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Abstract:

Using the partial adjustment model with the financial constraint of over-leverage and under-leverage taken into account, this study investigates the impact of macroeconomic conditions and their interactions with firm-specific factors on the determination of capital structure in the context of the textile, plastics and electronics industries in Taiwan. The empirical results show that macroeconomic conditions have a positive effect on capital structure decisions for firms with the financial constraint of under-leverage relative to the target debt ratio. In addition, the interaction between macroeconomic conditions and firm-specific variables also affects capital structure decisions; however, this effect depends upon whether the firms are over-leveraged or under-leveraged relative to their target debt ratios. Further, we also find the variation in the rate of adjustment toward their target debt ratios that is dependent on whether the firms are over-leveraged or under-leveraged vis-à-vis their debt-ratio target. This finding on adjustment rate is consistent with Byoun (2008) but does not support Flannery and Rangan (2006).

Keywords: capital structure, macroeconomic conditions, financial constraint, partial adjustment model.

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1. Introduction

Over the last several decades, there has been a voluminous amount of studies on capital structure. Focusing mainly on the effects of factors at the firm and industry levels, these studies have documented common determinants of capital structure. Among these prior studies, some firm-specific factors, namely firm size, growth opportunities, profitability, non-debt tax shields and asset tangibility, affect the determination of capital structure. However, some of these firm-level determinants of capital structure, for example growth opportunities, may vary with macroeconomic conditions. In particular, there are more future investment and growth opportunities available at economic trough than at economic peak. This suggests that firms would adjust their capital structure in response to the change in growth opportunities arising from the fluctuations of macroeconomic conditions, in particular at economic trough and peak. Thus, firms have to determine their capital structure with macroeconomic conditions taken into account. However, based on different models of capital structure, conflicting theoretical conclusions can be drawn on the impact of macroeconomic conditions on capital structure, as discussed later in Literature Review. In spite of these, very few studies have directly investigated the role of macroeconomic conditions in the determination of capital structure. Thus, there is a need for further research on the effect of macroeconomic conditions on capital structure.

Further, prior studies on capital structure have mostly been conducted based on developed countries rather than on emerging economies. Glen and Singh (2004) find that capital structure in emerging countries is different from that observed in developed countries. Taiwan has a successful experience of economic transition from being an emerging country to becoming a developed one. The textile, plastics and electronics industries played an important role in the economy of Taiwan during the period from the 1960s to the mid-1990s. In addition, the textile, plastics and electronics industries have labor-intensive, capital-intensive and technology-intensive characteristics, respectively. Therefore, the study is conducted within the context of the textile, plastics and electronics industries of Taiwan. In doing so, this study provides a new perspective on the impact of macroeconomic conditions and their interactions with firm-specific variables on capital structure over the business cycles.

This study utilizes the partial adjustment model of capital structure in examining the impact of macroeconomic conditions on capital structure. In the application of the partial adjustment model, financial constraint of over-leverage and under-leverage is not considered by prior studies. As discussed later in the section of Methodology, the partial adjustment model permits us to neatly investigate the effect of macroeconomic conditions on capital structure and to have a better understanding of the adjustment behavior of capital structure decisions of firms with financial constraint of over-leverage and under-leverage over the business cycles. This paper could provide evidence of the following issues: (1) Does macroeconomic conditions affect the adjustment behavior

2

of capital structure? (2) Is capital structure influenced by the interactions between macroeconomic conditions and firm-specific factors? and (3) Does the adjustment behavior of capital structure vary with the financial constraint of over-leverage and under-leverage relative to the target capital structure? The rest of the paper is organised as follows: Section 2 provides a literature review; Section 3 discusses the methodology; the empirical results and analyses are presented in Section 4; and finally, Section 5 concludes the study.

2. Literature Review

After the fundamental work of Modigliani and Miller (1958), extensive studies have been conducted on capital structure decisions, as summarized by Harris and Raviv (1991). In addition, as stated earlier, these previous studies have addressed the issue at the firm and industry levels and some common determinants of capital structure at these levels have been identified. However, these studies have rarely included macroeconomic conditions. Further literature review is discussed as follows.

2.1 Macroeconomic Conditions and Capital Structure

Economic output and growth fall during the period of recession but increase during the period of expansion, particularly at economic trough and peak. Some determinants of capital structure, for example growth opportunities, may also vary with the current state of the economy over the business cycles. There are more future growth opportunities at economic trough but less growth opportunities at economic peak available to firms. The connection among macroeconomic conditions, firm-level factors and capital structure suggests that capital structure will be related to macroeconomic conditions.

Stulz (1990) analyzes the problem of managerial discretion and capital structure in his model and contends that financing policy, by influencing the resources under management's control, can reduce the costs of overinvestment and underinvestment arising from the agency problem between management and shareholders. Stulz argues that management always benefits from increasing investment even when the firm invests in a negative net present value (NPV) project. Thus, when cash flow is high, management will have the incentive to invest too much in negative NPV investment opportunities, i.e. overinvestment. On the other hand, when cash flow is low, managers may not have sufficient funds to invest in positive NPV projects, thus resulting in underinvestment. This is because shareholders cannot believe management pronouncements that cash flows are insufficient and may therefore not be willing to provide additional funding.

Consequently, Stulz argues that firms' financial policy could reduce the agency cost of managerial discretion. Issuing debt that forces management to pay out funds when cash flow is high can reduce the overinvestment cost but it can exacerbate the underinvestment cost when cash flow decreases. On the other hand, issuing equity that increases the resources under management's control reduces

the underinvestment cost but it can worsen the overinvestment when cash flow increases. To reduce the cost of overinvestment and underinvestment, firms finance with more debt when cash flow increases but finance with less debt when cash flow decreases. Jensen's free cash flow theory (1986) also asserts that debt can be used to motivate managers and their organizations to be efficient in the case of large free cash flow. Thus, firms would tradeoff the benefit of increasing leverage against the cost of bankruptcy arising from the increase in debt to determine their optimal leverage. Stulz (1990) concludes that optimal face value of debt increases if cash flow increases. This implies that, in order to reduce the agency problem between management and shareholders, firms would finance with more debt at economic peak due to the increase in cash flow but with less debt at economic trough due to the decrease in cash flow. Therefore, capital structure will be positively related to macroeconomic conditions.

