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September 13, 2007

To
The Surface Transportation Board
395 E Street, S.W.
Washington, DC 20423-0001

Re: Methodology to Be Employed In Determining the Railroad Industry's Cost Of Capital

With this letter and my electronic submission today to the Surface Transportation Board (STB), I submit the document entitled "Determining an Appropriate Cost of Capital for Railroads". I am the Phillip H. Geier Jr. Associate Professor of Accounting at Columbia Business School. I have earned a Ph.D. in Business Economics from Harvard University and was previously on the faculty of the Stern School of Business at New York University.

I am an expert in the field of cost of capital, and have authored one of the most highly cited papers on the topic of ex-ante cost of capital, namely "Inferring the Cost of Capital Using the Ohlson-Juettner Model" (*Review of Accounting Studies* 8 (3), December, 399-431) which is cited in the attached document. I also currently serve on the editorial board of *The Accounting Review*, the premier publication for reporting studies in accounting research. I have done extensive research work on accounting based valuation, with an emphasis on measuring the cost of capital using ex-ante methods, such as the STB's current DCF method.

While my preference would have been to address both cost of capital and ROIC together as the two issues are inextricably linked, given the STB's current directive focusing only on the cost of capital, my attached document will analyze solely this issue. I strongly encourage the STB to not explore the cost of capital issue in isolation, as under the current directive, but to jointly examine both cost of capital and ROIC for a complete and rigorous analysis of revenue adequacy.

The STB is currently proposing to abandon the current DCF method in favor of an ex-post method, the capital asset pricing model (CAPM), to determine the cost of capital for railroads. I view the STB's departure from its precedent DCF method to the CAPM as unwarranted. The main drawback of the DCF method, based on the Gordon Growth Model, is that the DCF method does not account for perpetual growth rates which are likely to be lower than the growth rate assumption in the DCF method's calculation. In the attached document, I analyze two alternatives to the STB's CAPM based framework which do not suffer from CAPM's flaws and account for short-term growth rates that are higher, either explicitly or implicitly, than perpetual growth rates. The proposed CAPM is fraught with many problems



both at a theoretical as well as at a practical level. I also demonstrate that the STB's current assumptions for beta and risk premium are inappropriate. While it would be absolutely critical to spend the time and effort required to measure beta and risk premium properly for application of the CAPM, I believe it is more worthwhile to continue using an ex-ante approach to estimate cost of equity.

Application of the STB's currently proposed CAPM model will create disincentives for railroads to invest in their infrastructure and encourage inefficient economic behavior in the movement of more freight tonnage over government funded highways at a time when our nation's infrastructure is in decay, as exemplified by the recent and tragic Minnesota bridge collapse. I am certain the last thing the STB intends is to limit railroads' access to financial markets, since the more freight tonnage that moves on privately funded railroads, the greater the benefits to the United States economy.

The two approaches I analyze are the Ohlson-Juettner (OJ) Model and the Residual Income Valuation (RIV) Model. Most importantly, these two ex-ante methods produce estimates for cost of equity using entirely different approaches which are stable across time and stable across the four major U.S. Class I railroads. Furthermore, these two methods clarify the error in STB's proposed application of CAPM. The attached document demonstrates that railroads' cost of equity is 10.5% to 12.0% in 2005 versus the STB's proposed cost of equity of 8.4%.

I look forward to an opportunity to discuss these matters with you.

Sincerely

Partha. S. Mohanram

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Determining an Appropriate Cost of Capital for Railroads

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1. Introduction

The calculation of the cost of capital is a critical component to financial markets. Equity valuation models use the cost of capital as the discount rate to estimate stock value as the present value of expected dividends. In regulated markets such as the railroad industry, the cost of capital is a critical determinant of rate regulation to ensure that both the service provider receives an appropriate rate of return for the riskiness of operations and the recipient of the service does not overpay for services received. This paper analyzes the current and proposed methods for the determination of the cost of capital for the railroad industry and presents a third, superior method for carrying out the calculation.

The transportation industry is at a crossroads presently. The current state of road infrastructure appears inadequate to meet the demands of a growing economy. As the recent Minnesota bridge tragedy suggests, significant investments need to be made in order to just maintain infrastructure at current levels. Significant maintenance investment lessens the likelihood that government funding will be available to substantially increase the capacity of highway miles in the foreseeable future. As a result, railroads will likely carry a greater percentage of the nation's freight tonnage. In order for the railroad industry to make the necessary investments to gear for this growth, the railroad industry needs to be equitably compensated.

Railroad regulation encompasses the concept of revenue adequacy. A railroad is considered to be revenue adequate when its return on invested capital (ROIC) exceeds its cost of capital for a multi-year period.¹ Currently, none of the railroads meet this definition of revenue adequacy, but recent proposals by the STB to modify the methodology used to measure the cost

¹ source: "Standards for Railroad Revenue Adequacy" STB Ex Parte No. 393

of capital would accelerate the determination of revenue adequacy versus the former rules and at revenue levels lower than what the financial markets deem acceptable.

The cost of capital is typically calculated as the weighted average of the cost of debt and cost of equity, with the relative proportion of debt and equity in the capital structure serving as weights. The cost of debt can usually be calculated with little error or subjectivity either by examining actual debt issuances or from credit ratings. The cost of equity, on the other hand, is an extremely subjective notional concept. It is the rate at which equity investors discount future expected dividends from a firm in order to derive stock price. Hence, most of the variation in the calculation of cost of capital derives from the method employed to calculate the cost of equity.

There are fundamentally two approaches to calculate the cost of equity: ex-ante and ex-post. In the ex-ante method, the cost of equity is that discount rate under which the discounted expected future stream of dividends (or often earnings as a proxy for dividends) equals stock price. The ex-post method (called ex-post because historical data is an input), on the other hand, typically uses a valuation model such as the Capital Asset Pricing Model (CAPM) to estimate the cost of equity.

Since the early-1980s, the Interstate Commerce Commission (ICC) and its successor, the Surface Transportation Board (STB) has been employing a DCF method.² This ex-ante method is essentially based on the Gordon Growth Model that sets current stock price to equal the present value of the perpetuity of dividends with growth. This method has been criticized because the growth rates assumed are often higher than the perpetual growth rates firms would be expected to maintain in competitive equilibrium. The STB has recently proposed to move to a CAPM-based, ex-post approach, which is a material departure from the STB's precedent method

² source: Railroad Cost of Capital – 1982, 367 I.C.C. 662, 670 (1983).

of calculating cost of capital. If adopted, the CAPM would lead to a reduction in the cost of equity from around 15.2% to 8.4% for 2005, according to STB estimates.³ I do not find this departure from precedent to be warranted or prudent.

In this paper, I will demonstrate that this proposed change in STB policy would adversely affect railroads and does not fairly represent market valuation. Railroads are currently penalized by the fact that the measurement of ROIC overstates their true profitability for a number of reasons, including the understatement of net asset value and the inconsistent treatment of financial accounting and tax depreciation. A move to reduce the cost of capital has the potential to further penalize railroads' ability to make necessary investments at a time when such investments are needed to meet the challenges of increased freight tonnage.

My preference would have been to address both cost of capital and ROIC together as the two issues are inextricably linked. However, given the STB's current directive focusing only on the cost of capital, this paper will analyze solely this issue. I strongly encourage the STB to not explore the cost of capital issue in isolation, as under the current directive, but to jointly examine both cost of capital and ROIC for a complete and rigorous analysis of revenue adequacy. Most importantly, a discussion of revenue adequacy that considers both cost of capital and ROIC will lessen the dangers of unintended consequences from STB regulation. In particular, I am concerned that the proposed change in cost of capital methodology will create disincentives for railroads to invest in their infrastructure and, by extension, encourage inefficient freight flows onto the already overburdened government-funded highway system. The ROIC issue remains germane and potentially as important to the determination of revenue adequacy. I plan to address

³ source: STB Late Release August 20, 2007 Ex Parte No. 664

URL:

<http://www.stb.dot.gov/decisions/readingroom.nsf/51d7c65c6f78e79385256541007f0580/5c5691d3c88156fa8525733d00707063?OpenDocument>

ROIC and the corresponding appropriate cost of capital in a future research paper to be submitted to the STB.

This paper analyzes both the current cost of capital method as well as the proposed new method. I argue that while the current method is not without flaws, the current method has some significant advantages to the proposed new methodology. I will show that ex-ante methods are inherently superior because ex-ante methods are based on the future expected earnings returns as opposed to ex-post methods that rely on a noisy time series of realized past returns. Further, recent research in empirical finance has questioned the ability of CAPM to produce representative measures of required rates of return. In addition, the STB's implementation of CAPM has many questionable assumptions that dramatically understate the true cost of equity for railroads. This paper proposes a superior approach, a modification to the existing ex-ante method to calculate an estimate of the cost of equity that addresses the problems associated with the DCF method.

I rely on recent theoretical and empirical research in accounting-based equity valuation to propose two alternative methods to calculate the cost of equity that have some appealing features. First, my proposed methods allow for short term growth rates to be high, while at the same time recognizing that growth rates have to eventually decline to something approaching the long-run growth rate of the economy. Secondly, these alternative methods are not affected by accounting issues, i.e. issues such as understated or overstated book values of assets and equity do not have a significant effect on the estimation procedure. Finally, the recommended Ohlson-Juettner (OJ) method provides a parsimonious ex-ante approach to estimating the cost of capital that is based on the very same Gordon Growth Model on which the well understood DCF model is based.

My analysis indicates that that the new method proposed by the STB drastically understates the true cost of equity for the railroad sector. I estimate sector wide average costs of equity in the 11% to 13% range. The estimates are reasonable, stable across time and across the four major U.S. Class I railroads and are significantly greater than the 8.4% cost of equity estimate for 2005 calculated by the STB under the new CAPM based methodology. These estimates also corroborate CAPM-based estimates that use reasonable parameters for β and risk premium.

The rest of the paper is organized as follows. Section 2 provides a brief historical overview of railroad regulation and describes the proposed new changes. Section 3 critically analyzes the current DCF method. Section 4 sheds light on the new method, identifies theoretical as well as empirical problems with CAPM and presents the ex-ante approach as an alternative. Section 5 describes the ex-ante method based on the OJ model that infers ex-ante cost of equity directly from earnings estimates. Section 6 presents an alternative ex-ante method, based on the residual income valuation model. Section 7 concludes with normative recommendations for the STB.

2. Railroad Regulation

2.1 Historical Overview: Railroad Regulation until 1980

The railroad industry was the first industry to be regulated in the US under the aegis of the Interstate Commerce Commission (ICC) from the beginning of the 20th century. The principle guiding the ICC's rate setting was to ensure prices were high enough to cover costs, provide reasonable rates of return to the railroads, and ensure equitable and fair access to markets. In

addition to rate regulation, the ICC closely monitored and controlled railroad service and network geometry. As a result, railroads encountered significant difficulty in quickly adjusting their network structures through downgrading service or track abandonment, even if a change in market conditions made a route unprofitable. Further, railroads were not allowed to price discriminate by offering lower rates to either high volume users or unit train users⁴.

The railroad industry also faced increased competition from the nearly 47,000 miles of government funded interstate highway construction that was initiated by the Eisenhower administration in the 1950s, facilitating the birth and rapid expansion of a trucking industry that moves goods faster and more reliably.⁵ Railroads struggled to attain even a modicum of profitability with the mean ROICs declining from 4.1% in 1940s to 3.7% in 1950s, 2.8% in 1960s and 2.0% in 1970s.⁶ By the mid 1970s, many railroads were in the throws of bankruptcy, with over 20% of track miles operating under bankruptcy protection during the 1970s.⁷

2.2 Deregulation: The Staggers Act

In response, Congress de-regulated rails with the Staggers Act of 1980, limiting the regulating powers of the ICC which later became the STB. Currently, the burden of proof is on the shipper to prove rails are charging excessive rates. Rails can now price service based on market demand, costs, competitor analysis, and volumes; shippers and carriers can enter into private contracts; and rail track abandonment is much easier, albeit still reviewed.

