}_t \quad (2.3.4)$$

Deflated total profit model

$$\bar{z}_t = v_0 + v_1 r_{t-1} + v_2 \bar{k}_{t-1} \text{ or } \bar{z}_t = v_0 + v_1 \bar{y}_{t-1} + v_2 s_{t-1}, \quad (2.3.5)$$

Variables are defined as follows:

$\bar{k}$ = log deflated capital stock $\bar{K}$
$\bar{y}$ = log deflated (real) output $\bar{Y}$
r = log profit rate R (equal to total profit divided by capital)
s = log profit margin S (equal to total profit divided by output)
$\bar{z}$ = log deflated (real) total profit $\bar{Z}$
F = Federal funds rate in percent (financial sector variable)
$\dot{\bar{D}}$= growth rate of deflated nonfinancial debt outstanding in percent (financial sector variable), where $\bar{K}$ = antilog $\bar{k}$, $\bar{Y}$= antilog $\bar{y}$, R = antilog r, S = antilog s, and $\bar{Z}$= antilog $\bar{z}$

between the logarithms of deflated $\bar{K}_t$, deflated (real) $\bar{Y}_t$, R_t, S_t, and deflated total profit $\bar{Z}_t$:

$$\bar{k}_t = \bar{y}_t - r_t + s_t \quad (2.40)$$

$$\bar{y}_t = r_t - s_t + \bar{k}_t \quad (2.41)$$

$$r_t = \bar{y}_t + s_t - \bar{k}_t \quad (2.42)$$

$$s_t = -\bar{y}_t + r_t + \bar{k}_t \quad (2.43)$$

$$\bar{z}_t = r_t + \bar{k}_t = s_t + \bar{y}_t, \quad (2.44)$$

where the coefficients of the contemporaneous relationships between the logarithms of the principle variables in the model ($\bar{y}_t$, $\bar{k}_t$, r_t, s_t, and $\bar{z}_t$) are either ±1 as posited by theory.

As before, the simplest models of expectations or forecasts for each variable in period t use the values of other variables in the previous period $t - 1$ as follows:

$$\bar{k}_t = \alpha_0 + \alpha_1 \bar{y}_{t-1} + \alpha_2 r_{t-1} + \alpha_3 s_{t-1} \tag{2.45}$$

$$\bar{y}_t = \beta_0 + \beta_2 r_{t-1} + \beta_3 s_{t-1} + \beta_4 \bar{k}_{t-1} \tag{2.46}$$

$$r_t = \theta_0 + \theta_1 \bar{y}_{t-1} + \theta_3 s_{t-1} + \theta_4 \bar{k}_{t-1} \tag{2.47}$$

$$s_t = \omega_0 + \omega_1 \bar{y}_{t-1} + \omega_2 r_{t-1} + \omega_4 \bar{k}_{t-1} \tag{2.48}$$

$$\bar{z}_t = v_0 + v_1 r_{t-1} + v_2 \bar{k}_{t-1} = v_0 + v_1 \bar{y}_{t-1} + v_2 s_{t-1}, \tag{2.49}$$

where the left-hand-side variables are expected values or forecasts of deflated capital stock, deflated output, profit rate, profit margin, and deflated total profit in period t. A constant term is added to each equation for purposes of econometric estimation. Again, when lags of the variables are used for forming expectations, the coefficients associated with the lagged variables are no longer equal to plus or minus unity and forecasting errors exist. To minimize forecast errors other variables can be incorporated in the set of variables used for forecasting the fundamental business variables.

