

# Predicting Market Prices of Fixed Income Instruments Using Axiom Valuation Solutions' Credit Rating and Fair Value Pricing Platform

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Axiom Valuation Solutions' fixed income credit and fair value pricing platform is used to fair value fixed income instruments (leveraged loans, high yield corporate bonds, and securitizations [e.g. CLO and CDO interests]). This paper shows that the credit and pricing platform yields unbiased estimates of market prices and therefore meets an important and emerging standard being applied by regulatory authorities.

## Introduction

In the current regulatory environment a necessary but not a sufficient condition for establishing a non-traded asset's fair value price is to demonstrate that the system used to produce it yields an unbiased estimate of a transaction price at the measurement date. This developing standard is being applied by oversight organizations as well as audit firms. For example, the Securities and Exchange Commission's ***Aberrational Performance Initiative*** is designed to uncover misreporting of fair values of underlying assets of hedge and private equity funds. While many hedge funds only invest in financial securities that trade, many fixed income funds as well as CLOs and CDOs invest in debt instruments that do not trade on a regular basis and for which there is no dealer quote. In cases where dealer bid-asked quotes are available, they often do not accurately reflect the range with which the transaction would take place. In this case, a dealer quote does not meet the fair value financial reporting standard. Since a significant percentage of fixed income securities do not trade on a regular basis and are not routinely priced as a result, other means need to be employed that properly mimic transaction market activity in order to establish a non-traded asset's fair value. This paper is the first of several papers that Axiom Valuation Solutions ("Axiom") will produce, to address this critical issue.

The research design employed by Axiom is divided into three distinct phases. In the first phase, one tests whether the system can accurately reproduce prices of traded securities. The second phase identifies factors that determine the illiquidity associated with non-traded securities. The third phase combines the results of the first two phases and tests how accurately the system reproduces reported prices at which illiquid securities have been exchanged. This paper reports phase one research results. ***These results indicate that Axiom's Credit Rating and Fair Value Pricing Platform produces unbiased estimates of market prices.***

The research design used here assumes that market prices reflect a security's intrinsic value. The assumption is consistent with Topic 820's definition of fair value that views a transaction price in a primary market under normal market conditions as the best indicator of a security's market value. This standard assumes that observed transaction prices reflect all the information that market participants have at the time of the transaction and therefore the price is consistent with received efficient market theory. In this context, a price prediction that is above or below a market price reflects pricing error and not an arbitrage opportunity.

In order to test the predictive accuracy of Axiom's Credit Rating and Fair Value Pricing Platform, we drew a sample of fixed income securities that were transacted on October 31, 2011 and reported on TRACE. These securities were not used to develop Axiom's Credit Rating and Fair Value Pricing Platform, and therefore the extent to which the system can reproduce these prices is a powerful test of the system's accuracy.

## The Process

Axiom's process for pricing fixed income securities is made up of five distinct parts.

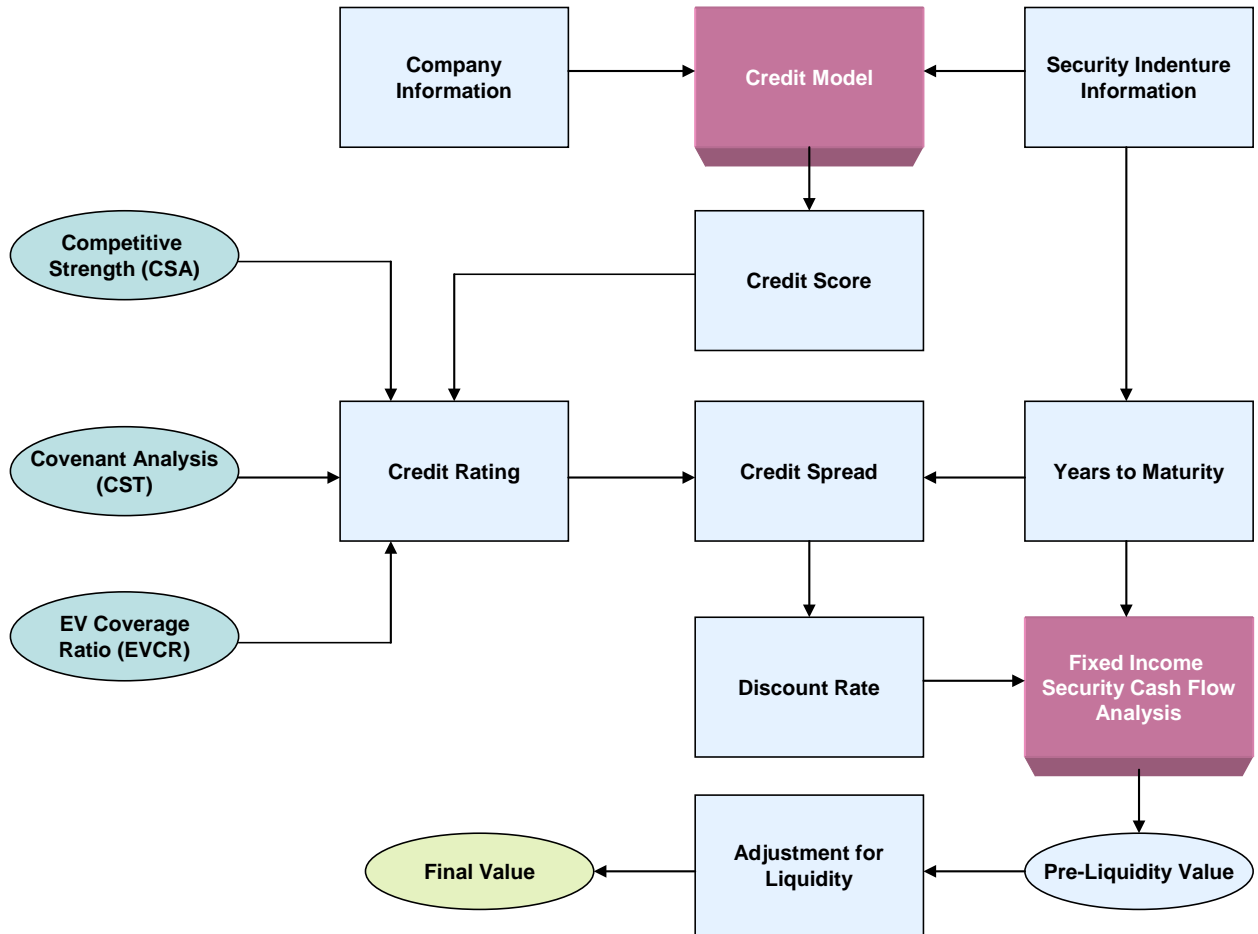
1. Develop an initial credit rating for the security in question using Axiom's credit rating model.
2. Augment the initial credit rating based on three factors.
  - a. Competitive Strength Assessment (CSA): Industry and firm-specific factors that determine the degree to which barriers to entry exist that mitigate or enhance the initial assessment of credit risk
  - b. Covenant Stress Testing (CST) based on indenture requirements
  - c. Calculating the Enterprise Value Coverage Ratio (EVCR) as the ratio of the enterprise value of the issuer, under the assumption that it is all-equity financed, to the debt being rated after the par value of all senior classes of debt are subtracted from the firm's enterprise value.
3. The final credit rating is established by adjusting the credit rating in step 1 based on the analysis in step 2. The rating adjustments never exceed plus/minus three notches from the initial rating.<sup>1</sup>
4. Given the rating established in 3 above, the required rate of return is then equal to the Treasury rate for a given maturity plus a credit spread. The credit spread is obtained as of the measurement date and it is for instruments that have the same credit risk and maturity as the security to be valued. The credit spread data is publicly available and reflects the reward that market participants require for taking on credit risk.
5. Given a security's coupon, the required rate of return, the amortization schedule, and the maturity of the instrument in question, the pre-liquidity value of the instrument is determined.

