# New evidence on the impact of financial leverage on beta risk: A time-series approach

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# NEW EVIDENCE ON THE IMPACT OF FINANCIAL LEVERAGE ON BETA RISK:

# A TIME SERIES APPROACH


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# NEW EVIDENCE ON THE IMPACT OF FINANCIAL LEVERAGE ON BETA RISK:

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*Abstract:*

The traditional estimation of a project's cost of capital often requires leverage adjustments to beta. Several researchers have empirically investigated the relationship between the debt/equity ratio (D/E) and beta implied by such leverage adjustments. Typically, this has involved cross-sectional analysis of a sample of US firms in selected industry classifications. The major contribution of the current study is to extend this evidence by investigating the relationship between financial leverage and beta using a time-series approach. This has several advantages over the cross-sectional approach. Our results reveal that while the estimated unlevered beta produced by the time series approach is quite close to the theoretically implied unlevered beta, the mean difference between the two measures across our sample of 348 US stocks is highly significant. Interestingly, the implied value is invariably larger than its time series estimated counterpart, with a sample average difference of between five and ten percent. The analysis also reveals that 30 to 40 percent of our full sample rejects a theoretical D/E restriction on the time series model. Moreover, the results suggest that the restriction is much more likely to be rejected for stocks with high debt/equity ratios, which in general have low unlevered betas. Further, there is a considerable cross sectional variation in the proportion of these rejections across industry groupings. Accordingly, these results suggest that due care needs to be applied when taking the traditional view of delevering beta risk.

## 1. Introduction

In the application of the capital asset pricing model (CAPM) to the estimation of a project's cost of capital, modern finance theory has been substantially influenced by the work of Hamada (1972), Bowman (1980), Conine (1980) and others, regarding the need to make leverage adjustments to beta, under certain circumstances. Considerable empirical work has been produced to extend and establish the validity of such leverage adjustments, and research representative of this literature includes: Logue and Merville (1972); Breen and Lerner (1973); Rubenstein (1973); Melicher (1974); Thompson (1976); Chance (1982); Mandelker and Rhee (1984); DeJong and Collins (1985); Bhandari (1988); Butler, Mohr and Simmonds (1991); Darrat and Mukherjee (1995) and Marston and Perry (1996).

In a recent paper, Marston and Perry (1996) empirically investigate the relationship between financial leverage and beta. Their approach involves a series of cross-sectional analyses across a sample of US firms in selected two-digit and four-digit SIC industry classifications. They investigate three subperiods over the interval 1974-1988 and compare the regression results to those predicted by the Hamada (1972) leverage adjustment. Generally, their results indicate that the techniques which are commonly applied for the purposes of unlevering beta, tend to over-penalize beta when higher levels of financial leverage are being utilized.

The current study aims to extend the evidence contained in the existing literature by investigating the impact of financial leverage on beta using a time-series approach. This delivers several major advantages over the cross-sectional approach used in all previous work. First, and perhaps the primary advantage, is that the time series approach provides a much stronger control for operating or business risk, as it avoids having to make a strong assumption of constant systematic business risk across a chosen industry grouping (see

Marston and Perry (1996)). Instead, we make the more reasonable assumption that systematic operating or business risk is constant for a given firm (although even this assumption can be tested and relaxed if necessary).

A second important advantage of our time-series approach is that it delivers a level of statistical power not possible in the cross sectional studies. As discussed later, our sample involves 348 stocks which represents a much larger sample than is allowed by industry regressions or by the matched pair sample approach of Marston and Perry (1996), for example. Thus, with more observations, the current study has more power to reject the hypothesis that the difference between the empirical and the implied theoretical unlevered betas is equal to zero. Third, following on from the preceding point, our time series approach allows the examination of a number of industries that would be precluded in the cross-sectional approach due to an insufficient number of firms within the industry.

A fourth advantage of our time series methodology is that it allows for the time variation in debt-equity (D/E) ratios, which have been found to be quite substantial for most companies over certain periods in their life history. The notion that the time-variation in the D/E ratio causes time variation in beta risk and risk generally, is widely cited in the finance literature [see, for example, Black (1976) and Christie (1982)]. Indeed, the relatively recent proliferation of generalized autoregressive conditional heteroskedasticity (GARCH) model applications and, in particular, the popularity of the asymmetric variations thereof [for example, see Nelson (1991), Glosten, Jagannathan and Runkle (1993) and Engle and Ng (1993)] have invoked leverage arguments to explain their empirical success.

A fifth advantage is that, unlike Marston and Perry (1996) and others, financial firms can be validly included in this analysis, despite their extreme values of D/E, without compromising the homogeneity of the sample. This is so because the time series approach means that the results of such extreme D/E ratio firms are produced independently of the results of firms with less extreme financial leverage. Accordingly, the evidence we provide considerably broadens the scope of our understanding in this area. A sixth advantage relates to the fact that an unlevered beta can be estimated directly using data for a single company in isolation of all other companies (except for the need to utilize a market index return). Moreover, the estimated unlevered beta can be used in conjunction with the time series of D/E to generate a series of time-varying (levered) equity betas. A seventh and final advantage of the time series approach is that it gives a new insight to an issue that has traditionally been tested in a cross sectional way.[1]

In general our results reveal that while the estimated unlevered beta produced by the time series approach is quite close to the theoretically implied unlevered beta, the mean difference between the two measures across the sample of 348 US stocks is highly significant. Interestingly, the implied value is invariably larger than its time series estimated counterpart, with a sample average difference of ten percent (4.8 percent) when the no taxes (tax-adjusted) framework is employed. Further, our analysis also reveals that 40 percent (29.3 percent) of our sample rejects a theoretical restriction on the time series model in the no taxes (tax-adjusted) setting. Moreover, the results suggest that the restriction is much more likely to be rejected for stocks with high and variable debt/equity ratio's which in general have low unlevered betas. Further, there is a considerable cross sectional variation in the proportion of these rejections across industry groupings. Hence, the principal message that this study delivers is the need for particular care to be taken in these 'high risk' situations when applying the unlevered beta approach. Specifically, our analysis generally re-enforces the implication of Marston and Perry (1996), namely, that we must be careful when using traditional techniques so as not to over-penalize beta in situations of high leverage.

[1] For example, Denis and Kadlec (1994, p.1808) make this same argument in their study of the relationship between trading activity, the measurement of security returns and systematic risk.

The remainder of this paper is organized as follows. In section 2 the empirical framework is briefly outlined, while section 3 presents and analyses the results. The final section presents a summary and conclusion.

## 2. Empirical framework

### *2.1. No taxes case*

As shown by Hamada (1972) and others, the levered equity beta can be decomposed into a business risk and a financial risk component. Specifically, the business risk component of systematic risk is captured by an unlevered or pure equity beta ($\beta_{ui}$), while the financial risk component is a product of the D/E ratio employed by the firm and the pure equity beta. This is reflected in the well-known equation due to Hamada (1972) and Bowman (1980) [in which it is assumed that there are no taxes and that corporate debt is riskless]:

$$\beta_i = \beta_{ui} (1 + D/E_i), \qquad \ldots (1)$$

The traditional application of equation (1) is to combine information on the average debt equity ratio with an estimate of the firm's (levered) equity beta to produce the theoretically implied unlevered beta.

An alternative approach is the substitution of a time series version of equation (2) into the standard market model,

$$R_{it} = \alpha_i + \beta_i R_{mt} + e_{it}, \qquad \ldots (2)$$

where $R_{it}$ is the rate of return on asset i in period t; $\alpha_i$ is the intercept term; $\beta_i$ is an estimate of the systematic risk of asset i; $R_{mt}$ is the rate of return on a market index in period t; and $e_{it}$ is mean zero random error term. This substitution produces the following specification:

$$R_{it} = \alpha_i + \beta_{ui} R_{mt} + \beta_{ui} [D/E_{it} * R_{mt}] + e_{it}, \qquad \ldots (3)$$

This is the restricted version of the model, which can be compared to the unrestricted model,

$$R_{it} = \alpha_i + b_i R_{mt} + \gamma_i [D/E_{it} * R_{mt}] + e_{it}, \qquad \ldots (4)$$

Thus, the leverage hypothesis imposes the restriction of equality of coefficients and we can test the null hypothesis:

$$H_0: \gamma_i = b_i, \qquad \text{. . . (5)}$$

*2.2.Corporate tax-adjusted case*

In a Modigliani and Miller (1963) world of corporate taxes, debt financing attracts a tax subsidy that leads to the well-known (corporate) tax-adjusted version of the relationship between levered and unlevered betas. Specifically, equation (1) becomes:

$$\beta_i = \beta_{ui} [1 + (1 - t_c) D/E_i], \qquad \text{. . . (6)}$$

where $t_c$ is the corporate tax rate.

Similar to the no taxes case, we can combine a time series version of this equation with the market model, to create a restricted time series model:

$$R_{it} = \alpha_i + \beta_{ui} R_{mt} + \beta_{ui} [(1 - t_c) * D/E_{it} * R_{mt}] + e_{it}, \qquad \text{. . . (7)}$$

that can be statistically compared to its unrestricted counterpart:

$$R_{it} = \alpha_i + b_i R_{mt} + \gamma_i [(1 - t_c) * D/E_{it} * R_{mt}] + e_{it}, \qquad \text{. . . (8)}$$

We can also test the null hypothesis of (5) stated above in the context of this specification.[2 3]

[2] Of course there is also the version of these approaches that relaxes the zero beta of corporate debt assumption. This version is not investigated here because of a degrees of freedom problem. That is, the time-series model cannot distinguish a separate estimate of an unlevered equity beta from the beta of debt. Further, making a zero beta of debt assumption is not uncommon in the literature – see for example, Bartov, Bodnar and Kaul (1996, p. 124). Nevertheless, in response to the legitimate concern about this assumption, part of the later discussion of our results will focus on the subset of our sample in which this assumption is not such a serious issue, namely, the non-extreme D/E companies.