Equations (2.45), (2.46), (2.47), (2.48), and (2.49) can be used for forming expectations or forecasting deflated capital stock, deflated output, profit rate, profit margin, and deflated total profit. Different econometric methods can be employed to estimate these equations. As before, when using a system approach for estimating all the equations, we can reduce the number of equations (and coefficients) to be estimated by using the forecasts of some of the variables generated in the model to forecast other variables. For instance, to forecast profit margin s_t per equation (2.43), we can use the forecast of $\bar{k}_t$ from equation (2.45), forecast of $\bar{y}_t$ from equation (2.46), and forecast of r_t from equation (2.47). In this way we obtain the following profit system model:

$$\bar{k}_t = \alpha_0 + \alpha_1 \bar{y}_{t-1} + \alpha_2 r_{t-1} + \alpha_3 s_{t-1} \tag{2.50.1}$$

$$\bar{y}_t = \beta_0 + \beta_2 r_{t-1} + \beta_3 s_{t-1} + \beta_4 \bar{k}_{t-1} \tag{2.50.2}$$

$$r_t = \theta_0 + \theta_1 \bar{y}_{t-1} + \theta_3 s_{t-1} + \theta_4 \bar{k}_{t-1} \tag{2.50.3}$$

$$s_t = \bar{k}_t + r_t - \bar{y}_t \tag{2.50.4}$$

$$\bar{z}_t = v_0 + v_1 r_{t-1} + v_2 \bar{k}_{t-1} \text{ or } \bar{z}_t = v_0 + v_1 \bar{y}_{t-1} + v_2 s_{t-1}. \tag{2.50.5}$$

The empirical profit system model comprised of dynamic equations (2.50) can be extended to include more lags of the fundamental variables and other variables to improve forecasts of the fundamental variables. Table 2.3 provides an example of such a system of equations. In this model output, capital stock, and total profit variables are deflated by an output price deflator. Also, the system of equations is augmented with financial sector variables (i.e., the Federal funds rate and the growth rate of deflated nonfinancial debt outstanding).

2.2.1.2 Extended Profit System Model with Goods and Services Plus Labor Markets

The previous basic profit system models can be combined and extended to include a labor market as shown in Table 2.4. In this model deflated capital stock and real output are first computed. Equations (2.4.1), (2.4.2), (2.4.3), (2.4.4), and (2.4.5) are

Table 2.4 Extended profit system model with goods and services plus labor markets

Goods market equations

Deflated capital stock model

$$\bar{k}_t = \alpha_0 + \alpha_1 \bar{y}_{t-1} + \alpha_2 r_{t-1} + \alpha_3 s_{t-1} + \alpha_5 \dot{\bar{D}}_{t-L} + \alpha_6 F_{t-L} \tag{2.4.1}$$

Deflated (real) output model

$$\bar{y}_t = \beta_0 + \beta_2 r_{t-1} + \beta_3 s_{t-1} + \beta_4 \bar{k}_{t-1} + \beta_5 \dot{\bar{D}}_{t-L} + \beta_6 F_{t-L} \tag{2.4.2}$$

Profit rate model

$$r_t = \theta_0 + \theta_1 \bar{y}_{t-1} + \theta_3 s_{t-1} + \theta_4 \bar{k}_{t-1} + \theta_5 \dot{\bar{D}}_{t-L} + \theta_6 F_{t-L} \tag{2.4.3}$$

Profit margin model

$$s_t = \bar{k}_t + r_t - \bar{y}_t \tag{2.4.4}$$

Deflated total profit model

$$\bar{z}_t = v_0 + v_1 r_{t-1} + v_2 \bar{k}_{t-1} \text{ or } \bar{z}_t = v_0 + v_1 s_{t-1} + v_2 \bar{y}_{t-1} \tag{2.4.5}$$

Additional goods and services market equations

Price model

$$\widehat{p}_t = \varphi_0 + \varphi_1 \widehat{p}_{t-1} + \varphi_2 \widehat{p}_{t-2} + \varphi_3 \bar{F}_{t-L} \tag{2.4.6}$$

Nominal capital stock model

$$k_t = \bar{y}_t + s_t + \widehat{p}_t - r_t \tag{2.4.7}$$

Nominal output model

$$y_t = k_t + r_t - s_t \tag{2.4.8}$$

Nominal total profits model

$$z_t = \bar{z}_t + \widehat{p}_t \tag{2.4.9}$$

Sales tax model

$$T_t = \tau_t Y_t \tag{2.4.10}$$

Depreciation expense model

$$G_t = g_t K_t \tag{2.4.11}$$

Table 2.4 (continued)

