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North America

Buy-and-Hold Strategies for Corporate Bond Investors

Static Corporate Bond Portfolios Offer Attractive Returns[1]

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With thanks to
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- An historical analysis of corporate bond defaults and returns suggests that multi-year buy-and-hold investments in default-risky bonds of similar agency ratings offer attractive risk-reward characteristics relative to U.S. Treasuries and equities.

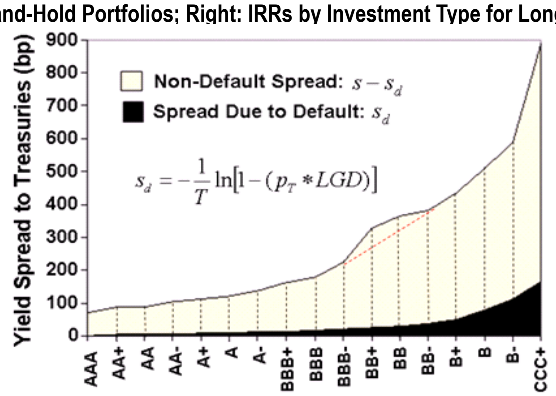
- This conjecture was confirmed directly using historical data to construct five-year buy-and-hold portfolios of single-A through single-B rated corporate bonds annually from 2001 until 2011, with bonds having maturities of less than five years.

- We also tested several strategies for reinvestment of coupon and principal received prior to the maturities of the trades.

- Average annual excess (over T-bills) internal rates of return (IRRs) for annual five-year corporate bond trades with reinvestment of early proceeds in T-notes until maturity ranged from 2.5% for single-A to 3.8% for double-B portfolios with Sharpe ratios ranging from 1.7 for single-As to 1.1 for single-Bs.

- In a set of longer-horizon simulations, all annual proceeds from each five-year trade were reinvested in subsequent annual similarly-rated portfolios from initiation until 2012. IRRs for the longest (11-year) trades range from 5.8% for single-A bonds to 9.8% for single-B, far exceeding returns from Treasury or equity investments.

Figure 1. Left: Relationship of Spread Owing to Default and Non-Default for Corporate Bonds that Suggests Attractiveness of Buy-and-Hold Portfolios; Right: IRRs by Investment Type for Long-Term Buy and Hold Investments



	SPX	1M T-Bill	5Y UST	A	BBB	BB	B
2001	0.20%	1.90%	4.04%	5.77%	6.75%	8.76%	9.79%
2002	1.74%	1.76%	4.27%	5.71%	6.32%	7.94%	8.56%
2003	6.03%	1.77%	2.82%	5.37%	6.05%	8.23%	9.60%
2004	4.57%	1.87%	2.59%	5.29%	5.79%	7.00%	7.81%
2005	3.24%	1.95%	2.95%	4.61%	5.41%	6.83%	7.54%
2006	0.74%	1.76%	3.60%	5.74%	6.22%	7.74%	8.21%
2007	-0.15%	1.15%	4.40%	5.67%	6.28%	7.33%	8.02%
2008	-4.07%	0.35%	2.53%	4.67%	5.90%	7.07%	8.12%
2009	-3.08%	0.09%	1.03%	6.19%	7.70%	11.27%	17.76%
2010	12.61%	0.08%	1.04%	2.05%	4.61%	5.55%	6.10%
2011	8.04%	0.05%	0.40%	4.32%	4.41%	4.77%	5.85%
Mean	2.72%	1.16%	2.70%	5.04%	5.95%	7.50%	8.85%
StdDev	4.57%	0.75%	1.14%	1.12%	0.77%	1.43%	3.03%
Ratio	0.6	1.5	2.4	4.5	7.7	5.2	2.9

Source: Citi Research

[1] We especially thank Charles Monet, Head of Economic Capital and Stress Testing at Citigroup, who brought the idea for this investment to our attention and provided the initial statistical evidence of its attractiveness. Also, we are grateful to the students in the Master of Financial Engineering program at the University of California at Los Angeles (UCLA) for performing some preliminary simulations of these portfolios. Finally, we thank Margaret Quinlan for editorial assistance.

Contents

Executive Summary

Corporate bonds pay a yield premium over the spread to Treasuries required to compensate investors for bonds' likelihoods of default. We call this yield spread the "credit risk premium." An analysis of historical default rates and credit spreads suggests that multi-year buy-and-hold investments in portfolios of default-risky corporate bonds offer attractive risk-reward characteristics. We tested this directly using historical data from bonds in Citi's corporate indexes from 2001-2012. Portfolios were constructed annually, each with bonds of a single-letter rating category and having maturities of five years or less. Portfolio returns were calculated from the data to mimic buy-and-hold to maturity strategies. Given that these portfolios generate coupon and principal income prior to the end of the five-year holding period (from bonds that mature, are called, and from amounts recovered from bonds that default), we simulated reinvestment strategies for cash received prior to maturity. These included (1) rolling all cash received in monthly T-bill investments; (2) investing annual proceeds in multi-year T-notes over the years remaining in the five-year trade; and (3) a longer-term strategy in which annual proceeds are invested in the next year's five-year buy-and-hold portfolio of the same rating category.

Average annual excess (over T-bills) and internal rates of return (IRRs) were computed for the annual five-year trades with reinvestment of early proceeds in either T-bills or T-notes until maturity. For comparison, we analyzed returns from the S&P500 Index and US Treasuries under similar conditions. For five-year corporate bond trades with reinvestment in T-notes, average IRRs for trades initiated annually from 2001 to 2011 ranged from 2.5% for single-A-rated portfolios to 3.8% for double-Bs with Sharpe ratios of 1.7 and 1.1, respectively. Using returns from the five-year trades, we simulated annual trades with horizons ranging from one to eleven years; those initiated in 2011 to 2001, respectively. For those simulations all proceeds received during a given year were reinvested in the next year's corresponding portfolio from initiation until 2012. (Thus, after a five-year period, investors would have investments in all five open trades.) IRRs for the longest (11-year) corporate bond trades ranged from 5.8% for single-A bonds to 9.8% for single-B. Similar eleven-year investments in the S&P500 equity index, T-bills, and five-year T-notes were much smaller at 0.2%, 1.9%, and 4.0%, respectively. The results demonstrate clearly the advantages of buy-and-hold investments in default-risky securities over U.S. Treasuries and equities and the beneficial effects of compounding on enhancing internal rates of return.