[3] In a Miller (1977) world of corporate and personal taxes, debt financing attracts a tax subsidy that leads to a (corporate and personal) tax-adjusted version of the relationship between levered and unlevered betas. The extent of the effective tax subsidy is however controversial. At one extreme, Miller (1977) argued for the possibility of an equilibrium in which all of the tax benefit is competed away. In such a case (and again assuming that the beta of corporate debt is zero), the relationship effectively reverts back to the no taxes case, outlined in section 2.1.

Accordingly, our empirical investigation involves initially estimating equation (2) to provide the market model beta estimates across our total sample of firms. Following this, we estimate both the restricted and unrestricted versions of the financial leverage-adjusted market model for the no taxes case [equations (3) and (4), respectively] and for the tax-adjusted case [equations (7) and (8), respectively]. This produces an empirical estimate for the unlevered beta of each firm and allows us to test the null hypothesis of (5) above. Further, we de-lever the market model beta estimate of each firm according to equation (1) [equation (6)] in the no taxes case (tax-adjusted case) to uncover the theoretically implied value for the unlevered beta in the traditional way. For both the no taxes and the tax-adjusted cases, we then conduct a test of the hypothesis that the mean difference between the empirically estimated and theoretically implied unlevered betas is equal to zero across our sample. Finally, we calculate the cross-sectional correlation between various variables used in the analysis to uncover any further patterns in our results.

*2.3. A test of the hypothesis of equality of unlevered beta risk within an industry*

One final set of analysis is conducted relating to the common assumption that operating (systematic) risk within an industry is equal across companies that belong to that industry. Specifically, within the framework developed in the current paper, we examine a set of four-digit SIC classifications and test this equality of risk hypothesis using our estimates of unlevered beta as proxies for operating risk. This is performed using systems of seemingly unrelated regressions for each four-digit SIC grouping, with a Wald test of the null hypothesis:

$$H_0: \beta_{u1} = \beta_{u2} = ... = \beta_{un} \qquad ... (9)$$

This test is applied to both the no tax and tax-adjusted versions of our model.

## 3. Results

### *3.1. Data*

In this paper we examine all US stocks for which we could obtain complete quarterly data on both equity returns (from the CRSP database) and the debt/equity ratio (from the COMPUSTAT database) from the second quarter of 1979 to the final quarter of 1994. A total of 348 stocks satisfied these criteria. Two variants of the debt/equity ratio are considered, namely, (a) Total Liabilities/Total Equity; and (b) (Total Liabilities + Preferred Stock)/Total Equity. Equity and Preferred stock are measured as market values, whereas liabilities are measured as book values.[4] As the results of each set of analysis are qualitatively similar, we only report those of the former case (a). The final piece of information necessary to perform our empirical analysis is the tax rate information. Over the period 1979 to 1985 we adopt the rate of 46 %, from 1986 we take the rate as 34 %, while for the remaining portion of our sample period we use a rate of 35 %.[5]

### *3.2. Initial results: no taxes versus tax-adjusted cases*

#### *3.2.1. Overall results*

Initially we present our analysis for: (1) the sample of all 348 stocks; (2) stocks arranged into quartiles by estimated market model beta ($\hat{\beta}_{MM}$); (3) stocks arranged into quartiles by estimated unlevered beta ($\hat{\beta}_u$); (4) stocks arranged into quartiles by average debt/equity ratio (D/E); (5) stocks arranged into quartiles by the coefficient of variation of the debt/equity ratio (CVDE); and (6) stocks classified as those which reject the restrictions of model (Sig F) and those which fail to reject the restrictions of model (Insig F). For each of these classifications

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[4] The valuation of debt in book value form is common in the literature – see for example, Bartov, Bodnar and Kaul (1996, p. 125).

[5] These tax rates represent the top bracket rates applicable to US companies over our sample period.

we report in Table 1: (i) the average D/E; (ii) the average CVDE; (iii) the average estimated market model beta; (iv) the average estimated unlevered beta; (v) the average implied unlevered beta;[6] (vi) the t-statistic testing the null hypothesis that the mean difference between the estimated unlevered beta and the implied unlevered beta equals zero; and (vii) the number of cases in which the F-statistic suggests rejection of the unlevered beta restriction, $H_0$: $\gamma_i = b_i$ [hypothesis (5)].

Panel A of Table 1 reports the overall results in three variations. In the first instance the complete sample of all 348 stocks are included, while the remaining two variations examine subsets of the complete sample for which the constant business risk assumption is more tenable. First, consider the overall results for the complete sample of all 348 stocks. In this case the average of the individual stock debt/equity ratio is 3.98283 and the average OLS market model beta is 1.11160. In the case of the no taxes setting the average unlevered beta is 0.44220, while the tax adjusted counterpart reveals a value of 0.5636.[7] While the average unlevered beta (in both settings) is considerably less than its average market model beta counterpart as expected, the differential appears close to that predicted by theory. Indeed, the average implied unlevered beta for the no taxes case (tax-adjusted case), equal to 0.48765 (0.59067), is only 10 percent (4.8 percent) larger than the average estimated unlevered beta from the time series model. However, a test of the mean difference between these two measures in the no taxes setting (tax-adjusted setting) across the full sample of 348 stocks reveals a highly significant differential reflected by a t-statistic equal to -15.07 (-7.79).[8]

[6] The implied unlevered beta for each stock is achieved by applying the standard de-levering formula – that is, for the no taxes (tax-adjusted) case it is calculated according to equation (1) [equation (6)] in the text. For a given category, the average value is then an equally-weighted average of implied unlevered beta of stocks belonging to the relevant sample.

[7] The two unlevered beta estimates are highly correlated, producing a correlation coefficient of 0.984 across the full sample.

[8] The robustness of these parametric results was confirmed using the non-parametric Wilcoxen signed-rank test procedure. Specifically, in the no taxes setting the Wilcoxen test statistic was –14.97 and in the tax-adjusted setting the Wilcoxen test statistic was –6.13, thus confirming the strong rejection of the hypothesis of a zero mean difference.

Further, it can be reported that for the no taxes setting (tax-adjusted setting) 317 (224) of the total 348 stocks produced an estimated unlevered beta lower than its theoretically implied counterpart.

It is interesting to note that in the no taxes (tax-adjusted) case, 0.30177 (0.3065) is the greatest difference between the estimated unlevered beta and its implied unlevered counterpart. In this case the implied unlevered beta is 0.82648 (0.42757) compared to the estimated unlevered beta with a value of 0.52471 (0.12107). Thus, not only do we observe statistical significance between the estimated versus implied unlevered betas, but when we go beyond a simple comparison of averages, an indication of economic significance is in evidence for a nontrivial portion of our sample.

Finally, with regard to the overall results for the complete sample of 348 stocks reported in Panel A, in the case of the tax-adjusted analysis we observe a relatively small proportion of rejections (102 cases out of 348 or 29.3 %) of the unlevered beta restriction, $H_0$: $\gamma_i = b_i$. It is noted that the incidence of rejections increases somewhat in the no taxes setting (139 rejections or approximately 40 % of cases), suggesting that the tax-adjusted version is more consistent with the data.

One concern about the above analysis, which includes the complete set of 348 companies, is that the constant business (unlevered) risk assumption invoked for each included company may be questionable. This is particularly so given the fact that our sample period covers a 15-year timeframe and over such a lengthy interval a non-trivial number of companies may have changed their main area of business activity. Accordingly, we also investigated two sub-samples in our overall analysis, for which the constant business risk assumption is more plausible. Specifically, we screened companies based on whether their SIC codes changed over the sample period. Hence, the second variation of our overall analysis is restricted to the sub-sample of 327 stocks for which the primary SIC classification did not change. Further, the third variation of the overall analysis is restricted to the sub-sample of 290 stocks for which the four-digit SIC classification did not change. These cases are also reported in Panel A of Table 1.

In general, we see from Panel A that the outcome of the restricted samples of the overall analysis very closely mimic the findings for the complete sample. For example, we again find very strong evidence rejecting the equality of the estimated and implied unlevered betas, in both the no taxes and tax-adjusted settings. As a further example, we observe similar proportions of rejections of the unlevered beta restriction $H_0$: $\gamma_i = b_i$. Specifically, in the no taxes setting the 40 % level is maintained, while in the case of the tax-adjusted setting percentages in the high 20s are found (27-28 %). In summary, the close similarity of these results suggests that the stability of business risk assumption is not a critical issue, and hence, for the sake of brevity in all the remaining analysis, we only report the variation in which all of our complete sample of 348 stocks are eligible for inclusion.

*3.2.2. Quartile results*

In general, the breakdown of our results into quartiles as reported in the remaining panels of Table 1 is quite revealing. There are some cases where the results are fairly insensitive. In general the average coefficient of variation for the debt/equity ratio varies little across the quartiles. For example, across the quartiles ranked by market model beta the range is 0.457 to 0.598. The same insensitivity is also true for the average market model beta across quartiles. For example, across the quartiles ranked by average debt/equity ratio the range is 1.044 to 1.193.