Labor market equations	
Total employment compensation model	
$C_t = Y_t - Z_t - G_t - T_t$	(2.4.12)
Total employment model	
$h_t = \omega_0 + \omega_1 r_{t-1} + \omega_2 s_{t-1} + \omega_4 \bar{k}_{t-1} + \omega_5 \bar{b}_{t-1}$	(2.4.13)
Labor productivity model	
$\bar{b}_t = \bar{y}_t - h_t$	(2.4.14)
Wage rate model	
$w_t = c_t - h_t$	(2.4.15)

Variables are defined as follows:

$\bar{k}$ = log deflated capital stock $\bar{K}$
$\bar{y}$ = log deflated (real) output $\bar{Y}$
r = log profit rate (equal to total profit divided by capital stock) R
s = log profit margin (equal to total profit divided by output) S
$\bar{z}$ = log deflated (real) total profit $\bar{Z}$
z = log nominal total profit Z
F = Federal funds rate in percent (financial sector variable)
$\bar{F}$= deflated (real) Federal funds rate in percent (financial sector variable)
$\dot{\bar{D}}$= growth rate of deflated nonfinancial debt outstanding in percent (financial sector variable)
$\widehat{p}$ = log general price level deflator $\widehat{P}$
k = log nominal capital stock K
y = log nominal output Y
T = total sales tax
G = capital depreciation expenses
C = total employees' compensation
h = log of the number of hours of employment or the number of employees hired
τ = sales tax rate
g = capital depreciation rate
$\bar{b}_t$ = log labor productivity
w = log wage rate
c = log total employees' compensation C,

where K = antilog k, $\bar{K}$ = antilog $\bar{k}$, Y = antilog y, $\bar{Y}$ = antilog $\bar{y}$, R = antilog r, S = antilog s, Z = antilog z, $\bar{Z}$ = antilog $\bar{z}$, $\widehat{P}$ = antilog $\widehat{p}$, H = antilog h, $\bar{B}$ = antilog $\bar{b}$, W = antilog w, and C = antilog c.

the same as those in the basic profit system model in Table 2.3. Equation (2.4.6) is a general form of a price level (inflation) function for the output of the firm, industry, or business sector with lagged prices used for forecasting prices in period t. Inflation in this price model is determined by the real interest rate represented by the deflated Federal funds rate (Wicksell 1898). In applications of the model to individual firms, other variables such as labor cost, energy cost, and labor productivity can be added to the equation. Equation (2.4.7) is the expectation or forecasted model in log form of nominal capital stock k_t based on equation (2.19). In words, equation (2.4.7) sums log output in real terms and log profit margin (i.e., equal to log total profit in real terms, or $\bar{y}_t + s_t$), plus the expected log of output price $\widehat{p}_t$ (i.e., equal to the expected value of log total profit in nominal terms z_t), and then divides or discounts using log profit rate r_t to yield log capital stock in nominal terms.

Equation (2.4.8) computes the log of nominal output y_t from log nominal capital stock k_t, profit rate r_t, and profit margin s_t. Equation (2.4.9) gives the log of total profit in nominal terms z_t as the sum of log deflated total profit ($\bar{z}_t$) plus log output price $\widehat{p}_t$.

Notice that labor equations are added to the aforementioned goods and services market equations. The variables estimated in logarithms are transformed into levels and used in equations (2.4.10), (2.4.11), and (2.4.12) for estimating the expected values of total sales tax (T), total depreciation expenses (G), and total employee compensation (C) in the business sector. Equation (2.4.13) is the empirical representation of the log of employment (h_t) based on log-linearized employment equation (2.14a) using values of deflated capital stock, profit rate, profit margin, and labor productivity. Equation (2.4.14) gives the log of labor productivity ($\bar{b}$) as the difference of log real output and log employment, or $\bar{y}_t - h_t$. And, equation (2.4.15) defines the log of wage rate (w_t) (i.e., wage per hour or per person W_t) as the difference between log total employee compensation and log employment, or c_t–h_t.