⁴ source: "Freight Railroads: A Historical Perspective." Association of American Railroads (AAR) Policy and Economics Department. URL: http://www.aar.org/GetFile.asp?File_ID=140

⁵ Source: US Department of Transportation

⁶ source: "Freight Railroads: A Historical Perspective." Association of American Railroads (AAR) Policy and Economics Department. URL: http://www.aar.org/GetFile.asp?File_ID=140

⁷ source: "Freight Railroads: A Historical Perspective." Association of American Railroads (AAR) Policy and Economics Department. URL: http://www.aar.org/GetFile.asp?File_ID=140

Railroads have continued to invest in their networks (approximately \$370B from 1980-2005)⁸, leading to large productivity gains (among highest in US according to the Department of Labor)⁹. From 1980-2005, for example, ton-miles per dollar of operating expenses increased by 168% on an inflation-adjusted basis¹⁰. Industry ROIC also slowly improved in the 1980s to 4.4%, though still below cost of capital.¹¹

The railroad industry continued to merge after Staggers with the number of Class I railroads decreasing from 40 in 1980 to 7 today.¹² However, a combination of poor planning, unexpected complexity of mergers and surging volumes lead to major service issues in the wake of the mergers. In fact, service deteriorated so much that the STB blocked the Burlington Northern and Canadian National merger proposal in 2000 and placed a 15 month freeze on industry consolidation until service levels were restored¹³.

2.3 The Railroad Renaissance

Currently, railroads are focused on integration and improving efficiency. Industry ROIC improved to approximately 7% by 2005¹⁴, but is still below the cost of capital for nearly all operators. Railroad freight rates continue to remain low, with real rail rates in 2005 nearly 60%

⁸ source: "Freight Railroad Capacity Issues." Association of American Railroads (AAR) Policy and Economics Department. URL: http://www.aar.org/GetFile.asp?File_ID=769

⁹ source: "Railroad Productivity." Association of American Railroads (AAR) Policy and Economics Department. URL: http://www.aar.org/GetFile.asp?File_ID=146

¹⁰ source: "Rail Industry Structure and Market Behavior." Association of American Railroads (AAR) Policy and Economics Department. URL: http://www.aar.org/GetFile.asp?File_ID=145

¹¹ source: "Freight Railroads: A Historical Perspective." Association of American Railroads (AAR) Policy and Economics Department. URL: http://www.aar.org/GetFile.asp?File_ID=140

¹² source: "The Number of U.S. Class I Freight Railroads and the Role of Rail Mergers." Association of American Railroads (AAR) Policy and Economics Department. URL: http://www.aar.org/GetFile.asp?File_ID=834

¹³ source: Public Views on Major Rail Consolidations, STB Ex Parte No. 582.

¹⁴ source: "Freight Railroads: A Historical Perspective." Association of American Railroads (AAR) Policy and Economics Department. URL: http://www.aar.org/GetFile.asp?File_ID=140

below 1980 levels.¹⁵ While rails move close to 40% of US freight ton-miles, rails earn approximately 10% of freight revenues¹⁶. In retrospect, one could argue that much of aforementioned productivity gains achieved by rails accrued to shippers and, by extension, the recent move to consistently increase rail rates may be in part a lagged recovery of those productivity gains by railroads.

2.4 Current Railroad Regulation

One of the guiding principles of STB regulation has been the notion of revenue adequacy. The STB considers a railroad to be revenue adequate when its ROIC exceeds its cost of capital for a multi-year period.¹⁷ Under the current method for the calculation of cost of capital, none of the railroads are technically revenue adequate. However, in 2004, Norfolk Southern's ROIC exceeded its cost of capital, and if Norfolk Southern continues to maintain its strong ROIC performance, Norfolk Southern is likely to be deemed revenue adequate in the coming years.

The determination of revenue adequacy depends on the relative magnitudes of cost of capital and ROIC. The ROIC as calculated on STB Schedule 250 filings is measured as net railroad operating profit after tax divided by net investment base less accumulated deferred tax liabilities. This measure overstates ROIC versus a standard financial market evaluation for a variety of reasons. First, historical cost accounting significantly understates the asset base for industries with long lived assets such as railroads. Many materials and labor skills simply cost more per unit than in the past, even after adjusting for inflation and productivity. At a recent conference, the CEO of Union Pacific, James R. Young, highlighted this by noting that a bridge

¹⁵ source: "Rail Industry Structure and Market Behavior." Association of American Railroads (AAR) Policy and Economics Department. URL: http://www.aar.org/GetFile.asp?File_ID=145

¹⁶ source: "Overview of U.S. Freight Railroads." Association of American Railroads (AAR) Policy and Economics Department. URL: http://www.aar.org/GetFile.asp?File_ID=140

¹⁷ source: "Standards for Railroad Revenue Adequacy" STB Ex Parte No. 393

on Union Pacific's balance sheet at \$160,000 depreciated was destroyed by bad weather and cost \$20M to replace.¹⁸ A given railroad's ROIC will be much lower if one measures asset values using a replacement cost measure, such as the depreciated optimized replacement cost (DORC) method used by energy regulators in Australia [see Johnstone (2003)]; this inflation-adjusted ROIC, of course, must be used alongside with a measure of the cost of capital that controls for inflation. Second, even using historical financial statement information, there is an inherent inconsistency between using a financial accounting measure of operating profit in the numerator and a tax accounting measure of net assets in the denominator. One should either use a tax based measure of operating profit (which would be lower because of the greater depreciation charge) or a financial accounting base of assets (which would be higher because deferred tax liabilities would not be netted out).

Either approach would more appropriately measure ROIC at levels lower than the current approach taken by the STB. The effect can be quite dramatic – according to the STB's revenue adequacy calculations per Schedule 250 for CSX in 2006,¹⁹ net operating profit was \$1.1B while the net asset base was \$20.4B before removing \$6B of deferred tax liabilities. Using the tax base of \$14B understates assets by approximately 30%, which in turn overstates ROIC by approximately 40% (7.6% vs. 5.4%).

The other critical determinant of revenue adequacy is obviously the cost of capital. The recent move by the STB to change the method for the cost of capital is likely to have a substantial impact on determination of revenue adequacy. Specifically, the proposed revision

¹⁸ source: Comments made by James R. Young during presentation at North American Rail Shippers Association Conference, May 23-25, 2007, Washington, D.C.

¹⁹ source: CSX Schedule 250 Filing with STB,
URL:[http://www.stb.dot.gov/econdata.nsf/f039526076cc0f8e8525660b006870c9/e7981a0182dd52a0852572f700649553/\\$FILE/CSX%20Transportation%20Inc.%202006%20Schedule%20250.pdf](http://www.stb.dot.gov/econdata.nsf/f039526076cc0f8e8525660b006870c9/e7981a0182dd52a0852572f700649553/$FILE/CSX%20Transportation%20Inc.%202006%20Schedule%20250.pdf)

lowers the estimated industry cost of capital dramatically from 12.2% to 7.5%.²⁰ The proposed method understates railroads' cost of capital, increasing the error between the STB assessment of railroad financial health and the market's assessment of financial health. Combining the error in the proposed method for cost of capital with the inconsistent valuation of asset value, the STB will incorrectly label a railroad as revenue adequate when indeed the true ROIC lies significantly below the true cost of capital. As the STB has chosen to limit the focus to the cost of capital issue in this round of hearings, the balance of this paper will also focus solely on the cost of capital calculation.

3. The Current Method for Calculating the Cost of Equity

3.1 Current Method

The STB has thus far used a DCF based method to calculate the cost of equity for railroad stocks. The DCF method used is an implied cost of equity measure that is imputed from current stock price, dividend yield and expected growth rates in earnings. The DCF method is based on the Gordon Growth Model, which essentially is a dividend discount model. The Gordon Growth Model can be stated as

$$P_0 = D_1 / (r_e - g)$$

where P_0 is the current price, D_1 is the expected dividend a year from now, r_e is the cost of equity and g is expected growth in future earnings (or dividends if payout is constant)

This can be rearranged as

²⁰ source: STB Late Release August 20, 2007 Ex Parte No. 664

URL: <http://www.stb.dot.gov/decisions/readingroom.nsf/51d7c65c6f78e79385256541007f0580/5c5691d3c88156fa8525733d00707063?OpenDocument>

$$r_e = D_1/P_0 + g$$

Practically, the STB expressed D_1 as $D_0 \cdot (1+g/2)$, essentially assuming a half year of growth from current dividends D_0

The formula is hence

$$r_e = (D_0/P_0) \cdot (1+g/2) + g^{21}$$

3.2 Problems with the Current Method

Before I analyze the problems in the current method, I want to first acknowledge its strengths. First, the current method is a parsimonious model that uses a very few inputs – current price and dividends and expected future growth. Second, the current method provides a closed form solution with a simple formula for computation and no need for numerical solutions. Third, the current method is an ex-ante cost of equity measure. Recent research in finance and accounting [Elton (1999), Gebhardt, Lee and Swaminathan (2001) and Gode and Mohanram (2003)] have identified that commonly used methods for the estimation of the cost of capital such as CAPM suffer from the drawback that these methods use a noisy time series of realized past returns to determine expected future returns. This is especially problematic because the relationship between expected returns and realized returns is weak.

The primary drawback with the current method is its inability to handle high growth rates. By its very construction, the current method constrains the growth rate to be lower than the cost of equity, as otherwise the formula breaks down as price would be meaningless. If growth rates are unsustainably high, the current method will lead to inflated estimates of the cost of

²¹ source: Railroad Cost of Capital – 1982, 367 I.C.C. 662, 670 (1983)

equity. The model in its simple form does not allow for a period of high growth with a reversion to a growth rate that is more in line with the expected economy wide growth rate

The second drawback of the DCF model is its reliance on the estimate of expected growth, which is typically derived from analysts' estimates of earnings growth over a five year horizon. Academic literature analyzing the accuracy of analysts' forecasts identifies many drawbacks with this category of forecasts. For instance, Dechow, Sloan and Hutton (2000) show that analysts can be systematically optimistic or pessimistic about these forecasts. Further, these numbers tend to be noisy across time, with little correlation to actually realized growth outcomes.

3.3 Multi-Stage DCF Methods

One potential solution to the problem of high growth rates is to use a multi-stage growth model. The basic principle behind multi-stage methods is to assume that firms can grow at a relatively high growth rate for a reasonable horizon but eventually growth rates will have to conform to long run economy wide growth rates. For instance, the STB could use a two stage growth rate that assumes that the short run growth rate would be in effect for a twenty year horizon after which growth will subside to economy wide rate. Using a two stage method, the STB estimates a cost of equity value of 7.2% for the railroad industry in 2005 as opposed to 15.2% under the basic DCF method. Clearly, the two-stage method has a dramatic impact on the calculated cost of equity.

There are however many problems with the two-stage method. The primary problem is that the two-stage method assumes that growth literally falls off a cliff at an arbitrary point. In reality, growth rates show a gradual convergence, i.e. a firm that is rapidly growing will see a

gradual reduction in its growth rate over an extended period of time towards the economy wide rate. In addition, the two-stage model cannot provide a closed form solution; the two-stage model has to be run iteratively to produce a numerical solution. Finally, there is a high degree or arbitrariness with regard to when the period of high growth stops and economy wide growth rate comes into effect. Some of these problems can be partially addressed by moving from a two-stage to a three-stage DCF model, with a period of intermediate growth in between the current and long-term growth rates. However, this method becomes even more arbitrary through the introduction of an additional degree of freedom.

An ideal method for the computation of the cost of equity would be an ex-ante method that parsimoniously provides a closed form solution, while at the same time has the ability to handle high short run growth rates without assuming high perpetual growth. In later sections to follow, I will propose using one such method, the Ohlson-Juettner or OJ method which also has the appealing feature of being based on a generalization of the very same Gordon Growth Model which is the basis of all the DCF based models.

As the STB proposal mandates the use of the CAPM for the computation of cost of equity, I will now critically analyze the CAPM and its application for railroads.

4. The Proposed CAPM Method

The proposed method for the calculation of the cost of capital uses the CAPM to compute the cost of equity for railroads. In its basic form, the CAPM equation for expected return for firm i can be represented as

$$R_i = R_f + \beta_i * (E[R_m] - R_f)$$

where R_f is the risk free rate, β or Beta is a measure of systematic risk and $E[R_m] - R_f$ is the risk premium

The risk free rate measures the rate of return on a risk less investment, and is usually the yield on long-term US treasuries. β is a measure of how more risky a stock is than the market as a whole. β is the covariance between market returns and the returns of the firms and estimated from a regression of past stock market returns on the firm's returns. Finally, the risk premium is an estimate of the return premium for equity as a whole over the risk-free rate.