[TABLE 1 ABOUT HERE]

Panel B of Table 1 reveals the quartile results ranked by market model beta. Generally, as expected, we observe a positive relationship between the average debt/equity ratio and the average market model beta across the quartiles. As was the case for the aggregate overall results, the average implied unlevered beta is always marginally larger than the average time series estimated unlevered beta. In the no taxes setting as before, the test of the mean difference between these two measures in all quartiles reveals a highly significant differential (t-statistics ranging from -6.29 to -9.77). However, in the tax adjusted case, only in the upper two quartiles are the differences clearly significant at conventional levels. Further, while the number of rejections of the unlevered beta hypothesis ($H_0$: $\gamma_i = b_i$) appears to be positively associated with the size of the market model beta in the no taxes setting, the pattern is less clear for its tax-adjusted counterpart. For the smallest market model beta quartile, 25 or 28.7 % (20 or 23 %) of cases reject the restriction, while for the largest market model beta quartile, 40 or 46 % (30 or 34.5 %) of cases reject the restriction for the no taxes (tax-adjusted) analysis.

Panel C of Table 1 reveals the quartile results ranked by the unlevered beta. Not surprisingly we find that the lowest quartile based on unlevered beta provides the highest average debt/equity ratio and that as the average unlevered beta increases across quartiles, there is a compensating decrease in the average debt/equity ratio. This is consistent with the notion of achieving some balance between financial risk (as reflected by the debt/equity ratio) and business/operating risk (as proxied by the unlevered beta). Yet again, while the average implied unlevered beta is always marginally larger than the average estimated unlevered beta, (with the exception of highest quartile) the test of the mean difference between these two measures in all quartiles reveals a highly significant differential. Finally, with regard to the unlevered beta restriction ($H_0$: $\gamma_i = b_i$), regardless of the setting, it appears to be more likely that the restriction will be rejected for lower values of the unlevered beta. That is, the proportion of rejections decreases as a function of unlevered beta. For example, in the no taxes setting the smallest unlevered beta quartile produces 55 or 63.2 % rejections, whereas the largest unlevered beta quartile produces only 22 or 25.3 % rejections.

Panels D and E report similar quartile based results as discussed above, with one major exception. Specifically, in the tax-adjusted setting, the lowest quartiles of both the D/E and CVDE ranked analysis reveal a significant positive differential between the estimated unlevered beta and the implied unlevered beta. This is in contrast to the negative differential observed in all other cases. Further, with regard to the incidence of rejections of the unlevered beta restriction, while we find that rejections tend to increase with D/E and CVDE for both the no taxes and tax-adjusted settings, the pattern appears to be stronger in the case of the former. In the case of the smallest D/E quartile (for which the maximum average D/E ratio is 0.5637), only 13 or 14.9 % (10 or 11.5 %) of cases reject the restriction for the no taxes (tax-adjusted) analysis. In contrast, in the case of the largest D/E quartile (for which the minimum average D/E ratio is 2.876), 52 or 59.8 % (35 or 40.2 %) of cases reject the restriction for the no taxes (tax-adjusted) analysis. Summarizing the unlevered beta restriction results over Panels B to E, we can state that the restriction is much more likely to be rejected for stocks with high and variable debt/equity ratio's, which in general have low unlevered betas.[9]

Now consider Panel F of Table 1 which reports the analysis partitioned on the basis of significant versus insignificant cases of testing the unlevered beta restriction, $\gamma_i = b_i$. As noted earlier, we find considerably greater support for the restriction in the tax-adjusted case.[10] For the 139 (102) stocks that reject the restrictions, the average debt/equity ratio is 5.81473 (5.01244), as compared to an average debt/equity ratio of 2.76448 (3.55591) for the remaining 209 (246) stocks. While this differential is highly significant for the no taxes case, it is only

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[9] One plausible reason for the failure of the restriction to be accepted at high debt levels is that the assumption of the beta of debt being equal to zero in these cases is tenuous. From this viewpoint the high incidence of rejections for high levels of financial leverage is not a great surprise.

[10] Nevertheless, the F-statistics for the no taxes versus the tax-adjusted settings are highly correlated, producing a correlation coefficient of 0.913 across the full sample.

significant at the 10 % level in the tax-adjusted setting. Further, the average unlevered beta produced from the time series model for those cases where the restriction is rejected, are somewhat smaller (and highly statistically so) than for those cases where the restriction cannot be rejected (0.33974 versus 0.51034 in the no tax setting and 0.46651 versus 0.60386 in the tax-adjusted setting). Thus, the results suggest that regardless of whether we adopt a no taxes or a tax adjusted approach, the restriction is much more likely to be rejected for stocks with high debt/equity ratio's, which in general have low unlevered betas. Finally, it is of interest to note that we are more likely to reject the hypothesis of equality of the unlevered beta and implied unlevered beta, if the unlevered beta restriction ($H_0$: $\gamma_i = b_i$) is also rejected.

### *3.3. Tax-adjusted correlation results*[11]

For each of the classifications (1) to (6) discussed in the preceding section, Table 2 reports the cross-sectional correlation: (i) between the average debt/equity ratio and the estimated market model beta; (ii) between the average debt/equity ratio and the estimated unlevered beta; (iii) between the estimated market model beta and estimated unlevered beta; (iv) between the estimated market model beta and the coefficient of variation of the debt/equity ratio; (v) between the estimated unlevered beta and the coefficient of variation of the debt/equity ratio; and (vi) between the average debt/equity ratio and the coefficient of variation of the debt/equity ratio.

As seen in Panel A of Table 2, the market model beta and average debt/equity ratio are positively correlated across all stocks, although only mildly so. While the positive correlation is not surprising, theory suggests that for a given level of business risk there should be a

[11] From this point onwards (unless stated otherwise), the no taxes based results are not reported to conserve space. This analysis is available from the authors upon request.

strong positive correlation. This is best revealed in the unlevered beta quartile analysis (Panel C) where the correlations are much higher attaining a maximum of 0.84456 in the third quartile. Referring to Panel A again, we see for the overall sample the average debt/equity ratio and unlevered beta exhibit a strong negative correlation of -0.63246. This re-inforces the earlier observation that a balance of overall risk, between the financial and business risk elements, is expected. Indeed, (with the exception of the lowest D/E quartile) such a strong negative correlation is observed across all quartile disaggregations provided in Table 2.

[TABLE 2 ABOUT HERE]

Generally, with respect to the correlations reported in Table 2, we find a pattern in five cases. First, the correlation between the average debt/equity ratio and the market model beta falls as the market model beta increases. Second, in contrast the correlation between the coefficient of variation of the debt/equity ratio and the market model beta increases as the market model beta increases. Third, with respect to the correlation between the average debt/equity ratio and the unlevered beta we find this to be an increasing function of the unlevered beta and (fourth) also a decreasing function of the average debt/equity ratio. Finally, we also find the correlation between the market model beta and the unlevered beta to be a decreasing function of the average debt/equity ratio.

The measured correlations also vary greatly across the quartiles. The highest positive correlation is 0.953 between the market model beta and the unlevered beta in the first quartile for the average debt/equity ratio. Other high correlations are 0.93795 between the market model beta and unlevered beta for the second quartile of the average debt/equity ratio, and 0.84456 between the average debt/equity ratio and the market model beta for the third quartile of the unlevered beta. In contrast, the most negative correlation is –0.80343 between the average debt/equity ratio and the unlevered beta for the second quartile of the market model beta. Interestingly, by all correlation measures, stocks that reject the restriction, and stocks that fail to reject the restriction appear quite similar.

*3.4. Exploring potential industry effects*

Having decomposed our results into quartiles, we now consider the impact of disaggregation into industry classifications. The investigation of how well our time series model performs across industries is worthwhile because of the documented patterns of financial leverage relative to characteristics of industrial structure. At one extreme it is noted that banks and financial institutions can successfully operate at very high levels of debt to equity, as opposed to the other extreme in which, for example, we observe mining and resources companies employing very low levels of debt to equity.

We initially disaggregated our total sample into twelve industry groupings following the classifications employed by Breeden, Gibbons and Litzenberger (1989) and these results are presented in Table 3. [12] In a related disaggregation analysis we report in Table 4, the results for selected two digit SIC codes, namely, those industries in which ten or more companies provided valid data for analysis.

First consider Table 3, which reports the results for the twelve aggregate industries. The average debt/equity ratios range from a low value of 0.776 in the Food and Tobacco industry, to a high value of almost 14 in the Finance and Real Estate industry. Interestingly, despite having the lowest (highest) average D/E ratio, the Food and Tobacco (Finance and Real Estate) industry does not provide the lowest (highest) average market model beta. Rather these titles go to the Petroleum and Transportation industries, respectively. Accordingly, the apparent contradiction between the D/E and market model beta is explained by the average estimated unlevered beta across the twelve industries. For example, Finance and Real Estate

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[12] Breeden, Gibbons and Litzenberger (1989, pp. 243) adapt the classification utilized by Sharpe (1982).

has an average unlevered beta of only 0.1847 compared to a value of 0.9435 for Leisure. Further, while the average implied unlevered beta is, once again, mostly (marginally) larger than the average estimated unlevered beta, the test of the mean difference between these two measures reveals a highly significant differential, in seven of the twelve industry categories. Consistent with earlier results, it seems that industries for which this hypothesis is rejected also produce quite high incidences of rejections of the unlevered beta restriction, ($H_0$: $\gamma_i = b_i$). In addition, the rejection of this unlevered beta restriction seems (as before) to be generally a positive function of D/E and a negative function of unlevered beta.

[TABLE 3 ABOUT HERE]

The correlation results reported in Table 3 are very interesting, particularly (a) between D/E and the market model beta; and (b) between D/E and the unlevered beta. Assuming that these industry groupings represent an effective control on inherent business risk, as argued earlier we would expect to observe a strong positive correlation for the former and a strong negative correlation for the latter. Indeed, we do observe strong positive correlations between D/E and the market model beta for Petroleum (0.483); Finance and Real Estate (0.575); Transportation (0.538); and Services (0.577). Moreover, a strong negative correlation between D/E and unlevered beta is found across all twelve industries, ranging between -0.2 and -0.839. These observations strongly confirm the aggregated results presented in the earlier tables.

