Using Microsoft Corporation to Demonstrate the Optimal Capital Structure Trade-off Theory

John C. Gardner, Carl B. McGowan Jr., and Susan E. Moeller[1]

ABSTRACT

In this paper, we apply the trade-off theory of capital structure to Microsoft. We use data for bond ratings, bond risk premiums, and levered CAPM betas to compute the cost of equity and the weighted average cost of capital for Microsoft at different debt levels. This study shows the impact of increasing financial leverage on WACC. As financial leverage increases, the WACC decreases until the optimal debt ratio is reached, after which, the WACC begins to rise. At this debt ratio, the value of Microsoft will be maximized. Our results indicate the optimal debt ratio for Microsoft is 37.5 percent.

Introduction

One of the most difficult concepts for finance students to learn and for faculty to teach is how a firm determines its optimal capital structure. While most corporate finance textbooks stress the importance of maximizing the value of the firm by minimizing its opportunity cost of capital, how a firm can actually achieve the appropriate debt–to–capital ratio is often a mystery. Brigham and Ehrhardt (2008) in *Financial Management: Theory and Practice* outline a framework that can be used by financial practitioners to determine a firm's optimal capital structure. Modigliani and Miller (1958 and 1963) provide the basis for the trade-off theory which is how firms can conceptually determine their optimal capital structure. What is lacking in these expositions, however, is a systematic demonstration of the process through which an actual corporation might apply these concepts. This paper provides such a demonstration.

According to the trade-off theory of financial leverage, a firm's weighted average cost of capital (WACC) at first decreases as debt is added to its capital structure due to the tax benefit of acquiring debt. Although a firm's costs of debt and equity at first increase as it raises the proportion of debt in its capital structure, the overall WACC will decrease over this initial range as the tax benefit outweighs the negative impact of the increases in the component costs of the WACC. At a certain level of financial leverage, however, the tax benefit will no longer provide a sufficient advantage to overcome the rising costs of debt and equity. Past a certain debt ratio, the market will demand a yet higher interest rate and cost of equity as the market perceives that the firm's risk of bankruptcy is increasing because of the firm's rising debt load. Consequently, after this point of financial leverage, the firm's WACC begins to increase. At the point where a firm's WACC is minimized, the firm's value is maximized, a relationship which can be demonstrated using simple algebra.

In this study, we provide an empirical demonstration of the trade-off theory of financial leverage using Microsoft Corporation, a company that has had no long-term debt in its capital structure since its inception thirty years ago (the capital structure is 100 percent equity)[2]. We show how, in principle, Microsoft Corporation could maximize the firm's value by increasing its financial leverage. Application of the theory involves calculating the firm's weighted average cost of capital under different financial leverage scenarios using actual market information to determine Microsoft's costs of debt and equity as financial leverage increases.

---

[2] For an empirical explanation of why companies choose to be debt free see Gardner and Trzcinka (1992).

The next section illustrates how the WACC of Microsoft can be calculated and used in conjunction with the trade-off theory to determine its optimal capital structure. To maximize its market value, Microsoft would continue to increase its debt ratio until the WACC is minimized.

Calculating the Optimal Capital Structure for Microsoft Corporation

Determining the Cost of Debt as Financial Leverage Increases

Assuming that the bond market is efficient in determining the risk of a firm's debt allows the use of the yield to maturity of a firm's new bond issues as a proxy for a firm's cost of debt. Of course, the firm's debt ratio is not the only factor that changes as a firm's bond rating decreases. The models used by bond rating agencies are more complex and include numerous factors, all of which deteriorate as the riskiness of the firm increases. We use the debt ratio alone as a proxy for these various effects.

Table 1 is derived from S&P (2006) and Damodaran (2008) and shows the average debt ratio and interest rate for each S&P rating from AAA to B. Using *Standard and Poor's Ratings and Ratios* (2006, page 54), we can estimate the yield to maturity or the cost of debt for Microsoft Corporation by using the *pro forma* bond rating for each level of financial leverage. Table 1 provides the average total debt ratios for six different categories of bond ratings from AAA to B. The bond ratings and total debt ratio data are taken from the average total debt ratio for bonds for a corporation with an AAA bond rating. As Table 1 show, the debt ratio for a company with an AAA bond rating is 0.124 or 12.4 percent. Otherwise stated, manufacturing corporations with a bond rating of AAA, on average, have 12.4 percent of total assets financed with debt. At the other end of the spectrum, the average total debt ratio for bonds for a corporation with a B bond rating is 0.758 or 75.8 percent, reflecting the tendency for a manufacturing corporation's bond rating to decrease as it increases the amount of financial leverage in the capital structure.