4.1 Theoretical Problems with CAPM

While CAPM is widely taught in academic curricula, and while CAPM has historically been a ubiquitous method for the measurement of cost of equity, the CAPM suffers from serious drawbacks which are reducing its application in sophisticated financial evaluation. Firstly, β is estimated from a regression that uses past realized returns, while CAPM is a model of expected returns. However, the literature on finance has shown that the relationship between expected returns and realized returns is weak [see Elton (1999)]. Secondly, this also affects the estimation of expected risk premium, which is also estimated using realized risk premium. Traditionally, common practice was to use estimates in the order of 6.0% to 7.5%. This was based on the historical spreads between the return to the stock market as a whole (R_m) and the risk free rate (R_f), using a long time series of returns over an extended period. However, estimates of risk premiums became much lower in the late 1990s, when justification of increasingly demanding stock market valuations necessitated usage of a lower risk premium assumption [see Claus and Thomas (1991)].

The bigger problem with CAPM has been that mounting evidence over the past two decades have questioned the validity of the model. Fama and French (1992) find that when one considers the variation in two factors – size and the book-to-market ratio, β fails to show any relationship with stock returns. In their 1996 paper entitled “The CAPM is wanted, Dead or Alive”, Fama and French (1996) state

“FAMA AND FRENCH (FF 1992) PRODUCE two negative conclusions about the empirical adequacy of the capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965): (i) when one allows for variation in CAPM markets that is unrelated to size, the univariate relation between β and average return for 1941–1990 is weak; (ii) β does not suffice to explain average return. Size (market capitalization) captures differences in average stock returns for 1941–1990 that are missed by β . For the post-1962 period where we have book equity data, BE/ME (the ratio of book to market equity) and other variables also help explain average return.”

Based on the results of the many Fama and French papers, standard practice in the asset pricing literature is to use a three-factor model as the benchmark for expected returns. In addition to the traditional market factor, one also includes size and book-to-market as additional risk factors. The three factor model can be represented as

$$R_i = R_f + \beta_i \cdot (E[R_m] - R_f) + s_i \cdot E(\text{SMB}) + h_i \cdot E(\text{HML})$$

where $E(\text{SMB})$ and $E(\text{HML})$ are the expected returns to factor-mimicking portfolios that isolate the effects of size (SMB = Small minus Big) and the book-to-market (HML = High BM minus Low BM) effect and s_i and h_i can be viewed as factor loadings with respect to these factors, i.e. the analogs of beta in a multifactor model.

4.2 Practical Issues with CAPM Implementation for Railroads

Figure 1 below presents the comparison between the cost of equity calculated using the CAPM, and the DCF method currently used, based on data from the recent STB decision report.

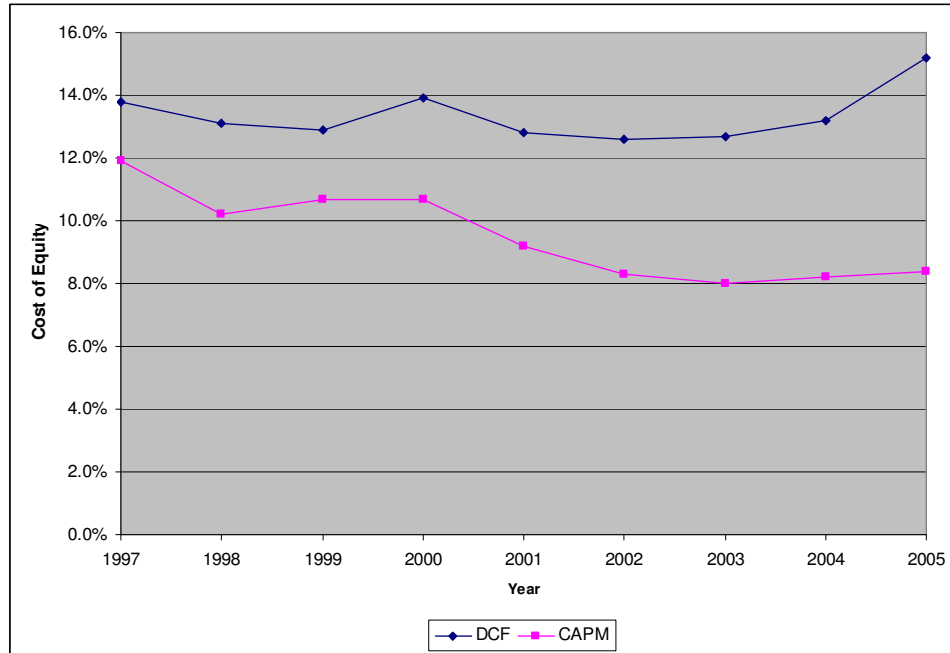


Figure 1: STB Estimates of Cost of Equity from DCF and CAPM Methods

Given that the risk free rate (yield on 10 year treasury) is currently around 4.5%, the 2005 estimate of 8.4% for cost of equity implies an estimate of 3.9% for the expected risk premium, if β is assumed to be 1. As the analysis that follows will illustrate, both these estimates are low.

4.2.1 An Appropriate Risk Premium

The STB is proposing to use the NYSE as the benchmark in the determination of an appropriate risk premium. In addition, the STB would use the 10 year Treasury Bond as the measure of the risk-free rate. These STB proposed indices are inconsistent with the usual practice espoused in the academic literature to use the broader market index as a measure of market return or the 1 month Treasury Bill as the measure of the risk-free rate [see Fama and French (1997) or the calculation in Kenneth French's publicly available database at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html]

Panel A of Table 1 presents the annual value weighted stock performance of the NYSE over the past eighty years as well as annual returns to the T-Bill and T-Bond. Panel B uses this information to calculate average market premiums over horizons of different length, using either the T-Bill or the T-Bond as the measure of the risk-free rate. As the results indicate, the risk premium is the highest for the shortest and longest horizon, and slightly lower for intermediate horizon. Focusing on the 50 year horizon that the STB proposes, the risk premium is 5.4% using the T-Bond and 6.6% using the T-Bill. If one uses the entire time series of data from 1928, the risk premium is considerably higher at 6.7% using the T-Bond and 8.0% using the T-Bill rate. The results are presented below graphically in Figure 2.

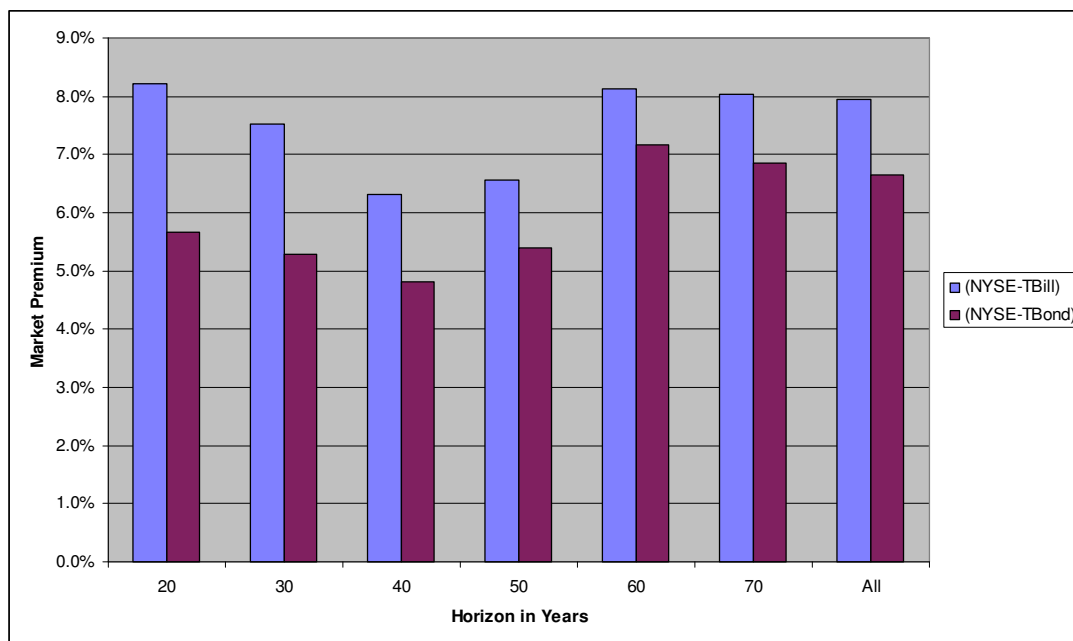


Figure 2: Risk Premium Under Different Horizons Using Different Risk Free Rates

Note that using the NYSE return as the measure of the market understates the risk premium versus either the S&P 500 or the broader market by 0.2% according to my calculations. The analysis of historical returns does not justify the use of a risk premium of 3.9% since the average risk premium across varying horizons is closer to 6%.

Fama and French (1997) analyze the cost of capital at an industry level for 48 different industry groupings. Fama and French estimate the risk premiums at the industry level using both CAPM as well as the three-factor model described before. While Fama and French do not analyze railroads by themselves, they do analyze the transportation sector. An excerpt from a relevant table from their paper is presented in Table 2. I have included the results for the transportation sector (in bold) as well as other asset intensive industries.

As their results indicate, the risk premium estimate for the transportation sector is around 6% for the CAPM model and over 7% when one uses a three-factor risk model. The results for the transportation sector are not outliers; indeed the risk premiums for other asset intensive industries such as construction, shipping, real estate, and steel are also in a similar range. These results reinforce the appropriateness of using at least 6% as the measure of risk premium for the railroad sector in the determination of cost of equity.

4.2.2 An Appropriate β

Another proposal made by the STB is to use a β of 1 for the railroad sector. The ostensible logic for this assumption is that a β of 1 eliminates the need to estimate β since 1 is by construction the β of the entire market. I reject that assertion and view it as the equivalent of a garment manufacturer saying that all pants produced will be of waist 38" and inseam 32" because that describes the average American male. Recent evidence does not support the use of β of 1.

As mentioned earlier, one problem with the estimation of β is the use of historical returns, which may not represent the risk of a firm going forwards. One approach is to estimate what are referred to as "forward-looking" β . A forward-looking β is typically estimated using a

variety of information including firm specific fundamental information and the volatility of option prices. A survey by Bruner et al (1998) finds that over 40% of financial advisors use forward looking estimates of β , a number which probably has risen since the time of the survey. The most ubiquitous source of forward-looking β is BARRA. According to BARRA, the forward-looking β for the 4 railroad stocks, as of July 1st 2007 were: 1.230 for BNI, 1.432 for CSX, 1.283 for NSC and 1.151 for UNP, or a simple average across the 4 firms of 1.274. Finally, Fama and French (1997) estimate betas of 1.21 using the entire time series of data and 1.16 using a five year period for the transportation sector (the column labeled “b” in Table 2. This reinforces the view that a β of 1 understates the true systematic risk faced by railroad firms.

4.3 Conclusion: An Appropriate Cost of Equity Using CAPM

Fama and French (1997) estimate a CAPM β of around 1.2 for the transportation sector. If one assumes a β of 1.2, and a reasonable risk premium of 6% and a risk-free rate of 4.5%, one obtains a cost of equity of $4.5\% + 1.2 \times 6\%$, or 11.7%. Even with a β of 1, a risk premium of 6% and a risk-free rate of 4.5%, the cost of equity is 10.5%. Both these numbers are considerably higher than the 8.4% cost of equity proposed by the STB for 2005.

While it would be absolutely critical to spend the time and effort required to get the proper and correct parameters for use in the CAPM model if the current proposal were to be adopted, I believe that it is more worthwhile to continue to use the ex-ante approach towards the estimation of cost of equity. In the following sections, I present two alternatives that use the ex-ante method while fixing the one key weakness inherent in the two-stage DCF model – the fact that current growth rates are unlikely to be representative of future growth rates.

I have now demonstrated that both the current method and the proposed method have serious flaws, both in their theoretical construct and in the STB implementation of these theories.

While DCF methods have the advantage of being ex-ante methods, they are hamstrung by unrealistic assumptions about steady state using growth rates that are likely to overstate the actual growth rate in perpetuity. Shifting to CAPM does not improve the situation, but instead introduces a new litany of problems such as relying on noisy realized returns as a proxy for expected returns. Further, academic research indicates that the usefulness of a single factor model such as CAPM is limited and has proposed multi-factor asset pricing models instead. Finally, the parameters used by the STB in its proposed CAPM implementation dramatically understate the true cost of equity for railroads.

4.4 An Alternative to CAPM using the Ex-Ante Approach

In lieu of the current proposal, the STB should simply modify and enhance its existing and long accepted method to address model flaws stemming from the forecast horizon and unrealistic growth rates. Recent advances in academic research present us with two. The first method, based on research by Ohlson and Juettner (2005) and Gode and Mohanram (2003) is referred to as the OJ model. The second method, based on research by Gebhardt, Lee and Swaminathan (2001), is referred to as the residual income valuation or RIV model.