However, the asymmetric information models arrive at opposite conclusion about the impact of free cash flow and profitability on capital structure due to the asymmetric information problem between management and outside investors. The asymmetric information models assume that investors are less well informed than the inside management about the value of the firm's assets. The information asymmetry attributes to the under-pricing of firms' equity and then firm's underinvestment occurs. Ross (1977) argues that firms tend to issue debt to be taken as a valid signal of a more productive firm. In addition, Myers and Majluf (1984) argue that there is a pecking order of financing: firms will finance new investment first with internal funds, then with debt, and finally with equity. Further, Narayanan (1988), assuming that debt is risky rather than assumedly risk-free in the model of Myers and Majluf (1984), analyzes this issue further in his model and concludes that debt is always better than equity which is therefore consistent with the pecking order theory of financing. Narayanan also contends that, in a world of asymmetric information regarding the new investment opportunity, firms tend to finance with debt rather than its undervalued equity to avoid underinvestment. This implies that, based on the asymmetric information theory, firms tend to finance with debt rather than equity to avoid passing up valuable investment opportunities at economic trough. Therefore, capital structure will be negatively correlated with macroeconomic conditions according to the asymmetric information models.

Miller (1977) reported that debt ratios of the typical non-financial companies varied with the business cycles between 1920 and 1960 and, in addition, debt ratios tended to fall during economic expansions. Ferri and Jones (1979) examined the determinants of capital structure for the years during expansion and recession, respectively. Their results suggest that capital structure seems to vary with macroeconomic conditions. However, Ferri and Jones (1979) did not provide clear-cut evidence on the impact of macroeconomic conditions on capital structure. Korajczyk and Levy (2003) examine the impact of macroeconomic conditions on capital structure. They split their sample into two sub-samples, financially constrained and financially unconstrained, which allows them to test whether the tradeoff theory and the pecking order theory can explain the effects of financial

4

constraints and macroeconomic conditions on capital structure decisions. Korajczyk and Levy find that corporate leverage is counter-cyclical for financially unconstrained firms. Hackbarth, Miao and Morellec (2006) present a contingency-claims model and analyze credit risk and capital structure. They argue that shareholders' value-maximization default policy is characterized by a different threshold for each state and, in addition, default thresholds are countercyclical. Their model predicts that market leverage should be countercyclical. Further, Levy and Hennessy (2007) develop a general equilibrium model for corporate financing over the business cycles. Levy and Hennessy argue that managers would hold a proportion of their firm's equity, i.e. managerial equity shares, in order to avoid agency conflicts. Firms finance less debt due to the increases in managerial wealth and in risk sharing during expansions than during contractions. Based on their simulations, Levy and Hennessy find a counter-cyclical variation in leverage for less constrained firms. Their finding on a negative effect of macroeconomic conditions on capital structure is consistent with Korajczyk and Levy (2003).

Based on the above discussion, it appears therefore that, theoretically, there is no agreement as to the impact of macroeconomic conditions on capital structure. Thus, this paper addresses this gap for further evidence from Taiwan, a newly industrialized country.

2.2 Interactions between Macroeconomic Conditions and Firm-Level Factors

As suggested by prior studies, capital structure is related to firm-specific variables such as growth opportunities, profitability and the level of firm sales. In addition, as discussed earlier in the last subsection, firm-specific variables such as growth opportunities and profitability vary with macroeconomic conditions over the business cycles. These suggest that the relationship between capital structure and its firm-level determinants is influenced by macroeconomic conditions.

However, rarely did previous studies address the impact of interactions between macroeconomic conditions and firm-level factors on capital structure. As stated previously, Ferri and Jones (1979) find that the relationship between firm size and capital structure is positive during economic expansion but not significant during economic recession. Nonetheless, no studies provide evidence on the impact of interactions between firm-level variables and macroeconomic conditions. Thus, this paper addresses the issue to provide evidence of the interaction effect on capital structure decisions.

3. Methodology

This section discusses the econometric model for the adjustment behavior of capital structure first, followed by the research sample and period and the operational definitions for the variables. Finally, the empirical models for the capital structure adjustment and the actual level of capital structure of firms with financial constraint of over-leverage and under-leverage relative to the target capital structure over business cycles in the study is discussed.

3.1 Econometric Model of Capital Structure

As suggested by previous studies (Byoun 2008; Flannery & Rangan 2006; Hovakimian et al. 2001; Marsh 1982; Taggart 1977), firms adjust toward the target capital structure over time. Following the related studies, in particular Flannery and Rangan (2006) and Byoun (2008), this study utilizes the model to examine the impact of macroeconomic conditions and their interactions with firm-specific variables on the adjustment behavior of capital structure over the business cycles. The extent of the capital structure adjustment or the change in capital structure from the previous level to the current one can be expressed as a proportion (ρ) of the difference between the target capital structure (Y_{it}^{*}) and the previous capital structure (Y_{it-1}). In the application of the partial adjustment model, the capital structure adjustment can be expressed as follows:

$$Y_{it} - Y_{it-1} = \rho_{t}(Y_{it}^{*} - Y_{it-1}) + \varepsilon_{it} \qquad (1)$$

where, Y_{it}: the actual capital structure of firm *i* at the end of year *t*, Y_{it-1}: the actual capital structure of firm *i* at the beginning of year *t*, ρ: the adjustment speed or the proportion of the difference between the target capital structure and the actual capital structure of previous year, Y_{it}^{*}: the target capital structure of firm *i* at year *t* and ε_{it}: error term. It is worth noting that the rate of adjustment toward the target level is between 0 and 1 according to most of the application of the partial adjustment model.

The capital structure adjustment depends upon whether financial constraint of a positive or a negative adjustment gap exists between the target capital structure and the previous capital structure. Firms have the financial constraint of under-leverage relative to the target capital structure if the gap between the target capital structure and the previous capital structure is positive. The greater the adjustment speed, the greater is the increase in capital structure and the smaller is the spare debt capacity that can be reserved for future investment and growth opportunities. On the other hand, firms have the financial constraint of over-leverage relative to the target capital structure if the gap between the target capital structure and the previous capital structure is negative. The greater the adjustment speed, the greater is the decrease in capital structure and the smaller is the probability that firms get into financial distress or go bankrupt. In brief, the relationship between the adjustment rate and the capital structure adjustment varies according to whether the financial constraint is over-leverage or under-leverage relative to the target capital structure. Therefore, this paper takes the financial constraint of over-leverage and under-leverage into account in the application of the partial adjustment model to investigate the impact of macroeconomic conditions and the interactions of macroeconomic conditions and firm-specific factors on capital structure over the business cycles.