Table 1 (Row1) shows the total debt ratio of the firm for each of the six categories of bond ratings considered. Table 1 (Row 2) provides the average yield to maturity on debt for the six different categories of bond ratings from AAA to B. The bond yields are calculated using the bond yield spread for each category of bond rating taken from Damodaran (2008)[3] plus the Treasury bond rate taken from *Stocks, Bonds, Bills and Inflation* (2007). The yield for bonds for a corporation with an AAA bond rating is 4.15 percent and increases to 9.05 percent for a firm with a B bond rating. Clearly, as a manufacturing corporation increases the amount of financial leverage in the capital structure, the bond rating deteriorates and the cost of debt increases.

Table 1 Debt Ratios and Interest Rates for S&P Debt Ratings							
Row	Bond Rating	AAA	AA	A	BBB	BB	B
1	TD/(TD+E)*	0.124	0.283	0.375	0.425	0.537	0.758
2	Yield (%)*	4.150	4.650	4.900	5.900	7.050	9.050
*Debt ratios taken from S&P and corresponding yields from Damodaran (2008)							

Determining the Cost of Equity as Financial Leverage Increases

As a first step in determining the impact of increased financial leverage on the cost of capital of Microsoft Corporation, the firm's cost of equity is determined by re-leveraging the firm's beta. Graham and Harvey (2001) report that 73.5 percent of respondents in a survey of 392 respondents indicate that their company uses the Capital Asset Pricing Model (CAPM) to determine the marginal cost of common stock equity capital or expected rate of return of common stock equity. In keeping with this confirmation of the empirical relevance of the CAPM, the cost of equity for Microsoft Corporation is calculated using the Security Market Line (SML).

---

[3] http://pages.stern.nyu.edu/~adamodar/

$$k_e = k_f + \beta_{MS}(k_m - k_f)$$

where

        k_e = the estimated cost of equity for the Microsoft Corporation
        k_f = the risk free rate of return
        k_m = the return on the market
        β_{MS} = beta of Microsoft Corporation
        $(k_m - k_f)$ = the equity risk premium

As the foregoing SML equation indicates, the required rate of return on equity equals the risk-free rate of return plus a risk premium. The risk premium is determined by the amount of risk, measured by beta, and the market price of risk, which is equal to the expected rate of return on the market minus the risk-free rate.

Determining the Effect of Leverage on Beta as Financial Leverage Increases

The beta for Microsoft Corporation at various levels of financial leverage is determined using the Hamada (1969) beta formula, which adjusts the unlevered beta by adding the impact of debt to determine the re-levered equity beta. The Hamada (1969) formula for computing the impact on beta of increasing leverage is

$$\beta_{equity} \quad = \quad [1+(1-t)(D/E)]^* \, \beta_{unlevered}$$

where,

        β_{equity} = the beta coefficient for Microsoft adjusted for financial leverage
        $\beta_{unlevered}$ = the beta coefficient for Microsoft with no financial leverage
        t = the marginal tax rate for Microsoft
        D = the market value of debt for Microsoft
        E = the market value of equity for Microsoft
        D/E = the debt to equity ratio for Microsoft

Table 2 shows the impact of financial leverage on the beta for the Microsoft Corporation. As financial leverage increases, the beta coefficient of Microsoft increases. Per *Yahoo Finance*, the September 2008 beta for Microsoft was 1.36, using no debt in its capital structure.

	Table 2 Relevered Betas Microsoft						
1	Unlevered Beta	1.36					
2	Bond Rating	No Debt	AAA	AA	A	BBB	BB	B
3	Debt/Equity	0.000	0.142	0.395	0.600	0.739	1.160	3.132
4	Re-Levered Beta	1.360	1.485	1.709	1.890	2.013	2.385	4.129

The Hamada formula shows that the Microsoft Corporation beta rises from 1.36 with no debt to 4.129 with sufficient debt to reduce the bond rating from AAA to B. In conjunction with Table 1, showing that as the debt ratio rises from 12.4 percent to 75.8 percent, the firm's yield to maturity rises from 4.15 percent to 9.05 percent, these results support the financial theory that as a firm's risk increases with increases in the debt ratio and that the cost of debt rises accordingly.