Exhibit 1 below summarizes the components of Axiom's Credit Rating and Fair Value Pricing Platform.

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<sup>1</sup> An example of the adjustment to the initial credit rating, keeping in mind that a lower value implies lower credit risk, is the following: If the initial Axiom credit rating is 12, the CSA is three or higher, the CST is less than 85% and the EVCR is greater than 1.10, the final credit rating is 9. Alternatively, a CSA less than three, CST greater than 95%, and an EVCR below one, yields a final rating of 15.

**Chart 1-1: Flow of Fixed Income Security Pricing Process**  
Source: Axiom

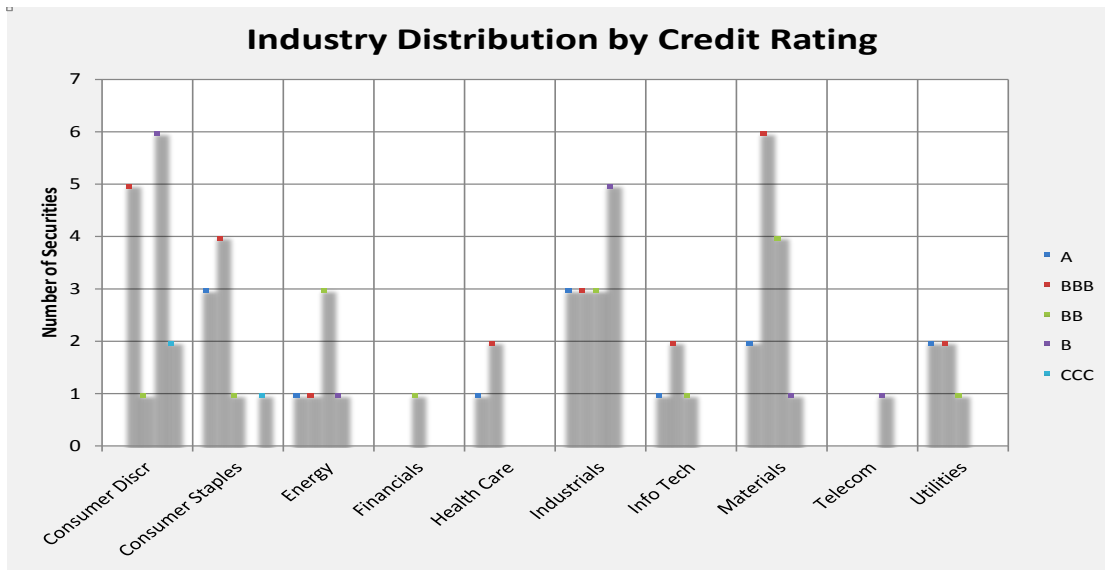


### Characteristics of the Test Sample

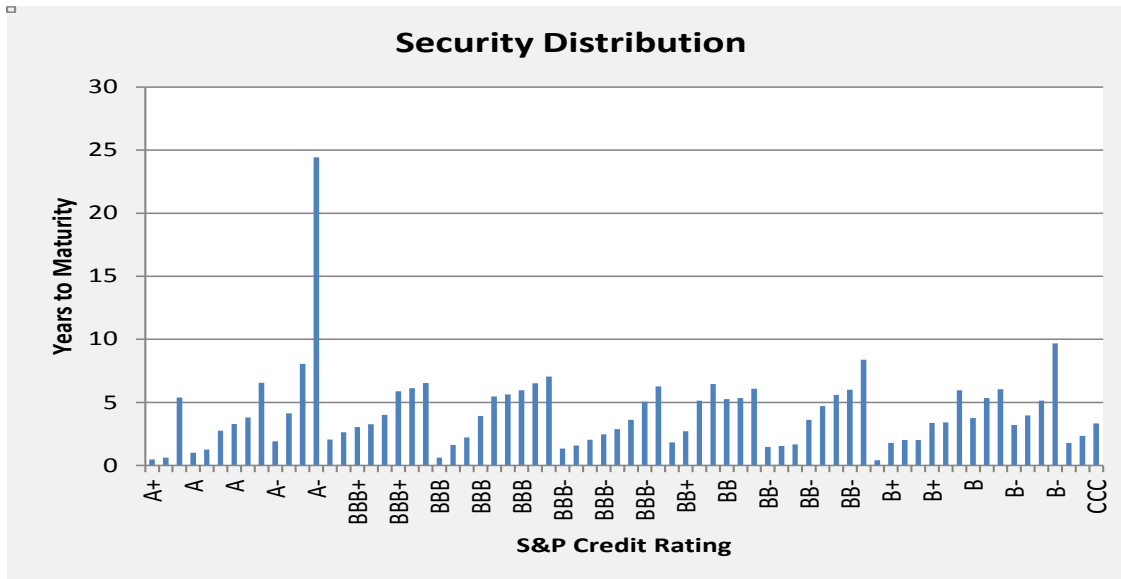
The source of the study's data is TRACE. Each of the 70 bonds in the sample was transacted on October 31, 2011 and the prices were reported on TRACE. The bonds were evenly distributed across industries and ratings categories as shown in Chart 1-2. AAA bonds were not included in the sample since Axiom's model was designed to price financial securities in the lower end of the credit risk spectrum.