However, the target capital structure is unobservable in the partial adjustment model. As suggested by prior studies (Ferri & Jones 1979; Flannery & Rangan 2006; Harris & Raviv 1991; Hovakimian et al.

2001; Korajczyk & Levy 2003), we assume that the target capital structure is a linear function of firm-specific variables, industry type, macroeconomic conditions and the interactions between firm-specific variables and macroeconomic conditions. This study includes these variables in the partial adjustment model through Y_{it}^* to examine the significance of macroeconomic conditions and their interactions with firm-specific variables in the determination of capital structure over business cycles. The firm-specific factors, namely firm size, growth opportunities, profitability, non-debt tax shields and asset tangibility, and industry type are used as control variables to capture the firm-specific and industry effects in examining the impact of macroeconomic conditions and their interactions with firm-specific variables on capital structure. Consequently, the equation for the target capital structure (Y_{it}^*) can be expressed as follows:

$$Y_{it}^* = \sum_{j=1}^{k} \beta_{jt} X_{jit}^{FC} + \beta_t^{IND} IND_{it} + \beta_t^{EC} EC_{it} + \sum_{j=1}^{k} \beta_{k+jt} X_{jit}^{FC} \times EC_{it} \qquad (2)$$

where, Y_{it}^*: the target capital structure of firm i at the end of year t, β: regression coefficient, X_{jit}^{FC}: the firm-specific variable j at firm i at year t and j = 1 to k, IND: industry type, EC: macroeconomic conditions and $X_{jit}^{FC} \times EC_{it}$: interactions between firm-specific variables and macroeconomic conditions for firm i at year t. The former two items in the right side of Equation 2 are control variables, namely firm-specific factors and industry type. The latter two items in the right side of Equation 2 are test variables, namely macroeconomic conditions and their interactions with firm-specific factors.

Substituting Y_{it}^* in Equation 2 into Equation 1, we derive the equation for the determination of capital structure adjustment $(Y_{it} - Y_{it-1})$ as follows:

$$Y_{it} - Y_{it-1} = \rho_t (\sum_{j=1}^{c} \beta_{jt} X_{jit}^{FC} + \beta_t^{IND} IND_{it} + \beta_t^{EC} EC_{it} + \sum_{j=1}^{c} \beta_{jt}^{FC \times EC} X_{jit}^{FC} \times EC_{it} - Y_{it-1}) + \varepsilon_{it} \qquad (3)$$

Incorporating the firm-specific variables, as suggested by prior studies, into Equation 3, we rewrite the equation as follows:

$$\begin{aligned} Y_{it} - Y_{it-1} = \rho_t (&\beta_{1t} SIZE_{it} + \beta_{2t} GROWTH_{it} + \beta_{3t} PROFITABILITY_{it} + \beta_{4t} NDTS_{it} \\ &+ \beta_{5t} TANGIBILITY_{it}) + \rho_t \beta_t^{IND} IND_{it} + \rho_t \beta_t^{EC} EC_{it} + \rho_t (\beta_{6t} SIZE_{it} \times EC_{it} \\ &+ \beta_{7t} GROWTH_{it} \times EC_{it} + \beta_{8t} PROFITABILITY_{it} \times EC_{it} \\ &+ \beta_{9t} NDTS_{it} \times EC_{it} + \beta_{10t} TANGIBILITY_{it} \times EC_{it}) - \rho_t Y_{it-1} + \varepsilon_{it} \end{aligned} \qquad (4)$$

where, Y_{it}: the actual capital structure of firm i at the end of year t, Y_{it-1}: the actual capital structure of firm i at the beginning of year t, ρ: the adjustment speed or the proportion of the gap of

($Y_{it}^* - Y_{it-1}$), *β*: regression coefficient, *SIZE*: firm size, *GROWTH*: growth opportunities, *PROFITABILITY*: profitability, *NDTS*: non-debt tax shields, *TANGIBILITY*: asset tangibility, *EC*: macroeconomic conditions, *SIZE×EC, GROWTH×EC, PROFITABILITY×EC, NDTS×EC* and *TANGIBILITY×EC*: interactions between firm-specific variables and macroeconomic conditions and *ε*: error term.

Rearranging Equation 4, then Equation 5 for the determination of the actual capital structure (Y_{it}) can be obtained as written as follows:

$$
\begin{aligned}
Y_{it} = \rho_t(\beta_{1t}SIZE_{it} &+ \beta_{2t}GROWTH_{it} + \beta_{3t}PROFITABILITY_{it} + \beta_{4t}NDTS_{it} \\
&+ \beta_{5t}TANGIBILITY_{it}) + \rho_t\beta_t^{IND}IND_{it} + \rho_t\beta_t^{EC}EC_{it} + \rho_t(\beta_{6t}SIZE_{it} \times EC_{it} \\
&+ \beta_{7t}GROWTH_{it} \times EC_{it} + \beta_{8t}PROFITABILITY_{it} \times EC_{it} \\
&+ \beta_{9t}NDTS_{it} \times EC_{it} + \beta_{10t}TANGIBILITY_{it} \times EC_{it}) + (1-\rho_t)Y_{it-1} + \varepsilon_{it}
\end{aligned}
\tag{5}
$$

Equations 4 and 5 represent the econometric models used for the determination of capital structure adjustment and actual capital structure for firms with financial constraints of over-leverage and under-leverage taken into account to examine the significance of macroeconomic conditions and their interactions with firm-specific variables in the determination of capital structure in this study.

Equations 4 and 5 reflect the adjustment behavior of capital structure of firms. Firms may deviate away from their target capital structure over the business cycles when the adjustment rate is not equal to 1. When the adjustment rate is equal to 1, then the actual capital structure is exactly same as the target capital structure and no gap exists between them. In other words, the partial regression coefficient of the precious actual capital structure will be significantly greater than 0 and different from 1 whenever the deviation away from the target capital structure occurs.