Ex-ante methods have the following characteristics in common

- Ex-ante methods require a simple set of easily available information for their computation. The basic information required is expectations of future earnings as derived from easily available sell-side analysts' forecasts of expected future earnings and long term growth, and estimates of dividend payout which can be easily derived from past financials

- Ex-ante methods allow for firms to have short term growth rates to be high and implicitly or explicitly, allow the growth rates to decline to more reasonable perpetual growth levels
- Ex-ante methods are not adversely affected by accounting issues that may lead to understated or overstated book values of assets or equity.

In the following sections, I will outline the salient features of each method. I will then implement each method for four railroads (Burlington Northern, Norfolk Southern, CSX and Union Pacific) for the ten year period from 1997 to 2006.

5. Inferring Ex-Ante Cost of Equity using the OJ Model

5.1 Theory Underpinning the OJ Model

The OJ model relates the current price (P_0) to forthcoming earnings per share (eps_1), forthcoming dividends per share (dps_1), two-year-ahead eps (eps_2), and an assumed perpetual growth rate (g_p). The short-term growth ($(eps_2 - eps_1)/eps_1$) is assumed to decay asymptotically to g_p . One can view g_p as being the long run growth rate of the economy. The OJ model can be viewed as a generalization of the basic Gordon growth model: $P_0 = D_1/(r_e - g)$

The OJ model is a parsimonious model that only needs the following inputs

- eps_1 and eps_2 which are the one year and two year ahead EPS estimates
- an estimate of dividend payout to calculate dps_1 from eps_1
- P_0 , the current stock price
- g_p , an estimate of perpetual growth rate

The OJ model is based on abnormal earnings valuation. In the next paragraph, I will attempt to outline the basic intuition of the abnormal earnings valuation model. Consider a firm which is expected to earn an earnings stream of eps_1 and eps_2 in the next year, and has a cost of equity capital of r_e . For simplicity, consider the case where no dividends are paid. In this setting, the entire eps_1 stream is reinvested in the firm, and hence contributes to growth. If this growth is normal, i.e. earning just the cost of equity, then one would expect eps_2 to equal $eps_1 \cdot (1+r_e)$. Hence the abnormal component of earnings can be viewed as $eps_2 - eps_1 \cdot (1+r_e)$. What the OJ model assumes is that the abnormal earnings grow at the long run perpetual growth rate, g_p . The implication of this for the stream of long run earnings is that short term growth rates can be high while at the same time perpetual growth rates converge to reasonable levels. Figure 3 below illustrates how the model implicitly drags the growth rate from a high initial level (21%) to a more reasonable growth rate of around 9% fifteen years into the future for the case of Union Pacific in 2004.

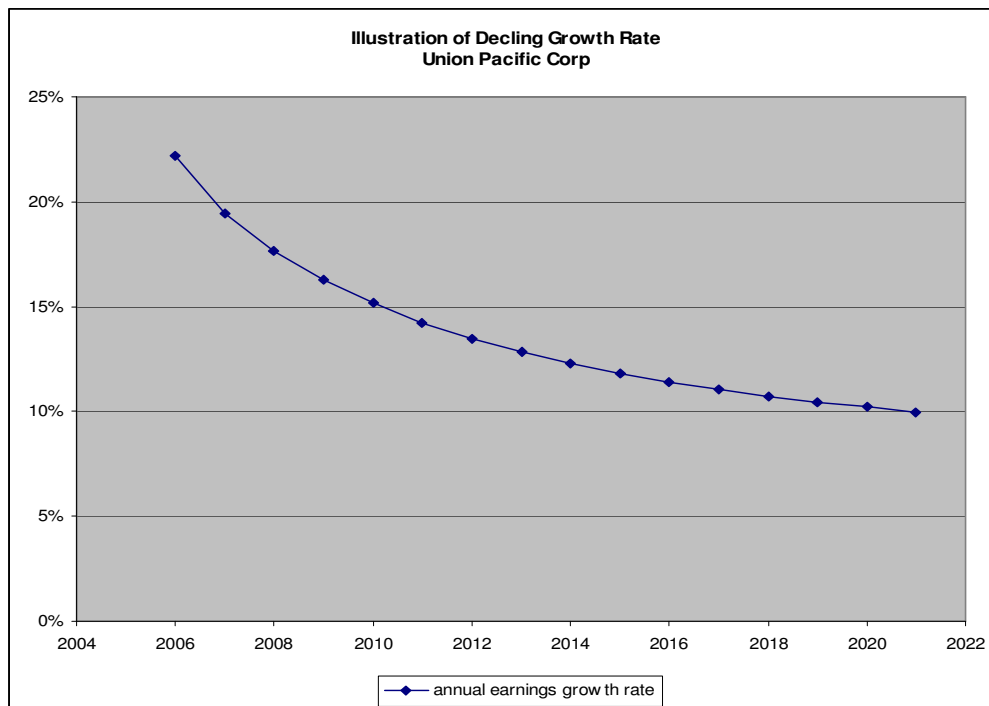


Figure 3: Declining Growth Rates Across Time with the OJ Model

The Appendix on page 37 presents the derivation of the OJ formula used to derive the implied cost of equity. Given the parameters eps_1 , eps_2 , dps_1 and g_p , the OJ model calculates the cost of capital as

$$r_e = A + \sqrt{A^2 + \frac{eps_1}{P_0}(g_2 - g_p)}$$

where $A = \frac{1}{2} \left(g_p + \frac{dps_1}{P_0} \right)$ and $g_2 = \frac{(eps_2 - eps_1)}{eps_1}$

5.2 Implementing the OJ Model

I implement the OJ Model for all four railroad firms in the sample. For consistency, I calculate the cost of capital at the same time for all firms in the industry. I obtain the mean consensus forecast of one year ahead earnings per share (eps_1) as well as two year ahead earnings per share (eps_2) from the I/B/E/S summary database of sell-side analysts' forecasts at the end of June of each year. I measure the stock price on the same date as the date of the consensus forecast, using the data from I/B/E/S itself to ensure that there are no discrepancies between the stock price and the eps forecasts because of not properly adjusting for splits etc.

To estimate dps_1 , I first calculate the mean payout over the past three years for each firm (dividends divided by earnings). I obtain data on earnings and dividends from the Compustat® database. Payout is defined as the dividends (Annual Data Item # 21) divided by income before extraordinary items (Annual Data Item # 18). If earnings are negative, payout is not defined. In these instances, payout is calculated as the ratio of dividends divided by 6% of total assets (Annual Data Item #6). This method is consistent with approaches used in the prior literature

[Gedbbhardt, Lee and Swaminathan (2001) and Gode and Mohanram (2003)]. I also use this approach in years when because of low earnings, payout is unreasonably high (greater than 1). To ensure that results are not driven by outliers, I use the three year average of payout for a given firm. For instance, the payout used in cost of equity calculations for 2006 would be the average of the payouts in fiscal years 2005, 2004 and 2003. Obviously, dps_1 is defined simply as eps_1 multiplied by payout. Finally, I need to get an estimate of g_p , the perpetual growth rate. To be conservative, I assume that g_p (nominal GDP growth) equals 4%.

5.3 Results of the Implementation

Table 3 presents the summary of all the inputs as well the computation of the OJ model for a ten year period (1997 to 2006) over which the cost of equity is estimated for the four railroad stocks in separate panels for each of the four railroad stocks. As Table 3 illustrates, implementing the OJ model is very simple as the model is parsimonious and presents a “closed form solution”, i.e. a simple, intuitive and easy to apply formula. Figure 4 below graphically presents the cost of equity for the 4 firms as well as an industry average over the ten year period.

Analyzing the results, one can see several interesting trends. Firstly, the cost of capital is consistently above the 10% mark for all firms in all years. The average across time for the four firms is 12.6% for Burlington Northern, 15.7% for CSX, 13.6% for Norfolk Southern and 15.8% for Union Pacific. The time series average across all firms for the ten years is 14.4%. However, Figure 4 also illustrates one potential drawback of this method – the variability of the measure.

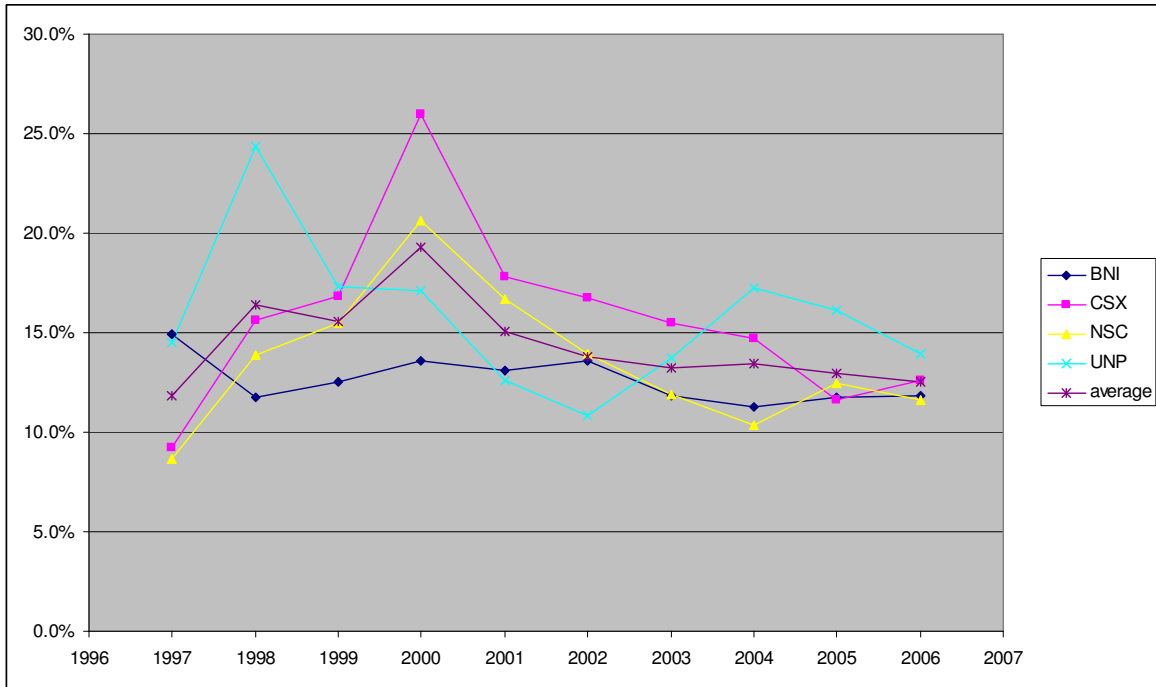


Figure 4: Implied Cost of Equity (r_e) using the OJ Model

Analyzing Table 3, the source of variability is apparent. Consider the few observations for which the cost of equity seems unreasonably high (greater than 20%), for instance the cases of CSX and NSC in the year 2000. The root cause of the high cost of equity number is the extremely high value of short term growth g_2 (69.6% for CSX, 55% for NSC) that resulted from these railroads' absorption of Conrail, a one time event which resulted in relatively high levels of eps_2 with respect to eps_1 . Clearly, these are not sustainable growth rates. STB could either drop "exception" years such as these from any future analysis or as an alternative, I put a maximum cap of 20% for short term growth rates. Table 4 presents the results of the revised methodology, which are also graphed in Figure 5 below.