Determining the Required Rate of Return for Equity for Microsoft Corporation

Having demonstrated the effects of increased risk on the cost of debt, we now turn to the cost of equity. In this part of the exercise, we use publicly available information to estimate the variables required by the CAPM to calculate Microsoft Corporation's cost of equity. A beta of 1.36 with zero debt is used for Microsoft Corporation as reported by *Yahoo! Finance* at the end September 2008. Table 3 shows the computation of the required rates of return for equity using the re-levered betas and market yield data from SBBI (2007). The risk-free rate as of September 2008 was 4.14 percent,[4] which is the average rate for each

---

[4] http://www.federalreserve.gov/releases/h15/data/Monthly/H15_TCMNOM_Y20.txt

calendar day in the month for the 15-year Treasury bond rate, taken from the Federal Reserve website. Data from the *Stocks, Bonds, Bills, and Inflation, Market Results for 1926 -2006, 2007 Yearbook*, published by Morningstar are used to estimate the market risk premium. The appropriate market risk premium is 6.5 percent, which is the difference between the average annual long-term government bond (risk-free) rate of 5.8 percent and the average annual market return. The proxy for the market return is the return of a portfolio of large capitalization stocks measured by the S&P Composite Index, is equal to 12.3 percent. Both are averages for the period 1926 through 2006.

Table 3 Computing Require Rate of Return for Equity Microsoft							
Bond Rating	No Debt	AAA	AA	A	BBB	BB	B
1 Rf	4.14%	4.14%	4.14%	4.14%	4.14%	4.14%	4.14%
2 Rm-Rf	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%
3 Beta	1.360	1.485	1.709	1.890	2.013	2.385	4.129
4 CAPM Required ROR	12.98%	13.79%	15.25%	16.43%	17.23%	19.64%	30.98%

Using the above estimates in the CAPM and given that the current beta for Microsoft is 1.36, with no debt, we estimate the firm's cost of equity as follows:

$$k_e \ = \ 4.14\% \ + \ 1.36 \ (\ 6.5 \ \% \ ) = \ 12.98\%$$

From the above equation, we can easily see that with no long-term debt in its capital structure, Microsoft's cost of equity (k_e) and WACC are the same at 12.98 percent. In addition, as shown in Table 3, the cost of equity rises as the added risk associated with increased debt causes beta to rise as determined by the Hamada equation. At a bond rating of B, the CAPM required rate of return is 30.98 percent.

Determining the Weighted Average Cost of Capital for Microsoft

Figure 1 shows the steps involved in calculating the weighted average cost of capital for a company. The calculation of the WACC begins with the determination of the market values of the firm's debt and equity. The market value of debt (D) can be determined by multiplying the number of bonds outstanding time the price per bond, and the market value of equity (*E*) by multiplying the number of shares of stock outstanding by the price per share. The weights are calculated as the market value of each component divided by the total value of the firm, *D + E*. The yield to maturity for the bonds is the YTM on newly issued bonds and the required rate of return is calculated using beta and the security market line.

To calculate the WACC for Microsoft in the simulation in this paper, the sequence is modified, without changing the logic of the valuation process. We begin the process of calculating the WACC for Microsoft by determining the debt ratio at each bond rating value from S&P and the YTM from Damodaran (2008). These data appear in Table 4. This table presents hypothetical parameters such as the tax rate and estimates of the variables needed to calculate the weighted average cost of capital for various debt ratios and corresponding bond ratings ranging from AAA to B. Following the standard textbook approach, we assume that as additional debt is issued, the proceeds from the sale of new bonds are used to repurchase Microsoft equity in the open market.

Table 4 combines the data from Tables 1 to 3 and follows the process set forth in Figure 1 to compute the weighted average cost of capital (WACC). The values in Row 1 represent the cost of debt at each bond rating, Row 2 the tax rate assumed for Microsoft, Row 3 the cost of debt adjusted for taxes, Row 4 the total debt ratio, and Row 5 the market value weighted component cost of debt after taxes. Row 6 is the CAPM required rate of return for equity, Row 7 the total equity ratio, and Row 8 the market value weighted component cost of equity. Finally, Row 9 presents the weighted average cost of capital, derived by adding the market value weighted component cost of debt after taxes (Row 5) and the market value weighted component cost of equity (Row 8).