3.2 Research Sample and Period

This study is conducted within the industries of textile, plastics and electronics that are labor-intensive, capital-intensive and technology-intensive, respectively. The sample firms in these industries are listed on the Taiwan Stock Exchange and have complete financial data in the research period. However, we exclude the firms that experienced financial distress or trade suspension on the Taiwan Stock Exchange.

The research period starts from 1983 and ends in 1995. The year 1983 is chosen as the starting point for the study due to the reason of data availability, particularly in relation to the electronics industry that started to take off only in the 1980s in Taiwan. The choice of 1995 as the end of the sample period risks judgment of the study as being "dated"; doing so, however, allows the study to control for and avoid a number of other intervening and complicating factors which occurred after 1995 such as the Asian Financial Crisis in 1997 and the implementation of a tax integration in Taiwan on January 1, 1998. Thus, given these considerations, the sample period from 1983 to 1995 allows the study to

examine in a robust and reliable manner the impact of macroeconomic conditions on capital structure decisions in the context of Taiwan over three business cycles.

Further, the research period covering three business cycles allows an examination on the effect of macroeconomic conditions on capital structure decisions and a better understanding of the adjustment behavior of capital structure decisions. The research is conducted at the years of economic peak and trough during the period from 1983 to 1995. According to the reference dates shown in the Business Indicators published by the Council for Economic Planning and Development of Executive Yuan of Taiwan, the years at the economic peak and trough are used to represent the shifts in macroeconomic conditions. Therefore, the years of 1983, 1988 and 1994 closest to the reference dates of economic peak and the years of 1985, 1990 and 1995 closest to the reference dates of economic trough, respectively, are selected to represent the shifts in macroeconomic conditions over three business cycles.

3.3 Operational Definitions

The dependent variable of corporate capital structure and the explanatory variables at the firm level, except the dummy variables, are calculated at book value. The operational definitions for the dependent variable, the test variables including macroeconomic conditions and interactions between macroeconomic conditions and firm-specific variables as well as the control variables are described as follows:

Following most of prior empirical studies, the ratio of total debts to total assets, i.e. total debt ratio (DR), and the change in the debt ratios (dDR) are used as a proxy for the dependent variable of the actual capital structure and the capital structure adjustment, respectively. Further, we use binary dummy variable (EC) as a proxy for macroeconomic conditions with a value of 0 for years at economic trough and 1 for years at economic peak. In order to control for the effect of business cycle, the dummy variables, BC7 and BC8, with a value of 1 are used to indicate Business Cycle 7 and 8, respectively. The dummy variables, BC7 and BC8, with a value of 0 are used to indicate Business Cycle 6. Furthermore, we use the product of firm-specific variables and macroeconomic conditions as a proxy for the interactions of macroeconomic conditions and firm-specific variables (Jaccard & Turrisi 2003).

As suggested by prior studies, this study include the firm-specific and industry variables as control variables in the model to avoid model misspecification and to control for the firm-specific and industry effects as well. The major firm-specific determinants of capital structure such as firm size, growth opportunity, profitability, non-debt tax shields and asset tangibility are used to control for firm-specific effects. We utilize the natural logarithm of net sales (*ln*S) as a proxy for firm size (Booth 2001; Chu et al. 1992; Huang & Song 2006; Rajan & Zingales 1995; Titman & Wessels 1988; Wiwattanakantang 1999). The annual growth rate of total assets (gTA) is used as the proxy for

growth opportunity (Bevan & Danbolt 2002; Titman & Wessels 1988). The ratio of net operating income to total assets (OITA) is used to represent profitability (Titman & Wessels 1988). We use the ratio of depreciation to total assets (DEPTA) as a proxy for non-debt tax shields (Chu et al. 1992; Kim & Sorensen 1986; Titman & Wessels 1988; Wald 1999; Wiwattanakantang 1999). The ratio of inventory plus net fixed asset to total assets (INVFATA) is used as a proxy for asset tangibility (Chu et al. 1992; Downs 1993; Titman & Wessels 1988; Wald 1999). Further, to control for industry effect, the dummy variables, IND13 and IND14, with a value of 1 are used to indicate the plastics and textile industries, respectively. The dummy variables, IND13 and IND14, with a value of 0 are used to indicate the electronics industry.

3.4 Empirical Model

Incorporating the proxies for the variables in Equations 4 and 5, then Equations 6 and 7 for the determination of the capital structure adjustment and the actual level of capital structure of firms are written, respectively, as follows:

$$
\begin{aligned}
dDR_{it} &= \beta_1 \rho_t \ln S_{it} + \beta_2 \rho_t gTA_{it} + \beta_3 \rho_t OITA_{it} + \beta_4 \rho_t DEPTA_{it} + \beta_5 \rho_t INVFATA_{it} \\
&\quad + \beta^{IND13} \rho_t IND13_{it} + \beta^{IND14} \rho_t IND14_{it} + \beta^{EC} \rho_t EC_{it} + \beta^{BC7} \rho_t BC7_{it} \\
&\quad + \beta^{BC8} \rho_t BC8_{it} + \beta_6 \rho_t \ln S_{it} \times EC_{it} + \beta_7 \rho_t gTA_{it} \times EC_{it} + \beta_8 \rho_t OITA_{it} \times EC_{it} \\
&\quad + \beta_9 \rho_t DEPTA_{it} \times EC_{it} + \beta_{10} \rho_t INVFATA_{it} \times EC_{it} - \rho_t DR_{it-1} + e_{dDR}
\end{aligned}
\tag{6}
$$

$$
\begin{aligned}
DR_{it} &= \beta_1 \rho_t \ln S_{it} + \beta_2 \rho_t gTA_{it} + \beta_3 \rho_t OITA_{it} + \beta_4 \rho_t DEPTA_{it} + \beta_5 \rho_t INVFATA_{it} \\
&\quad + \beta^{IND13} \rho_t IND13_{it} + \beta^{IND14} \rho_t IND14_{it} + \beta^{EC} \rho_t EC_{it} + \beta^{BC7} \rho_t BC7_{it} \\
&\quad + \beta^{BC8} \rho_t BC8_{it} + \beta_6 \rho_t \ln S_{it} \times EC_{it} + \beta_7 \rho_t gTA_{it} \times EC_{it} + \beta_8 \rho_t OITA_{it} \times EC_{it} \\
&\quad + \beta_9 \rho_t DEPTA_{it} \times EC_{it} + \beta_{10} \rho_t INVFATA_{it} \times EC_{it} + (1 - \rho_t) DR_{it-1} + e_{dDR}
\end{aligned}
\tag{7}
$$