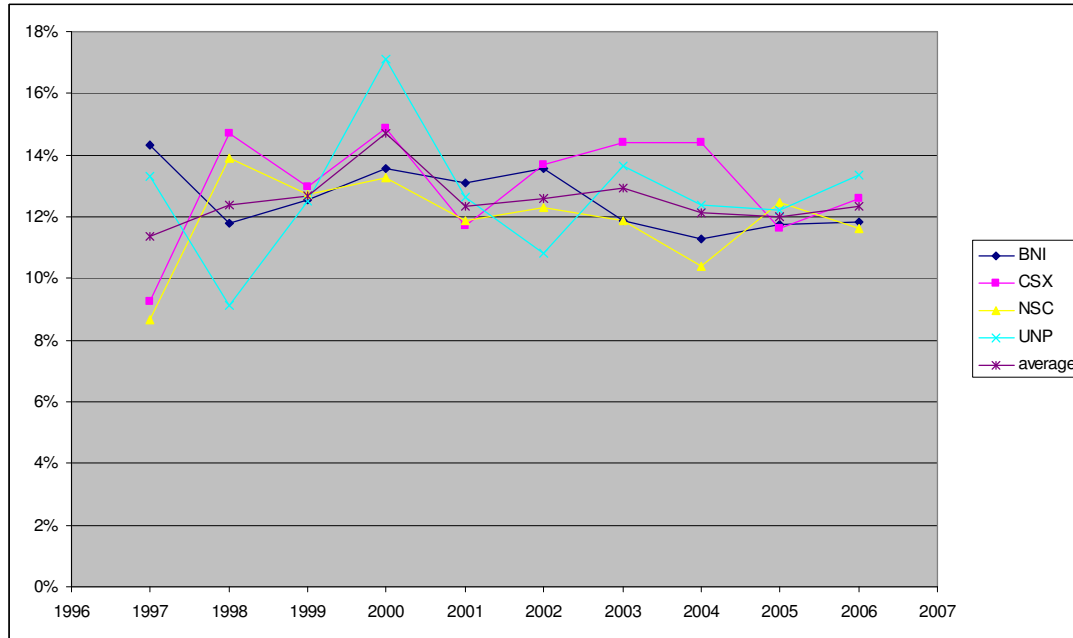


Figure 5: Implied Cost of Equity (r_e) using the OJ Model with short term growth rate capped at 20%

Capping short term growth rates drastically reduces the variability in the measures. As Figure 5 indicates, the average cost of equity across the industry stays in an extremely tight range between 11.4% and 12.9% in nine of the ten years, with only one year having a slightly higher average cost of equity (14.9% in 2000). The average cost of equity across the period is also remarkably similar for the four firms at 12.6% for BNI, 13.0% for CSX, 11.9% for NSC and 12.7% for UNP, which implies a time series average of 12.6% across the period. The significance of the stable performance of this adjusted metric across time and across firms is quite significant. Note that this time period (1997-2006) includes a boom period (1997-2000) followed by a bust period (2001-2003) that encompassed a recession. Despite variable macroeconomic conditions and more importantly significant variations in market sentiment and valuations, the model performs in a stable fashion.

The biggest advantage of the OJ model is that the OJ model provides a “closed form solution” – i.e. a simple formula that needs very few inputs. There is no need for an iterative or

numerical approach, where one makes an initial guess and converges to a solution. The analogy here is with the Black-Scholes model providing a closed form solution for option pricing. This model hence retains the simplicity of the basic DCF model. As the results indicate, the estimates of the cost of equity are slightly lower than the basic DCF model, primarily because the OJ model no longer assumes that current growth rates will persist.

In the next section, I will introduce another alternative to the OJ model, which also uses an ex-ante approach to calculate the cost of capital, but is based on a valuation model referred to as the residual income valuation model. This model is growing in importance in the field of accounting based equity valuation.

6. Inferring Ex-Ante Cost of Equity using the RIV Model

In the last section, I showed that the OJ model produces reasonable estimates of costs of capital that are stable across firms and across time. I now present an entirely different approach to estimating the cost of capital that gives similar results. I will use the residual income valuation model to estimate the cost of capital, using the same ex-ante approach as for the OJ model. The inputs are the same – estimates of future earnings, long term growth, perpetual growth and dividend payout. In addition, the RIV Model needs the beginning book value of equity and an estimate of the industry median ROE as inputs. As before, the cost of equity will be inferred from the price and the inputs to the valuation model; however, one will need to take a numerical approach (i.e., iterative computation) as there is no closed form solution.

6.1 The Residual Income Valuation (RIV) Model

The fundamental concept underlying the RIV Model is the notion of abnormal earnings or residual income. A firm is said to have "normal earnings" simply when the rate of return on equity is equal to the cost of equity. Any earnings over and above that are referred to as abnormal earnings or residual income. Hence, if a firm has a cost of equity of 15%, a book value of equity of \$1B, and Net Income of \$200M, the firm's normal earnings are $15\% * \$1B = \$150M$, and its residual income is \$50M. In other words

$$\text{Residual Income}_1 = \text{Earnings}_1 - r_e * \text{Book Value}_0$$

Why should the stock market pay more for a firm than its book value? The answer is either because the stock market expects the firm to earn abnormal rates of return in the future and is willing to pay the discounted value of the abnormal earnings in the future, or because the book value is understated as compared to the market value of the asset portfolio.

Hence, if V is the "value of equity" as calculated, RI is residual income and BV is the book value of equity, then the equation becomes

$$V_0 = BV_0 + \sum_{i=1}^{\infty} \frac{E[RI_t]}{(1 + r_e)^i}$$

where the $E[]$, stands for 'expectation'. Hence, if a firm is expected to earn no residual income in the future, the firm's value will simply equal its book value. If a firm is expected to earn residual income in the future, the firm's value will exceed the book value. This is analogous to bond valuation – if a bond is expected to earn a rate of return greater than the discount rate, the bond will trade for above its face value and conversely if the bond is expected to earn below the discount rate.

As is normally the case, the RIV Model is typically implemented as the sum of book value, a finite discounted stream of abnormal earnings and a terminal value. In other words

$$V_0 = BV_0 + \sum_{i=1}^N \frac{E[RI_t]}{(1+r_e)^i} + \frac{TV_N}{(1+r_e)^N}$$

The RIV Model has several appealing features. First, the RIV Model is self-correcting in nature. If book values are understated (as is frequently the case and especially so for railroads), then the basis for the computation of “normal earnings” are also understated and hence residual income is overstated. This implies in the equation above that the understatement of BV_0 will be offset by the overstatement of the future stream of residual income. Second, the RIV Model incorporates balance sheet information. Studies analyzing the value relevance of financial statements have indicated that balance sheet information in the form of book values contribute a significant explanatory power in explaining the cross-section of prices. Indeed, as the value relevance of earnings has been alleged to decline across time, the value relevance of balance sheets has actually increased [see Collins, Maydew and Weiss (1997)]. Finally, incorporating a stable financial figure like book value is likely to lend much more stability to a valuation model than one that is based simply on flows such as earnings or dividends.

In the following sub-section, I will describe how the STB could implement the residual income valuation model. Specifically, I will describe how the inputs to the model will generate future streams of expected earnings, book values, abnormal earnings as well as a terminal value estimate.

6.2 Implementing the Residual Income Valuation Model to Infer the Cost of Equity

Our implementation of the residual income valuation is based largely on Gebhardt, Lee and Swaminathan (2001). I start with our estimates obtained from analysts - EPS estimates for

the next two years (eps_1 , eps_2) and an estimate of long term growth (ltg), which is typically a five-year horizon. I estimate eps_3 , eps_4 and eps_5 from eps_2 by simply compounding the growth rate across time. Table 5 illustrates an example for Burlington Northern in 1997. Given that eps_2 is \$2.49 and the long term growth rate is 12.7%, I calculate eps_3 as simply $\$2.49 \times (1 + 0.127)$ or \$2.81 and so on for eps_4 and eps_5 .

Simultaneously, I estimate implicit book values. I start with beginning book value, which is defined as total common equity (Data Item #60 from Annual Compustat®) at the end of the prior year, divided by shares outstanding. I use shares outstanding from I/B/E/S (variable SHOUT) to ensure consistency between the price and eps estimates. Once I have starting book value ($bvps_0$), I can estimate future book values from starting book values as below.

$$\begin{aligned}bvps_1 &= bvps_0 + eps_1 \times (1 - \text{payout}) \\bvps_2 &= bvps_1 + eps_2 \times (1 - \text{payout}) \\&\dots \\bvps_5 &= bvps_4 + eps_5 \times (1 - \text{payout})\end{aligned}$$

Finally, I need to think about what happens after year 5. For that, a well known fact in economics is useful – the fact that in the long run, the return on equity (ROE) of individual firms will converge to an industrial average (see Figure 6). Many studies analyzing the long run behavior of ROE indicate that ROEs tend to mean-revert, i.e. firms with high ROEs are unable to maintain their abnormal profitability as factors such as competition drive their returns down, while firms with lower ROEs improve through actions like restructuring and management change.

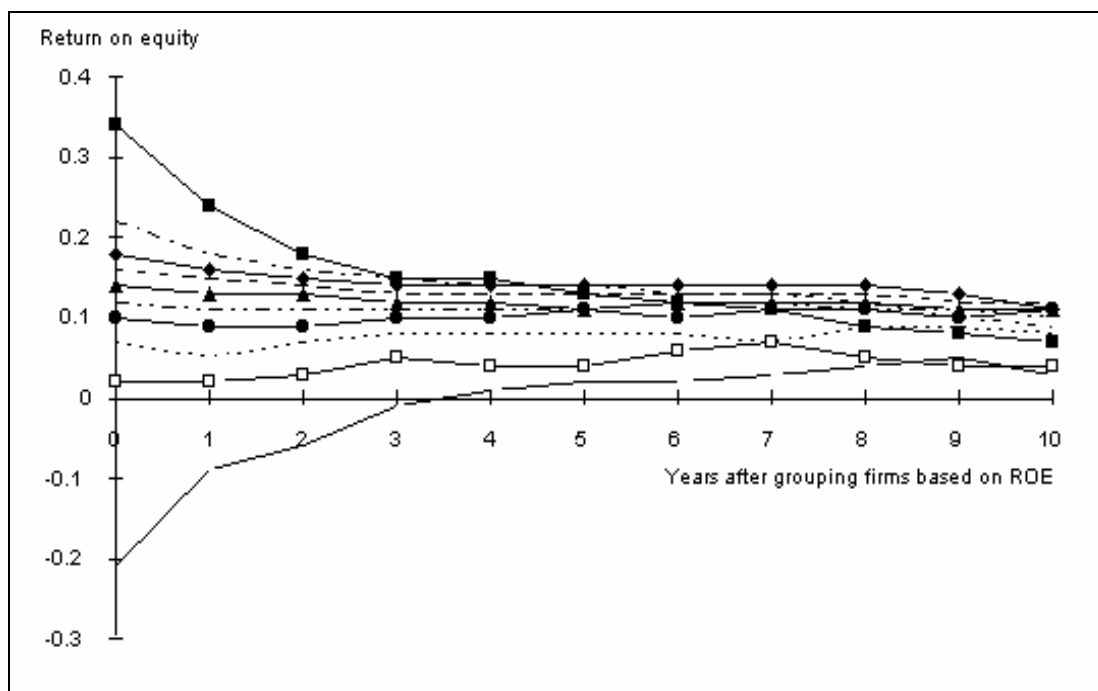


Figure 6: The Convergence of ROE to industry medians across time
[from “Business Analysis and Valuation” by Palepu, Healy and Bernard, 3rd Edition,
Southwestern Press]

Using the past twenty-five years of data, I estimate the industry median ROE for the railroad sector to be 13%, where ROE is defined as Net Income before Extraordinary Items (Compustat® Data Item #18) divided by beginning book value (Compustat® Data Item #60). I then set the ROE in year 15 for the firm to be 13% and make the ROE converge from its year 5 levels to 13% in a linear fashion. Once I know ROEs, I can easily infer implicit EPS estimates.

In the Burlington Northern example, ROE in year 5 is 18.1%. I can hence estimate ROE in year 6 as 17.6% as ROEs converge to the 13%. As ROE in year 6 is 17.6%, this ROE must imply that expected EPS in year 6 is 17.6% of year 5 book value per share (\$21.94) or \$3.86. Then, as before, I can compute ending book values from the payout assumption. Panel A of Table 5 presents the entire sequence of ROEs, EPS forecasts and Book Values from year 1 through 15.

I can easily compute residual income forecasts from EPS and beginning book value forecasts as

$$\begin{aligned} ri_1 &= eps_1 - bvps_0 * r_e \\ ri_2 &= eps_2 - bvps_1 * r_e \\ &\dots \\ &\dots \\ ri_{15} &= eps_{15} - bvps_{14} * r_e \end{aligned}$$

where r_e is our estimate of the cost of equity

Finally, I need to estimate terminal value. One can make the simple assumption that residual income grows in perpetuity at the long run growth rate of the economy, g_p . In other words, the terminal value in the year 15 is simply calculated using the standard terminal value formula

$$TV_{15} = RI_{15} * (1 + g_p) / (r_e - g_p)$$

Our value estimate is hence the sum of book value in year 0, discounted residual income from years 1 through 15 and the terminal value. Note that I do not know what r_e is; r_e is what I am solving for. I need to solve this numerically. In Panel A of Table 5, I make an initial guess of 11%. The initial guess of 11% results in a value estimate of \$24.83 per share, below the prevailing share price of \$29.21. Clearly the cost of equity is lower. When I use 9%, the estimate of value is \$38.57, higher than stock price (Panel B). r_e can be iteratively solved for using standard techniques such as GoalseekTM or SolverTM. As indicated in Panel C, the estimated cost of equity in this case is 10.19%.