The Static Corporate Bond Portfolio

Figure 2. Price Risk versus Value Risk for a 10-Year US Treasury Bond and a 5-Year Double-B-Rated Corporate Bond

	Price Risk Perspective	Value Risk Perspective
10-Year US Treasury Bond	8% potential MTM loss, assuming market rates rise by 100bp	Negligible risk if bond held to maturity
5-Year BB/Ba-rated Corporate Bond	28% potential MTM loss, assuming 924bp spread shock seen in 2008	Average 1-year default rate since 1991 is 0.89% and worst is 4.22%

Source: Citi Research

With US Treasury yields at near-record lows and the U.S. Federal Reserve's intention to hold short-term yields near zero until 2014 (Appelbaum, 2012), investors in short-term money market funds are faced with accepting negative real yields.[2] Furthermore, extending duration via longer-term Treasuries to increase yield is relatively unrewarded and exposes investors to near-inevitable future increases in yields. That is, yields on long-term Treasury debt are also currently at historically low levels, thereby providing little incentive for holding long-term U.S. government bonds.[3] Furthermore, since yields are expected to rise as economic recovery progresses in the US, investors would incur mark-to-market losses on current investments and, if holding present-day investments to maturity, would be forgoing opportunities for future investment in Treasury bonds with higher yields.

In this report, we describe investment strategies intended for buy-and-hold investors who wish to earn attractive absolute and risk-adjusted returns The strategy involves investing in five-year static portfolios of corporate bonds of single whole-letter rating categories, all with maturities of five years or less.[4] Rating categories examined ranged from single-A to single-B, inclusive of plus and minus categories in each. Also, as interest and principal is returned from the trade prior to maturity, it can be reinvested. We examined several strategies for reinvestment including (1) rolling all cash received in monthly T-bill investments; (2) investing annual proceeds in multi-year T-notes over the years remaining in the five-year trade; and (3) a longer-term strategy in which annual proceeds are invested in the next year's five-year buy-and-hold portfolio of the same rating category. In addition, we compare the returns from our corporate bond portfolios with investments in US Treasury securities and equity markets. Our analyses confirm the attractiveness of the static corporate bond investments, even for relatively default-risky high yield bonds. Those analyses are described below.

Note: Readers who prefer to skip the underlying rationale and preliminary historical analyses should proceed directly to the simulation results (see "Simulating Returns from Static Bond Portfolios" below).

Price Risk versus Value Risk

Figure 3. Descriptive Statistics for One-Year Default Probabilities by Rating Category, 1981- 2011

	Mean (%)	Median (%)	StdDev (%)	Min (%)	Max (%)
AAA	0.00	0.00	0.00	0.00	0.00
AA	0.02	0.00	0.00	0.00	0.38
A	0.08	0.00	0.07	0.00	0.38
BBB	0.24	0.19	0.11	0.00	1.02
BB	0.89	0.73	0.27	0.00	4.22
B	4.48	3.62	3.32	0.25	13.84
CCC/C	26.82	22.07	12.68	0.00	48.68

Source: Citi Research

A central concept underlying the static portfolio investment involves distinguishing between price risk and value risk. Price risk is used to describe the potential losses on a security from selling it at a price lower than that at purchase. Typically, this occurs mainly for bonds sold prior to maturity, but can also occur for bonds purchased at a premium to par. Value risk is the potential for losses on a bond's par value that result from failure to receive nominal cash flows on investments. In general, price risk tends to be much greater than value risk, although the loss of value in default, when it occurs, can be large. Consider the example in Figure 2 that illustrates potential price risk and value risk for a 10-year US Treasury bond (top row) and a five-year double-B-rated corporate bond. If interest rates rise by 100bp early in the term of the 10-year Treasury bond, the mark-to-market loss on the bond may approach 8% of face value. Thus, if an investor sold that bond at the market price, they would incur a loss of 8%, mitigated somewhat by the values of any coupons received in the interim. However, if the investor chooses to hold the bond to maturity, the expected loss on the bond would be negligible as the US

[2] The *real yield* is the return on an investment adjusted for the effects of inflation.

[3] For example, as of April 30, five-, 10- and 30-year US Treasury benchmark yields were at 0.82%, 1.93% and 3.12%, respectively.

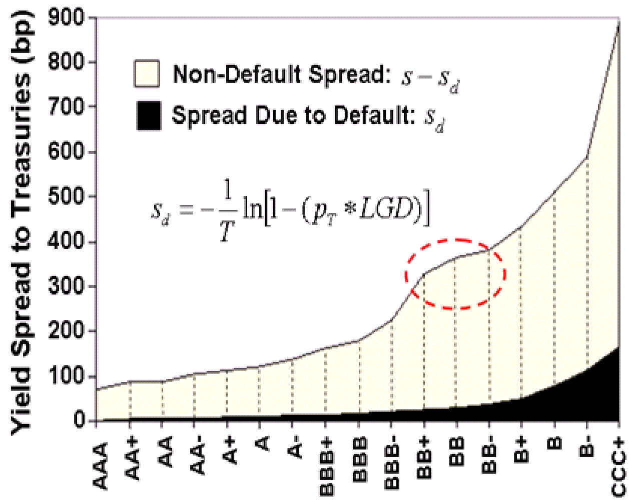
[4] Each whole letter rating category includes credits with plus and minus ratings, and portfolios were constructed for single-A, triple-B, double-B and single-B rated bonds.

government is currently rated double-A-plus.[5] In contrast to the relative safety of US Treasuries, Figure 2 indicates that five-year double-B-rated bonds have much greater price risk, having lost 28% of their value amid the 924bp rise in average double-B spreads in 2008.

Price risk is greater than value risk for US Treasuries and double-B-rated bonds.