where, dDR: debt ratio adjustment; DR: total debt ratios = total debts/total assets, DR_{t-1}: total debt ratios of the previous year, β: regression coefficient, ρ: the speed of adjustment toward the target debt ratios, lnS: firm size = natural logarithm of net sales, gTA: growth opportunities = annual growth rate of total assets, OITA: profitability = net operating income/total assets, DEPTA: non-debt tax shields = depreciation/total assets, INVFATA: asset tangibility = inventory plus net fixed assets/total assets, IND13: dummy variable with a value of 1 for the plastics industry and 0 for the textile and electronics industries, IND14: dummy variable with a value of 1 for the textile industry and 0 for the plastics and electronics industries, EC: dummy variable with a value of 0 for economic trough and 1 for economic peak, BC7: dummy variable with a value of 1 for the Business Cycle 7 of Taiwan and 0 for the Business Cycles 6 and 8, BC8: dummy variable with a value of 1 for the Business Cycle 8 of Taiwan and 0 for the Business Cycles 6 and 7 and e: error term.

To investigate the adjustment behavior of capital structure of firms with financial constraints of over-leverage and under-leverage taken into account over the selected business cycles according to Equations 6 and 7, the study classifies the research sample into two subsamples based on negative and positive adjustments: one subsample with a negative adjustment to represent the case of firms with the financial constraint of over-leverage relative to the target debt ratio and another subsample with a positive adjustment to represent the case of firms with the financial constraint of under-leverage relative to the target debt ratio, as discussed earlier in Section 3.1. It is expected that, based on the argument of Stulz (1990), macroeconomic conditions (EC) will have a positive effect on the dependent variables (dDR and DR) in Equations 6 and 7. In addition, the regression coefficients of the interactions between macroeconomic conditions and firm-specific variables will not be totally equal to zero.

4. Empirical Results and Analyses

4.1 Data Analysis

The sample consists of the listed firms with the standard industrial classification (SIC) codes from 1301 to 1399, 1401 to 1499 and 2301 to 2399 in the textile, plastics and electronics industries of Taiwan. The sample includes 627 observations of the listed firms in these industries during the years of economic peak (i.e. 1983, 1988 and 1994) and trough (i.e. 1985, 1990 and 1995) over Business Cycles 6 to 8 in Taiwan. The debt ratios of the firms in the sample are less than 0.9. This suggests that no firm in the sample is in financial distress. The descriptive statistics of the full sample are shown in Table 1. In addition, no observations of 'zero' debt ratio adjustment are found in the sample. This shows that the sample data allows the application of the partial adjustment model to investigate the adjustment behavior of capital structure. Further, high correlation is found amongst the explanatory variables; therefore, the centering technique suggested by Cronbach (1987) is utilized to avoid the problem of multi-collinearity.

Table 1. Descriptive Statistics for the Full Sample

Variable	N	Mean	Standard Deviation	Minimum	Maximum
dDR	627	-0.02276	0.09831	-0.46459	0.32244
DR_t	627	0.45062	0.17005	0.01396	0.87985
DR_{t-1}	627	0.47338	0.17620	0.02426	0.89139
EC	627	0.46411	0.49911	0	1.00000
BC7	627	0.37321	0.48404	0	1.00000
BC8	627	0.50399	0.50038	0	1.00000
IND13	627	0.14514	0.35252	0	1.00000
IND14	627	0.38437	0.48683	0	1.00000
*ln*S	627	21.48528	1.20916	15.99580	25.23950
gTA	627	0.31132	0.47841	-0.30866	4.93033
OITA	627	0.08304	0.08064	-0.16390	0.59860
DEPTA	627	0.03618	0.02387	0	0.18216
INVFATA	627	0.55177	0.17214	0.02850	0.89525

Notes:

dDR = debt ratio adjustment;
DR$_t$ = the debt ratio at time t;
DR$_{t-1}$ = the previous debt ratio at time t;
EC = 0 for economic trough and 1 for economic peak;
BC7 = 0 for Business Cycles 6 and 7, and 1 for Business Cycle 7;
BC8 = 0 for Business Cycles 6 and 7, and 1 for Business Cycle 8;
IND13 = 0 for the textile and electronics industries and 1 for the plastics industry;
IND14 = 0 for the plastics and electronics industries and 1 for the textile industry;
*ln*S = natural logarithm of net sales;
gTA = annual growth rate of total assets;
OITA = net operating income/total assets;
DEPTA = depreciation/total assets;
INVFATA = inventory plus net fixed assets/total assets.

4.2 Regression Results

Based on Equations 6 and 7, the regression results for the determination of the debt ratio adjustment and the actual debt ratio in the subsamples with a negative and a positive adjustment gap are shown in Tables 2 and 3, respectively. As shown in Note 4 of Table 2, the explanatory power, i.e. adjusted R-square, of the models for the determination of the debt ratio adjustment and the actual debt ratio in the subsample with a negative adjustment gap is 43.41% and 79.61%, respectively. In addition, no serious residual auto-correlation problems are found according to the Durbin-Watson D value that is close to 2, i.e. 1.957 as also shown in Note 4 of the table. Further, as can be seen in the VIF column of Table 2, the values of variance inflation factor (VIF) much less than the critical value of 10 are often regarded as indicating no problematic multi-collinearity (Chatterjee & Price 1991). Furthermore, no sample observations with values of DFFITS are greater than 1.02 that indicates no outlier effect in the subsample with a negative adjustment gap (Belsey et al. 1980).