6.3 Results of the RIV Implementation

I employ the methodology described above to numerically calculate the implied cost of equity for each of the four railroad stocks for the same ten year period from 1997 to 2006

analyzed earlier. The results are presented in Table 6 and graphed in Figure 7 below. As the results indicate, the cost of equity is in a very narrow range between 10% and 12% for almost all observations. The time series average across all firms is 10.5%. This is lower than the 12.6% average that the OJ model provides. However, one must note that the inputs to the model have been very conservative, in particular the assumption of a 13% long run industry ROE, especially as railroad stocks have recently earned higher ROEs because of their understated balance sheets. If one uses a 14% ROE, the mean implied cost of equity across the period increases to 11%.

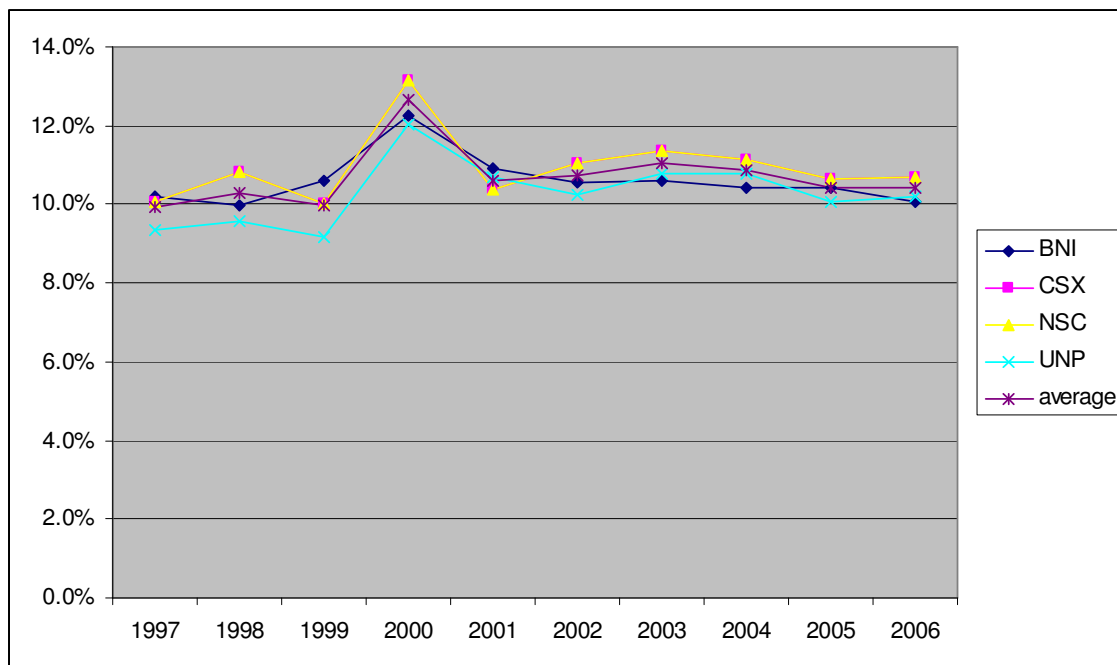


Figure 7: Implied Cost of Equity (r_e) using the Residual Income Valuation Model

While the RIV Model produces stable estimates of the cost of capital, the RIV Model has some drawbacks. The primary drawback is that the RIV Model does not provide a closed form solution and must be solved numerically. Another drawback is the fact that the RIV Model is not parsimonious as one also needs to make assumptions about the convergence of ROEs to industry

median. For instance, deciding the horizon over which ROE converges to the industry median allows for an additional degree of freedom in calculation. Finally, the RIV Model also relies on noisy estimates of long term growth in earnings or dividends.

Despite these drawbacks, the implementation of the RIV Model provides an important insight. Using a completely independent model as compared to the OJ Model, one is able to obtain estimates of costs of equity comparable to the OJ Model. Further, the costs of capital estimates are steady across time and across firms.

7. Recommendation to the STB

The STB has proposed to eliminate the DCF based model and employ a CAPM based approach in order to address the one problem that afflicts the DCF model – the inability to handle high growth rates in the short and intermediate term which may not persist into the future. However, CAPM also introduces a litany of new problems in theory and in practice.

I recommend the STB adopt the Ohlson-Juettner (OJ) Model as presented in this paper to compute the cost of capital. The OJ Model is based on the generalization of the very same dividend discount model on which the DCF model is based. The OJ Model has the added feature of being able to handle growth and the OJ Model is parsimonious, requiring only estimates of earnings per share in the next two years (eps_1 and eps_2) as well as an estimate of dividend payout. The OJ Model also provides a closed form solution in the form of a simple and easy to apply formula.

The OJ model provides consistent and reasonable estimates of the cost of equity, especially when the short term growth rates used in its computation ($eps_2/eps_1 - 1$) are capped at

20%. The estimates are stable across time as well as across the individual railroad firms. The OJ Model provides an average estimate of approximately 12.6% over the 1997-2006 period and 12.4% using only 2006 data.

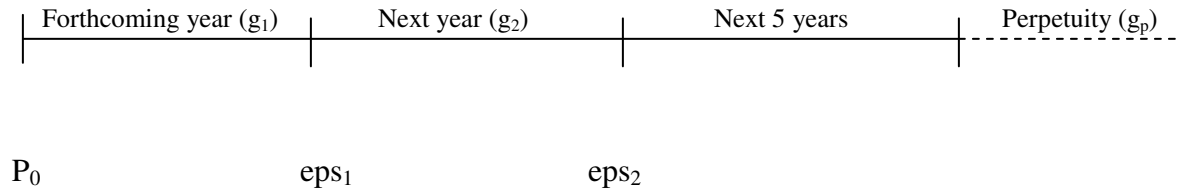
I recommend that the STB use the OJ Model to compute the cost of equity, capping the short term growth rates at 20%. In the event the STB decides to use a CAPM based framework to estimate the cost of capital, the STB needs to ensure that the input parameters used are appropriately measured. I have demonstrated in this paper that the risk premium used in CAPM should be approximately 6% and β at least 1.1. These parameters yield a cost of equity estimate of 11.1% assuming a risk free rate of 4.5%, which is much closer to the OJ estimate of 12.0% than the 8.4% proposed by the STB for 2005.

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APPENDIX: DERIVING THE OHLSON-JUETTNER MODEL

The Ohlson-Juettner (2005) or OJ model relates price to expected earnings and growth in expected earnings. Analysts typically provide three growth forecasts: eps_1 , eps_2 , and annualized five-year earnings growth. Although analysts do not provide estimates of “perpetual” growth, their valuation models assume a perpetual growth rate either explicitly or implicitly when a terminal value is calculated.



To elucidate the intuition underlying the OJ model, I present the OJ model as a generalization of the Gordon growth model. The formal assumptions of the OJ model are provided after this generalization. The Gordon growth model makes the following assumptions: (1) Price equals the present value of expected dividends; (2) There is a fixed dividend payout in relation to earnings. For simplicity, I examine the case of a full payout; (3) There is a constant perpetual earnings growth rate g_p .

These assumptions yield the following well-known formula: $P_0 = \frac{eps_1}{r_e - g_p}$, where r_e is the cost of equity capital. Adding and subtracting $\frac{eps_1}{r_e}$ to the right-hand side of the above equation yields the following:

$$P_0 = \frac{eps_1}{r_e} - \frac{eps_1}{r_e} + \frac{eps_1}{r_e - g_p} = \frac{eps_1}{r_e} + \frac{g_p eps_1}{r_e(r_e - g_p)}$$

Because $g_p eps_1 = eps_2 - eps_1$ due to the uniform growth rate assumption of the Gordon Growth model, I get with some simple algebra

$$P_0 = \frac{eps_1}{r_e} + \frac{eps_2 - eps_1}{r_e(r_e - g_p)}$$

The OJ model generalizes this formula in the following ways:

- i. The OJ model makes the same basic assumption that price equals present value of expected dividends (see assumption 1 of the OJ model below).
- ii. The OJ model imposes NO restrictions on the payout policy. Instead, it builds in Modigliani-Miller dividend irrelevance by correcting for earnings foregone due to dividend payouts (see assumption 2 of the OJ model below). Thus, instead of $[eps_2 - eps_1]$, the OJ model uses $[eps_2 - eps_1 - r_e(eps_1 - dps_1)]$; i.e., the abnormal change in earnings is defined to be the change in earnings in excess of the return on net reinvestment during the period $r_e(eps_1 - dps_1)$. Note that with full payout (i.e., $dps_1 = eps_1$), the abnormal change in earnings simply equals $[eps_2 - eps_1]$.
- iii. Instead of a single constant perpetual growth rate g_p , the OJ model allows the short-term growth $\hat{g}_2 = \frac{(eps_2 - eps_1 - r_e(eps_1 - dps_1))}{eps_1}$ to differ from g_p . The short-term growth is assumed to decay asymptotically to g_p . The decay rate is also determined by g_p (see assumption 2 below).

Formally, the OJ model makes the following assumptions:

Assumption 1: $P_0 = \sum_{t=1}^{\infty} \frac{dps_t}{(1+r_e)^t}$, where $r_e > 0$ is a fixed constant.

Assumption 2: Let $z_t = \frac{(eps_{t+1} - eps_t - r_e(eps_t - dps_t))}{r_e}$. The sequence $\{z_t\}_{t=1}^{\infty}$ satisfies $z_{t+1} =$

$$(1+g_p)*z_t$$

$t = 1, 2, \dots$, where $0 \leq g_p \leq r_e$ and $z_1 > 0$.

The OJ model yields the following pricing equation:

$$P_0 = \frac{eps_1}{r_e} + \frac{(eps_2 - eps_1 - r_e(eps_1 - dps_1))}{r_e(r_e - g_p)}$$

Rearranging, one gets the following:

$$\begin{aligned} r_e &= A + \sqrt{A^2 + \frac{eps_1}{P_0}(g_2 - g_p)} \\ \text{where } A &= \frac{1}{2} \left(g_p + \frac{dps_1}{P_0} \right) \text{ and } g_2 = \frac{(eps_2 - eps_1)}{eps_1} \end{aligned}$$

Note that the expression above yields the Gordon growth model if $dps_t = k*eps_t$ and $g_2 = g_p$.