	Table 4							
	Computing WACC							
	Microsoft							
	Bond Rating	No Debt	AAA	AA	A	BBB	BB	B
1	Cost of Debt	0.00%	4.15%	4.65%	4.90%	5.90%	7.05%	9.05%
2	Tax Rate (%)	35%	35%	35%	35%	35%	35%	35%
3	Cost of debt times (1-tax)	0.00%	2.70%	3.02%	3.19%	3.84%	4.58%	5.88%
4	Total Debt/(TD + TE) (%)	0.000	0.124	0.283	0.375	0.425	0.537	0.758
5	Wd*Kd(1-tax)	0.00%	0.33%	0.86%	1.19%	1.63%	2.46%	4.46%
6	CAPM Required ROR	12.98%	13.79%	15.25%	16.43%	17.23%	19.64%	30.98%
7	Total Equity/(TD+TE) (%)	1.000	0.876	0.717	0.625	0.575	0.463	0.242
8	Ws*Ks	12.98%	12.08%	10.93%	10.27%	9.91%	9.10%	7.50%
9	WACC	12.98%	12.42%	11.79%	11.46%	11.54%	11.56%	11.96%

Reviewing the final results of our computations, reported in Row 9 of Table 4, we can observe the behavior of the WACC as Microsoft's debt ratio increases from zero percent (AAA bond rating) to 75.8 percent (B rating). The WACC at each possible bond rating is computed using the expression

$$\textbf{WACC} = \textbf{w}_d\textbf{k}_d\textbf{(1-t)} + \textbf{w}_e\textbf{(k}_e\textbf{)}$$

computed in the table as

$$\textbf{WACC} = \textbf{(Row 4) x (Row 1) x (1-Row 2) + (Row 7) x (Row 6)}$$
$$= \textbf{(Row 5) + (Row 8).}$$

For example, with a debt level corresponding to an A bond rating, the cost of capital is computed as follows:

$$\textbf{WACC} = \textbf{(.375) x (4.90\%) x (1-.35) + (.625) x (16.43\%)}$$
$$= \textbf{(1.19\%) + (10.27\%) = 11.46\%.}$$

As the figures in Table 4 illustrate, the WACC decreases as the amount of debt increases, reaching a minimum of 11.46 percent with an A bond rating and a debt ratio of 0.375. As the debt ratio increases beyond this point, the WACC rises, indicating that 0.375 is the optimal debt ratio.

To bring the patterns in Table 4 into sharper relief, Figure 2 presents the results graphically. From the outset, the costs of equity and debt rise as the amount of financial leverage employed increases. Although the component costs rise, the WACC at first decreases due to the increasing proportion of debt in the capital structure until an A rating is reached, after which the WACC rises. Clearly this pattern is consistent with the predictions of the trade-off theory of optimizing a firm's capital structure and identifies 0.375 as the optimal debt ratio of this firm.

Determining the Market Value of Microsoft as Financial Leverage Increases

As noted earlier, the trade-off theory of capital structure predicts that the market value of the firm moves inversely to the WACC. This relationship is reflected in Table 5, which shows the computations used to estimate the value of Microsoft using the simulated WACC at each bond rating level. The Row 1 values are the net cash flows of Microsoft assuming zero debt. These cash flow estimates are the product of the firm's market value as of September 30, 2009, and Microsoft's estimated required rate of return as of that date. Numerically, this value equals $30,938 million and is determined by multiplying $238,348 million times 0.1298, taken from Table 4, Row 9. Given the free cash flows, we can compute the value of the firm using the WACC. The values of the WACC, taken from the last Row of Table 4, appear in Row 2 of Table 5. The value of the firm in Row 3 of Table 5 is the value of free cash flow in Row 1 divided by

the WACC in Row 2. The figures in the third row represent the value of the firm, used to determine the optimal amount of leverage.

	Table 5 Microsoft Computing Market Value							
	Variable	Zero Debt	AAA	AA	A	BBB	BB	B
1	NCF (Zero)	30938	30938	30938	30938	30938	30938	30938
2	WACC	12.98%	12.42%	11.79%	11.46%	11.54%	11.56%	11.96%
3	Value of the firm*	238348	249145	262446	269923	268196	267715	258771
	*Value of the firm = NCF/WACC, the present value of the firm's future cash flows. NCF(Zero) and Value of the firm are in millions of dollars.							