Table 2. Regression Results in the Subsample with a Negative Adjustment Gap

Variables	(1) Dependent variable: Debt Ratio Adjustment (dDR)			(2) Dependent variable: Actual Debt Ratio (DR)		
	Coefficient	t Value	VIF[5]	Coefficient	t Value	VIF[5]
DR$_{t-1}$	-0.14831	-5.81[a]	1.24180	0.85169	33.38[a]	1.24180
EC	0.01955	1.54	4.62215	0.01955	1.54	4.62215
BC7	-0.03833	-3.77[a]	2.75424	-0.03833	-3.77[a]	2.75424
BC8	-0.02832	-2.71[a]	3.25398	-0.02832	-2.71[a]	3.25398
IND13	0.00894	0.69	1.48972	0.00894	0.69	1.48972
IND14	-0.00279	-0.29	2.44645	-0.00279	-0.29	2.44645
*ln*S	0.00974	2.78[a]	1.14516	0.00974	2.78[a]	1.14516
gTA	0.00842	0.58	3.12928	0.00842	0.58	3.12928
OITA	-0.18957	-2.65[a]	5.34009	-0.18957	-2.65[a]	5.34009
DEPTA	-0.36932	-2.02[b]	4.36228	-0.36932	-2.02[b]	4.36228
INVFATA	0.06859	2.16[b]	1.88959	0.06859	2.16[b]	1.88959
*ln*S×EC	-0.00474	-0.69[b]	1.09215	-0.00474	-0.69	1.09215
gTA×EC	-0.06379	-2.69[a]	3.26808	-0.06379	-2.69[a]	3.26808
OITA×EC	0.12082	1.23	5.43026	0.12082	1.23	5.43026
DEPTA×EC	-0.27691	-0.71	1.53247	-0.27691	-0.71	1.53247
INVFATA×EC	0.06152	1.06	1.58520	0.06152	1.06	1.58520

Notes:
1. dDR$_t$ = total debt ratio adjustment in the current year;
   DR$_t$ = total debt ratio at the end of the current year;
   DR$_{t-1}$ = total debt ratio at the end of the previous year;
   EC = 0 for economic trough and 1 for economic peak;
   BC7 = 0 for Business Cycles 6 and 8 and 1 for Business Cycle 7;
   BC8 = 0 for Business Cycles 6 and 7 and 1 for Business Cycle 8;

IND13 = the dummy variable with a value of 1 for the plastics industry;
IND14 = the dummy variable with a value of 1 for the textile industry;
lnS = natural logarithm of net sales;
gTA = annual growth rate of total assets;
OITA = net operating income/total assets;
DEPTA = depreciation/total assets;
INVFATA = inventory plus net fixed assets/total assets;
lnS×EC, gTA×EC, OITA×EC, DEPTA×EC and INVFATA×EC = interactions between firm-specific
     variables and macroeconomic conditions.

2. [a], [b] and [c] indicate the significance level of 1%, 5% and 10%, respectively.

3. The value of the coefficient is the product of the rate of adjustment (ρ) and the regression coefficient (β) of each
independent variable except the previous actual debt ratio (DR_{t-1}) as shown in Equations 5-5 and 5-5A.

4.   N   Adj. R-square   F value   Durbin-Watson D value
   (1) 365   0.4341   18.56[a]   1.957
   (2) 365   0.7961   90.05[a]   1.957

5. VIF: Variance Inflation Factor

Table 3. Regression Results in the Subsample with a Positive Adjustment Gap

Variables	(1) Dependent variable: Debt Ratio Adjustment (dDR)			(2) Dependent variable: Actual Debt Ratio (DR)		
	Coefficient	t Value	VIF[5]	Coefficient	t Value	VIF[5]
DR_{t-1}	-0.03474	-1.63	1.52995	0.96526	45.39[a]	1.52995
EC	0.02614	2.79[a]	4.43960	0.02614	2.79[a]	4.43960
BC7	0.05854	6.30[a]	2.81518	0.05854	6.30[a]	2.81518
BC8	0.04836	5.61[a]	4.27679	0.04836	5.61[a]	4.27679
IND13	-0.00140	-0.14	1.55342	-0.00140	-0.14	1.55342
IND14	0.01052	1.37	2.16445	0.01052	1.37	2.16445
lnS	-0.00284	-0.91	1.47421	-0.00284	-0.91	1.47421
gTA	0.05348	5.66[a]	4.23168	0.05348	5.66[a]	4.23168
OITA	-0.09458	-1.42	4.33455	-0.09458	-1.42	4.33455
DEPTA	0.07070	0.45	4.31468	0.07070	0.45	4.31468
INVFATA	0.02752	1.11	1.91207	0.02752	1.11	1.91207
lnS×EC	-0.00532	-0.90	1.32431	-0.00532	-0.90	1.32431
gTA×EC	-0.03602	-2.80[a]	4.49244	-0.03602	-2.80[a]	4.49244
OITA×EC	-0.01229	-0.13	4.43071	-0.01229	-0.13	4.43071
DEPTA×EC	-0.49382	-1.43	1.52787	-0.49382	-1.43	1.52787
INVFATA×EC	0.10742	2.39[b]	1.58020	0.10742	2.39[b]	1.58020

Notes:
1. dDR_t = total debt ratio adjustment in the current year;
  DR_t = total debt ratio at the end of the current year;
  DR_{t-1} = total debt ratio at the end of the previous year;
  EC = 0 for economic trough and 1 for economic peak;
  BC7 = 0 for Business Cycles 6 and 8 and 1 for Business Cycle 7;
  BC8 = 0 for Business Cycles 6 and 7 and 1 for Business Cycle 8;
  IND13 = the dummy variable with a value of 1 for the plastics industry;
  IND14 = the dummy variable with a value of 1 for the textile industry;
  lnS = natural logarithm of net sales;
  gTA = annual growth rate of total assets;
  OITA = net operating income/total assets;
  DEPTA = depreciation/total assets;
  INVFATA = inventory plus net fixed assets/total assets;
  lnS×EC, gTA×EC, OITA×EC, DEPTA×EC and INVFATA×EC = interactions between firm-specific
     variables and macroeconomic conditions.

2. [a], [b] and [c] indicate the significance level of 1%, 5% and 10%, respectively.

3. The value of the coefficient is the product of the rate of adjustment (ρ) and the regression coefficient (β) of each
independent variable except the previous actual debt ratio (DR_{t-1}) as shown in Equations 5-5 and 5-5A.

