A DYNAMIC FINANCIAL RATIO ADJUSTMENT MODEL

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ABSTRACT

This paper proposes an alternative model for analyzing the dynamic adjustment process of financial ratios; the model includes a firm's internal effect, industry-wide effect, and strategic management. The model can explain (1) that a firm's financial ratios reflect unexpected changes in the industry, (2) active attempts to achieve the desired target by management, and (3) an individual firm's financial ratio movement. We consider the internal effect of the dynamic adjustment process of financial ratios to an equilibrium state on a firm, and use quarterly data rather than annual data for examining these effects. Empirical findings indicate that the specific effect on the firm indeed improves the explanatory ability of the dynamic adjustment process of financial ratios. Further, optimal target financial ratios may be affected by a firm's internal movement, external shocks, and strategic adjustment by the management.

JEL: C51; G17; M41

KEYWORDS: Financial ratio adjustment, Industry-wide effect, Lev's model

INTRODUCTION

Financial ratios are often used to evaluate a firm's financial performance by investors. Additionally, these ratios are used to measure financial situations of a firm through a comparison of its ratios with others in the same industry sector. Lev (1969) was the first to employ a partial adjustment model for describing the dynamic adjustment process of firm's financial ratios. After Lev's dynamic adjustment model, the following empirical and analytical studies (Frecka and Lee, 1983; and Wu and Ho, 1997) find that firms attempt to adjust their individual values with those of the industries in which they operate, thereby aiming to identify the areas of abnormal performance in their organization. Why must industry averages be the expected targets for financial accounting ratios? This is because investors usually compare economic conditions within the industry. If the extent of earnings of a firm differs considerably from the industry average, investors may regard it as a good indication of the future success of a firm (Kallunki and Martikainen, 1999). Thus, the amount of earnings management of a firm must not substantially deviate from the industry average. Therefore, Wu and Ho (1997) proposed an error correction model that explains the evolution of financial ratios over time. They concluded that there are two main effects can explain financial ratio movements. The first effect is a passive adjustment effect that occurs due to exogenous factors that affect the entire industry in which a firm operates, and the second effect is the active adjustment effect that is caused due to the efforts of the management to achieve the desired target. We further propose an alternative model that includes a firm's internal effect, industry-wide effect, and strategic management for analyzing the dynamic adjustment process of financial ratios. The model helps to explain a firm's internal financial ratio movement that can adjust to the financial ratio short-term equilibrium state for an individual firm.

In this paper, we focus on the Taiwanese notebook PC industry. In the fiscal year 2006, the growth in the shipments of Taiwanese notebook PCs to over 80% of the world market rose to 6.3 billion units. The business models of OEMs (Original Equipment Manufacturers) such as Quanta, Compal, Wistron, and Inventec—the top four Taiwanese notebook PC manufacturers—are completely dependent on orders from international brands; therefore, the proportion of OEM business for the Taiwanese notebook PC industry has remained at approximately 90%. Taiwanese notebook PC makers enjoy certain advantages over their worldwide competitors in terms of product design, manufacturing cost, flexible shipment, and global logistics, which have resulted in the current OEM industry model. Thus, it is important to analyze the financial ratios among these companies.

This article organizes as follows. We start by describing the literature review in Section 2. We then propose a dynamic financial ratio adjustment model in Section 3. After proposing the model, we introduce the data source and have some basic statistics in Section 4. Using the data to examine our model, the major empirical results and comparisons with Wu and Ho (1997) are in Section 5. Finally, we have some conclusions and further research in Section 6.

LITERATURE REVIEW

Lee, C. F., Finnerty J. E., and Wort D. H. (1990) indicated that analysis of ratios could take one of two following methods. First, the analyst can compare the ratios of one firm with those similar firms or with industry averages at a specific time point. This is one type of cross-sectional analysis technique that may indicate the relative financial condition and performance of a firm. The second method of ratio comparison involves the comparison of a present ratio with that same firm's past and expected ratios. This kind of time-series analysis will indicate whether the financial condition has improved or not.