Table 1: Estimation of the Risk Premium Using Historical Data**Panel A: Historical Performance of US Equity Markets**

Year	NYSE	T-Bill	T-Bond	Year	NYSE	T-Bill	T-Bond	Year	NYSE	T-Bill	T-Bond
1928	39.0%	3.1%	0.8%	1955	25.3%	1.2%	-1.3%	1981	-4.1%	15.5%	8.2%
1929	-14.6%	3.2%	4.2%	1956	8.5%	2.5%	-2.3%	1982	21.0%	10.9%	32.8%
1930	-28.8%	4.6%	4.5%	1957	-10.4%	3.2%	6.8%	1983	22.8%	7.9%	3.2%
1931	-44.4%	2.3%	-2.6%	1958	44.8%	3.0%	-2.1%	1984	5.8%	9.0%	13.7%
1932	-8.5%	1.1%	8.8%	1959	12.6%	2.8%	-2.6%	1985	31.7%	8.1%	25.7%
1933	57.5%	1.0%	1.9%	1960	1.2%	4.5%	11.6%	1986	17.3%	7.1%	24.3%
1934	4.3%	0.3%	8.0%	1961	26.9%	2.3%	2.1%	1987	2.9%	5.5%	-5.0%
1935	44.8%	0.2%	4.5%	1962	-9.9%	2.6%	5.7%	1988	17.6%	5.8%	8.2%
1936	32.2%	0.2%	5.0%	1963	21.4%	2.9%	1.7%	1989	29.6%	8.1%	17.7%
1937	-34.6%	0.1%	1.4%	1964	16.3%	3.5%	3.7%	1990	-4.3%	7.6%	6.2%
1938	28.1%	0.1%	4.2%	1965	14.1%	3.8%	0.7%	1991	30.7%	6.7%	15.0%
1939	2.1%	0.0%	4.4%	1966	-8.9%	4.4%	2.9%	1992	8.2%	4.1%	9.4%
1940	-7.4%	0.0%	5.4%	1967	26.8%	5.0%	-1.6%	1993	10.7%	3.2%	14.2%
1941	-9.6%	0.0%	-2.0%	1968	12.8%	5.0%	3.3%	1994	-0.1%	3.1%	-8.0%
1942	16.3%	0.3%	2.3%	1969	-9.8%	6.0%	-5.0%	1995	35.0%	5.6%	23.5%
1943	28.0%	0.4%	2.5%	1970	1.3%	7.8%	16.8%	1996	21.3%	5.1%	1.4%
1944	21.4%	0.4%	2.6%	1971	15.8%	4.9%	9.8%	1997	32.3%	4.9%	9.9%
1945	38.5%	0.4%	3.8%	1972	17.6%	4.0%	2.8%	1998	19.2%	5.2%	14.9%
1946	-5.9%	0.4%	3.1%	1973	-16.9%	5.1%	3.7%	1999	10.3%	4.4%	-8.3%
1947	3.4%	0.4%	0.9%	1974	-26.8%	7.5%	2.0%	2000	3.8%	5.4%	16.7%
1948	2.3%	1.0%	2.0%	1975	37.7%	7.2%	3.6%	2001	-8.5%	5.7%	5.6%
1949	20.0%	1.2%	4.7%	1976	26.2%	5.4%	16.0%	2002	-18.2%	1.8%	15.1%
1950	30.0%	1.1%	0.4%	1977	-4.8%	4.4%	1.3%	2003	29.1%	1.8%	0.4%
1951	20.8%	1.3%	-0.3%	1978	7.3%	6.1%	-0.8%	2004	13.9%	2.2%	4.5%
1952	13.3%	1.7%	2.3%	1979	21.9%	9.1%	0.7%	2005	8.5%	4.3%	2.9%
1953	0.4%	2.1%	4.1%	1980	32.6%	12.0%	-3.0%	2006	17.6%	4.9%	2.0%
1954	50.3%	1.6%	3.3%								

Panel B: Calculation of Risk Premium

Horizon	Period	NYSE	T-Bill	T-Bond	NYSE-T-Bill	NYSE-T-Bond
last 20 years	1987-2006				8.2%	5.7%
last 30 years	1977-2006				7.5%	5.3%
last 40 years	1967-2006				6.3%	4.8%
last 50 years	1957-2006				6.6%	5.4%
last 60 years	1947-2006				8.1%	7.2%
last 70 years	1937-2006				8.0%	6.8%
Entire Period	1928-2006				8.0%	6.7%

Table 2: Excerpts from Fama and French (1997) paper on Industry Costs of Equity (Table 7, page 172-173)

Regression slopes and risk premiums in CAPM and three-factor costs of equity

The industries are defined in Appendix A. The risk premiums (*CE*'s) in the cost of equity are obtained by substituting the regression slopes in the table and the average monthly $R_M - R_f$, *SMB*, and *HML* returns for 7/63 to 12/94 (Table 1) into (2) and (4) and then multiplying by 12. The full-period *CE*'s use the slopes from (2) and (4) for 7/63 to 12/94 in Table 2. The five-year *CE*'s use shrunk CAPM and three-factor slopes (see Appendix C) estimated on the five years of monthly returns ending in 12/94. The conditional *CE*'s use the slopes from (6) for 7/65 to 12/94. For these estimates, $s = s_1 + s_2 \ln(ME)$ and $h = h_1 + h_2 \ln(BE/ME)$, where s_1 , s_2 , h_1 , and h_2 are slopes from Table 4, and $\ln(ME)$ and $\ln(BE/ME)$ are for 12/94.

	CAPM				Three-Factor								
	Full-period		Five-year		Full-period				Conditional				Five-year
	CE	b	CE	b	CE	b	s	h	CE	b	s	h	CE
Restaurants	6.75	1.32	6.73	1.32	6.81	1.12	0.74	-0.24	7.23	1.12	0.56	0.05	8.24
Construction	6.52	1.28	6.42	1.26	6.42	1.21	0.21	-0.09	9.69	1.23	0.77	0.17	8.68
Retail	5.68	1.11	5.96	1.17	5.88	1.04	0.27	0.06	5.65	1.05	0.28	-0.12	4.51
Agriculture	5.11	1.00	4.98	0.97	6.51	0.85	0.71	-0.02	6.03	0.84	0.60	0.04	5.65
Machinery	5.93	1.16	5.49	1.08	6.46	1.11	0.25	- 0.00	7.54	1.12	0.45	0.07	9.09
Aircraft	6.43	1.26	4.98	0.97	7.54	1.15	0.51	0.00	7.57	1.15	0.20	0.20	5.25
Electrical Equipment	5.86	1.15	5.91	1.16	5.98	1.15	- 0.00	0.02	6.05	1.16	- 0.04	0.05	6.43
Building Materials	5.76	1.13	5.19	1.02	6.40	1.11	0.15	0.05	6.74	1.12	0.16	0.10	5.93
Transportation	6.17	1.21	5.92	1.16	7.39	1.16	0.30	0.09	7.30	1.16	0.38	0.03	7.78
Fabricated Products	6.71	1.31	5.81	1.14	9.69	1.11	1.10	0.09	8.82	1.09	0.92	0.05	5.24
Apparel	6.33	1.24	6.80	1.33	8.85	1.09	0.83	0.11	6.37	1.07	0.68	-0.24	6.28
Chemicals	5.57	1.09	5.44	1.06	6.58	1.13	-0.03	0.17	6.60	1.13	-0.05	0.18	6.13
Shipbuilding, Railroad Equipment	6.07	1.19	4.86	0.95	8.63	1.09	0.66	0.17	5.85	1.03	0.69	-0.31	8.99
Non-metallic Mining	4.99	0.98	3.38	0.66	7.65	0.91	0.53	0.23	6.96	0.91	0.66	0.03	7.85
Textiles	5.71	1.12	6.00	1.17	9.18	1.03	0.71	0.30	7.60	1.02	0.79	-0.03	9.12
Real Estate	5.99	1.17	5.19	1.02	11.16	1.01	1.18	0.40	11.55	1.00	1.27	0.43	9.00
Steelworks etc.	5.94	1.16	5.43	1.06	9.61	1.17	0.40	0.43	9.12	1.16	0.57	0.25	9.13
Automobiles & Trucks	5.13	1.01	5.24	1.03	9.39	1.10	0.17	0.60	5.12	1.12	0.37	-0.33	11.74

Table 3: Calculating the OJ Cost of Equity for Railroad Firms

year	PRICE ₀	eps ₁	eps ₂	payout	dps ₁	g ₂	g _p	A	r _e
Panel A: Burlington Northern (BNI)									
1997	29.21	2.04	2.49	35.9%	0.73	22.1%	4.0%	3.3%	14.9%
1998	32.87	2.38	2.68	34.6%	0.82	12.6%	4.0%	3.3%	11.8%
1999	31.19	2.42	2.79	19.9%	0.48	15.3%	4.0%	2.8%	12.5%
2000	23.44	2.68	3.02	19.5%	0.52	12.7%	4.0%	3.1%	13.6%
2001	29.64	2.48	2.87	19.2%	0.48	15.7%	4.0%	2.8%	13.1%
2002	29.79	2.11	2.52	21.7%	0.46	19.4%	4.0%	2.8%	13.6%
2003	29.35	2.15	2.45	23.2%	0.50	14.0%	4.0%	2.9%	11.9%
2004	34.29	2.46	2.77	25.2%	0.62	12.6%	4.0%	2.9%	11.3%
2005	49.21	3.8	4.28	26.7%	1.02	12.6%	4.0%	3.0%	11.7%
2006	73.31	4.91	5.64	24.7%	1.22	14.9%	4.0%	2.8%	11.8%
Panel B: CSX Corp (CSX)									
1997	27.06	2.11	2.27	28.6%	0.60	7.6%	4.0%	3.1%	9.2%
1998	23.53	1.83	2.25	29.0%	0.53	23.0%	4.0%	3.1%	15.7%
1999	22.84	1.3	1.77	34.8%	0.45	36.2%	4.0%	3.0%	16.8%
2000	10.25	0.79	1.34	33.1%	0.26	69.6%	4.0%	3.3%	26.0%
2001	17.99	0.83	1.26	30.4%	0.25	51.8%	4.0%	2.7%	17.8%
2002	17.19	1.11	1.46	33.6%	0.37	31.5%	4.0%	3.1%	16.8%
2003	15.3	1.11	1.37	32.7%	0.36	23.4%	4.0%	3.2%	15.5%
2004	15.92	1.09	1.32	40.8%	0.44	21.1%	4.0%	3.4%	14.7%
2005	21.42	1.51	1.71	28.2%	0.43	13.2%	4.0%	3.0%	11.6%
2006	30.93	2.18	2.53	26.3%	0.57	16.1%	4.0%	2.9%	12.6%
Panel C: Norfolk Southern (NSC)									
1997	33.33	2.16	2.31	38.2%	0.82	6.9%	4.0%	3.2%	8.7%
1998	29.88	2.07	2.45	39.4%	0.82	18.4%	4.0%	3.4%	13.9%
1999	32.94	1.71	2.25	42.7%	0.73	31.6%	4.0%	3.1%	15.5%
2000	17.19	1	1.55	39.2%	0.39	55.0%	4.0%	3.1%	20.6%
2001	20.57	0.96	1.38	33.8%	0.32	43.8%	4.0%	2.8%	16.7%
2002	22.11	1.17	1.48	26.3%	0.31	26.5%	4.0%	2.7%	13.9%
2003	20.95	1.37	1.58	24.8%	0.34	15.3%	4.0%	2.8%	11.9%
2004	25.07	1.77	1.96	25.4%	0.45	10.7%	4.0%	2.9%	10.4%
2005	32.14	2.51	2.88	22.1%	0.56	14.7%	4.0%	2.9%	12.5%
2006	49.75	3.46	3.96	19.8%	0.69	14.5%	4.0%	2.7%	11.6%
Panel D: Union Pacific (UNP)									
1997	69.88	3.87	4.82	47.7%	1.85	24.5%	4.0%	3.3%	14.5%
1998	45.25	0.95	3.08	68.5%	0.65	224.2%	4.0%	2.7%	24.4%
1999	58.81	2.77	3.98	53.2%	1.47	43.7%	4.0%	3.3%	17.3%
2000	40.75	3.92	4.69	44.8%	1.76	19.6%	4.0%	4.2%	17.1%
2001	54.91	4.07	4.73	19.9%	0.81	16.2%	4.0%	2.7%	12.6%
2002	64.27	4.34	4.88	23.1%	1.00	12.4%	4.0%	2.8%	10.8%
2003	59.88	4.22	5.07	19.8%	0.84	20.1%	4.0%	2.7%	13.7%
2004	58.08	3.26	4.61	20.0%	0.65	41.4%	4.0%	2.6%	17.3%
2005	65.67	3.34	4.59	30.4%	1.02	37.4%	4.0%	2.8%	16.1%
2006	87.59	5.28	6.45	35.4%	1.87	22.2%	4.0%	3.1%	14.0%