Most of the bonds matured within one to five years, with about 38% with longer maturities. Maturities by credit category are shown in Chart 1-3.

**Chart 1-2: Distribution of Bonds Across Industry and Credit Categories**  
Source: Axiom



**Chart 1-3: Distribution of Bonds Across Credit Categories by Maturity**  
Source: Axiom



### Question 1 Results

We first developed a credit rating for each bond using Axiom’s Credit Rating Platform. This raw rating was then adjusted depending on the size of the EVCR.<sup>2</sup> If the EVCR was high (greater than 1.5), the credit rating was raised. Alternatively, if the EVCR was below unity, the credit rating would be lowered. If the EVCR was between 1 and 1.5, the credit rating was not adjusted. The raw rating was never adjusted by more than three notches (e.g. CCC+ to B+) which reflects the average difference between the Axiom and S&P credit rating.

Once the credit rating was determined, the yield to maturity (YTM) on the security was set equal to the Treasury rate plus a credit spread. Both the Treasury rate and the credit spread were based on the same maturity as the security being priced. Credit spreads were based on data from Reuters and Bloomberg. Given a security’s YTM, and contract cash flows, we calculated its value. The table below summarizes the overall results.

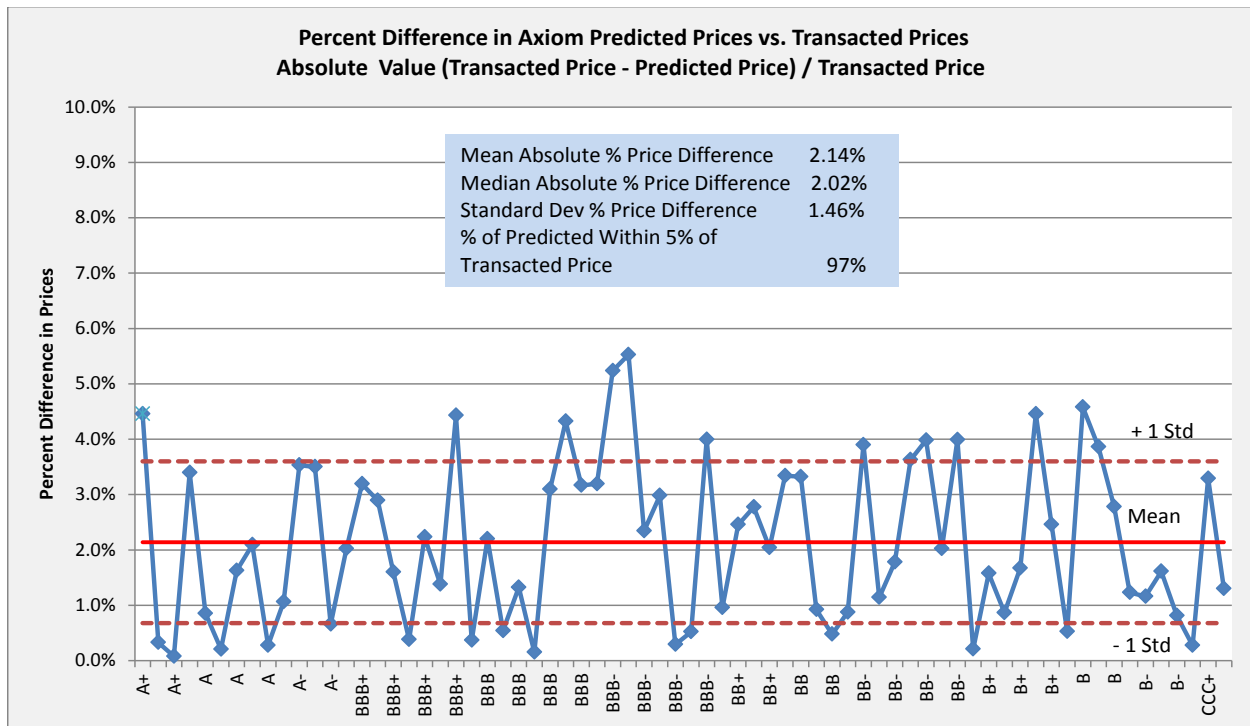
	Axiom
Within 5%	97%
Within 10%	100%

The results indicate that Axiom’s system generated prices that are within 5% of the transaction price for 97% of the securities priced. Chart 1-4 below shows this result in more detail.

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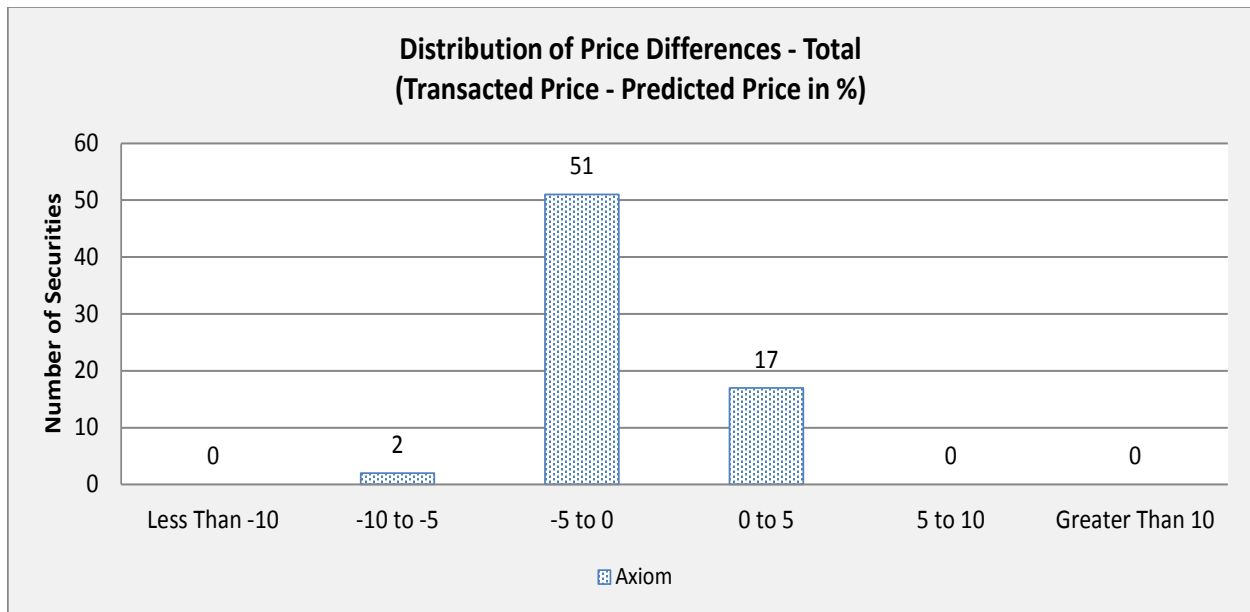
<sup>2</sup> While Axiom’s platform evaluates other factors to arrive at a final rating as discussed in the overview section, we only used EVCR in the study since it is a quantitative and fully objective way to adjust the raw credit rating.