The total value of Microsoft, computed as the present value of the firm's net cash flows with zero growth, is maximized when the firm reaches a debt level of 37.5 percent, corresponding to an A level bond rating. The value of Microsoft at this level is $269,923 million. As indicated in Table 4, this is also the amount of leverage at which the WACC is minimized, at 11.46 percent. This correspondence between the optimal debt ratio indicated by the WACC and the value of the firm conforms to the prediction of financial leverage trade-off theory.

Summary and Conclusions

In this paper, we demonstrate how the trade-off theory of capital structure can be applied to an actual corporation, Microsoft. We do so using empirical data taken from categories of bond ratings, risk premiums for different bond ratings, and levered betas to compute the cost of equity and finally the weighted average cost of capital for Microsoft at different debt levels.

The results of this analysis show the impact of increasing financial leverage in the capital structure, which allows us to determine hypothetical values of the corporation at various debt ratios and to identify the ratio which the minimizes the WACC for Microsoft Corporation. The debt ratio corresponding to the minimum WACC also maximizes the value of the firm. As the values in the tables indicate, as the amount of financial leverage increases, the WACC decreases and the value of the firm rises until the optimal debt ratio is reached, after which point the WACC begins to rise and the value of the firm falls. Our results indicate the optimal debt ratio for Microsoft is at about 37.5 percent debt. If Microsoft Corporation were to increase its financial leverage beyond this point, the firm's value would decrease because the benefits from using lower cost debt would be more than offset by the rising costs of debt and equity resulting from the increased risk of bankruptcy.

Figure 1 Steps in Calculating the Weighted Average Cost of Capital (WACC) for Microsoft Corporation Under Normal Circumstances	
Calculation of the weights of the component costs of capital:	
Calculate the value of debt:	Price per bond * total bonds outstanding
Calculate the value of equity:	Price per share * total shares outstanding
Calculate the weight of debt:	$D/(D+E)$
Calculate the weight of equity:	$E/(D+E)$
Calculate the after-tax cost of debt: $k_d(1-t)$	
Calculated the weighted after-tax cost of debt: $w_d * k_d * (1-t)$	
Calculate the levered (Hamada) beta for different leverage ratios: $\beta_{equity} = [1+(1-t)(D/E)] * \beta_{unlevered}$	
Calculate the cost of equity using the CAPM: $k_e = k_f + \beta_{MS}(k_m - k_f)$	
Calculate the weighted cost of equity: $w_e * k_e$	
Add the weighted costs of debt and equity to determine the WACC: $w_d * k_d * (1-t) + w_e * k_e$	