4.   N   Adj. R-square   F value   Durbin-Watson D value
   (1) 262   0.7210   43.32[a]   2.138
   (2) 262   0.9161   179.75[a]   2.138

5. VIF: Variance Inflation Factor

On the other hand, the explanatory power, i.e. adjusted R-square, of the models for the determination of the debt ratio adjustment and the actual debt ratio in the subsample with a positive adjustment gap is 72.10% and 91.61%, respectively, as shown in Note 4 of Table 3. In addition, no serious residual auto-correlation problems are found according to the value of Durbin-Watson D that is close to 2, i.e. 2.138, as also shown in Note 4 of Table 3. Further, no serious multi-collinearity problem is found according to the values of variance inflation factor (VIF) shown in the VIF column of Table 3 that are much less than the critical value of 10. Furthermore, no sample observations with values of DFFITS are greater than 1.02 that indicates no outlier effect in the subsample with a positive adjustment gap (Belsey et al. 1980). Further analyses on the regression results in the subsamples with a negative and a positive adjustment gap over Business Cycles 6 to 8 shown in Tables 2 and 3 are now discussed.

4.2.1 Macroeconomic Conditions and Their Interactions with Firm-Specific Variables

According to the t-value shown in the t-value columns in Table 2 in the subsample with a negative adjustment gap, the dummy proxy for macroeconomic conditions, i.e. EC, in the subsample with a negative adjustment gap is not significantly related to the debt ratio adjustment and the actual debt ratio of the listed firms in the textile, plastics and electronics industries during the period from 1983 to 1995 over Business Cycles 6 to 8 in Taiwan. On the other hand, according to the t-value shown in Table 3 in the subsample with a positive adjustment gap, the dummy proxy for macroeconomic conditions is statistically significant and positively related to the debt ratio adjustment and the actual debt ratio of the listed firms in the textile, plastics and electronics industries over Business Cycles 6 to 8 in Taiwan. The result in the subsample with a positive adjustment gap is consistent with the conclusion of Stulz (1990) that firms finance with less debt at economic trough in response to future investment and growth opportunities. In addition, the findings in the subsamples with a negative or a positive adjustment gap suggest that the effect of macroeconomic conditions on the debt ratio adjustment and the debt ratios varies according to whether the adjustment gap between the target debt ratio and the previous actual debt ratio is positive or negative.

Further, according to the t-value shown in the t-value columns in Table 2, the interaction between growth opportunities and macroeconomic conditions (gTA×EC) is statistically significant and negatively related to the debt ratio adjustment and the actual debt ratio in the subsample with a negative adjustment gap. The results show that the effect of growth opportunities on the debt ratio adjustment and the actual debt ratio is augmented by macroeconomic conditions although macroeconomic conditions do not have a direct effect on the debt ratio adjustment and the actual debt ratio in the subsample with a negative adjustment gap. On the other hand, according to the t-value shown in Table 3, the interaction between growth opportunities and macroeconomic conditions (gTA×EC) is statistically significant and negatively related to the debt ratio adjustment and the actual debt ratio in the subsample with a positive adjustment gap. As can be seen in Table 3, growth opportunities have a positive main effect on debt ratio but the effect is diminished by the negative

interaction with macroeconomic conditions. In addition, the interaction between asset tangibility and macroeconomic conditions is statistically significant and positively related to the debt ratio adjustment and the actual debt ratio in the subsample with a positive adjustment gap. The findings on the interaction effect in the subsamples with negative and positive adjustment gaps illustrate the variation in the effect of interactions between firm-specific variables and macroeconomic conditions on the debt ratio adjustment and the actual debt ratio.

As a whole, the findings above suggest that the effects of macroeconomic conditions and their interaction with firm-specific variables vary according to whether firms have the financial constraint of over-leverage or under-leverage, i.e. a negative or a positive adjustment gap between the target debt ratio and the previous actual debt ratio.

4.2.2 Adjustment Rate

Looking at the t-value shown in column t-value of Tables 2 and 3, regression coefficient of the previous actual debt ratio (DR_{t-1}) is significantly different from 0 in the case of a negative and a positive gap over Business Cycles 6 to 8 for the listed firms in the textile, plastics and electronics industries of Taiwan. The regression coefficient of the previous actual debt ratio in the empirical model for the determination of actual debt ratio, i.e. Equation 7, is exactly equal to 1 minus the adjustment rate of debt ratio adjustment ($1-\rho$). Therefore, the adjustment rate of debt ratio is 0.14831 (i.e. $1-0.85169$) according to the regression coefficients of the previous actual debt ratio for the determination of the debt ratio adjustment and the actual debt ratio in Table 2. On the other hand, as shown in Table 3, the adjustment rate of debt ratio is 0.03474 (i.e. $1-0.96526$) according to the regression coefficient of the previous actual debt ratio for the determination of the debt ratio adjustment and the actual debt ratio in the subsample with a positive adjustment gap. It is worth noting that the effect of the explanatory variables, except the previous actual debt ratio, on the debt ratio adjustment is a proportion of the regression coefficients of these variables in Equations 6 and 7. The proportion depends upon the adjustment rate, as shown in Equations 6 and 7.

The findings above suggest that the adjustment rate of debt ratio for firms with a negative adjustment gap, i.e. a financial constraint of over-leverage, is faster than for those with a positive adjustment gap, i.e. a financial constraint of under-leverage. Firms with the financial constraint of over-leverage tend to gear down their leverage due to the high risk of bankruptcy and adjust faster to rebalance their debt ratio toward the target level. This suggests that firms adjust at a different rate of debt ratio adjustment over time when they have a negative or a positive adjustment gap between the target debt ratio and the previous actual debt ratio. This finding does not support the constant adjustment rate of Flannery and Rangan (2006) but is consistent with Byoun (2008).

Moreover, in order to contrast the difference when negative and positive adjustment gaps are or are not taken into account in the estimation of the modified partial adjustment model utilized in the study, the regression results for the determination of the debt ratio adjustment and the actual debt

ratio in the full sample when negative and positive adjustment gaps are not taken into account are shown in Table 4.

As shown in Note 4 in Table 4, the adjusted R-square for the model without negative and positive adjustment gaps taken into account is much lower than that for the model used in the study, as shown in Tables 2 and 3. There is residual auto-correlation problem due to the Durbin-Watson D value (1.279) close to 1, as shown in Table 4. In addition, based on Equations 6 and 7, the regression coefficient of the previous actual debt ratio is respectively equal exactly to the negative value of the adjustment rate ($-\rho$) and to 1 minus the adjustment rate ($1-\rho$). The adjustment rate of debt ratio (0.21824 or $1-0.78176$) shown in Table 4 is overestimated without the adjustment gaps taken into account. It is much higher than the adjustment rates of 0.14831 and 0.03474 shown respectively in Tables 2 and 3 with negative and positive adjustment gaps taken into account. These additional regression results reflect the fact that, in the application of the partial adjustment model for capital structure adjustment, the estimation should take into account whether the adjustment gap between the target capital structure and the previous actual capital structure is negative or positive.