Table 4, which provides more disaggregated results based on two-digit SIC codes, reveals somewhat similar conclusions to Table 3 and, hence, will not be discussed in great detail. Worthy of note however, is the variation in the proportions of rejections of the restriction, $b_i = \gamma_i$, across two-digit industrial classifications. The industry classification with the highest debt/equity ratio (Depository Institutions, SIC Code 60, Average D/E = 18.4221) has 31.3 % of stocks which reject the restriction. However, Insurance Carriers (SIC Code 63, Average D/E = 4.96168) which also has a higher than average debt/equity ratio has only 18.2 % of stocks which reject the restriction. Also of note is the Primary Metal Industries classification (belonging to the Basic Industries grouping of Table 3) having only one out of eleven stocks which reject the restriction. Interestingly, while the Food and Kindred Products classification produces no companies that reject this restriction, the estimated unlevered beta is significantly different to (higher than) its implied theoretical counterpart.

[TABLE 4 ABOUT HERE]

Our analysis of two-digit SIC classifications suggests that important variations in the results are obtained across the different industry classifications. Thus, it would seem worthwhile to disaggregate our results even further to four-digit SIC classifications. The 348 stocks in our sample disaggregate across 153 four-digit SIC classifications. The majority of these classifications contain only one or two stocks.[13] Hence, given that in many instances the small sample size makes such an analysis of limited value, we only report four general cases grouped according to the two-digit classification. Specifically, the results of this analysis are reported for: (a) the Chemicals and Allied Products Industry (SIC Code 28) in Table 5; (b) the Industrial Commercial Machinery and Computer Equipment Industry (SIC Code 35) in Table 6; (c) the Transportation Equipment Industry (SIC Code 37) in Table 7; and (d) the Depository Institutions Industry (SIC Code 60) in Table 8. A brief discussion of the major features of these tables is now provided. [14]

From the tables, it can be seen that the estimated unlevered beta is considerably less than its average market model beta counterpart in all cases, as expected. A comparison of the average implied unlevered beta to the counterpart average estimated unlevered beta provides a close similarity in most instances. For the Chemicals and Allied Products Industry (Table 5),

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[13] In fact, 72 classifications contain only a single stock, and a further 47 classifications contain only two stocks.

[14] More detailed disaggregated analysis is available from the authors upon request.

typified by low D/E and, hence, low financial risk, the comparison of the average estimated unlevered beta with the implied unlevered beta is very close for all four-digit constituents. For the Industrial Commercial Machinery and Computer Equipment Industry (Table 6) typified by slightly higher financial risk, there is a degree of divergence in the comparison of unlevered betas for some companies. For example, in the case of Industrial Trucks and Tractors (SIC Code 3537) and General Industrial Machinery and Equipment (SIC Code 3569) the implied unlevered betas are substantially larger (in both instances about twice the size) than their estimated unlevered beta counterparts. Interestingly, these two companies have the highest D/E ratio in the SIC 35 two-digit classification and are also cases in which the equality hypothesis is rejected.

[TABLES 5 & 6 ABOUT HERE]

For the Transportation Equipment Industry (Table 7), a comparison of the implied and estimated unlevered betas, while a little mixed, is not dramatically divergent across all four-digit constituents. Furthermore, for the Depository Institutions Industry (Table 8), typified by extremely high D/E and, hence, very high financial risk, a comparison of the implied and estimated unlevered betas is reasonably close for all four-digit constituents.

[TABLES 7 & 8 ABOUT HERE]

Finally, consider how proportions of rejections of the restriction, $b_i = \gamma_i$, vary across the four-digit SIC classifications reported in Tables 5 to 8. Consistent with previous discussion, the industry classifications with higher than average debt/equity ratios tend to have rejection frequencies that are high. For instance, State Commercial Banks (SIC Code 6022) contains 17 stocks, has an average debt/equity ratio of 16.1432 and has 47.1 % of its stocks reject the restriction. However, National Commercial Banks (SIC Code 6021) contains 30 stocks, has an average debt/equity ratio of 19.778 and has a relatively low 23.3 % rejections.

Table 9 reports the results of testing the equality of unlevered betas within a given four-digit SIC grouping, for a selection of cases. Specifically, we choose to report the findings for those four-digit industries in which there are at least five member companies. The table reveals that nine such cases exist in our sample. The primary motivation for examining this issue relates to the common assumption that within an industry sector, the operating (business) systematic risk of constituent companies is equal.

[TABLE 9 ABOUT HERE]

From the table we see that in general this equality of unlevered beta hypothesis cannot be supported for our four-digit industry groups. Specifically, for only two of the nine groups is the hypothesis not rejected, namely, Quarry Non-metal Minerals (SIC 1400) and Real Estate Investment Trusts (SIC 6798). However, even for these cases the within industry range of unlevered beta estimates (from the unrestricted specification) seems relatively large. For example, in the tax-adjusted analysis for SIC 1400 the betas range between 0.4316 to 1.0530. Accordingly, we conclude that the commonly applied assumption of equal operating systematic risk across companies within a particular "industry" grouping is one that should not be automatically applied without careful investigation.

## 4. Summary and Conclusion

A considerable volume of empirical research has investigated the relationship between the debt/equity ratio and beta, encouraged by the theoretical work produced by Hamada (1972), Bowman (1980), Conine (1980) and others. Typically, such empirical analysis, most recently represented by Marston and Perry (1996), has adopted a cross-sectional approach. Generally, their results indicate that the techniques which are commonly applied for the purposes of unlevering beta, tend to over-penalize beta when higher levels of financial leverage are being utilized. The major contribution of the current study is to extend this evidence by investigating the impact of financial leverage on beta risk using a time-series approach.

This time series methodology which has never before been utilized, offers several advantages over the widely employed cross-sectional approach. First, and perhaps most important, is that the time series approach provides a much stronger control for operating or business risk, as it avoids having to make a strong assumption of constant systematic business risk across a chosen industry grouping. Second, the time-series approach delivers a level of statistical power not possible in the cross sectional studies. Third, our time series approach allows the examination of a number of industries that would be precluded in the cross-sectional approach due to an insufficient number of firms within the industry. Fourth, it allows for the time variation in debt-equity (D/E) ratios, which have been found to be quite substantial for most companies over certain periods in their life history. Fifth, financial firms can be validly included in this analysis, despite their extreme values of D/E. A sixth advantage relates to the fact that an unlevered beta can be estimated directly using data for a company in isolation of all other companies. A final advantage of the time series approach is that it gives a new perspective on an issue which has traditionally been tested in a cross sectional way.

Our study reveals several principal findings. First, we find that while the estimated unlevered beta produced by the time series approach is quite close to the theoretically implied unlevered beta, the mean difference between the two measures across the sample of 348 US stocks is highly significant. Second following on from the preceding issue, the implied value is invariably larger than its time series estimated counterpart, with a sample average difference of ten percent (4.8 percent) when the no taxes (tax-adjusted) framework is employed. Third, the analysis also reveals that 40 percent (29.3 percent) of our sample rejects a theoretical restriction on the time series model in the no taxes (tax-adjusted) setting. Fourth, the results suggest that the restriction is much more likely to be rejected for stocks with high and variable debt/equity ratio's, which in general have low unlevered betas. Further, there is a considerable cross sectional variation in the proportion of these rejections across industry groupings. Fifth, we find that in the context of testing within a given four-digit SIC grouping, the hypothesis of equality between the unlevered beta risk of individual companies was soundly rejected.

Accordingly, the major thrust of our analysis can be stated as follows. First, given that we find a high proportion of our sample supports the time series leverage restriction, we can conclude that making such leverage adjustments are in general justified. Second, the above conclusion warrants a careful qualification as our analysis suggests that traditionally applied adjustments work reasonably well in some circumstances but not universally so. Specifically, it is found that only for relatively low D/Es (in the order of 1:1 or below), do the leverage adjustments of beta risk seem well specified. Hence, our results suggest that due care needs to be applied when taking the traditional view of delevering beta risk. Moreover, this finding is important because it serves to confirm and re-enforce the conclusion drawn by Marston and Perry (1996) that traditionally applied leverage adjustments tend to over-penalize beta, particularly when high levels of financial leverage are being employed.

A third major thrust of our study is that given there is appreciably greater support for the tax-adjusted leverage adjustment, our findings commend the use of taxation adjusted techniques. While this may at first seem a trivial confirmation of long held wisdom, it should be remembered that one version of the equilibrium outcome of the Miller (1977) model (that incorporates both corporate and personal taxes), effectively produces an outcome 'as if' a no taxes scenario was in force.  Thus empirical discrimination between these alternatives is important.

The final major thrust emanating from our work relates to our finding that the hypothesis of the equality of unlevered beta risk across companies within four-digit SIC groupings is, in general, strongly rejected. The fact that in many past situations researchers have invoked this assumption does not necessarily suggest that the resultant analysis is unreliable. However, it does require us to reconsider conclusions drawn upon the existing work in those situations where such an assumption may be potentially critical to the analysis. Moreover, it also requires us to be a little more circumspect in invoking such risk equality assumptions in similar research settings in the future.

**References**

Bartov, E., Bodnar, G. and Kaul, A., (1996), "Exchange Rate Variability and the Riskiness of U.S. Multinational Firms: Evidence from the Breakdown of the Bretton Woods System", *Journal of Financial Economics*, Vol. 42, pp. 105-132.