**Chart 1-4: Percent Difference in Axiom Predicted Prices vs. Transacted Prices**  
**Source: Axiom**



The results indicate that Axiom’s Credit Rating and Fair Value Pricing Platform can accurately predict transaction prices. A 2% error means that on average a security transacting for 100 would be priced at 98. The standard deviation of the pricing difference indicates there is a narrow range between predicted and transaction prices. This last point is supported by the results shown in the chart below.

**Chart 1-5: Distribution of Price Differences**  
 Source: Axiom



Although Axiom’s platform accurately predicts security prices, it does not do it perfectly. The question is whether these errors are systematic or random. If the errors are systematic, this would indicate that the system that generated the prices was incomplete; that is, the system was not reflective of the factors that market participants consider when valuing fixed income financial instruments. In order to test this hypothesis, we regressed Axiom predicted prices against actual transaction prices. If the constant term and the slope coefficient of the regression are not significantly different from zero and unity respectively, we can conclude that predicted prices are unbiased estimates of transaction prices<sup>3</sup>. This means that the differences between Axiom predicted and transaction prices are on average random and that Axiom predicted prices offer the best estimate of transaction prices. The results of this regression are shown below.

<sup>3</sup> This test is formally known as the Mincer-Zarnowitz test.



**Table 1-6: Regression Results of Price Differences for Axiom Adjusted Prices and Traded Prices**  
**Source: Axiom**

<i>Regression Statistics</i>						
Multiple R	0.955381796					
R Square	0.912754377					
Adjusted R Square	0.911471353					
Standard Error	2.226131146					
Observations	70					
ANOVA						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	1	3525.499688	3525.499688	711.4087273	9.74103E-38	
Residual	68	336.9848718	4.955659879			
Total	69	3862.48456				
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	-0.518529545	4.0625903	-0.127635205	0.898814373	-8.62530227	7.588243179
Predicted Price	1.02064158	0.038266052	26.67224639	9.74103E-38	0.944282862	1.097000299

***The above results support the conclusion that the forecast errors generated by Axiom's system are random. This indicates that Axiom's Credit Rating and Fair Value Pricing Platform is consistent with the way market participants price bonds.***

## Results for Question 2

We also compared Axiom price forecasts with those generated using the S&P rating. The methodology employed was the same as before. The YTM was calculated as the Treasury base rate plus a credit spread based on the rating assigned by S&P. We used the same 70 bonds as in the previous test. The results are reported below.

	S&P Rating	Axiom
Within 5%	76%	97%
Within 10%	97%	100%

The results indicate that Axiom's Credit Rating and Fair Value Pricing Platform provides a better estimate of a security's price than simply basing the projected price on the S&P rating. Relative to S&P's 76%, 97% of Axiom's price forecasts are within 5% of their respective transaction prices. This improvement may be a function of the fact that the S&P rating may be stale while Axiom's rating is based on the most recent financial information about the performance of the issuing company. The table below displays the S&P - Axiom comparison in terms of the average, median, and standard deviation of the price difference.

## Credit Rating and Fair Value Pricing Platform

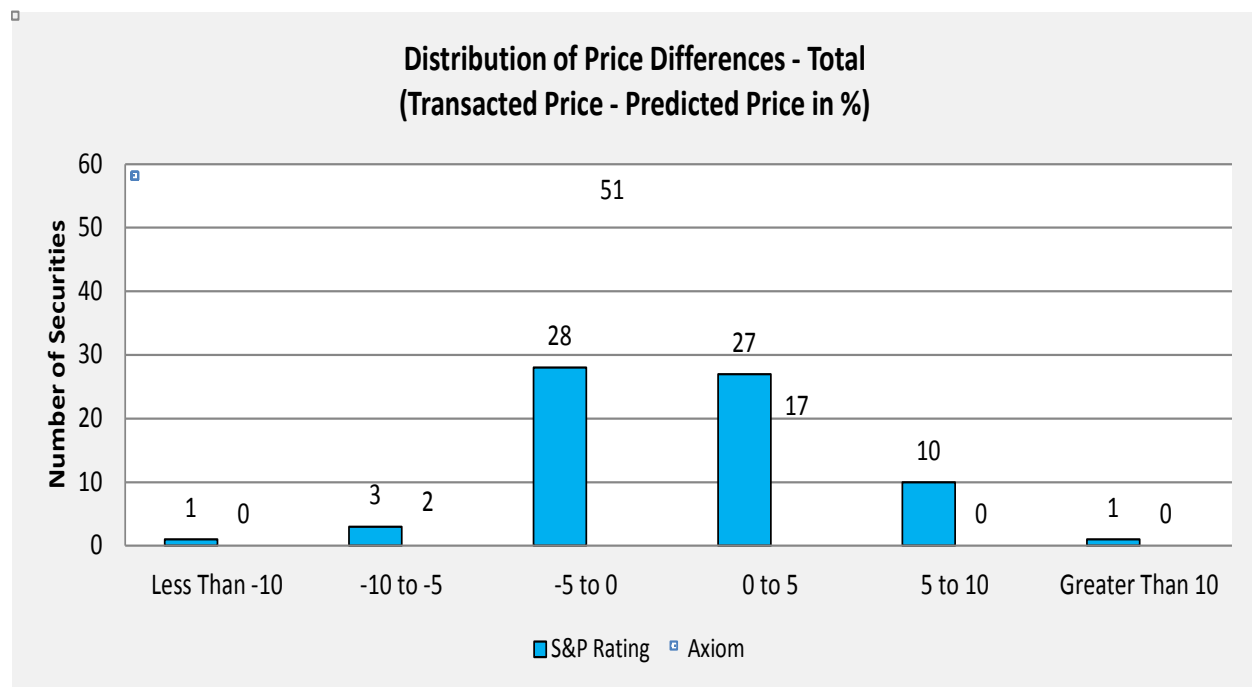
	Difference in Price (%)	
	S&P	Axiom
Average	3.04%	2.14%
Median	2.02%	2.02%
STD	3.03%	1.46%

While the median price difference is the same for S&P and Axiom, the variability of Axiom's price difference is 50% of S&P's standard deviation while the average Axiom price difference is about a third lower than the S&P price difference.