In basic finance and accounting courses, industry norms are generally used to determine whether the magnitude of a firm's financial ratios is acceptable. This can lead to some problems in making comparisons among and drawing conclusions from them. In addition, by making only static, one-ratio-to-another comparisons, we are not taking advantage of all the information they can provide. Thus, a more dynamic analysis can improve our ability to compare companies with one another and to forecast future ratios. Regressing current ratios against past ratios helps one analyze the dynamic nature and the adjustment process of a firm's financial ratio. Lev (1969) first used the concept of the partial-adjustment model to define a dynamic financial-ratio adjustment process as:

$$Y_{j,t} = Y_{j,t-1} + \delta_j (Y^*_{j,t} - Y_{j,t-1}), \tag{1}$$

where $0 \le \delta_j \le 1$, δ_j is a partial adjustment coefficient, $Y_{j,t}$ equals firm's j-th financial ratio period t and $Y^*_{j,t}$ is firm's j-th financial ratio target in period t. This model is used in a wide variety of empirical applications of the dynamic properties of financial analysis and forecasting, such as the investment, financing, and dividend decisions, and forecasting. A generalization of Lev's (1969) partial adjustment model is the short-run dynamics of firm's financial ratios, which are linked to a rational distributed lag of industry average ratios and can be expressed as follows:

$$(1-\phi_1 B)\ln y_t = b_t + (\lambda - \theta_1 B)\ln x_{t-1} + u_t, \tag{2}$$

where y_t is a firm's financial status at time t, b_t is the drift term conditional on the information known at time t, ϕ_1 and θ_1 are lagged coefficients, λ is the responsive coefficient to industry shocks, x_{t-1} is the industry average ratio at time t-1, u_t is a disturbance term with zero mean and constant variance, and the roots of the first-order polynomials in the lag operator B are outside the unit circle.

Lev's partial adjustment model captures the effect of the response of a firm's financial ratio to unexpected changes in the past industry average ratio triggered by economic shocks. Wu and Ho (1997) generalized model (2) in order to take into account the manager's long-run objective. They impose the condition that the current financial ratio converges to its target, which is expressed as follows:

$$\ln[y_t / x_{t-1}] \to \beta \quad \text{as} \quad t \to \infty. \tag{3}$$

The value of β could be time varying or dependent on certain stationary variables. However, it is assumed a constant in this paper without a loss of generality.

The long-run equilibrium condition in (3) can be imposed on the short-run dynamics in (2), thereby yielding the following relationship:

$$\ln(y_{t+1}/y_t) = g_t + \lambda[\ln(x_t/x_{t-1}) - k_{t-1}] + \gamma[\beta - \ln(y_t/x_{t-1})] + u_{t+1}, \quad (4)$$

where g_t is the expected logarithmic change in a ratio at time t, k_{t-1} is the expected logarithmic change in industry average ratio at time $t-1$, β is the long-run steady-state target ratio, γ is the coefficient associated with the error-correction component that drags a current financial ratio toward the long-run steady-state target ratio and u_{t+1} equals white noise.

THE FINANCIAL RATIO MODEL

Though the model (4) is embedded in the short-run financial ratio dynamics, however, it does not consider the distributions of the firm-specific effect. Kallunki and Martikainen (1999) concluded that accounting earnings are managed for the purposed of attaining a firm-specific target. If a firm reports a consistent increase in earnings year after year, shareholders may treat this behavior as a signal of trouble in the business operations of the firm. Following Wu and Ho (1997), we can postulate that a firm's financial ratios are related to their industry averages. The changes in industry can either be permanent or merely transitory fluctuations. A firm's financial ratio adjustment toward the industry mean would depend on the manager's assessment of the persistence of the current change in the industry mean. Excessive deviation of a firm's ratio from the industry mean is considered to be undesirable. Akin to previous studies on financial ratios, we assume that a manager can either manipulate accounting figures or include desired ratios in the firm's budgets and then control business operations in order to achieve the desired ratio levels. Our main purpose is to determine the general tendency of a firm's financial ratios. We propose a firm's internal movement in (5), which represents the changes in the firm's financial ratio in previous year, as follows:

$$\ln(y_{t+1}/y_t) = g_t + \lambda[\ln(x_t/x_{t-1}) - k_{t-1}] + \gamma[\beta - \ln(y_t/x_{t-1})] + \delta \ln(y_t/y_{t-1}) + u_{t+1}. \quad (5)$$