Figure 2
WACC for Microsoft*
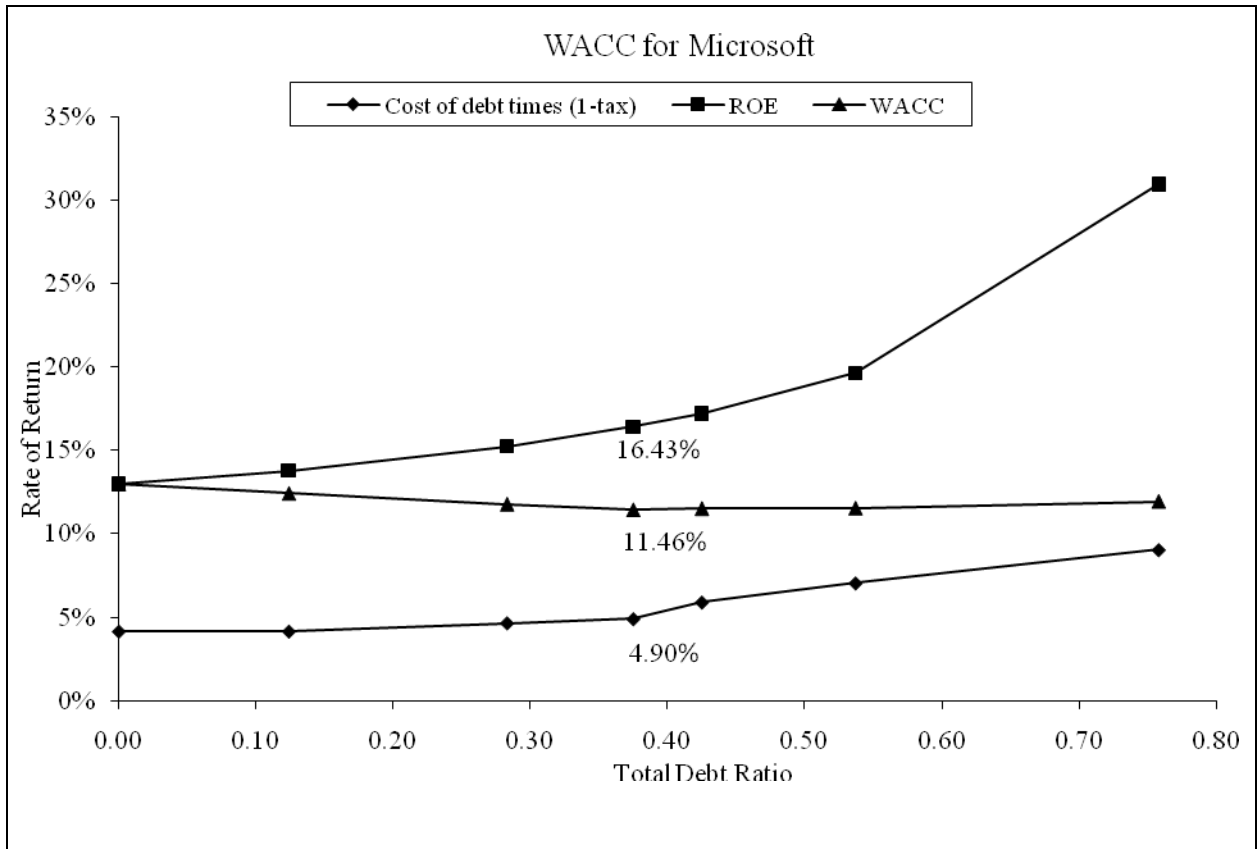
*Chart Values

Total Debt/(Total debt + equity) (%)	$k_d(1-t)$	k_s	WACC
0.0000	4.2%	13.0%	12.98%
0.1240	4.2%	13.8%	12.42%
0.2830	4.7%	15.2%	11.79%
0.3750	4.9%	16.4%	11.46%
0.4250	5.9%	17.2%	11.54%
0.5370	7.1%	19.6%	11.56%
0.7580	9.1%	31.0%	11.96%

References

Brigham, Eugene F. and Michael C. Ehrhardt. 2008. *Financial Management, Theory and Practice*, *Twelfth Edition*, Mason, OH: Thomson/Southwestern.

Damodaran, Aswath. Damodaran Online, January 2008, http://pages.stern.nyu.edu/~adamodar/.

Gardner, John C. and Charles Trzcinka. 1992. "All Equity Firms and the Balancing Theory of Capital Structure*" Journal of Financial Research*, 15: 77-90.

Graham, John R. and Campbell R. Harvey. 2001. "The Theory and Practice of Corporate Finance: Evidence form the Field," *Journal of Financial Economics*, 60: 187-243.

http://nobelprize.org/nobel_prizes/economics/laureates/1990/press.html

Hamada, Robert S. 1969. "Portfolio Analysis, Market Equilibrium, and Corporation Finance," *Journal of Finance*, Volume 24, March 1969, pp. 13-31.

Kraus, A. and R.H. Litzenberger, "A State-Preference Model of Optimal Financial Leverage," *Journal of Finance*, 28: 911-922.

Miller, Merton H. 1977. "Debt and Taxes," *Journal of Finance*, 32: 261-275.

Modigliani, Franco and Merton H. Miller. 1958 "The Cost of Capital, Corporation Finance, and the Theory of Investment," *American Economic Review*, 48: 261-296.

Modigliani, Franco and Merton H. Miller. 1963. "Corporate Income Taxes and the Cost of Capital: A Correction," *American Economic Review*, 53: 433-443.

Ratings and Ratios, *Standard and Poor's, 2006*, page 54.

Stocks, Bonds, Bills, and Inflation, Market Results for 1926-2006, 2007 Yearbook, Classic Edition, Morningstar, 2007.