The values in Figure 3 are Standard & Poor's (2012) average annual default rates and other descriptive statistics for corporate bonds by whole-letter rating categories from 1981-2011. The values for double-B-rated credits are highlighted in the figure. The table indicates that the mean and median double-B annual default rates are 0.89% and 0.73%, respectively and the standard deviation is 0.27%. The maximum annual default rate for double-B-rated credits since 1981 is 4.22% and that occurred in 1982. Indeed, even during the height of the credit crisis in 2008 and 2009, the double-B corporate default rates were 0.78% and 0.79%. During those same years, single-B-rated credits had default rates of 4.00% and 10.43% with the rates for triple-C and below at 26.00% and 48.68%. The results presented in Figure 2 and Figure 3 indicate that price risk is much greater than value risk and this report presents a strategy to unlock that value for buy-and-hold investors.

Figure 4. Average Yield Spreads to US Treasuries by Rating Category and Attribution of Spread to Default and Non-Default (i.e., Risk Premium) Sources as Described in Appendix 1



S&P Credit Rating	4.5 Year Implied PD	Average Spread (bp)	Spread Due to Default (bp)	Non-Default Spread (bp)
AAA	0.3%	70	1	69
AA+	0.3%	87	4	82
AA	0.4%	88	5	83
AA-	0.5%	104	6	98
A+	0.6%	113	8	105
A	0.7%	122	9	112
A-	0.9%	137	11	126
BBB+	1.0%	160	14	146
BBB	1.3%	178	17	161
BBB-	1.6%	223	21	201
BB+	1.9%	326	25	301
BB	2.3%	366	30	336
BB-	2.7%	383	36	347
B+	3.8%	438	51	386
B	5.7%	511	77	433
B-	8.2%	588	113	476
CCC+	11.8%	891	164	727

Source: Citi Research

Why Static Credit Portfolios?

Historical analyses suggest that credits of average risk provide the best balance between absolute returns and risk-adjusted returns.

In this section, we describe the rationale for focusing on static credit portfolios. To do this, consider the double-B-rated static portfolio investment. A preliminary analysis of historical data on credit spreads and default rates suggests that returns from double-B-rated credits provide a favorable balance between absolute returns and risk-adjusted returns. For example, consider the left panel of Figure 4 that displays average monthly credit spreads over US Treasuries by credit agency rating category since 1991, with their numerical values in the table in the right panel. As described in detail in previous publications (Benzschawel and Lee, 2011;

[5] The historical cumulative default rate for a ten-year double-A-plus rated corporate bond is 0.37%. That is, based on history, there is a 37 out of 10,000 chance that a bond rated double-A-plus today will default within the next 10 years (Standard & Poor's, 2008). Typically, in a corporate default on an unsecured bond, investors recover approximately 40% of face value of their investment (Altman and Kishore, 1996).

Benzschawel and Assing, 2012) and briefly in Appendix 1 of this report, credit spreads can be decomposed into yield attributable to expectations of not receiving cash flows due to default[6] and the remainder, the non-default spread, also called the *credit risk premium.* The default-related yield is represented by the dark portion of the spread curve in the left panel of Figure 4, with the lighter portion representing the spread magnitude of the risk premium. The dashed circle in the figure highlights the bulge in the upward sloping function relating credit spreads to agency ratings. This suggests an outsized increase in spread from triple-B-rated credits to double-Bs, with only slight increases in expected loss from default. The table in the right portion of Figure 4 indicates that that average triple-B 4.5 year default rate is 1.3%, accounting for 17bp of spread (assuming 40% recovery), whereas those same values for double-B bonds are 2.3% and 30bp, respectively. That is, for an extra expected spread loss from default at 4.5 years of 13bp, double-B credits return an extra 185bp of non-default-related return if held to maturity.

Figure 5. Volatilities of Expected Losses by Rating Category using Historical and Pro Forma Volatilities of Default Rates from Moody's

Rating	Historical σ of the Default Loss Rate	Implied σ Based on Worst 1-Year Loss
A/A	0.07%	0.14%
BBB/Baa	0.20%	0.31%
BB/Ba	0.73%	1.16%
B/B	2.42%	3.28%
C/Caa	11.38%	17.99%

Source: Moody's Investors Service and Citi Research

The following analysis, provided to us by Charles Monet of Citi's Capital Optimization Group, is based on default rates from 1982 to 2010 as reported by Moody's (Ou, Chiu and Metz, 2011). For this analysis, expected returns were calculated for five- and 10-year static portfolios of credits of a single rating category from triple-A to triple-C. Returns were estimated based on the average spread of the rating category minus the expected losses from default.[7] Although average annual default rates for each rating category are used to estimate expected losses, those rates were stressed using *pro forma* standard deviations of default rates based on the worst observed losses over the period since 1982. That is, the pro forma volatility of the default rates for a given rating category, σ_p, is defined as:

$$\sigma_p = \frac{Max_p - \overline{X}_p}{2.05}, \tag{1}$$

where Max is used to denote the maximum default rate observed for a given rating category since 1982, $\overline{X}_p$ is the average default rate, and the division by 2.05 is because there are 30 years of default data.[8] A comparison of standard deviations of expected losses on single-rated portfolios assuming 40% recovery in default appear in Figure 5. The volatilities based on pro forma analysis are larger than those based on historical default rates, reflecting the non-Gaussian distribution of default rates which are skewed toward higher values. Accordingly, we use the pro forma standard deviation for risk analysis.

Returns from hold-to-maturity strategies were calculated by adjusting yields for loss of coupon income from obligors that default prior to maturity and for losses from default.

Since the portfolios are static and intended to be held to maturity, expected returns are calculated on hold-to-maturity basis. To accomplish this, the nominal average spread of the portfolio must be adjusted for loss of coupon income from obligors that default prior to maturity and losses from defaults must be accumulated over the term of the trade. That is, obligors that default during the holding period will not pay subsequent coupons. For estimating losses from default, we compute annual default rates using the cumulative default rates over the holding horizon, but assume that the defaults occur evenly over time. This involves solving for the annual default rate necessary to equal the number of surviving firms at the maturity

[6] The portion of the bond yield due to default is the amount of yield compensation required to break even with a similar duration investment in US Treasuries given expected probabilities of default and recovery value in default.