The rationale of adding a firm's internal movement is that the existence of expectation adjustment lag must be confirmed, which has been considered in Lee and Wu (1988). For the purpose of convenience in estimation of the parameters, model (5) can be rearranged and transformed as

$$\ln(y_{t+1}/y_t) = \lambda + \alpha \ln(x_t/x_{t-1}) + \beta \ln(y_t/x_{t-1}) + \gamma \ln(y_t/y_{t-1}) + u_{t+1}. \quad (6)$$

We can use regression analysis to estimate the parameters. The model offers several advantages over previous studies. First, the desired target ratio is a latent variable that cannot be observed but need not be specified. This model can avoid the problem of estimating the unobserved target ratio as done in previous studies (e.g., Lev, 1969; Frecka and Lee, 1983). Second, the model considers the economic equilibrium relationship. Financial ratios can fluctuate extensively; however, economics force will push them back to the equilibrium state. Last, our model not only takes into account the external shocks to financial ratios but also the internal movements that are caused by a firm's growth. In brief, our model is different from Lev's partial adjustment on account of three factors—passive industry-wide effect, active management to attain equilibrium, and firm's internal growth movements.

DATA

The data for this study was obtained from the quarterly Taiwan Econometric Journal (TEJ) report for the period 1990–2008. Six financial ratios, as given in Lev (1969), Frecka and Lee, (1983) and Wu and Ho,

(1997) are constructed: current, quick, equity to total debt, sales to inventory, sales to total assets, and net operating income to total assets ratios; these are presented in Table 1. The right panel indicates the definition of these financial ratios. We group these ratios into five categories—short-term liquidity, long-term solvency, short-term capital turnover, long-term capital turnover, and return on investment ratios. The twelve companies under analysis are Foxconn, Compal, ECS, Inventec, Clevo, Twinhead, Gigybyte, MSI, Quanta, Mitac, Compeq, and Wistron, all of which belong to the Taiwanese notebook PC OEM industry during the period. The summary statistics are presented in Table 2. Industry averages compute using arithmetic means as a proxy for the target ratio.

Table 1: Selected Financial Ratio and Definitions

Category	Ratio Selected	Definition
Short-term liquidity ratios	Current ratio	Current assets/current liabilities
	Quick ratio	Current assets less inventory/current liabilities
Long-term solvency ratios	Equity to total debt ratio	Equity/total debt
Short-term capital turnover ratios	Sales to inventory ratio	Sales/inventory
Long-term capital turnover ratios	Sales to total assets ratio	Sales/total assets
Return on investment ratios	NOI (Net Operating Income) to total assets ratio	NOI/total assets

Liquidity ratios are calculated from information obtained from the balance sheet of the companies; these ratios measure the relative strength of a firm's financial position. Crudely interpreted, these are coverage ratios that indicate a firm's ability to meet short-term obligations. The current ratio is the most popular of the liquidity ratios because it is easy to calculate and possesses intuitive appeal. It is also the most broadly defined liquidity ratio, as it does not take into account the differences in relative liquidity among the individual components of current assets. A more specifically defined liquidity ratio is the quick or acid test ratio, which excludes the least liquid portion of current assets—inventories.

The long-term solvency ratio measures a firm's ability to meet fixed obligations of one form or another. The time interest paid, which is earnings before interest and taxes over interest expense, measures a firm's ability to service the interest expense on its outstanding debt. A more broadly defined ratio of this type is the fixed-charge coverage ratio, which includes not only the interest expense but also all other expenses that the firm is obligated to pay by contract.

Short-term and long-term capital turnover ratios measure how efficiently a firm is utilizing its assets. However, caution must be exercised with regard to the interpretation of extreme results in either direction; very high values may indicate possible difficulties in the long term, and very low values may indicate a current problem of not generating sufficient sales or not taking stock of obsolete assets. The reason that high activity may not be good in the long term is that the firm may not be able to adjust to an even higher level of activity and therefore may miss out on a market opportunity. Better analysis and planning can help a firm deal with this problem.