Table 4: Calculating the OJ Cost of Equity for Railroad Firms with short term growth rate capped at 20%

year	PRICE ₀	eps ₁	eps ₂	payout	dps ₁	g ₂	g _p	A	r _e
Panel A: Burlington Northern (BNI)									
1997	29.21	2.04	2.49	35.9%	0.73	20.0%	4.0%	3.3%	14.3%
1998	32.87	2.38	2.68	34.6%	0.82	12.6%	4.0%	3.3%	11.8%
1999	31.19	2.42	2.79	19.9%	0.48	15.3%	4.0%	2.8%	12.5%
2000	23.44	2.68	3.02	19.5%	0.52	12.7%	4.0%	3.1%	13.6%
2001	29.64	2.48	2.87	19.2%	0.48	15.7%	4.0%	2.8%	13.1%
2002	29.79	2.11	2.52	21.7%	0.46	19.4%	4.0%	2.8%	13.6%
2003	29.35	2.15	2.45	23.2%	0.50	14.0%	4.0%	2.9%	11.9%
2004	34.29	2.46	2.77	25.2%	0.62	12.6%	4.0%	2.9%	11.3%
2005	49.21	3.8	4.28	26.7%	1.02	12.6%	4.0%	3.0%	11.7%
2006	73.31	4.91	5.64	24.7%	1.22	14.9%	4.0%	2.8%	11.8%
Panel B: CSX Corp (CSX)									
1997	27.06	2.11	2.27	28.6%	0.60	7.6%	4.0%	3.1%	9.2%
1998	23.53	1.83	2.25	29.0%	0.53	20.0%	4.0%	3.1%	14.7%
1999	22.84	1.3	1.77	34.8%	0.45	20.0%	4.0%	3.0%	13.0%
2000	10.25	0.79	1.34	33.1%	0.26	20.0%	4.0%	3.3%	14.9%
2001	17.99	0.83	1.26	30.4%	0.25	20.0%	4.0%	2.7%	11.7%
2002	17.19	1.11	1.46	33.6%	0.37	20.0%	4.0%	3.1%	13.7%
2003	15.3	1.11	1.37	32.7%	0.36	20.0%	4.0%	3.2%	14.4%
2004	15.92	1.09	1.32	40.8%	0.44	20.0%	4.0%	3.4%	14.4%
2005	21.42	1.51	1.71	28.2%	0.43	13.2%	4.0%	3.0%	11.6%
2006	30.93	2.18	2.53	26.3%	0.57	16.1%	4.0%	2.9%	12.6%
Panel C: Norfolk Southern (NSC)									
1997	33.33	2.16	2.31	38.2%	0.82	6.9%	4.0%	3.2%	8.7%
1998	29.88	2.07	2.45	39.4%	0.82	18.4%	4.0%	3.4%	13.9%
1999	32.94	1.71	2.25	42.7%	0.73	20.0%	4.0%	3.1%	12.7%
2000	17.19	1	1.55	39.2%	0.39	20.0%	4.0%	3.1%	13.3%
2001	20.57	0.96	1.38	33.8%	0.32	20.0%	4.0%	2.8%	11.9%
2002	22.11	1.17	1.48	26.3%	0.31	20.0%	4.0%	2.7%	12.3%
2003	20.95	1.37	1.58	24.8%	0.34	15.3%	4.0%	2.8%	11.9%
2004	25.07	1.77	1.96	25.4%	0.45	10.7%	4.0%	2.9%	10.4%
2005	32.14	2.51	2.88	22.1%	0.56	14.7%	4.0%	2.9%	12.5%
2006	49.75	3.46	3.96	19.8%	0.69	14.5%	4.0%	2.7%	11.6%
Panel D: Union Pacific (UNP)									
1997	69.88	3.87	4.82	47.7%	1.85	20.0%	4.0%	3.3%	13.3%
1998	45.25	0.95	3.08	68.5%	0.65	20.0%	4.0%	2.7%	9.1%
1999	58.81	2.77	3.98	53.2%	1.47	20.0%	4.0%	3.3%	12.5%
2000	40.75	3.92	4.69	44.8%	1.76	19.6%	4.0%	4.2%	17.1%
2001	54.91	4.07	4.73	19.9%	0.81	16.2%	4.0%	2.7%	12.6%
2002	64.27	4.34	4.88	23.1%	1.00	12.4%	4.0%	2.8%	10.8%
2003	59.88	4.22	5.07	19.8%	0.84	20.0%	4.0%	2.7%	13.7%
2004	58.08	3.26	4.61	20.0%	0.65	20.0%	4.0%	2.6%	12.4%
2005	65.67	3.34	4.59	30.4%	1.02	20.0%	4.0%	2.8%	12.2%
2006	87.59	5.28	6.45	35.4%	1.87	20.0%	4.0%	3.1%	13.4%

Table 5: Illustrating the Calculation Of Implied Cost Of Capital Using The Residual Income Valuation Method

Input Parameters for Burlington Northern (BNI) in 1997

Price on Jun 30th, 1997	\$29.21
Book Value per Share for year ended Dec 31st 1996	\$12.94
EPS Forecasts for next two years	\$2.04 for 1997 \$2.49 for 1998
Long Term Growth Rate Forecast	12.70%
Dividend Payout	35.90%
Industry Median ROE	13%
Terminal Growth for Residual Income	4%

PANEL A: INITIAL GUESS (11%)

Year	0	EXPLICIT FORECASTS		IMPLICIT FORECASTS			ROE REVERSION TO INDUSTRY MEDIAN BY YEAR 15									
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Book Value	12.94	14.24	15.84	17.64	19.66	21.94	24.42	27.09	29.97	33.06	36.35	39.85	43.57	47.48	51.59	55.88
EPS Forecast		2.04	2.49	2.81	3.16	3.56	3.86	4.17	4.49	4.82	5.14	5.47	5.79	6.11	6.42	6.71
ROE Forecast		15.8%	17.5%	17.7%	17.9%	18.1%	17.6%	17.1%	16.6%	16.1%	15.6%	15.0%	14.5%	14.0%	13.5%	13.0%
RI		0.62	0.92	1.06	1.22	1.40	1.45	1.49	1.51	1.52	1.51	1.47	1.41	1.32	1.19	1.03
TV																15.33
RI+TV		0.62	0.92	1.06	1.22	1.40	1.45	1.49	1.51	1.52	1.51	1.47	1.41	1.32	1.19	16.36
PV of RI Stream	\$11.90															
Add Book Value	\$12.94															
Value	\$24.83															
Gap	(\$4.38)															
Guessed Cost of Equity	11.00%															

PANEL B: REVISED GUESS (9%)

		EXPLICIT FORECASTS		IMPLICIT FORECASTS			ROE REVERSION TO INDUSTRY MEDIAN BY YEAR 15									
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Book Value	12.94	14.24	15.84	17.64	19.66	21.94	24.42	27.09	29.97	33.06	36.35	39.85	43.57	47.48	51.59	55.88
EPS Forecast		2.04	2.49	2.81	3.16	3.56	3.86	4.17	4.49	4.82	5.14	5.47	5.79	6.11	6.42	6.71
ROE Forecast		15.8%	17.5%	17.7%	17.9%	18.1%	17.6%	17.1%	16.6%	16.1%	15.6%	15.0%	14.5%	14.0%	13.5%	13.0%
RI		0.88	1.21	1.38	1.57	1.79	1.89	1.98	2.05	2.12	2.17	2.20	2.21	2.19	2.14	2.06
TV																42.92
RI+TV		0.88	1.21	1.38	1.57	1.79	1.89	1.98	2.05	2.12	2.17	2.20	2.21	2.19	2.14	44.99
PV of RI Stream	\$25.64															
Add Book Value	\$12.94															
Value	\$38.57															
Gap	\$9.36															
Guessed Cost of Equity	9.00%															

PANEL C: SOLUTION (using solver or goalseek)

		EXPLICIT FORECASTS		IMPLICIT FORECASTS			ROE REVERSION TO INDUSTRY MEDIAN BY YEAR 15									
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Book Value	12.94	14.24	15.84	17.64	19.66	21.94	24.42	27.09	29.97	33.06	36.35	39.85	43.57	47.48	51.59	55.88
EPS Forecast		2.04	2.49	2.81	3.16	3.56	3.86	4.17	4.49	4.82	5.14	5.47	5.79	6.11	6.42	6.71
ROE Forecast		15.8%	17.5%	17.7%	17.9%	18.1%	17.6%	17.1%	16.6%	16.1%	15.6%	15.0%	14.5%	14.0%	13.5%	13.0%
RI		0.72	1.04	1.19	1.36	1.56	1.63	1.69	1.73	1.76	1.77	1.76	1.73	1.67	1.58	1.45
TV																24.31
RI+TV		0.72	1.04	1.19	1.36	1.56	1.63	1.69	1.73	1.76	1.77	1.76	1.73	1.67	1.58	25.75
PV of RI Stream	\$16.28															
Add Book Value	\$12.94															
Value	\$29.21															
Gap	\$0.00															
Guessed Cost of Equity	10.19%															

Table 6: Calculating the RIV Cost of Equity for Railroad Firms using Residual Income Valuation

year	PRICE ₀	eps ₁	eps ₂	payout	BVPS ₀	roe ₁	roe ₅	roe ₁₅	r _e
Panel A: Burlington Northern (BNI)									
1997	29.21	2.04	2.49	35.9%	12.94	15.8%	18.1%	13.0%	10.2%
1998	32.87	2.38	2.68	34.6%	14.41	16.5%	17.0%	13.0%	10.0%
1999	31.19	2.42	2.79	19.9%	16.54	14.6%	14.6%	13.0%	10.6%
2000	23.44	2.68	3.02	19.5%	19.40	13.8%	13.5%	13.0%	12.3%
2001	29.64	2.48	2.87	19.2%	19.09	13.0%	13.0%	13.0%	10.9%
2002	29.79	2.11	2.52	21.7%	20.49	10.3%	11.4%	13.0%	10.6%
2003	29.35	2.15	2.45	23.2%	21.22	10.1%	10.9%	13.0%	10.6%
2004	34.29	2.46	2.77	25.2%	22.91	10.7%	11.5%	13.0%	10.4%
2005	49.21	3.8	4.28	26.7%	24.73	15.4%	15.6%	13.0%	10.4%
2006	73.31	4.91	5.64	24.7%	26.07	18.8%	19.5%	13.0%	10.1%
Panel B: CSX Corp (CSX)									
1997	27.06	2.11	2.27	28.6%	11.47	18.4%	16.8%	13.0%	10.1%
1998	23.53	1.83	2.25	29.0%	13.16	13.9%	15.7%	13.0%	10.8%
1999	22.84	1.3	1.77	34.8%	13.52	9.6%	13.0%	13.0%	10.0%
2000	10.25	0.79	1.34	33.1%	13.17	6.0%	10.7%	13.0%	13.1%
2001	17.99	0.83	1.26	30.4%	14.10	5.9%	10.2%	13.0%	10.4%
2002	17.19	1.11	1.46	33.6%	14.41	7.7%	11.5%	13.0%	11.1%
2003	15.3	1.11	1.37	32.7%	14.55	7.6%	10.3%	13.0%	11.4%
2004	15.92	1.09	1.32	40.8%	15.03	7.3%	10.0%	13.0%	11.1%
2005	21.42	1.51	1.71	28.2%	15.73	9.6%	11.4%	13.0%	10.6%
2006	30.93	2.18	2.53	26.3%	17.95	12.2%	15.2%	13.0%	10.7%
Panel C: Norfolk Southern (NSC)									
1997	33.33	2.16	2.31	38.2%	13.23	16.3%	15.9%	13.0%	9.2%
1998	29.88	2.07	2.45	39.4%	14.38	14.4%	16.2%	13.0%	9.9%
1999	32.94	1.71	2.25	42.7%	15.58	11.0%	14.6%	13.0%	9.3%
2000	17.19	1	1.55	39.2%	15.48	6.5%	10.9%	13.0%	11.2%
2001	20.57	0.96	1.38	33.8%	15.14	6.3%	10.1%	13.0%	10.1%
2002	22.11	1.17	1.48	26.3%	15.69	7.5%	10.3%	13.0%	10.1%
2003	20.95	1.37	1.58	24.8%	16.68	8.2%	10.4%	13.0%	10.7%
2004	25.07	1.77	1.96	25.4%	17.79	10.0%	11.0%	13.0%	10.5%
2005	32.14	2.51	2.88	22.1%	19.76	12.7%	14.8%	13.0%	11.0%
2006	49.75	3.46	3.96	19.8%	22.40	15.5%	16.5%	13.0%	10.3%
Panel D: Union Pacific (UNP)									
1997	69.88	3.87	4.82	47.7%	33.31	11.6%	15.7%	13.0%	9.3%
1998	45.25	0.95	3.08	68.5%	33.26	2.9%	11.4%	13.0%	9.6%
1999	58.81	2.77	3.98	53.2%	29.84	9.3%	14.8%	13.0%	9.2%
2000	40.75	3.92	4.69	44.8%	32.28	12.1%	15.1%	13.0%	12.0%
2001	54.91	4.07	4.73	19.9%	34.94	11.7%	12.8%	13.0%	10.7%
2002	64.27	4.34	4.88	23.1%	38.02	11.4%	12.8%	13.0%	10.3%
2003	59.88	4.22	5.07	19.8%	41.92	10.1%	12.0%	13.0%	10.8%
2004	58.08	3.26	4.61	20.0%	47.67	6.8%	10.0%	13.0%	10.8%
2005	65.67	3.34	4.59	30.4%	48.12	6.9%	9.6%	13.0%	10.1%
2006	87.59	5.28	6.45	35.4%	50.96	10.4%	14.5%	13.0%	10.2%