[7] This assumes that all credits are purchased at par and are all held to a constant maturity of either five or 10 years, depending on the study. Corrections are made for lost coupons due to estimated defaults in years prior to maturity. Bonds with embedded options (calls and puts) were excluded from the analysis.

[8] With 30 years of observed losses, the worst observation should be roughly equivalent to a 2.05σ move if the default rates are normally (i.e. Gaussian) distributed.

of the trade. For example, if the cumulative default rate after five years is 5%, the annual default rate that results in 95% of firms surviving after five years is 1.02%.

Expected losses are negligible for investment-grade hold-to-maturity portfolios, but annual returns over Treasuries are under 2%.

A summary of the annual returns for each rating category from five-year hold-to-maturity portfolios is presented in Figure 6. Average yield spreads over that of five-year US Treasuries as of March 31, 2012 range from 1.55% for single-A credits to 10.32% for triple-C obligors. The second column for each rating category displays the spread values of expected lost income from coupons which are negligible for investment-grade single-A and triple-B portfolios. Lost coupon income for high-yield portfolios is only 28bp for double-Bs, but increases rapidly to 3.28% for single-B and 3.43% for triple-C portfolios. Similarly, expected losses of yield from defaults in single-A and triple-B portfolios are small at 10bp and 24bp, respectively, increasing to 1.38% for double-B portfolios and 3.11% and 7.02% for single-B and triple-C credits, respectively. Figure 6 also displays the yield spread to five-year Treasuries net of losses, with single-A and triple-B portfolios returning an annual excess of 1.44% and 1.95%, respectively. Expected returns over Treasuries net of estimated losses for double-B and single-B portfolios are larger at 2.68% and 2.24%, respectively, but, at least based on historical analysis, are -0.13% for a hold-to-maturity triple-C-rated portfolio.

Figure 6. Yield Spreads to Five-Year Treasuries, Expected Losses of Coupon Income and Principal, and Sharpe Ratios (Relative to the Five-Year US Treasury) by Rating Category for Ten-Year Hold-to-Maturity Portfolios by Rating

Rating	Average Spread as of 3/31/12	Lost Annual Income Due to Default	Expected Annual Principal Lost from Default	Annual Spread Net of Losses	Pro Forma Annual Volatility	Sharpe Ratio
A/A	1.55%	0.01%	0.10%	1.44%	0.14%	10.66
BBB/Baa	2.21%	0.03%	0.24%	1.95%	0.31%	6.20
BB/Ba	4.32%	0.26%	1.38%	2.68%	1.16%	2.32
B/B	6.26%	3.28%	3.11%	2.24%	3.28%	0.68
C/Caa	10.32%	3.43%	7.02%	-0.13%	17.99%	---

Source: Citi Investment Research and Analysis

Although Double-B credits do not have the highest Sharpe ratio of all rating categories, they offer the best balance between absolute and risk-adjusted returns.

Sharpe ratios for each rating-category hold-to-maturity portfolio were calculated from the expected spread net of losses and the annual spread values of pro-forma volatilities of annual default rates from 4 (repeated in Figure 6 for convenience).[9] In this case, the Sharpe ratios are relative to returns on the five-year US Treasury bond. Sharpe ratios for investment-grade portfolios of single-A and triple-B credits are largest at 10.66 and 6.20, respectively. Clearly, those investments are attractive investments from a risk-adjusted return point of view. The Sharpe ratio of 2.32 for the double-B credits is also impressive.[10] However, the Sharpe ratio for the single-B-rated hold-to-maturity portfolio is only 0.68 and is actually negative for the triple-C investment.

[9] The Sharpe Ratio, named after its originator, William Sharpe, is calculated as the incremental return on an investment over that of a risk-free asset for a given regular sampling, divided by the standard deviation of the returns over the sample period. It is customary to express the Sharpe Ratio as an annualized number.

[10] For comparison, Sharpe (1994) states that typical estimates of annual excess returns from the stock market of a developed country would be about 0.4.

We simulated returns from five-year static single-letter-rated corporate bond portfolios constructed annually from 2001 to 2011.

Simulating Returns from Static Bond Portfolios

Expected returns from the buy-and-hold strategies depend on the number and timing of defaults, the prices at which the bonds are purchased relative to par, and the number of bonds that mature or are called. That is, a disproportionately high default rate very early in the holding period results in greater lost coupon income than similar defaults later on, and the same holds true for bonds that mature early in the trade or are called. Finally, if bonds are purchased at a premium, losses of principal in default will be greater than similar losses from par bonds and those larger coupons from premium bonds will create greater losses of income. To capture the effects of the foregoing, we simulated actual returns from credit portfolios constructed using historical spread data. That is, to examine directly the implications of the statistical analysis presented above, we simulated returns from five-year static singe-letter-rated corporate bond portfolios from 2001 to 2011.[11] For comparison, we also simulated returns on buy-and-hold portfolios of U.S. equities and Treasury securities.

For the simulations, portfolios of corporate bonds of the same whole letter-rating-category (i.e., including plus and minus ratings) for single-A, triple-B, double-B and single-B were created in January of each year from 2001 to 2011. Each portfolio consisted of all single-letter-rated corporate bonds in either Citigroup's US Investment-Grade or High-Yield Market Index and all bonds had nominal maturities of five years or less.[12] The portfolios included callable and putable issues. Each annual portfolio was constructed with the expectation that the investment was to be held the entire five-year term. Of course, all constituent bonds will have matured by the five-year period of the investment.[13] Indeed, due to calls, maturities and receipt of recovery values from defaulted bonds, principal will be returned throughout the investment period. We computed returns on portfolios without reinvestment of any cash received prior to maturity. However, for most simulations, both principal and coupon income received during any calendar year were invested in a rolling series of one-month US Treasury bills (T-bills) until the end of that year. Then, at the start of each subsequent year of the trade, cash received during the previous year was either (1) rolled into the next set of twelve one-month T-bills; (2) invested in the US Treasury bond whose term matched the end of the static five-year investment term; or (3) invested the annual proceeds in the next year's similarly rated five-year static portfolio.