Return on investment ratios indicates the profitability of a firm's operations. It is important to note here that these measures are based on past performance. Generally, profitability ratios are the most volatile because a large number of the variables affecting them are beyond the firm's control. There are three groups of profitability ratios—those measuring margins, those measuring returns, and those measuring the relationship of market values to book or accounting values. Overall, all five different types of ratios (as indicated in Table

1) possess different characteristics stemming from the firm itself and the industry as a whole.

Table 2: Sample Statistics (Sample Period: 1990–2008)

Ratio	Min.	Max.	Mean	Median	Std. Deviation	Skewness	Kurtosis	N
Current ratio	32.6100	728.8000	120.7423	111.4700	58.4119	2.7526	19.1597	644
Quick ratio	61.4800	828.3000	176.4634	159.5000	68.7117	2.7250	14.4637	651
Equity to total debt ratio	0.0346	5.9531	1.3367	1.1466	0.7889	1.8350	5.3037	651
Sales to inventory ratio	0.7273	301.8829	13.8905	6.3294	28.0579	5.9367	43.4653	644
Sales to total assets ratio	0.0669	3.9533	1.1837	1.0310	0.7080	0.9142	0.5933	644
NOI to total assets ratio	–0.1442	0.4579	0.0537	0.0370	0.0724	1.7953	5.7813	651

This table shows the eight basic sample statistics of these five financial ratios from 1990 to 2008.

EMPIRICAL RESULTS

The full model in equation (6) and the partial model in equation (4) are first estimated using ordinary least squares regression (OLS). Table 3 summarizes the cross-sectional estimation results of the OLS. The overall results of the full model provide more significant explanatory power as compared with the partial model (4) description in Wu and Ho (1997), as indicated by the value of Adj-R^2. A majority of the intercept estimates are small and statistically insignificant.

The value of β coefficients indicates that adjustment coefficients are affected by the manager's decision. All of them are consistent with Wu and Ho (1997) and significant, except the sales to inventory and sales to total assets ratios. Although managers can control business operations to move toward the desired target, certain accounting items are not easy to change. For example, the sales to total assets ratio is affected by long-term factors, such as fixed assets and sales policy, which are more difficult to alter in the short run. Thus, the adjustment of this ratio requires fundamental changes in marketing and replacement of obsolete technology. On the other hand, the net operating income to total asset ratio has a high speed of convergence to the long-run equilibrium state. If a net operating income to total asset ratio were lower than the industry average, it would signify that the firm's performance is below the industry average, thereby increasing the firm's borrowing cost. Lev (1969) suggested that the cost of being out of equilibrium reflects the importance of the conformity of a particular ratio with the target.

The value of γ coefficients indicates that adjustment coefficients are affected by a firm's specific growth. A majority of these coefficients are negative at the 1% significance level except for the sales to total assets ratio in the full model. This value indicates the relationship between the growth in the current state and the subsequent period. It is a short-term adjustment factor for an individual firm.

Table 3: Full model vs. Wu and Ho (1997) (Sample Period: 1990–2008)

I : Full model: $\ln(y_{t+1}/y_t) = \lambda + \alpha \ln(x_t/x_{t-1}) + \beta \ln(y_t/x_{t-1}) + \gamma \ln(y_t/y_{t-1}) + u_{t+1}$

II : Wu and Ho (1997): $\ln(y_{t+1}/y_t) = \lambda + \alpha \ln(x_t/x_{t-1}) + \beta \ln(y_t/x_{t-1}) + u_{t+1}$