We apply this extended profit system model to the aggregate US business sector in Chapter 3's macroeconomic analyses of the national economy. In Chapter 4 the goods and services market part of this model is applied to the US corporate sector, which focuses on larger firms in the business sector. For these purposes the Appendix provides a general form of the extended profit system model that takes into account different forecast horizons and variable lag lengths.

Another approach for developing the extended business model is to start with the profit system model of the goods and services market in current dollars in Table 2.1, initially estimate forecasts of output and capital stocks in nominal terms, and then deflate these values using an output price deflator as in equation (2.4.6) in Table 2.4 to derive deflated values of output, capital stock, and profit rates. Subsequently, other variables can be estimated as shown in Table 2.4.

The empirical application of the above profit system models to firms and industries requires the estimation of the profit system macroeconomic model of the USA due to the fact that financial sector forecasts of the real Federal funds rate and growth rate of nonfinancial debt must be generated on a macrobasis. If these forecasts can be obtained from other sources, then the macromodel is not needed for firm and industry analyses.

In application of our models to individual firms, it is possible that the firm has losses rather than profits in some periods. Since firms embarking on production and capital formation activities anticipate positive expected profit, we treat losses as missing values. The economic intuition for this data adjustment is that losses are missed profit targets. In Chapter 7 we apply the model to a firm when there are losses in the time series of profits.

2.3 Summary

This chapter developed a profit system model of the firm consisting of output, capital stock, profit rate, profit margin, and total profit equations. No assumptions about profit maximization are required to derive the model. Although the modeling process began with the Cobb–Douglas production function, our model can be alternatively derived via an accounting approach. The model is applicable to firms, industries, and the business sector as a whole.

We presented empirical profit system models of the firm consisting of five fundamental business variables. Each of these five variables can be estimated from lags of the other variables. Also, we can include other relevant variables to minimize the forecast error terms in equations. For example, our experience with the model in application to the US business sector in Chapter 3 suggests that the Federal funds rate and growth rate of nonfinancial debt outstanding have explanatory power and improve the predictive power of the model. In general, lagged values of the variables contain almost all information needed for the model's estimation and application.

Additional contributions of our profit system model of the firm are as follows:

- *A new model of inflation transmission* is proposed using capital stock and output models. One of the least understood areas of economics is the channels of inflation transmission in the economy. The initial source of inflation transmission in our model is the attempt by owners of capital stock to adjust the rental values of their capital to the expected inflation. Inflation expectations contained in capital stock are then transmitted to output when nominal capital stocks are used for output planning. By contrast, the initial source of inflation in many economic models is workers' expected inflation, which in the augmented Phillips curve and other inflation models leads to a wage-price spiral. Hence, our model extends previous approaches in terms of both the source and the transmission mechanism of inflation.
- *A profit system concept of equilibrium* is provided. Economic equilibrium was defined to exist when ex post realized profit rates equal ex ante hurdle profit rates used to select capital formation projects. Firms and market participants form expectations about our five fundamental variables (i.e., real and nominal output, deflated and nominal capital stock, profit rates, profit margins, and total profit) at the time of project evaluation. After projects become operational, the firm's objective is to realize the expected values of these variables. That is, the firm seeks to minimize the difference between variables' realized and expected values. In forming expectations with respect to these fundamental business variables, firms and market participants may also form expectations about other factors that might influence these variables and include these factors in equations for the fundamental business variables to minimize forecast error terms. At the time of this writing, a global recession caused realized profit rates in many industries to be lower than the expected profit rates at the initial stage of project evaluation. Consequently, gross domestic product and stock price indexes in most countries

have declined in response to realized profit rates that are lower than hurdle profit rates.

- *A profit system model of economic growth* is derived. According to this new model, higher total factor productivity leads to higher profit rate, which causes higher output and reduces labor inputs for a given level of output, thereby releasing more labor input to be employed in new projects. Hence, economic growth in our model is driven by profit, which is consistent with Schumpeter's creative destruction.
- *A profit system business cycle theory* is proposed. Utilizing our profit system models of the firm, the business cycle comes about through the interaction between the output and the capital stock equations that is triggered by a change in total profit affecting profit rates (in the output equation's numerator and the capital equation's denominator) and profit margins (in the output equation's denominator and the capital equation's numerator).
- In profit system models of the firm, the discount rate R_t is a time-varying variable rather than a parameter, and the profit margin S_t is time varying also. The technology variable A_t is contained in the profit rate as shown by equation (2.5a).