Figure 7. Internal Rates of Return from Five-Year Rolling Investments in One-Month T-Bills from 2001 through 2007 and Shorter Periods after That

	Year Initiated	1M T-Bill
Matured Five-Year Trades	2001	2.01%
	2002	2.29%
	2003	2.88%
	2004	2.95%
	2005	2.71%
	2006	2.21%
	2007	1.15%
Open Trades	2008	0.35%
	2009	0.09%
	2010	0.08%
	2011	0.05%

Source: Citi Research

To provide a benchmark for interpreting returns from our simulated portfolios of corporate bonds, we calculated annual average internal rates of return (IRRs) from investments in one-month T-bills rolled into each subsequent month's T-bill over the five-year period of each trade. The resulting IRRs appear for each annual five-year investment in Figure 7. For example, the 2.01% annual IRR reported for the one-month US T-bill investment beginning in 2001 indicates that $100 invested in a rolling five-year sequence of one-month T-bill trades would have returned $110.45 at the end of 2005 because

$$\$110.45 = \$100 * (1.0201)^5 \quad . \qquad (2)$$

[11] Of course the portfolios constructed after 2007 have not yet matured, but their partial returns are recorded.

[12] The corporate bonds in the US Broad Investment Grade (BIG) Index are intended to track the performance of investment-grade US dollar-denominated bonds. The US High-Yield Market Index is a broad index of publically-placed fixed coupon, non-convertible bonds which includes cash-pay and deferred interest securities. A detailed description of the index constituents and monthly rebalancing criteria can be found in the Citigroup Index Catalog (Citigroup, 2012).

[13] We also simulated conditions of reinvestment of proceeds in subsequently constructed portfolios as described later in this report.

For annual portfolios constructed after 2007, which had not run for the five-year term, the returns are expressed as annual compounded IRRs over successively shorter terms, but otherwise are calculated using a similar method to that for the five-year trades.

We calculated returns from static portfolios of five-year US Treasury notes for comparison with investments in corporate bonds.

Risk-adjusted annualized internal rates of return (IRRs) from our annual five-year buy-and-hold portfolios appear in Figure 8. IRRs for annual hold-to-maturity investments in the on-the-run five-year US Treasury notes are also shown. The method for calculating average annual excess returns from each trade is as follows:

1. Compute the five-year compounded cumulative return from monthly investments in one-month T-bills;
2. For each annual corporate portfolio investment and the five-year US Treasury, compute the cumulative returns from cash returned from each portfolio investment over the five-year period;
3. Subtract the five-year return on the one-month T-bill from the corresponding cumulative return from each five-year portfolio to yield the cumulative excess return; and
4. Determine the annualized risk-adjusted IRR as the compounded annual rate of return that would produce the calculated excess return over the five-year period in accordance with Equation 2.

Annualized risk-adjusted IRRs for the matured trades (i.e., those beginning prior to 2008) and open-trades (2008 through 2011) appear in Figure 8. For those five-year trades that have not yet matured, annual returns are computed similarly, except that all remaining principal invested as of 2012 is assumed to be valued at its initial cost and the discounted annual rate is determined over a shorter period of time.

Figure 8. Risk-Adjusted Annualized Internal Rates of Returns (in Excess of One-Month T-Bills) for Five-Year Static US Treasury and Corporate Bond Portfolios for Several Conditions of Reinvestment of Returned Cash Flows During the Five-Year Trade Periods. Summary Statistics are also Shown as Well as Partial Returns from Trades that Have Not Yet Matured

		No Reivestment					Reinvestment in T-Bill					Reinvestment in 5-Year UST				
		5Y-US	A	BBB	BB	B	5Y-US	A	BBB	BB	B	5Y-US	A	BBB	BB	B
Matured Trades	2001	2.35%	1.23%	2.19%	3.67%	2.96%	2.52%	2.48%	3.47%	4.96%	4.58%	2.60%	3.06%	4.25%	5.77%	5.86%
	2002	1.84%	1.82%	2.18%	2.81%	1.07%	2.10%	3.45%	3.71%	4.48%	2.92%	2.07%	3.22%	3.49%	4.24%	2.70%
	2003	-0.07%	0.13%	0.93%	3.03%	3.76%	0.17%	2.40%	2.91%	5.13%	6.16%	0.14%	2.14%	2.68%	4.87%	5.80%
	2004	0.19%	-0.30%	-0.01%	0.12%	0.20%	0.41%	1.59%	1.71%	1.99%	2.23%	0.46%	2.08%	2.06%	2.32%	2.55%
	2005	0.68%	0.89%	0.93%	1.23%	0.79%	0.82%	1.18%	1.29%	1.70%	1.41%	0.96%	1.44%	1.60%	2.14%	2.04%
	2006	1.77%	1.35%	1.63%	1.69%	1.01%	1.85%	1.70%	2.06%	2.42%	1.77%	2.03%	2.44%	2.91%	3.64%	3.14%
	2007	3.13%	2.77%	2.86%	2.22%	1.78%	3.15%	2.89%	3.01%	2.45%	2.08%	3.29%	3.36%	3.54%	3.30%	3.07%
Open Trades	2008	2.14%	3.48%	4.12%	3.79%	3.96%	2.14%	3.33%	4.16%	3.85%	4.02%	2.81%	3.71%	4.38%	4.20%	4.32%
	2009	0.92%	4.93%	6.62%	9.60%	15.49%	0.92%	4.96%	6.65%	9.63%	15.53%	1.62%	5.05%	6.81%	9.84%	15.79%
	2010	0.96%	1.82%	4.29%	4.68%	4.83%	0.96%	1.83%	4.30%	4.70%	4.86%	2.54%	1.84%	4.31%	4.74%	4.90%
	2011	0.35%	4.27%	4.36%	4.72%	5.80%	0.35%	4.27%	4.36%	4.72%	5.80%	0.35%	4.27%	4.36%	4.72%	5.80%
	Mean	1.41%	1.13%	1.53%	2.11%	1.65%	1.58%	2.24%	2.59%	3.30%	3.02%	1.65%	2.53%	2.93%	3.75%	3.59%
	Std Dev	1.09%	0.95%	0.90%	1.11%	1.18%	1.04%	0.74%	0.85%	1.38%	1.60%	1.07%	0.65%	0.85%	1.22%	1.45%
	Sharpe Ratio	0.58	0.53	0.76	0.85	0.63	0.68	1.36	1.36	1.07	0.84	0.69	1.73	1.55	1.38	1.11
	Mean	1.09%	3.62%	4.85%	5.70%	7.52%	1.09%	3.60%	4.87%	5.72%	7.55%	1.83%	3.72%	4.96%	5.87%	7.70%
	Std Dev	0.65%	1.16%	1.03%	2.28%	4.65%	0.65%	1.17%	1.03%	2.28%	4.65%	0.96%	1.18%	1.07%	2.30%	4.70%

Source: Citi Research

Absolute and risk-adjusted returns without reinvestment are highest for the static double-B-rated portfolios.