Below is a table showing the distribution of price differences using the S&P credit rating and the Axiom rating. The distributions of price differences by credit rating are shown in the Appendix.

**Chart 1-7: Distribution of S&P and Axiom Ratings Price Differences**

Source: Axiom



Overall, these results indicate that Axiom's Credit Rating and Fair Value Pricing Platform is generally more accurate than simply using a credit agency rating and this is the case irrespective of risk class.

## **Conclusion**

This research presented herein shows that Axiom's Credit Rating and Fair Value Pricing Platform produces unbiased estimates of bond transaction prices. This finding is important since oversight authorities including the Securities and Exchange Commission are requiring reporting entities to demonstrate that the processes they use to fair value illiquid assets are consistent with transaction prices that would emerge if transactions took place at the measurement date.

Appendix

Chart A-1: Distribution of Price Differences – Total  
Source: Axiom

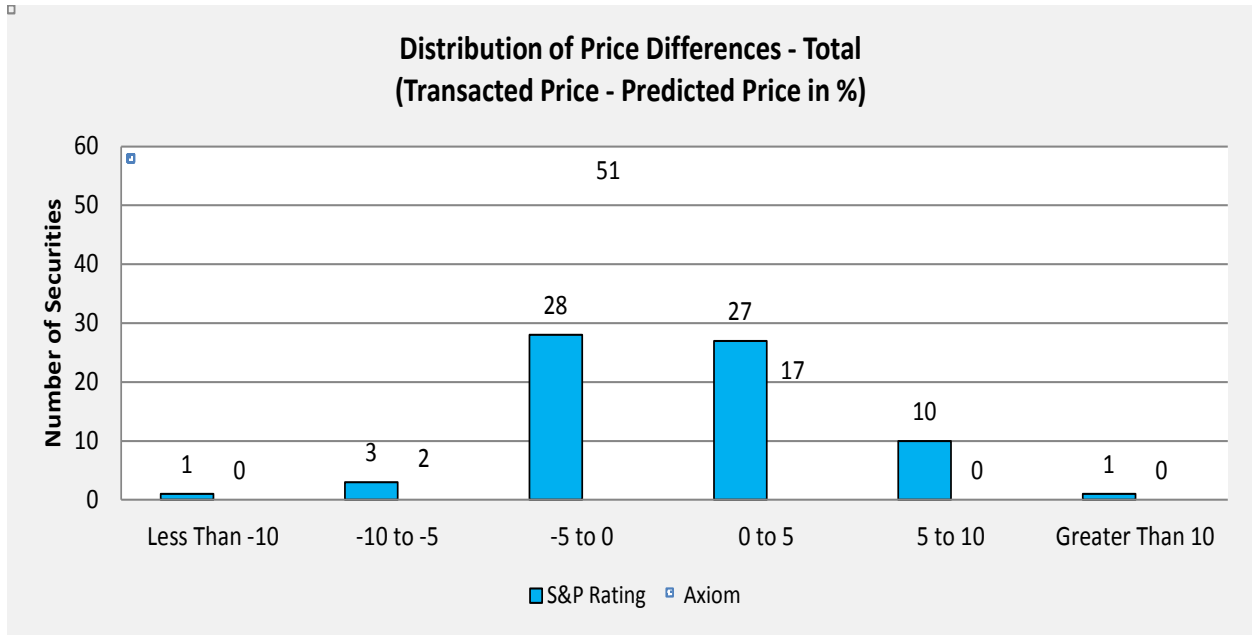
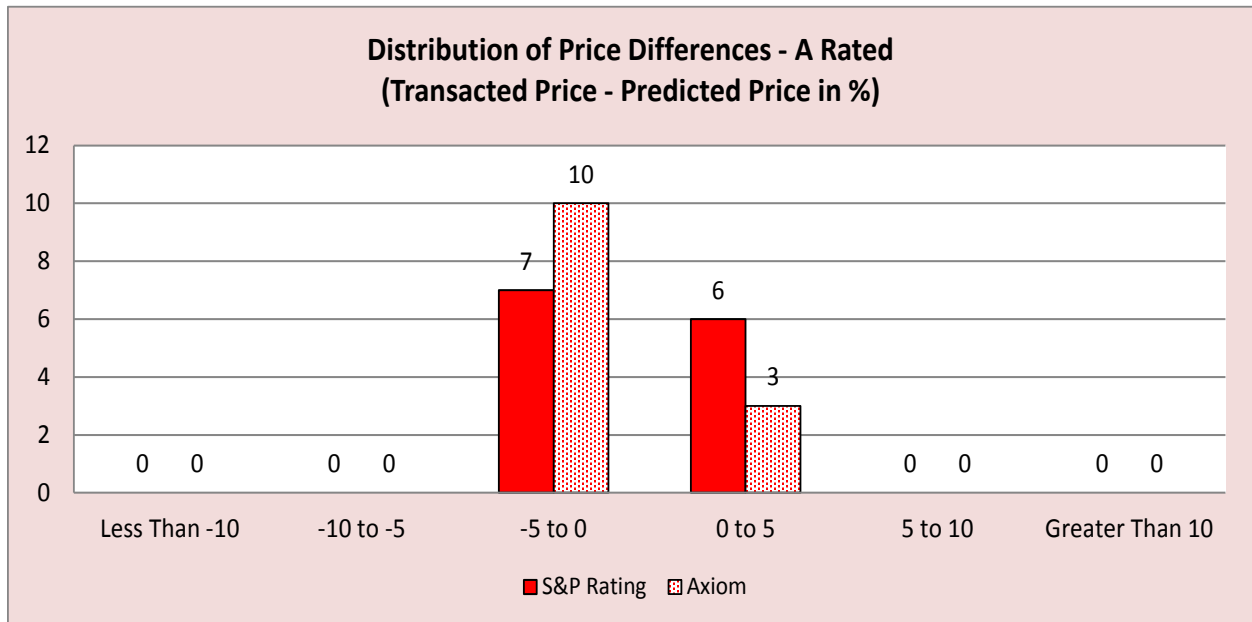
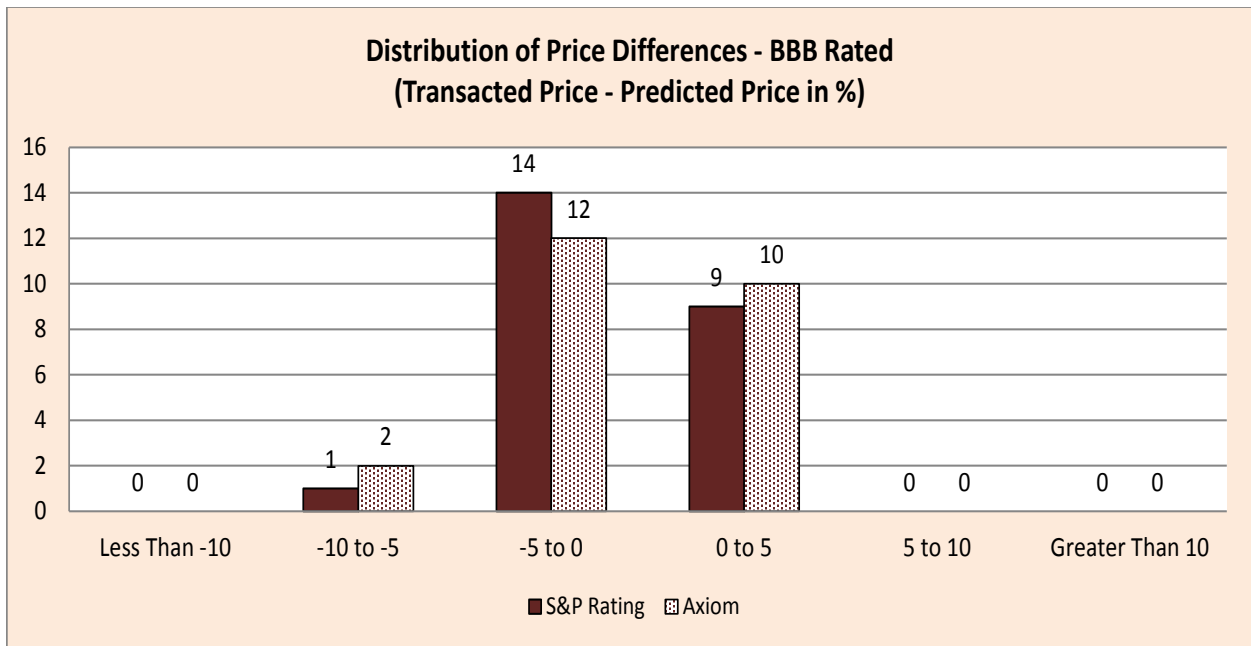