Bhandari, L.C., (1988), "Debt/Equity Ratio and Expected Common Stock Returns: Empirical Evidence", *Journal of Finance,* Vol. 43, pp. 507-528.

Black, F., (1976), "Studies of Stock Market Volatility Changes", *Proceedings of the American Statistical Association*, Business and Economic Statistics Section, pp. 177-181.

Bowman, R.G., (1980), "The Importance of a Market-Value Measurement of Debt in Assessing Leverage", *Journal of Accounting Research*, Vol. 18, pp. 242-254.

Breeden, D., Gibbons, M. and Litzenberger, R., (1989), "Empirical Tests of the Consumption-Oriented CAPM", *Journal of Finance*, Vol. 44, pp. 231-262.

Breen W.J., and Lerner, E.M., (1973), "Corporate Financial Strategies and Market Measures of Risk and Return", *Journal of Finance*, Vol. 28, pp. 339-351.

Butler, K. C. Mohr, R.M., and Simonds, R.R., (1991), "The Hamada and Conine Leverage Adjustments and the Estimation of Systematic Risk for Multisegment Firms", *Journal of Business Finance and Accounting*, Vol. 18, pp. 885-901.

Chance, D, (1982), "Evidence on a Simplified Model of Systematic Risk", *Financial Management*, Vol. 11, pp. 53-63.

Christie, A., (1982), "The Stochastic Behavior of Common Stock Variances: Value, Leverage and Interest Rate Effects", *Journal of Financial Economics*, Vol. 10, pp. 407-432.

Conine, T.E., (1980), "Corporate Debt and Corporate Taxes: An Extension", *Journal of Finance*, Vol. 35, pp. 1033-1037.

Darrat, A. and Mukherjee, T., (1995), "Inter-Industry Differences and the Impact of Operating and Financial Leverages on Equity Risk", *Review of Financial Economics*, Vol. 4, pp. 141-155.

De Jong, D.V. and Collins, D.W., (1985), "Explanations for the Instability of Equity Beta: Risk-Free Rate Changes and Leverage Effects", *Journal of Financial and Quantitative Analysis*, Vol. 20, pp. 73-94.

Denis, D. and Kadlec, G., (1994), "Corporate Events, Trading Activity, and the Estimation of Systematic Risk: Evidence from Equity Offerings and Share Repurchases", *Journal of Finance*, Vol. 49, pp. 1787-1811.

Engle, R. and Ng, V., (1993), "Measuring and Testing the Impact of News on Volatility", *Journal of Finance*, Vol. 48, pp. 1749-1778.

Glosten, L., Jagannathan, R. and Runkle, D., (1993), "On the Relation Between the Expected Value and the Volatility of the Nominal Excess Return on Stocks", *Journal of Finance*, Vol. 48, pp. 1779-1801.

Hamada, R. S., (1972), "The Effect of the Firm's Capital Structure on the Systematic Risk of Common Stocks", *Journal of Finance*, Vol. 27, pp. 435-452.

Logue, D. E., and Merville, L.J., (1972), "Financial Policy and Market Expectations", *Financial Management*, Vol. 1, pp. 37-44.

Mandelker, G.N., and Rhee, S.G., (1984), "The Impact of the Degrees of Operating and Financial Leverage on Systematic Risk of Common Stock", *Journal of Financial and Quantitative Analysis*, Vol. 19, pp. 45-57.

Marston, F. and Perry, S., (1996), "Implied Penalties for Financial Leverage: Theory Versus Empirical Evidence", *Quarterly Journal of Business and Economics*, Vol. 35, pp. 77-97.

Melicher, R.W., (1974), "Financial Factors Which Influence Beta Variations Within an Homogenous Industry Environment", *Journal of Financial and Quantitative Analysis*, Vol. 9, pp. 231-241.

Miller, M., (1977), "Debt and Taxes", *Journal of Finance*, Vol. 32, pp. 261-275.

Modigliani, F. and Miller, M., (1963), "Corporate Income Taxes and the Cost of Capital: A Correction", *American Economic Review*, Vol. 53, pp. 433-443.

Nelson, D., (1991), "Conditional Heteroscedasticity in Asset Returns: A New Approach", *Econometrica*, Vol. 59, pp. 347-370.

Rubenstein, M.E., (1973), "A Mean-Variance Synthesis of Corporate Financial Theory", *Journal of Finance*, Vol. 28, pp. 167-181.

Sharpe, W., (1982), "Factors in New York Stock Exchange Security Returns, 1931-1979", *Journal of Portfolio Management*, Vol. 8, pp. 5-19.

Thompson, D. J. (1976), "Sources of Systematic Risk in Common Stocks", *Journal of Business*, Vol. 49, pp. 173-188.

## Table 1: Average Values for Key Variables and Leverage-Based Hypothesis Tests: Overall Aggregate and Quartile Results

This table reports the: Average Debt/Equity Ratio (D/E); Average Coefficient of Variation of the Debt/Equity Ratio (CVDE); Average Market Model Beta ($\hat{\beta}_{MM}$); Average Unlevered Beta ($\hat{\beta}_u$); and Average Implied Theoretical Unlevered Beta. It is also reports the t-statistic for the null hypothesis that the mean difference between the estimated Unlevered Beta and the Implied Unlevered Beta equals zero and the number of cases in which the unlevered beta restriction is rejected.

| | No Taxes Setting | | | | | | | | Tax-Adjusted Setting | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | Ave D/E | Ave CVDE | Ave $\hat{\beta}_{MM}$ | Ave $\hat{\beta}_u$ | Ave Impl. $\hat{\beta}_u$ | t-stat [a] | Sig F [b] | n | Ave D/E | Ave CVDE | Ave $\hat{\beta}_{MM}$ | Ave $\hat{\beta}_u$ | Ave Impl. $\hat{\beta}_u$ | t-stat [a] | Sig F [b] |
| Panel A: Overall Results | | | | | | | | | | | | | | | | |
| All Stocks | 348 | 3.98283 | 0.51131 | 1.11160 | 0.44220 | 0.48765 | -15.07 | 139 | 348 | 3.98283 | 0.51131 | 1.11160 | 0.56360 | 0.59067 | -7.79 | 102 |
| All Stocks (stable SIC)[c] | 327 | 4.02025 | 0.51514 | 1.11451 | 0.44347 | 0.48832 | -14.39 | 131 | 327 | 4.02025 | 0.51514 | 1.11451 | 0.56463 | 0.59093 | -7.26 | 93 |
| All Stocks (stable SIC)[d] | 290 | 3.11442 | 0.51469 | 1.10313 | 0.46498 | 0.51012 | -13.43 | 114 | 290 | 3.11442 | 0.51469 | 1.10313 | 0.59036 | 0.61577 | -6.41 | 77 |
| Panel B: Market Model Beta Quartile Results | | | | | | | | | | | | | | | | |
| First Quartile | 87 | 1.73214 | 0.46680 | 0.72050 | 0.36712 | 0.39802 | -6.29 | 25 | 87 | 1.73214 | 0.46680 | 0.72050 | 0.45207 | 0.46572 | -1.93 | 20 |
| Second Quartile | 87 | 4.48703 | 0.45710 | 0.98962 | 0.40009 | 0.43231 | -7.59 | 37 | 87 | 4.48703 | 0.45710 | 0.98962 | 0.50972 | 0.51912 | -1.90 | 29 |
| Third Quartile | 87 | 4.05821 | 0.52102 | 1.18798 | 0.46470 | 0.50301 | -9.12 | 37 | 87 | 4.05821 | 0.52102 | 1.18798 | 0.59667 | 0.61530 | -3.35 | 23 |
| Fourth Quartile | 87 | 5.65392 | 0.59833 | 1.54852 | 0.53687 | 0.61723 | -9.77 | 40 | 87 | 5.65392 | 0.59833 | 1.54852 | 0.69592 | 0.76253 | -8.25 | 30 |
| Panel C: Unlevered Beta Quartile Results | | | | | | | | | | | | | | | | |
| First Quartile | 87 | 12.86330 | 0.58338 | 1.10687 | 0.07583 | 0.11842 | -7.04 | 55 | 87 | 12.80368 | 0.57568 | 1.08804 | 0.13046 | 0.17555 | -5.99 | 36 |
| Second Quartile | 87 | 1.78494 | 0.52082 | 1.01623 | 0.31146 | 0.37007 | -10.42 | 37 | 87 | 1.73403 | 0.52643 | 0.98168 | 0.44077 | 0.48300 | -6.87 | 33 |
| Third Quartile | 87 | 0.86668 | 0.45069 | 1.06330 | 0.52420 | 0.56869 | -8.00 | 25 | 87 | 0.89555 | 0.43998 | 1.06255 | 0.67244 | 0.68998 | -2.66 | 17 |
| Fourth Quartile | 87 | 0.41637 | 0.49053 | 1.26021 | 0.85792 | 0.89402 | -5.41 | 22 | 87 | 0.49805 | 0.50315 | 1.31435 | 1.01073 | 1.01414 | -0.52 | 16 |
| Panel D: Debt/Equity Ratio Quartile Results | | | | | | | | | | | | | | | | |
| First Quartile | 87 | 0.28535 | 0.48072 | 1.04439 | 0.79357 | 0.81337 | -5.26 | 13 | 87 | 0.28535 | 0.48072 | 1.04439 | 0.90109 | 0.88992 | 2.37 | 10 |
| Second Quartile | 87 | 0.85635 | 0.46143 | 1.09339 | 0.53696 | 0.59472 | -7.93 | 38 | 87 | 0.85635 | 0.46143 | 1.09339 | 0.70417 | 0.72624 | -3.46 | 25 |
| Third Quartile | 87 | 1.76175 | 0.52821 | 1.11516 | 0.34416 | 0.41191 | -10.91 | 36 | 87 | 1.76175 | 0.52821 | 1.11516 | 0.49113 | 0.54887 | -7.23 | 32 |
| Fourth Quartile | 87 | 13.07285 | 0.57487 | 1.19367 | 0.09409 | 0.13088 | -7.34 | 52 | 87 | 13.07285 | 0.57487 | 1.19367 | 0.15800 | 0.19763 | -6.40 | 35 |
| Panel E: CVDE Quartile Results | | | | | | | | | | | | | | | | |
| First Quartile | 87 | 2.74220 | 0.27353 | 1.00191 | 0.48710 | 0.50498 | -8.53 | 22 | 87 | 2.74220 | 0.27353 | 1.00191 | 0.60837 | 0.59879 | 2.58 | 21 |
| Second Quartile | 87 | 4.60001 | 0.38936 | 1.06190 | 0.43566 | 0.45866 | -11.31 | 25 | 87 | 4.60001 | 0.38936 | 1.06190 | 0.54530 | 0.55241 | -2.16 | 14 |
| Third Quartile | 87 | 5.37421 | 0.52021 | 1.18088 | 0.43720 | 0.48466 | -8.55 | 39 | 87 | 5.37421 | 0.52021 | 1.18088 | 0.55933 | 0.59423 | -5.34 | 24 |
| Fourth Quartile | 87 | 3.21488 | 0.86215 | 1.20193 | 0.40882 | 0.50226 | -11.51 | 53 | 87 | 3.21488 | 0.86215 | 1.20193 | 0.54139 | 0.61724 | -8.53 | 43 |
| Panel F: Partition on Significant/Insignificant F-Test Results | | | | | | | | | | | | | | | | |
| Significant F | 139 | 5.81473 | 0.59400 | 1.17799 | 0.33974 | 0.41423 | -12.58 | 139 | 102 | 5.01244 | 0.58560 | 1.17557 | 0.46651 | 0.53223 | -8.94 | 102 |
| Insignificant F | 209 | 2.76448 | 0.45631 | 1.06753 | 0.51034 | 0.53647 | -11.35 | 0 | 246 | 3.55591 | 0.48051 | 1.08515 | 0.60386 | 0.61490 | -3.27 | 0 |
| P-value [e] | - | 0.0000 | 0.0000 | 0.0023 | 0.0000 | 0.0003 | 0.0000 | - | - | 0.0722 | 0.0006 | 0.0209 | 0.0006 | 0.0351 | 0.0000 | - |