Consider first the set of portfolio returns obtained from matured trades which had no reinvestment of returned coupon or principal prior to maturity. These are the results that appear in the left portion of Figure 8. For this condition, coupon income and principal received prior to the maturity of the static trades were not reinvested, but were summed to compute the total return at five years from which the total return and annual excess IRR was computed.[14] Returns over T-bills from the yearly five-year investments in on-the-run five-year T-notes from 2001 though 2007 averaged 1.41% with a standard deviation of 1.08% and a Sharpe ratio of 0.58. The returns from static corporate bond portfolios without reinvestment of payouts received prior to maturity appear by rating category in the next set of columns in the left panel of Figure 8. Average annual risk-adjusted IRRs from matured trades range from 1.13% for single-A-rated credits to 2.11% from double-B corporate bonds. The standard deviations of the annual returns are similar, ranging from 0.90% for triple-B bonds to 1.18% for single-B issues. The five-year double-B-rated corporate bond investments had the highest excess return over T-bills and risk-adjusted returns of 2.11% and 0.85, respectively. Without reinvestment, the single-A portfolios performed worst, even below the five-year US Treasury, returning an average risk-adjusted IRR of 1.13% with a Sharpe ratio of 0.53. Even single-B-rated portfolios performed better than single-As without reinvestment, returning an annual risk-adjusted IRR of 1.18% and Sharpe ratio of 0.63.

Figure 9. Number of Defaulted Bonds in Each Five-Year Corporate Bond Portfolio

	A	BBB	BB	B
2001	4	7	15	17
2002	0	13	5	14
2003	0	1	4	6
2004	0	0	2	3
2005	2	0	0	1
2006	0	2	3	6
2007	16	4	6	10
2008	23	1	12	20
2009	0	9	1	14
2010	0	0	0	4
2011	0	0	0	1
Total	45	37	48	96
Mean	4.1	3.4	4.4	8.7
St.Dev.	7.9	4.4	5.0	6.6

Source: Citi Research

It is perhaps surprising that returns from the riskier portfolios (those comprised of bonds having lower credit ratings), with their increasingly higher average coupons, occasionally underperform or only slightly outperform the "risk-free" US T-note. Aside from greater average coupons with increasing riskiness (decreasing credit rating) of the portfolios, those portfolios have risk of default and, as indicated in Figure 9, all corporate bond portfolios had a significant number of defaults.[15] The pattern of defaults reveals the reason for the relatively poor performance of the single-A-rated portfolios; it reflects the inclusion of bonds in the single-A portfolio from financial firms that defaulted during the credit crisis (e.g. Lehman Brothers, Washington Mutual). In fact, the total number of defaulting bonds in the single-A portfolios from 2001-2012 is greater than that of the triple-B-rated ones and only slightly less than the number of double-B-rated defaults. Clearly, the greater number of defaults combined with the lower coupon on the single-A-rated bonds underlies the poorer performance of single-A portfolios, even relative to the US T-note (see left columns of Figure 8). Notice that that the number of bonds that defaulted in the single-B-rated portfolios is nearly twice that of all others, thereby accounting for its lower average IRR than for the double-B-rated portfolios despite its higher coupon. Still, the 1.65% average IRR from the single-B corporate portfolios is better than IRRs from all investment grade average portfolios, and its Sharpe ratio is higher than that for the US T-note and the single-A-rated portfolios.

More meaningful comparisons of results are obtained under conditions of reinvestment of coupons and principal received prior to maturity.

Although the results obtained for the buy-and-hold portfolio investments without reinvestment are instructive, more meaningful comparisons are obtained under conditions of reinvestment of coupons and principal received prior to maturity. Of course, as shown in the middle columns of Figure 8, allowing reinvestment of cash received prior to maturity in rolling one-month T-bills up to trades' five-year maturities produced greater returns for all portfolios. In fact, reinvestment of cash flows received prior to maturity alters the pattern of results observed without reinvestment. Improvement for the five-year T-note trades was least, from 1.41% to

[14] It might be suggested that it is more appropriate, when estimating excess returns from the static portfolios, to reinvest coupons received prior into rolling one-month T-bill trades until the maturity of the five year note. However, we wished to compare the total amount of cash returned from the T-note trade with that from the static portfolios without reinvestment. In fact, results with reinvestment appear in the right panels of Figure 8.

[15] It should be noted that, because portfolios were constructed at the beginning of each year and firms can change rating categories over the five-year term of the trades, the same defaulted bond may be present in several portfolios of the same rating category or even in portfolios of different rating categories.

1.58%, as only coupon income was returned prior to maturity. Still, reinvestment in T-bills improved the Sharpe ratio of T-note portfolios' annual IRRs from 0.58 to 0.68.

Allowing reinvestment of income from corporate portfolios in T-notes produced substantial improvements in risk-adjusted IRRs and Sharpe ratios.

Despite the small effect of reinvestment on T-note returns, reinvestment of returned cash flows improves greatly the annual risk-adjusted IRRs for all the corporate bond portfolios. For example, average IRRs for the static single-B-rated portfolios increased most when reinvestment in T-bills is allowed, rising from 1.65% to 3.02%, with an improvement in Sharpe ratio from 0.63 to 0.84. Improvements in average absolute and risk-adjusted returns for the buy-and-hold double-B portfolios were similar with IRRs increasing from 2.11% to 3.30% and Sharpe ratio rising from 0.85 to 1.07. Average risk-adjusted returns for single-A and triple-B portfolios each increased just over 1%, to 2.24% and 2.59%, respectively. The Sharpe ratio for the single-A portfolio improved most, nearly doubling from 0.53 to 1.36, with the Sharpe ratio for the triple-B portfolios also increasing to 1.36, but from 0.76. Finally, notice that when reinvestment in the T-bills is allowed, the corporate portfolios underperform the T-note infrequently. That is, only the single-A-rated portfolios in years 2001 and 2006, the single-B portfolio in 2006 and all portfolios in 2007 have smaller annualized compounded excess IRRs than the US Treasury note.