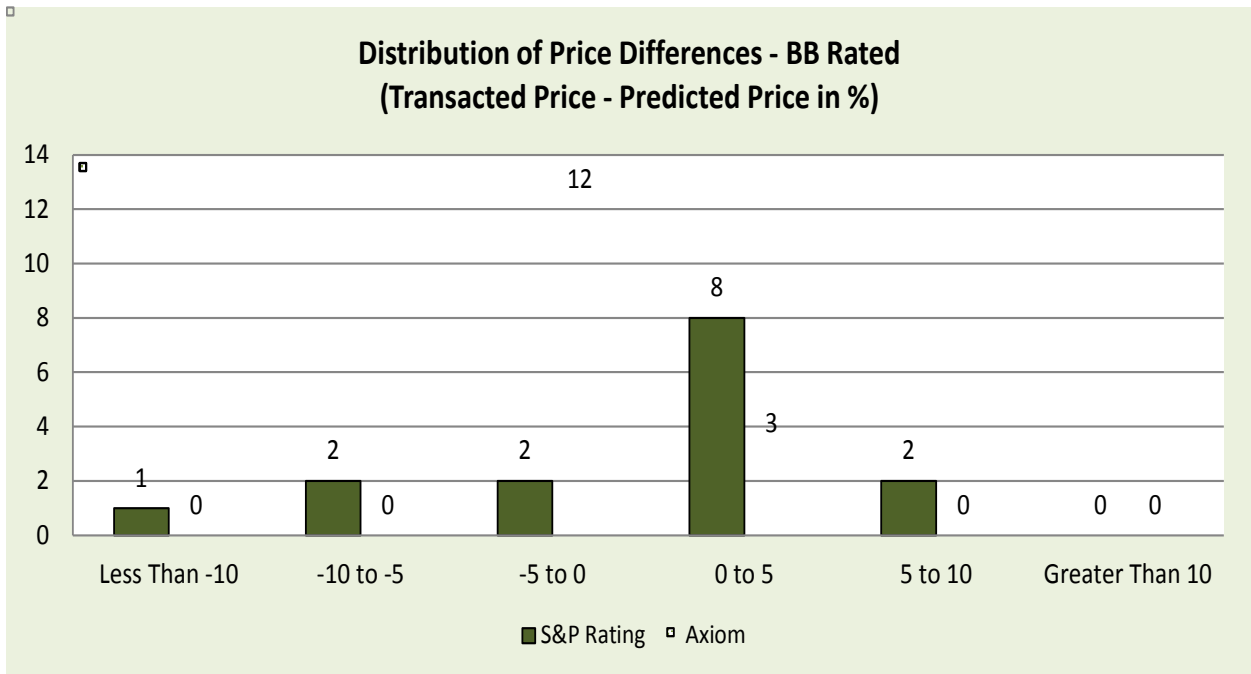
Chart A-2: Distribution of Price Differences – S&P A Rated (A+,A,A-)  
Source: Axiom