[a] $H_0$: Av ($\hat{\beta}_u$ - Impl $\hat{\beta}_u$) =0

[b] Number of cases in which the F-statistic suggests rejection of the unlevered beta restriction, $H_0$: $\gamma_i = b_i$

[c] Subset of All stocks in which primary SIC code is maintained across full sample period

[d] Subset of All stocks in which four-digit SIC code is maintained across full sample period

[e] P-value for the null hypothesis that the value of the given variable for the Significant F cases is different from the value for the Insignificant F cases

## Table 2
## Correlations between Key Variables and Tests of the Unlevered Beta Restriction for the Tax Adjusted Setting: Overall Aggregate and Quartile Results

This table reports the cross-sectional correlations between: (a) average debt/equity ratio and market model beta; (b) average debt/equity ratio and unlevered beta; (c) market model beta and unlevered beta; (d) market model beta and the coefficient of variation of the debt/equity ratio; (e) unlevered beta and the coefficient of variation of the debt/equity ratio; (f) average debt/equity ratio and the coefficient of variation of the debt/equity ratio.

| | Corr $(D/E, \hat{\beta}_{MM})$ | Corr $(D/E, \hat{\beta}_u)$ | Corr $(\hat{\beta}_{MM}, \hat{\beta}_u)$ | Corr. $(\hat{\beta}_{MM}$ CVDE) | Corr. $(\hat{\beta}_u$, CVDE) | Corr. (D/E, CVDE) |
|---|---|---|---|---|---|---|
| Panel A: Overall Results | | | | | | |
| All Stocks | 0.15796 | -0.63246 | 0.34041 | 0.19005 | -0.09333 | -0.00960 |
| Panel B: Market Model Beta Quartile Results | | | | | | |
| First Quartile | 0.16944 | -0.61586 | 0.38900 | -0.16482 | -0.16380 | -0.04805 |
| Second Quartile | 0.05874 | -0.80343 | 0.07196 | -0.13186 | -0.24440 | 0.06522 |
| Third Quartile | 0.04749 | -0.75785 | -0.00829 | -0.00275 | -0.20978 | -0.01143 |
| Fourth Quartile | -0.10184 | -0.69054 | 0.31637 | 0.17194 | -0.09110 | -0.11577 |
| Panel C: Unlevered Beta Quartile Results | | | | | | |
| First Quartile | 0.50905 | -0.62551 | -0.07826 | 0.06663 | -0.03405 | -0.30010 |
| Second Quartile | 0.79803 | -0.36455 | 0.12762 | 0.20779 | 0.03092 | 0.08521 |
| Third Quartile | 0.84456 | -0.27431 | 0.16119 | 0.31066 | 0.04945 | 0.18327 |
| Fourth Quartile | 0.52633 | -0.22720 | 0.66026 | 0.39091 | 0.19215 | 0.22937 |
| Panel D: Debt/Equity Ratio Quartile Results | | | | | | |
| First Quartile | 0.31578 | 0.07875 | 0.95300 | 0.03717 | 0.03134 | -0.19566 |
| Second Quartile | -0.04546 | -0.30659 | 0.93795 | 0.42083 | 0.30670 | 0.02402 |
| Third Quartile | 0.08646 | -0.37914 | 0.78892 | -0.01152 | -0.27494 | 0.02275 |
| Fourth Quartile | 0.15096 | -0.70539 | 0.27516 | 0.23631 | 0.16067 | -0.30691 |
| Panel E: CVDE Quartile Results | | | | | | |
| First Quartile | 0.19505 | -0.65434 | 0.36942 | 0.27951 | 0.04283 | 0.17673 |
| Second Quartile | 0.29293 | -0.69498 | 0.24350 | 0.05816 | 0.07275 | 0.00148 |
| Third Quartile | 0.00743 | -0.75247 | 0.35217 | 0.11021 | 0.12561 | -0.07101 |
| Fourth Quartile | 0.16855 | -0.45801 | 0.45569 | -0.03703 | -0.19828 | -0.03425 |
| Panel F: Partition on Significant/Insignificant F-Test Results | | | | | | |
| Significant F | 0.10623 | -0.57156 | 0.41704 | 0.11726 | -0.18492 | 0.00326 |
| Insignificant F | 0.17273 | -0.65817 | 0.35066 | 0.20130 | -0.00717 | -0.04422 |

# Table 3
## Results for Twelve Aggregate Industries in the Tax Adjusted Setting

This table reports the: Average Debt/Equity Ratio; Average Market Model Beta; Average Unlevered Beta; Average Implied Theoretical Unlevered Beta; the t-statistic for the null hypothesis that the mean difference between the Unlevered Beta and the Implied Unlevered Beta equals zero; the number of cases and percentage of the sample for which the unlevered beta restriction is rejected; and the cross-sectional correlations between: (a) average debt/equity ratio and market model beta; (b) average debt/equity ratio and unlevered beta; (c) market model beta and unlevered beta; (d) market model beta and the coefficient of variation of the debt/equity ratio; (e) unlevered beta and the coefficient of variation of the debt/equity ratio; and (f) average debt/equity ratio and the coefficient of variation of the debt/equity ratio.

| SIC Code | Industry Name | n | Ave D/E | Ave $\hat{\beta}_{MM}$ | Ave $\hat{\beta}_u$ | Ave Impl. $\hat{\beta}_u$ | t-stat [a] | Sig F | % Sig F | Corr $(D/E, \hat{\beta}_{MM})$ | Corr $(D/E, \hat{\beta}_u)$ | Corr $(\hat{\beta}_{MM}, \hat{\beta}_u)$ | Corr. $(\hat{\beta}_{MM}, CVDE)$ | Corr. $(\hat{\beta}_u, CVDE)$ | Corr. (D/E, CVDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13,29 | Petroleum | 23 | 1.86321 | 0.83735 | 0.38420 | 0.43266 | -3.89 | 9 | 39.1 | 0.48253 | -0.40696 | 0.53430 | 0.59807 | -0.23908 | 0.89498 |
| 60-65,67 | Finance and Real Estate | 74 | 13.94627 | 1.10533 | 0.18470 | 0.19674 | -3.45 | 22 | 29.7 | 0.57506 | -0.75872 | -0.40544 | -0.14411 | 0.31750 | -0.10812 |
| 30,36,37,50 | Consumer Durables | 52 | 1.10525 | 1.25494 | 0.79181 | 0.83511 | -5.04 | 17 | 32.7 | -0.00079 | -0.62804 | 0.72826 | 0.23290 | 0.05171 | 0.21828 |
| 10,14,24, 26,28,33 | Basic Industries | 54 | 0.95392 | 1.02924 | 0.68520 | 0.68834 | -0.33 | 9 | 16.7 | 0.22105 | -0.61526 | 0.59173 | 0.01571 | -0.19343 | 0.27062 |
| 1,20,21,54 | Food & Tobacco | 17 | 0.77573 | 0.90887 | 0.68142 | 0.66459 | 0.98 | 2 | 11.8 | 0.18935 | -0.51566 | 0.73147 | 0.29166 | 0.21222 | 0.14122 |
| 15,16,32 | Construction | 10 | 2.52617 | 1.24512 | 0.53462 | 0.59516 | -2.21 | 5 | 50.0 | 0.19396 | -0.79873 | 0.24151 | 0.35639 | -0.26146 | 0.19990 |
| 34,35,38 | Capital Goods | 56 | 1.29424 | 1.15424 | 0.68289 | 0.72369 | -4.33 | 17 | 30.4 | 0.07727 | -0.59351 | 0.68358 | 0.28127 | -0.11293 | 0.47730 |
| 40,42,44,45 | Transportation | 11 | 2.24167 | 1.37331 | 0.58252 | 0.65115 | -4.06 | 6 | 54.5 | 0.53796 | -0.79038 | 0.04766 | 0.32532 | -0.60291 | 0.67465 |
| 48,49 | Utilities | 10 | 1.99875 | 0.87210 | 0.43017 | 0.44010 | -0.73 | 4 | 40.0 | 0.10598 | -0.58881 | 0.66435 | 0.21292 | 0.31720 | 0.05362 |
| 22,23, 31,51,56 | Textiles &Trade | 15 | 1.55417 | 1.15315 | 0.59334 | 0.64544 | -2.10 | 4 | 26.7 | 0.04671 | -0.70116 | 0.61113 | 0.19669 | -0.21045 | 0.47665 |
| 73,80,82 | Services | 6 | 1.06054 | 1.35391 | 0.79301 | 0.83607 | -1.62 | 2 | 33.3 | 0.57727 | -0.20006 | 0.67175 | 0.64743 | 0.45324 | 0.26262 |
| 27,58 | Leisure | 10 | 1.06054 | 1.19429 | 0.94354 | 0.93862 | 0.35 | 2 | 20.0 | 0.22701 | -0.83936 | 0.31525 | -0.13634 | 0.09959 | -0.12989 |