We also tested longer-term buy-and-hold investments were all proceeds are rolled into the next year's corporate bond portfolios.

A more effective and "riskless" (as regards default) reinvestment strategy is to allow cash flows received each year prior to maturity to be collected and invested at the beginning of the following year in the *n*-year on-the-run US Treasury note, where *n* is the number of years remaining in the five-year investment period.[16] That is, since the cash flows from US Treasuries remain more or less certain, investors can profit more from the extension of duration than from rolling investments in one-month T-bills. The results for static bond portfolios under conditions of US Treasury note reinvestments, along with those for five-year T-notes, appear in the right columns of Figure 8. Allowing reinvestment in US Treasury notes improved absolute and risk-adjusted returns over the T-bill reinvestments for all portfolio types. Improvement was minimal for US Treasuries, with an increase in annual cumulative risk-adjusted returns of only 0.07% and an improvement of 0.01 in Sharpe ratio, but improvement for all corporate portfolios was significant. That is, average cumulative annual compounded returns increased between 0.3% and 0.5% across rating categories, with increases of 0.3 to 0.4 in Sharpe ratios for portfolios rated triple-B-rated and below. The Sharpe ratio for the single-A-rated portfolios increased most, from 1.36 to 1.73, but increases for other ratings classes were only slightly lower, ranging from 0.19 for triple-B, 0.31 for double-B, and 0.27 for single-B. Notice that when reinvesting in US T-notes allowed, annualized cumulative risk-adjusted IRRs are higher for double-B credits than for single-B for all years except 2003. In fact, the average annual risk-adjusted IRR is highest for the double-B-rated portfolios at 3.75%, but the Sharpe ration is highest for single-A-rated portfolios.

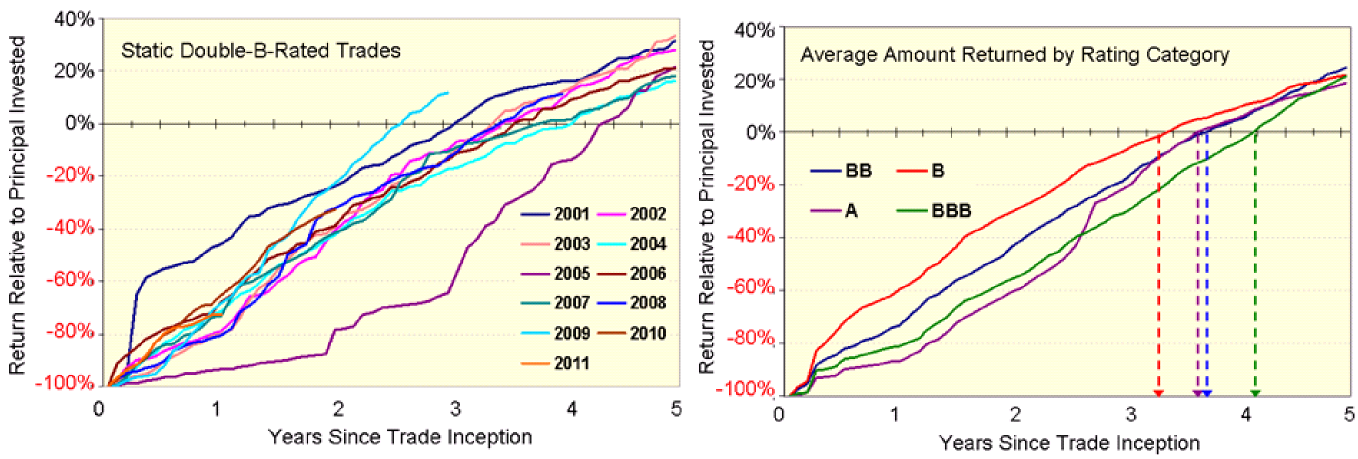
The expected time to recoup investors' initial investments in five-year static trades is about 3-4 years.

Another aspect of potential interest to a buy-and-hold investor in risky assets is the expected time it will take to recoup one's initial investment. This is the time after which the value of returned cash flows equals the initial investment. After that, all further cash flows are profits on the investment. For example, the left panel of Figure 10 shows cumulative returns of cash flows for the double-B-rated corporate bond portfolios relative to the magnitudes of their initial annual investments. The results shown are from conditions without reinvestment and cash returned relative to principal invested are shown for both matured and open trades. Although there is variability in the "break-even times" for the individual portfolios, almost all occur at times between three and four years after the investment. The right portion of Figure

[16] Cash flows received in months prior to December of each year are invested in rolling one-month T-bill trades until January of the following year at which time all proceeds are combined and rolled into the *n*-year US Treasury note, where *n* is the number of years remaining in the holding period.

10 displays the average time courses of returns relative to principal invested for each letter rating portfolio. Although the absolute returns for the credit rating categories differ, the pattern of the return of cash flows is similar to those for the single-B-rated trades. As shown in the figure, average recovery of principal invested is fastest for single-B-rated portfolios at just over 3.25 years. Because a significant portion of the single-B cash flows are generated from bonds that are called or defaulted (i.e., no longer generating coupon income), the average returns after breakeven are eclipsed by the double-B portfolio returns. Break-even times for both the double-B and single-A portfolios are about 3.5 years, with the breakeven point for triple-B-rated bond portfolios at 4.25 years.

Figure 10. Cumulate Return of Cash Flows Relative to the Magnitude of Initial Investment for Static Double-B-Rated Portfolios (Left) and The Average Cumulative Cash Flow Returns for Corporate Bond Portfolios of Each Rating Category Tested.



Source: Citi Research

Long-Term Buy-and-Hold Strategies

We evaluated a strategy in which all proceeds from a trade returned in a given year are invested in the next year's trade of its rating class.