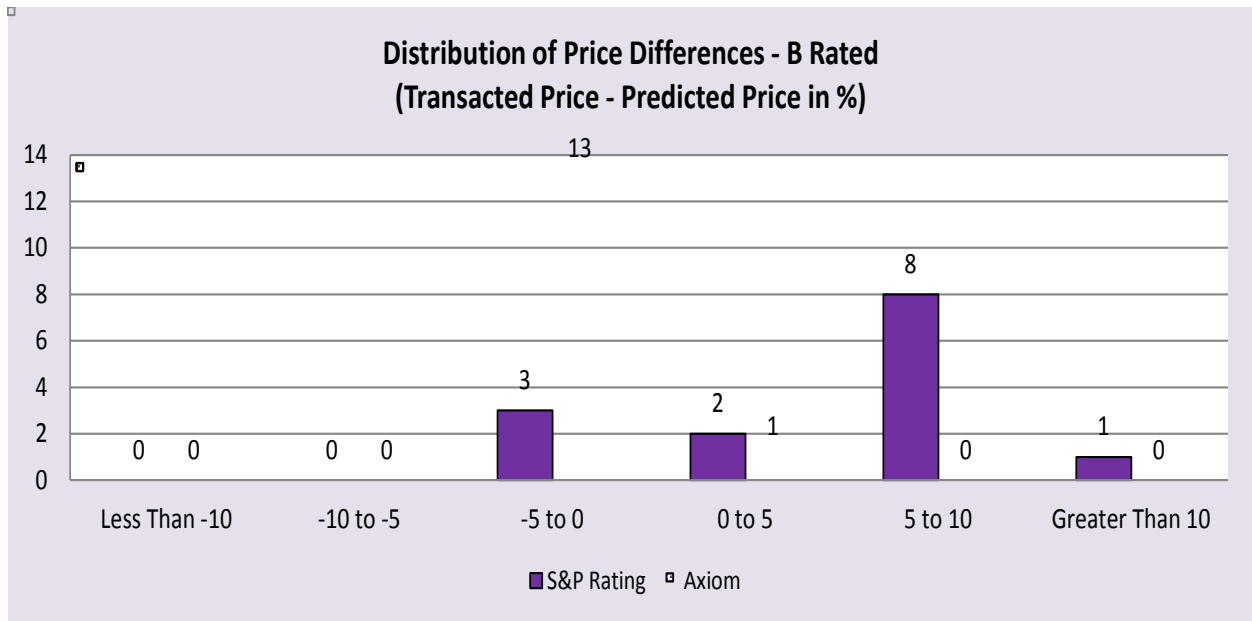
**Chart A-3: Distribution of Price Differences – S&P BBB Rated (BBB+,BBB,BBB-)**  
 Source: Axiom



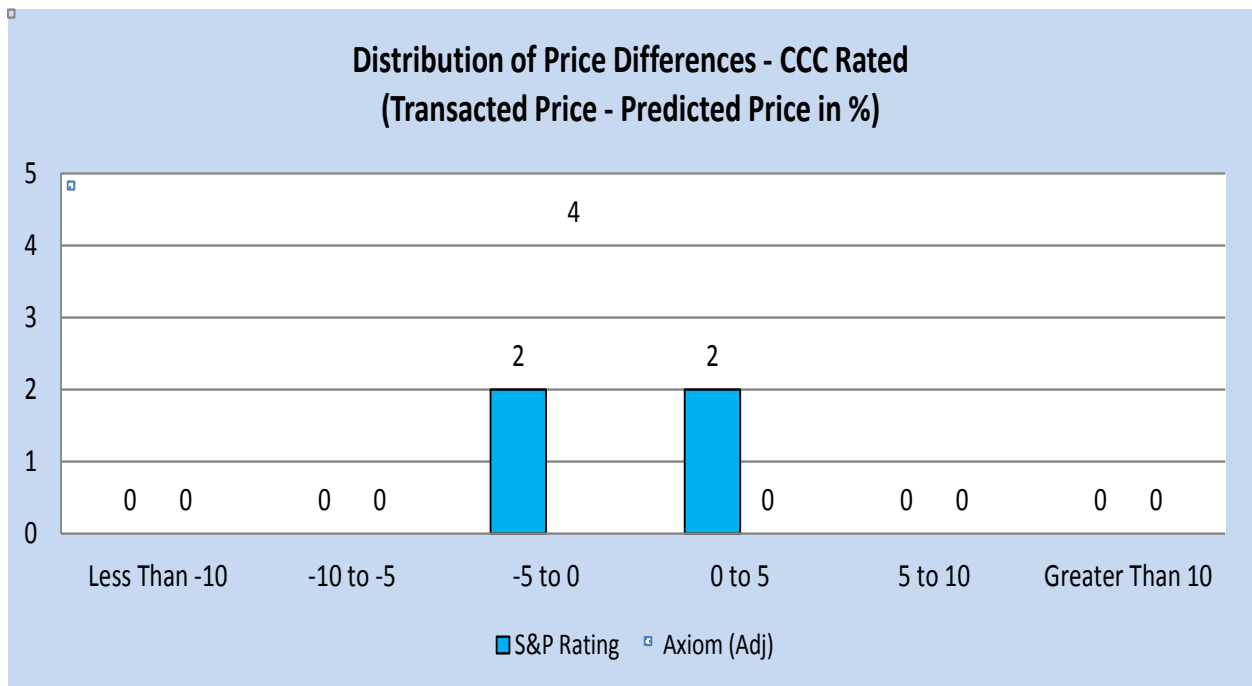
**Chart A-4: Distribution of Price Differences – S&P BB Rated (BB+,BB,BB-)**  
 Source: Axiom



**Chart A-5: Distribution of Price Differences – S&P B Rated (B+,B,B-)**  
Source: Axiom



**Chart A-6: Distribution of Price Differences – S&P CCC Rated (CCC+,CCC)**  
Source: Axiom



## About Axiom Valuation Solutions

Axiom is a global provider of expert valuation services for businesses, illiquid securities, fixed income portfolios, intangible and tangible assets, and other hard-to-value assets. We value thinly traded public companies and divisions of public companies for a variety of purposes. Examples include:

- Fair value reviews of fixed income portfolios with private company loans to meet FAS 157/ASC Topic 820
- Fair value determinations of Guaranteed Investment Contracts to meet FAS 157/ASC Topic 820 for year-end audits
- Certified valuations of stock option grants consistent with IRS Section 409A and determination of related option expenses under FASB 123R/ASC Topic 718
- Review of acquisition purchase price allocations under FAS 141R/ASC Topic 805 and goodwill impairment testing under FAS 142/ASC Topic 350
- Return authentication analyses of hedge fund and private equity interests for institutional investors consistent with FAS 157/ASC Topic 820
- Certified valuations of businesses and ESOPS fully compliant with IRS Revenue Ruling 59-60
- Certified valuations of limited liability corporations, family limited partnerships, and other special purpose entities used in estate planning fully compliant with IRS Revenue Ruling 59-60
- Accurate and cost-effective value estimates of private businesses for use in financial planning, risk management, strategy analysis, and initial ESOP assessments

Valuation issues are becoming increasingly complex and central to financial reporting for many organizations. Mastering these valuation challenges requires multi-disciplined expertise in finance, accounting, and economics; in-depth understanding of evolving financial markets; and skills in using and managing complicated valuation metrics. Our staff meets those requirements. They have undertaken extensive finance research and they have published in peer-reviewed journals, but their work is grounded in real world valuation experience.