	Model	λ	α	β	γ	F value	Adj-R^2
Current ratio	I	–0.0025	0.0480	–0.1379	–0.1578	22.0100***	0.0915
		(0.7402)	(0.5518)	(<.0001)	(0.0002)		
	II	–0.0040	–0.0370	–0.1673		25.6400***	0.0730
		(0.5975)	(0.636)	(<.0001)			
Quick ratio	I	–0.0012	0.2165	–0.1587	–0.1847	24.7100***	0.1031
		(0.9071)	(0.0101)	(<.0001)	(<.0001)		
	II	–0.0043	0.1080	–0.1965		27.1000***	0.0778
		(0.6784)	(0.1837)	(<.0001)			
Equity to total debt ratio	I	–0.0035	0.0185	–0.1255	–0.0752	15.6200***	0.0655
		(0.7668)	(0.8376)	(<.0001)	(0.0706)		
	II	–0.0052	–0.0252	–0.1350		21.7100***	0.0621
		(0.6613)	(0.7721)	(<.0001)			
Sales to inventory ratio	I	0.0251	–0.0289	–0.0267	–0.3545	40.9500***	0.1622
		(0.4499)	(0.8016)	(0.4955)	(0.0015)		
	II	0.0210	–0.3518	–0.0583		55.5400***	0.1498
		(0.5309)	(<.0001)	(0.1271)			
Sales to total assets ratio	I	–0.0099	–0.2703	–0.1043	–0.0354	39.2800***	0.1565
		(0.7477)	(0.1086)	(0.1941)	(0.8302)		
	II	–0.0101	–0.3012	–0.1088		58.9900***	0.1578
		(0.7406)	(0.0005)	(0.16)			
NOI to total assets ratio	I	–0.0608	0.0975	–0.2529	–0.2448	14.5900***	0.1715
		(0.3173)	(0.4641)	(0.006)	(0.024)		
	II	–0.0625	–0.0530	–0.3421		18.9000***	0.1537
		(0.3091)	(0.6499)	(<.0001)			

This table shows the regression results of the full model and Wu and Ho's partial model (1997). y_t *is the firm's financial ratio in period* t. x_t *is the average ratio of the industry in which the firm is classified in period* t. *p-values are given in parentheses. The *, ** and *** indicate significance at the 10, 5 and 1 percent levels respectively*

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Table 4: Estimates of Pooling Regressions (Sample Period: 1990–2008)

A: $\ln(y_{t+1}/y_t) = \lambda + \alpha \ln(x_t / x_{t-1}) + u_{t+1}$

B: $\ln(y_{t+1}/y_t) = \lambda + \beta \ln(y_t / x_{t-1}) + u_{t+1}$

C: $\ln(y_{t+1}/y_t) = \lambda + \gamma \ln(y_t / y_{t-1}) + u_{t+1}$

	Model	λ	α	β	γ	F value	Adj-R^2
Current ratio	A	0.0035	–0.1897			6.0400	0.0080
		(0.6485)	(0.0143)				
	B	–0.0042		–0.1708		51.1300***	0.0741
		(0.5762)		(<.0001)			
	C	0.0038			–0.2324	36.2200***	0.0533
		(0.62)			(<.0001)		
Quick ratio	A	0.0094	–0.0749			0.8700	0.0002
		(0.377)	(0.3518)				
	B	–0.0029		–0.1855		52.3700***	0.0766
		(0.7829)		(<.0001)			
	C	0.0108			–0.2371	37.5700***	0.0558
		(0.297)			(<.0001)		
Equity to total debt ratio	A	0.0121	–0.1429			2.6500	0.0026
		(0.3097)	(0.1037)				
	B	–0.0055		–0.1363		43.3900***	0.0634
		(0.6406)		(<.0001)			
	C	0.0127			–0.1399	12.7100***	0.0184
		(0.2833)			(0.0004)		

*This table shows the regression results of a firm's ratio against each of the independent variables. y_t is the firm's financial ratio in period t. x_t is the average ratio of the industry in which the firm is classified in period t. p-value is given in parentheses. The *, ** and *** indicate significance at the 10, 5 and 1 percent levels respectively.*

The highest absolute value is the coefficient of sales to inventory ratio. If a firm has a lower sale to inventory ratio in this period, the cost of capital would be higher in the next period. Investors would believe that the firm's benefit in the next period benefit would be reduced. Hence, a firm adjusts its sales to inventory ratio depending on the previous ratio. The lowest is the coefficient of sales to total assets ratio. This ratio is also difficult to alter in the short run.

Further, we run the regression of a firm's ratio against each of the independent variables. These regressions are presented in Table 4. The results are consistent with the contention that ratio movements are directed toward the long-run equilibrium state. The results reveal that when ratios are regressed against $\ln(x_t / x_{t-1})$, the Adj-R^2 is small, thereby indicating that a small proportion of ratio variation can be explained by the change in industry ratio, which is similar to the results obtained in Wu and Ho (1997).