[a] $H_0$: Av ($\hat{\beta}_u$ - Impl $\hat{\beta}_u$) =0

# Table 4
## Results for Selected Two-Digit SIC Industries in the Tax Adjusted Setting

This table reports the: Average Debt/Equity Ratio; Average Market Model Beta; Average Unlevered Beta; Average Implied Theoretical Unlevered Beta; the t-statistic for the null hypothesis that the mean difference between the Unlevered Beta and the Implied Unlevered Beta equals zero; the number of cases and percentage of the sample for which the unlevered beta restriction is rejected; and the cross-sectional correlations between: (a) average debt/equity ratio and market model beta; (b) average debt/equity ratio and unlevered beta; (c) market model beta and unlevered beta; (d) market model beta and the coefficient of variation of the debt/equity ratio; (e) unlevered beta and the coefficient of variation of the debt/equity ratio; and (f) average debt/equity ratio and the coefficient of variation of the debt/equity ratio.

| SIC Code | Industry Name | n | Ave D/E | Ave $\hat{\beta}_{MM}$ | Ave $\hat{\beta}_u$ | Ave Impl. $\hat{\beta}_u$ | t-stat[a] | Sig F | % Sig F | Corr (D / E, $\hat{\beta}_{MM}$) | Corr (D / E, $\hat{\beta}_u$) | Corr ($\hat{\beta}_{MM}$, $\hat{\beta}_u$) | Corr. ($\hat{\beta}_{MM}$ CVDE) | Corr. ($\hat{\beta}_u$, CVDE) | Corr. (D/E, CVDE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | Food and Kindred Products | 10 | 0.59282 | 0.86580 | 0.68729 | 0.65036 | 4.24 | 0 | 0.0 | 0.57567 | -0.40853 | 0.49906 | -0.29170 | 0.34948 | -0.57567 |
| 28 | Chemicals and Allied Products | 27 | 0.78501 | 1.00602 | 0.71148 | 0.71405 | -0.16 | 3 | 11.1 | 0.07275 | -0.68967 | 0.64938 | 0.08732 | -0.42596 | -0.21070 |
| 29 | Petroleum Refining and Related Industry | 16 | 1.47430 | 0.76928 | 0.37845 | 0.40970 | -2.42 | 7 | 43.8 | 0.59973 | -0.03401 | 0.77183 | 0.32730 | 0.08251 | 0.17477 |
| 33 | Primary Metal Industries | 11 | 1.33806 | 0.97123 | 0.58870 | 0.57856 | 0.94 | 1 | 9.1 | -0.18187 | -0.69077 | 0.79623 | 0.36471 | -0.05624 | -0.28630 |
| 34 | Fabricated Metal (Excluding Machinery, Transport Equipment) | 11 | 0.92460 | 1.05886 | 0.67835 | 0.71279 | -1.61 | 4 | 36.4 | 0.31287 | -0.47924 | 0.67164 | 0.41674 | -0.16813 | 0.82968 |
| 35 | Industrial Commercial Machinery, Computer Equipment | 30 | 1.65661 | 1.09819 | 0.57157 | 0.62449 | -3.86 | 8 | 26.7 | 0.18754 | -0.64482 | 0.52652 | 0.03902 | -0.16073 | 0.23121 |
| 36 | Electrical, Other Electrical Equipment (Excluding computers) | 19 | 0.61880 | 1.30075 | 0.91628 | 0.96018 | -3.25 | 7 | 36.8 | 0.21033 | -0.29577 | 0.86427 | -0.15900 | -0.13057 | 0.10567 |
| 37 | Transportation Equipment | 20 | 1.65444 | 1.31979 | 0.71482 | 0.77326 | -3.61 | 8 | 40.0 | -0.08883 | -0.68599 | 0.73608 | 0.05181 | 0.11023 | 0.17773 |
| 38 | Measurement Instrument, Photo goods, watches | 15 | 0.84246 | 1.33626 | 0.90888 | 0.93009 | -1.40 | 5 | 33.3 | -0.04225 | -0.57352 | 0.81845 | 0.42851 | 0.16860 | 0.31878 |
| 60 | Depository Institutions | 48 | 18.4221 | 1.16743 | 0.09083 | 0.10411 | -11.38 | 15 | 31.3 | 0.34488 | -0.69176 | 0.37851 | 0.03607 | 0.01045 | -0.20640 |
| 63 | Insurance Carriers | 11 | 4.96168 | 0.93561 | 0.28287 | 0.28302 | -0.01 | 2 | 18.2 | 0.03693 | -0.92816 | 0.03239 | -0.04760 | -0.17346 | -0.24880 |
| ALL | | 348 | 3.98282 | 1.11160 | 0.56360 | 0.59067 | -7.79 | 102 | 29.3 | 0.15796 | -0.63246 | 0.34041 | 0.19005 | -0.09333 | -0.00960 |

[a] $H_0$: Av ($\hat{\beta}_u$ - Impl $\hat{\beta}_u$) =0

**Table 5**

**Results for the Chemicals and Allied Products Industry (SIC 28) in the Tax Adjusted Setting**

This table reports the: Average Debt/Equity Ratio; Average Market Model Beta; Average Unlevered Beta; Average Implied Theoretical Unlevered Beta and Average Coefficient of Variation of the Debt/Equity Ratio. The number of cases and percentage of the sample for which the unlevered beta restriction is rejected, are reported in the final two columns.

| SIC Code | Industry Name | n | Ave D/E | Ave $\hat{\beta}_{MM}$ | Ave $\hat{\beta}_u$ | Ave Impl. $\hat{\beta}_u$ | Ave CVDE | Sig F | % (Sig F) |
|---|---|---|---|---|---|---|---|---|---|
| 2800 | Chemical & Allied Prods | 3 | 1.09221 | 1.03696 | 0.65843 | 0.62657 | 0.28785 | 0 | 0.0 |
| 2810 | Indl Inorganic Chemicals | 2 | 1.50817 | 0.96650 | 0.47573 | 0.49744 | 0.62905 | 0 | 0.0 |
| 2821 | Plastics, Resins, Elastomers | 3 | 1.08823 | 1.27730 | 0.80136 | 0.80002 | 0.45101 | 0 | 0.0 |
| 2834 | Pharmaceutical Preparations | 6 | 0.30834 | 0.94150 | 0.84468 | 0.79431 | 0.42599 | 1 | 16.7 |
| 2844 | Perfume, Cosmetic, Toilet Prep | 3 | 0.94004 | 0.77156 | 0.47215 | 0.50747 | 0.50874 | 0 | 0.0 |
| 2851 | Paints, Varnishes, Lacquers | 1 | 0.60150 | 1.26000 | 0.92328 | 0.92586 | 0.41683 | 0 | 0.0 |
| 2860 | Industrial Organic Chemicals | 4 | 0.90809 | 1.05589 | 0.69279 | 0.70406 | 0.46316 | 1 | 25.0 |
| 2890 | Misc Chemical Products | 5 | 0.54673 | 0.96795 | 0.74005 | 0.79487 | 0.60826 | 1 | 20.0 |
| 28 | Chemicals and Allied Products | 27 | 0.78501 | 1.00602 | 0.71148 | 0.71405 | 0.47658 | 3 | 11.1 |

**Table 6**

**Results for the Industrial Commercial Machinery and Computer Equipment Industry (SIC 35) in the Tax Adjusted Setting**

This table reports the: Average Debt/Equity Ratio; Average Market Model Beta; Average Unlevered Beta; Average Implied Theoretical Unlevered Beta and Average Coefficient of Variation of the Debt/Equity Ratio. The number of cases and percentage of the sample for which the unlevered beta restriction is rejected, are reported in the final two columns.