Our staff members also have many years of effective interaction with auditors of the Big 4, and other firms and their valuation specialists. This combination enables Axiom to deliver an unparalleled level of service to clients.

Axiom sells these standard services primarily through referral by accounting firms, law firms, private equity firms, hedge funds, and financial advisory firms. In addition, Axiom provides expert, valuation-related consulting services in the following areas:

- Merger and acquisition advisory services and fairness opinions
- Litigation consulting and expert testimony on valuation-related issues

## Professional Qualifications

### Stanley J. Feldman, Ph.D.

Dr. Feldman is Chairman and co-founder of Axiom Valuation Solutions based in Wakefield, Massachusetts. He is an expert in the valuation of complex financial securities, including thinly traded equity and fixed income instruments, and public and privately held businesses. He is the architect of Axiom's credit risk and valuation platforms which are used to fair value both liquid and illiquid investments of retirement plans, endowment funds and hedge funds. Dr. Feldman is a Certified Patent Valuation Analyst Faculty member and a leading expert in valuation issues related to Purchase Price Accounting (FAS 141R) and Goodwill Impairment (FAS 142), particularly as they impact the valuation of intangible assets. Dr. Feldman has extensive background in valuing complex capital structures of early and late stage VC and private equity financed firms and has conducted numerous assignments to meet the requirements of FAS 123R and IRS 409A. He is a Daubert-qualified expert and has provided expert testimony on numerous and complicated valuation issues. He has taught and researched valuation issues as a tenured Associate Professor of Finance at Bentley University in Waltham, Massachusetts. Dr. Feldman was a member of the Financial Accounting Standards Board's (FASB) Valuation Resources Group, an external advisory committee on valuation issues.

Dr. Feldman is the author of a professional book *Principles of Private Firm Valuation* published by John Wiley Publishers in 2005. He is also the principal author of *What Every Business Owner Should Know about Valuing Their Business* published by McGraw-Hill Professional Books in November 2002. He contributed the "The Valuation of Private Firms" chapter for Fabozzi's Handbook of Finance (2008).

Dr. Feldman is also an expert on industry revenue and profit forecasting. He served as Senior Vice President for Industry and Regional Services at DRI/McGraw-Hill in the late 1980s. He directed DRI's successful expansion into detailed industry forecasting by region and by state for private sector and government clients.

A sample of Dr. Feldman's valuation-related experience includes:

- Valuing small cap public companies with thinly traded securities in U.S. and international stock markets
- Valuing unregistered shares of a publicly held company for gifting purposes prior to an acquisition
- Valuing GICs, CMOs, CDOs, CDSs, ABSs, Pass-throughs, structured investment vehicles and credit linked notes
- Determining the fair value of alternative investments, such as hedge funds, funds of funds, and private equity funds for pension and endowment funds
- Valuation for acquisitions and divestitures
- Valuation of complex securities including warrants and contracts with embedded options
- Valuation of loans and other illiquid fixed income securities for well-known hedge funds
- Valuation of Auction Rate Securities for a large university which served as the basis of a tender offer for repurchase by the university
- Valuation of the Guaranteed Investment Contracts owned by the 401(k) fund for a union of elevator installation, repair, and maintenance workers
- Valuation of endowment fund investments made up of level 2 and 3 securities



### Related Experience

Dr. Feldman. Tenured Associate Professor of Finance, taught courses in corporate finance, business and financial policy, and investments at both the graduate and undergraduate levels at Bentley University - Waltham, MA for twenty years. He was for many years a member of the Board of Directors of the New England Economics Project, a regional forecasting consortium. Professor Feldman has written extensively on issues related to business valuation and small business financing for both the Boston Herald and the Boston Business Journal.

Prior to joining Data Resources, Professor Feldman was a senior economist with Prudential Insurance Company. In this capacity, he analyzed financial markets, forecasted interest rates and helped develop asset allocation strategies for those retirement assets that were actively managed by Prudential. Before joining Prudential, Professor Feldman was an economist with the Federal Reserve Bank of New York. Professor Feldman received a B.A. in economics from Hunter College, City University of New York, and a Ph.D. from New York University.

### Selected Publications

"The Valuation of Private Firms", *Handbook of Finance*, Fabozzi, Editor, John Wiley, 2008.

"Overcoming IRS Challenges to the Amount of Marketability Discount", *Estate Planning*, January 2005, pp. 33-35.

Principles of Private Firm Valuation, John Wiley, March 2005

What Every Business Owner Should Know About Valuing Their Business (with Dr. Tim Sullivan and Roger Winsby), McGraw-Hill Professional Books, November 2002.

"A Note on Using Regression Models to Predict the Marketability Discount", *Business Valuation Review*, September, 2002

"Calculating Goodwill Impairment: Valuation Issues Raised by Financial Accounting Statement 142", Terra-Firma Publications, May 2002.

"Investor Attitudes Toward the Value of Corporate Environmentalism: New Survey Findings" (with Peter Soyka) *Journal of Environmental Quality Management*, Autumn 1998.

"Does Improving a Firm's Environmental Management System and Environmental Performance Result in a Higher Stock Price?" (with Peter Soyka and Paul Ameer). *Journal of Investing*, Winter, 1997.

"Capturing the Business Value of EH&S Excellence" (with Peter Soyka). *Environmental Management Journal*, Winter, 1997.

"Sources of Structural Change in the United States, 1963-1978: An Input-Output Perspective" (with David McClain and Karen Palmer). *Review of Economics and Statistics*, Vol. LXIX, No. 3, August, 1987, pp. 503-510.

"Industry Analysis and Investment Decision-making Under Conditions of Uncertainty." *Managerial and Decision Economics*, Vol. 4, No. 3, 1983, pp. 193-207.

"The Determinants of Profit Growth in the Manufacturing Sectors" (with Richard DeKaser). *Profits, Deficits, and Instability*, D.B. Papadimitriou ed., Macmillan, 1992.

"The Impact of Productivity, Pricing, and Sales on Shareholder Wealth" (with Timothy Sullivan). *Data Resources Long-term Review*, Summer, 1992, pp. 19-23.

"Has the Private Rate of Return on Industry R&D Increased?" (with Timothy Sullivan and Richard DeKaser). *Data Resources Long-Term Review*, Winter, 1991, pp. 21-24.

Evaluation of Citibank's Debt Rating Model. This report reviewed Citibank's debt rating model, made suggestions for possible improvements and reviewed the literature on credit risk and default modeling, October, 1997.