Table 4. (continued)

Sales to inventory ratio	Model	λ	α	β	γ	F value	Adj-R^2
	A	0.0393	–0.4090			108.5200***	0.1480
		(0.2088)	(<.0001)				
	B	–0.0389		–0.2292		64.7100***	0.0933
		(0.2414)		(<.0001)			
	C	0.0326			–0.4056	122.5700***	0.1642
		(0.293)			(<.0001)		
Sales to total assets ratio	A	–0.0028	–0.4104			115.8300***	0.1565
		(0.9263)	(<.0001)				
	B	–0.0261		–0.3507		103.9700***	0.1426
		(0.3925)		(<.0001)			
	C	–0.0031			–0.3917	111.7700***	0.1518
		(0.9183)			(<.0001)		
NOI to total assets ratio	A	–0.0467	–0.3846			19.2500***	0.0848
		(0.4638)	(<.0001)				
	B	–0.0629		–0.3681		37.7400***	0.1572
		(0.3053)		(<.0001)			
	C	–0.0502			–0.3869	35.0000***	0.1472
		(0.4145)			(<.0001)		

When a firm's ratios are regressed against $\ln(y_t / x_{t-1})$ or $\ln(y_t / y_{t-1})$, the Adj-R^2 becomes much higher. The results also indicate that the explanatory power of pf $\ln(y_t / y_{t-1})$ is not less than $\ln(y_t / x_{t-1})$. The financial ratios of the next period are indeed affected by a firm's previous specific growth rate. If the absolute value of the regression coefficient is higher, then the sensitivity of the independent variable is higher. Thus, the most sensitive financial ratios are current and quick ratios. They reflect short-term behavior characteristics in the adjustment process toward the equilibrium state.

In order to provide the forecasting ability of the full model, which we proposed, the average mean square errors for the full and partial models, which are equal to those of Wu and Ho's model, were calculated and compared as shown in Table 5. Using $\ln(x_t / x_{t-1})$, $\ln(y_t / x_{t-1})$, $\ln(y_t / y_{t-1})$ and the parameters estimated from the full model, the estimates of future financial ratio could obtain from models (4) and (6). The prediction error was calculated as the difference between the actual and predicted values. Table 5 summarizes the mean and standard deviation of the mean square errors. As indicated, the full model produces smaller percentage and mean square errors than the partial model.

Table 5: Summary Prediction of Mean Square Errors (Sample Period: 1990–2008)

	Full Model		Partial Model	
	Mean	Std. Deviation	Mean	Std. Deviation
Current ratio	0.0345	0.1279	0.0352	0.1444
Quick ratio	0.0622	0.2314	0.0640	0.2713
Equity to total debt ratio	0.0827	0.2446	0.0831	0.2574
Sales to inventory ratio	0.5905	0.7069	0.6002	0.7208
Sales to total assets ratio	0.5611	0.7093	0.5611	0.7107
NOI to total assets ratio	0.7100	1.1955	0.7289	1.2735

The predicted errors are estimated as follows:
(i) For the full model, $e_{t+1} = \ln(y_{t+1}/y_{t-1}) - \hat{\lambda} - \hat{\alpha}\ln(x_t/x_{t-1}) - \hat{\beta}\ln(y_t/x_{t-1}) - \hat{\gamma}\ln(y_t/y_{t-1})$.
(ii) For the partial model, $e_{t+1} = \ln(y_{t+1}/y_{t-1}) - \hat{\lambda} - \hat{\alpha}\ln(x_t/x_{t-1}) - \hat{\beta}\ln(y_t/x_{t-1})$.
All remaining variables are defined in Table 3.

CONCLUSION

This paper proposes an alternative model that includes a firm's internal effect, industry-wide effect, and strategic management for analyzing the dynamic adjustment process of financial ratios. The model considers a firm's internal financial ratio movement that can adjust to the financial ratio short-term equilibrium state for an individual firm. All the companies in the Taiwanese notebook PC industry are included in our sample. The quarterly data was obtained from TEJ for the period 1990–2008. Empirical findings indicate that the firm's internal movements indeed affect and improve the existing explanatory ability for the dynamic adjustment process of financial ratios.

The further research can be considered the dynamic financial ratio adjustment process in different industries. We examine three effects, and try to find out which of them is important in the adjustment processes in different industries. We can also develop the forecasting model in determining the target financial ratios based on the historical and present accounting information.

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