Table 4. Regression Results in the Full Sample without Adjustment Gap Taken into Account

Variables	(1) Dependent variable: Debt Ratio Adjustment (dDR)			(2) Dependent variable: Actual Debt Ratio (DR)		
	Coefficient	t Value	VIF[5]	Coefficient	t Value	VIF[5]
DR_{t-1}	-0.21824	-10.22[a]	1.19843	0.78176	36.60[a]	1.19843
IND13	0.03679	3.48[a]	4.38644	0.03679	3.48[a]	4.38644
IND14	-0.00448	-0.49	2.67337	-0.00448	-0.49	2.67337
EC	-0.00201	-0.22	3.44276	-0.00201	-0.22	3.44276
BC7	0.00632	0.58	1.47378	0.00632	0.58	1.47378
BC8	-0.00321	-0.39	2.24711	-0.00321	-0.39	2.24711
lnS	0.00823	2.60[a]	1.23850	0.00823	2.60[a]	1.23850
gTA	0.05414	4.76[a]	3.56325	0.05414	4.76[a]	3.56325
OITA	-0.29697	-4.61[a]	4.70518	-0.29697	-4.61[a]	4.70518
DEPTA	-0.19678	-1.21	4.20475	-0.19678	-1.21	4.20475
INVFATA	0.08935	3.32[a]	1.81068	0.08935	3.32[a]	1.81068
lnS×EC	-0.00921	-1.50	1.16342	-0.00921	-1.50	1.16342
gTA×EC	-0.02852	-1.75[c]	3.66214	-0.02852	-1.75[c]	3.66214
OITA×EC	0.00751	0.08	4.76297	0.00751	0.08	4.76297
DEPTA×EC	-0.55087	-1.58	1.48393	-0.55087	-1.58	1.48393
INVFATA×EC	0.12555	2.56[b]	1.50778	0.12555	2.56[b]	1.50778

Notes:
1. dDR_t = total debt ratio adjustment in the current year;
   DR_t = total debt ratio at the end of the current year;
   DR_{t-1} = total debt ratio at the end of the previous year;
   EC = 0 for economic trough and 1 for economic peak;
   BC7 = 0 for Business Cycles 6 and 8 and 1 for Business Cycle 7;
   BC8 = 0 for Business Cycles 6 and 7 and 1 for Business Cycle 8;
   IND13 = the dummy variable with a value of 1 for the plastics industry;
   IND14 = the dummy variable with a value of 1 for the textile industry;
   lnS = natural logarithm of net sales;
   gTA = annual growth rate of total assets;
   OITA = net operating income/total assets;
   DEPTA = depreciation/total assets;
   INVFATA = inventory plus net fixed assets/total assets;
   lnS×EC, gTA×EC, OITA×EC, DEPTA×EC and INVFATA×EC = interactions between firm-specific
        variables and macroeconomic conditions.
2. [a], [b] and [c] indicate the significance level of 1%, 5% and 10%, respectively.

3. The value of the coefficient is the product of the rate of adjustment (ρ) and the regression coefficient (β) of each independent variable.

4. Case   N   Adj. R-square   F value   Durbin-Watson D value
   (1)   627   0.2331   12.91[a]   1.279
   (2)   627   0.7437   114.70[a]   1.279

5. VIF: Variance Inflation Factor

5. Conclusion

This paper utilizes the modified partial adjustment model to examine the adjustment behavior of capital structure decisions for the listed firms in the textile, plastics and electronics industries across years of economic trough and peak over Business Cycles 6 to 8 in Taiwan. With the controls for the effects of firm characteristics and industry type, the findings show a significant effect of macroeconomic conditions on the debt ratio adjustment and, in addition, the variation in the effect of macroeconomic conditions on the debt ratio adjustment. Macroeconomic conditions have a positive effect on the debt ratio adjustment and the actual debt ratio for firms with the financial constraint of under-leverage relative to the target debt ratio in the case of a positive adjustment gap. No significant effect, however, appears on the determination of the debt ratio adjustment and the actual debt ratio for firms with the financial constraint of over-leverage relative to the target debt ratio in the case of a negative adjustment gap. In addition, the interactions between macroeconomic conditions and firm-specific variables also vary according to whether firms have a negative or a positive adjustment gap.

Further, the adjustment rate of debt ratios varies according to the financial constraint of over-leverage or under-leverage relative to the target debt ratios in the adjustment gap between the target debt ratio and the previous actual debt ratio for the listed firms in the textile, plastics and electronics industries over Business Cycles 6 to 8. The adjustment rate is negatively related to the debt ratio adjustment for the listed firms with the financial constraint of over-leverage in the case of a negative adjustment gap. This indicates that the greater the adjustment rate, the greater is the decrease in the debt ratios of firms with the financial constraint of over-leverage relative to the target debt ratios. On the contrary, the adjustment rate is positively related to the debt ratio adjustment for the listed firms with the financial constraint of under-leverage relative to the target debt ratio in the case of a positive adjustment gap. This shows that the greater the adjustment rate, the greater is the increase in the debt ratios of firms with the financial constraint of under-leverage relative to the target debt ratios. As a whole, firms tend to adjust at a faster rate when firms have a negative adjustment gap with the financial constraint of over-leverage to gear down leverage due to the high risk of bankruptcy. The evidence on the variation in the adjustment rate of debt ratio is consistent with Byoun (2008) but does not support the constant adjustment rate over time as Flannery and Rangan (2006) conclude.

Finally, Taiwan has a most successful record of economic transition from being a less-developed country to becoming a newly industrialized country within few decades only. Within this context, the findings of this study provide new evidence on the effect of macroeconomic conditions on the debt

17

ratio adjustment and the determination of the actual debt ratios for firms with financial constraint of over-leverage and under-leverage relative to the target debt ratios. Future research might address the adjustment behaviour of capital structure decisions across the Asian countries to provide further evidence on the effect of macroeconomic conditions and on the variation in the adjustment rate of capital structure decisions. In particular, further evidence on the differences in the adjustment behavior of capital structure between developing and developed countries leaves for future research.

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