In general, the "power of profit" emanates from the central role it plays in firms, industries, and the business sector as a whole. We have sought in this chapter to exploit this focal measure of business activity in an effort to better understand how firms manage their output, capital, labor, and profit. The resultant profit system model of the firm is comprised of multiple, interconnected equations that can be utilized for analysis, planning, and forecasting of fundamental business variables. In forthcoming chapters we investigate these potential applications using US economic, industry, and firm data.

Appendix: General Form of the Extended Profit System Model with Goods and Services Plus Labor Markets

This appendix provides a general specification of the extended profit system model in Table 2.4. In the following model j is the forecast horizon, i is the lag order, and, for example, $E_t\bar{k}_{t+j}$ is the expected value of $\bar{k}$ in period $t + j$ estimated in period t. The subscripts 1, 2, 3, and 4 are assigned to coefficients for variables $\bar{y}$, r, s, and $\bar{k}$, respectively. Lags (L) of the Federal funds rate (F) and growth rate of deflated nonfinancial debt outstanding ($\dot{\bar{D}}$) are determined empirically.

Table 2.5 General form of extended profit system model with goods and services plus labormarkets

Goods market equations

Deflated capital stock model

$$E_t\bar{k}_{t+j} = \alpha_0 + \Sigma_{i=1}^{I}\alpha_{1i}\bar{y}_{t+j-i} + \Sigma_{i=1}^{I}\alpha_{2i}r_{t+j-i} + \Sigma_{i=1}^{I}\alpha_{3i}s_{t+j-i} + \alpha_5\dot{\bar{D}}_{t-L} + \alpha_6F_{t-L} \quad (2.5.1)$$

Table 2.5 (continued)

Deflated (real) output model

$$E_t\bar{y}_{t+j} = \beta_0 + \Sigma_{i=1}^{I}\beta_{2i}r_{t+j-i} + \Sigma_{i=1}^{I}\beta_{3i}s_{t+j-i} + \Sigma_{i=1}^{I}\beta_{4i}\bar{k}_{t+j-i} + \beta_5\dot{\bar{D}}_{t-L} + \beta_6F_{t-L} \quad (2.5.2)$$

Profit rate model

$$E_tr_{t+j} = \theta_0 + \Sigma_{i=1}^{I}\theta_{1i}\bar{y}_{t+j-i} + \Sigma_{i=1}^{I}\theta_{3i}s_{t+j-i} + \Sigma_{i=1}^{I}\theta_{4i}\bar{k}_{t+j-i} + \theta_5\dot{\bar{D}}_{t-L} + \theta_6F_{t-L} \quad (2.5.3)$$

Profit margin model

$$E_ts_{t+j} = E_tr_{t+j} + E_t\bar{k}_{t+j} - E_t\bar{y}_{t+j} \quad (2.5.4)$$

Deflated (real) total profits model

$$E_t\bar{z}_{t+j} = E_ts_{t+j} + E_t\bar{y}_{t+j} \quad (2.5.5a)$$

or

$$E_t\bar{z}_{t+j} = v_0 + \Sigma_{i=1}^{I}v_{1i}s_{t+j-i} + \Sigma_{i=1}^{I}v_{2i}\bar{y}_{t+j-i} \quad (2.5.5b)$$

or

$$E_t\bar{z}_{t+j} = v_0 + \Sigma_{i=1}^{I}v_{1i}r_{t+j-i} + \Sigma_{i=1}^{I}v_{2i}\bar{k}_{t+j-i} \quad (2.5.5c)$$

Other goods and services market equations

Wicksellian price model

$$E_t\,\widehat{p}_{t+j} = \varphi_0 + \Sigma_{i=1}^{I}\varphi_{1i}\,\widehat{p}_{t+j-i} + \varphi_2\bar{F}_{t-L} \quad (2.5.6)$$