| SIC Code | Industry Name | n | Ave D/E | Ave $\hat{\beta}_{MM}$ | Ave $\hat{\beta}_u$ | Ave Impl. $\hat{\beta}_u$ | Ave CVDE | Sig F | % (Sig F) |
|---|---|---|---|---|---|---|---|---|---|
| 3510 | Engines and Turbines | 2 | 1.40853 | 1.37566 | 0.74821 | 0.77746 | 0.41550 | 0 | 0.0 |
| 3523 | Farm Machinery & Equipment | 2 | 3.43380 | 0.99524 | 0.25593 | 0.34241 | 0.52427 | 1 | 50.0 |
| 3530 | Constr, Mining, Matl Handle Eq | 1 | 0.23804 | 1.02490 | 0.94507 | 0.89682 | 0.24306 | 1 | 100.0 |
| 3531 | Construction Machinery & Eq | 3 | 1.37237 | 1.18238 | 0.60134 | 0.64196 | 0.67180 | 0 | 0.0 |
| 3537 | Indl Trucks, Tractors, Trailrs | 1 | 4.49754 | 0.81382 | 0.14819 | 0.22004 | 0.50719 | 1 | 100.0 |
| 3540 | Metalworking Machinery & Eq | 2 | 1.23542 | 0.90101 | 0.50548 | 0.55519 | 0.44696 | 0 | 0.0 |
| 3541 | Machine Tools, Metal Cutting | 2 | 0.72290 | 1.17889 | 0.82278 | 0.83372 | 0.40158 | 0 | 0.0 |
| 3559 | Special Industry Machy, NEC | 2 | 1.26538 | 0.98709 | 0.54544 | 0.58647 | 0.46137 | 0 | 0.0 |
| 3560 | General Industrial Mach & Eq | 2 | 1.39593 | 1.25697 | 0.60464 | 0.70697 | 0.45292 | 1 | 50.0 |
| 3561 | Pumps & Pumping Equipment | 2 | 0.95742 | 0.74683 | 0.46369 | 0.48798 | 0.48617 | 0 | 0.0 |
| 3562 | Ball & Roller Bearings | 1 | 0.72031 | 0.85610 | 0.57627 | 0.59776 | 0.39309 | 0 | 0.0 |
| 3567 | Indl Process Furnaces, Ovens | 1 | 2.06630 | 1.45902 | 0.48715 | 0.65141 | 0.61598 | 1 | 100.0 |
| 3569 | General Indl Mach & Eq, NEC | 1 | 5.03044 | 1.16510 | 0.14238 | 0.28995 | 1.13623 | 1 | 100.0 |
| 3570 | Corp Computer & Office Equipmt | 2 | 1.50701 | 0.92353 | 0.43768 | 0.49070 | 1.10900 | 1 | 50.0 |
| 3571 | Electronic Computers | 1 | 0.22273 | 1.69139 | 1.50597 | 1.49201 | 0.78227 | 0 | 0.0 |
| 3578 | Calculate, Acct Mach, Ex Comp | 1 | 0.20906 | 0.65414 | 0.56622 | 0.58123 | 0.36237 | 0 | 0.0 |
| 3579 | Office Machines, NEC | 1 | 0.94963 | 1.24654 | 0.81642 | 0.79409 | 0.36924 | 0 | 0.0 |
| 3585 | Air Cond, Heating, Refrig Eq | 3 | 2.58864 | 1.25239 | 0.46259 | 0.57456 | 0.58603 | 1 | 33.3 |
| 35 | Industrial Commercial Machinery, Computer Equipment | 30 | 1.65661 | 1.09819 | 0.57157 | 0.62449 | 0.55928 | 8 | 26.7 |

**Table 7**
**Results for the Transportation Equipment Industry (SIC 37) in the Tax Adjusted Setting**

This table reports the: Average Debt/Equity Ratio; Average Market Model Beta; Average Unlevered Beta; Average Implied Theoretical Unlevered Beta and Average Coefficient of Variation of the Debt/Equity Ratio. The number of cases and percentage of the sample for which the unlevered beta restriction is rejected, are reported in the final two columns.

| SIC Code | Industry Name | n | Ave D/E | Ave $\hat{\beta}_{MM}$ | Ave $\hat{\beta}_u$ | Ave Impl. $\hat{\beta}_u$ | Ave CVDE | Sig F | % (Sig F) |
|---|---|---|---|---|---|---|---|---|---|
| 3711 | Motor Vehicles & Car Bodies | 3 | 3.59855 | 1.18278 | 0.37506 | 0.45432 | 0.71413 | 2 | 66.7 |
| 3714 | Motor Vehicle Part, Accessory | 7 | 1.32831 | 1.31090 | 0.71515 | 0.76981 | 0.51256 | 3 | 42.9 |
| 3716 | Motor Homes | 1 | 0.78056 | 2.11869 | 1.22573 | 1.44292 | 0.58158 | 1 | 100.0 |
| 3721 | Aircraft | 4 | 1.35021 | 1.22324 | 0.73838 | 0.80813 | 0.64020 | 2 | 50.0 |
| 3724 | Aircraft Engine, Engine Parts | 2 | 1.11665 | 1.23994 | 0.77492 | 0.76038 | 0.39685 | 0 | 0.0 |
| 3728 | Aircraft Parts, Aux Eq, NEC | 3 | 1.52681 | 1.39322 | 0.81205 | 0.83914 | 0.41354 | 0 | 0.0 |
| 37 | Transportation Equipment | 20 | 1.65444 | 1.31979 | 0.71482 | 0.77326 | 0.54535 | 8 | 40.0 |

**Table 8**
**Results for the Depository Institutions Industry (SIC 60) in the Tax Adjusted Setting**

This table reports the: Average Debt/Equity Ratio; Average Market Model Beta; Average Unlevered Beta; Average Implied Theoretical Unlevered Beta and Average Coefficient of Variation of the Debt/Equity Ratio. The number of cases and percentage of the sample for which the unlevered beta restriction is rejected, are reported in the final two columns.

| SIC Code | Industry Name | n | Ave D/E | Ave $\hat{\beta}_{MM}$ | Ave | Ave Impl. $\hat{\beta}_u$ | Ave CVDE | Sig F | % (Sig F) |
|---|---|---|---|---|---|---|---|---|---|
| 6021 | National Commercial Banks | 30 | 19.77800 | 1.16129 | 0.08417 | 0.09787 | 0.42618 | 7 | 23.3 |
| 6022 | State Commercial Banks | 17 | 16.14320 | 1.13113 | 0.09710 | 0.11063 | 0.48854 | 8 | 47.1 |
| 6035 | Savings Instn, Fed Chartered | 1 | 16.48900 | 1.96881 | 0.18387 | 0.18073 | 0.60818 | 0 | 0.0 |
| 60 | Depository Institutions | 48 | 18.42215 | 1.16743 | 0.09083 | 0.10411 | 0.45205 | 15 | 31.3 |

## Table 9
## Tests of Equality of Unlevered Beta within Selected Four-Digit SIC Industries

This table reports, for a given four-digit industry grouping, the lowest value of the unlevered betas (t-statistic in parentheses), the highest value of the unlevered betas (t-statistic in parentheses) and the test of equality of unlevered betas across the industry grouping (p-value in parentheses).

| Four-Digit SIC Industry | n | No Taxes Setting: Low Unlevered Beta | No Taxes Setting: High Unlevered Beta | No Taxes Setting: Wald Test $H_0: \beta_{u1} = \beta_{u2} = ... = \beta_{un}$ | Tax-Adjusted Setting: Low Unlevered Beta | Tax-Adjusted Setting: High Unlevered Beta | Tax-Adjusted Setting: Wald Test $H_0: \beta_{u1} = \beta_{u2} = ... = \beta_{un}$ |
|---|---|---|---|---|---|---|---|
| 1400: Quarry Non-Metal Minerals | 5 | 0.32368 (1.76) | 0.97912 (2.96) | 5.67050 (0.225) | 0.43162 (1.95) | 1.05303 (3.03) | 4.04791 (0.400) |
| 2834: Pharmaceutical Preparations | 6 | 0.56682 (5.85) | 0.88768 (7.48) | 14.5324 (0.013) | 0.65416 (6.03) | 0.99067 (7.46) | 14.4914 (0.013) |
| 2890: Miscellaneous Chemical Products | 5 | -0.07960 (-0.84) | 1.06597 (7.69) | 63.1101 (0.000) | -0.08702 (-0.64) | 1.14852 (7.65) | 45.31636 (0.000) |
| 2911: Petroleum Refining | 16 | 0.00408 (0.10) | 0.66632 (7.43) | 115.301 (0.000) | 0.02609 (0.44) | 0.82046 (7.37) | 104.9029 (0.000) |
| 3714: Motor Vehicle Part Accessory | 7 | 0.21579 (3.36) | 0.90339 (4.94) | 43.0574 (0.000) | 0.34325 (3.69) | 1.00259 (5.06) | 34.8993 (0.000) |
| 6021: National Commercial Banks | 30 | 0.01531 (2.70) | 0.08564 (5.34) | 191.883 (0.000) | 0.02128 (1.47) | 0.14256 (5.63) | 186.022 (0.000) |
| 6022: State Commercial Banks | 17 | 0.02699 (2.73) | 0.07487 (5.64) | 62.4799 (0.000) | 0.04389 (2.82) | 0.12724 (5.91) | 61.5396 (0.000) |
| 6331: Fire, Marine, Casualty Insurance | 7 | 0.05145 (1.23) | 0.34345 (8.33) | 30.1722 (0.000) | 0.07861 (1.29) | 0.47201 (8.39) | 26.8848 (0.000) |
| 6798: Real Estate Investment Trusts | 5 | 0.35701 (5.33) | 0.66786 (5.07) | 7.85329 (0.097) | 0.44390 (5.31) | 0.70441 (5.04) | 5.22378 (0.265) |