Nominal capital stock model

$$E_tk_{t+j} = E_t\bar{y}_{t+j} + E_ts_{t+j} + E_t\,\widehat{p}_{t+j} - E_tr_{t+j} \quad (2.5.7)$$

Nominal output model

$$E_ty_{t+j} = E_tk_{t+j} + E_tr_{t+j} - E_ts_{t+j} \quad (2.5.8)$$

Nominal total profits model

$$E_tz_{t+j} = E_ts_{t+j} + E_ty_{t+j} \quad (2.5.9)$$

Sales tax model

$$E_tT_{t+j} = \tau_{t+j}E_ty_{t+j} \quad (2.5.10)$$

Depreciation model

$$E_tG_{t+j} = g_tE_tK_{t+j} \quad (2.5.11)$$

Labor market equations

Employment compensation model

$$E_tC_{t+j} = E_tY_{t+j} - E_tZ_{t+j} - E_tT_{t+j} - E_tG_{t+j} \quad (2.5.12)$$

Employment model

$$E_th_{t+j} = \omega_0 + \omega_1r_t + \omega_2s_t + \omega_3\bar{k}_t + \omega_4\bar{b}_{t-1} \quad (2.5.13a)$$

or

$$E_th_{t+j} = \omega_0 + \Sigma_{i=1}^{L}\omega_{1i}r_{t+j-i} + \Sigma_{i=1}^{L}\omega_{2i}s_{t+j-i} + \Sigma_{i=1}^{L}\omega_{3i}\bar{k}_{t+j-i} + \Sigma_{i=1}^{L}\omega_{4i}\bar{b}_{t+j-i} \quad (2.5.13b)$$

Labor productivity model

$$E_t\bar{b}_{t+j} = E_t\bar{y}_{t+j} - E_th_{t+j} \quad (2.5.14)$$

Table 2.5 (continued)

Wage rate model	
$E_t w_{t+j} = E_t c_{t+j} - E_t h_{t+j}$	(2.5.15)

Variables are defined as follows:

$\bar{k}$= log deflated capital stock $\bar{K}$
$\bar{y}$ = log deflated (real) output $\bar{Y}$
r =log profit rate (equal to total profit divided by capital stock) R
s = log profit margin (equal to total profit divided by output) S
$\bar{z}$= log deflated (real) total profit $\bar{Z}$
z = log nominal total profit Z
$\widehat{p}$= log price level deflator $\widehat{P}$
k = log nominal capital stock K
y = log nominal output Y
T = total sales tax
G = capital depreciation expenses
C = total employees' compensation
h = log of the number of hours of employment or the number of employees hired
τ = sales tax rate
g = capital depreciation rate
$\bar{b}$ = log labor productivity
w = log wage rate
c = log total employees' compensation C
$\dot{\bar{D}}$ = growth rate of nonfinancial deflated debt outstanding in percent (financial sector variable)
F = nominal Federal funds rate in percent (financial sector variable)
$\bar{F}$ = real Federal funds rate in percent (financial sector variable)

where $E_t\bar{K}_{t+j}$ = antilog $E_t\bar{k}_{t+j}$, E_tK_{t+j} = antilog E_tk_{t+j}, $E_t\bar{Y}_{t+j}$ = antilog $E_t\bar{y}_{t+j}$, E_tY_{t+j} = antilog E_ty_{t+j}, E_tR_{t+j} = antilog E_tr_{t+j}, E_tS_{t+j} = antilog E_ts_{t+j}, E_tZ_{t+j} = antilog E_tz_{t+j}, $E_t\bar{Z}_{t+j}$ = antilog $E_t\bar{z}_{t+j}$, $E_t\widehat{P}_{t+j}$ = antilog $E_t\widehat{p}_{t+j}$, E_tH_{t+j} = antilog E_th_{t+j}, $E_t\bar{B}_{t+j}$ = antilog $E_t\bar{b}_{t+j}$, and E_tW_{t+j} = antilog E_tw_{t+j}.

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