We also tested an investment strategy that should be of interest for very long-term buy-and-hold investors. In this strategy, all proceeds from a trade (i.e., principal and coupon income) returned in a given year, *n*, are invested in the portfolio of its rating class assembled at the beginning of year *n+1*. For example, if a static double-B-rated portfolio constructed in 2001 returns an equivalent of 10% of the invested amount from coupon and principal during 2001, that 10% would be invested in the 2002 static double-B portfolio. Then in 2003, cash returned from portfolios constructed in both 2001 and 2002 are invested in the 2003 double-B portfolio, and so on. Thus, for this investment, no cash flows will be returned to investors unless they choose to close their positions (i.e., redeem the value of their investments in all five open trades) or decide to stop reinvesting coupons and returned principal. In the latter case, investors would let each portfolio mature, thereby receiving a five-year stream of annual payments from each open trade as they roll off.

We provide an example of investment and returns for the rolling static double-B portfolio investment in 2001.

An example of how the reinvestment process works for the rolling static trades is presented in Figure 11. The example is for an investment in the 2001 double-B-rated buy-and-hold trade. The top panel shows the returns, expressed as percentages of an original investment, for each annual static double-B portfolio.[17] To compute the cumulative value of the trade initiated in 2001, it is necessary to have information on the returns of all subsequent annual trades since then. Using

[17] The total return in percent of original investment on each static double-B trade without reinvestment is the sum of the values shown each year (i.e., along each row) in the top panel of Figure 11.

the information on cash flow returns (in percent of each annual investment) in the table at the top of Figure 11, one can trace the flow of cash from the initial investment through each of the subsequent investments as described with reference to the lower panel. To begin, assume an investor puts $100 in the static double-B portfolio assembled in 2001. The upper-left element of the matrix in the lower panel of Figure 11 (i.e., cell [1,1] with value of 54) indicates that the trade returned a cash equivalent of 54% of the initial investment in its first year.[18] That $54, also shown as "Proceeds" in the last row of the lower panel of Figure 11, was then invested in the 2002 static double-B portfolio.

Figure 11. Illustration of Cash Flows Into and Out of Rolling Static Double-B-Rated Corporate Bond Trade; Top: Annual Cash Flows Expressed as Percentages of Initial Investments for Trades Beginning Each Year from 2001 to 2011 and Summary of Cash Invested at the End of 2011; Middle: Cash (in US$) from Coupons and Principal from a $100 Initial Investment in the 2001 Static Double-B Portfolio and Re-Investments in Subsequent Annual Double-B Rated Portfolios, with Amounts Reinvested Each Year in the Last Row. Values of Each Successive Annual Investment Appear in the Last Column of the Lower Plot and Their Sum (the Shaded Box) is the Cumulative Value of the Initial $100 Investment.

	Percentage of Original Principal Returned by Year's End for Indiviual Portfolios										
Portfolio	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2001	54%	22%	22%	18%	16%						
2002		21%	38%	31%	19%	19%					
2003			20%	41%	27%	25%	21%				
2004				29%	29%	25%	16%	17%			
2005					6%	15%	14%	50%	35%		
2006						32%	29%	25%	21%	14%	
2007							27%	31%	31%	12%	17%
2008								20%	48%	19%	24%
2009									32%	45%	34%
2010										35%	33%
2011											27%

	Amount in the Portfolio for Rolling Trades Over 10 Years Starting from 2001											Trade
Portfolio	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Value
2001	54	22	22	18	16							132
2002		11	21	17	11	10						15
2003			7	14	9	8	7					11
2004				14	15	13	8	9				8
2005					4	9	9	31	22			13
2006						17	15	14	11	8		11
2007							16	18	18	7	10	10
2008								11	26	10	13	10
2009									26	37	28	26
2010										36	34	10
2011											27	5
Proceeds	54	33	50	62	54	58	55	82	104	98	112	252

Source: Citi Research

The proceeds from all open trades in a given year are rolled into the portfolio formed at the beginning of the next year.

Going forward into 2002, the $54 invested in the 2002 portfolio returned 21% that year (see cell [2,2] in the top panel of Figure 11), the equivalent of 11% (or $11) of profit on the initial $100 investment (see cell [2,2] in the lower panel). Meanwhile, the 2002 return on the 2001 portfolio was 22% (or $22) of the $100 investment. The sum of those returns, equal to $22 + $11 = $33 (shown for 2002 in the "Proceeds" row in the lower panel of Figure 11), is then invested in the 2003 trade.

[18] Incidentally, notice from the upper panel of Figure 11 that the 54% return-on-investment in 2001 for the 2001 static double-B portfolio was the largest annual return for any static double-B trade.

Thus, at the beginning of 2003, the investor has investments of \$100, \$54, and \$33 in the 2001, 2002 and 2003 portfolios, respectively. Using similar logic, one can work through the entire matrix of returns and reinvestments, such that after five-years, the buy-and-hold investor would always be invested in five successive annual trades, years *n, n+1, … , n+4.* Thus, by the end of 2011, one would have \$112 to invest in the 2012 portfolio (see "Proceeds" for 2011 in lower panel of Figure 11), with investments remaining in annual portfolios assembled from 2008-2011.

Figure 12. Values Used to Estimate Dollar Returns as Fraction of Original Principal from Open Trades at Time of Investment Liquidation from 2001 Static Double-B-Rated Portfolio with Annual Reinvestment

	Partial Returns on Open Trades	Total \$ Amount Invested at Onset	Years to Trade Expiry	Value (\$) Added by Open Trades
2008	4.14%	55	4	10
2009	9.69%	82	3	26
2010	4.76%	104	2	10
2011	4.77%	98	1	5

Source: Citi Research

At any time, an investor may choose to discontinue reinvestment of inter-year cash flows or choose to liquidate their entire outstanding investment. To determine, at any given time, the value of the investment requires knowledge of the profitability on the amount invested in each of the trades. Determining the returns from the portfolios that have matured (2001 through 2007) is straightforward; sum the five values in each row of the lower table to obtain the cumulative cash flows shown in the right column of the lower table in Figure 11. However, determining the non-terminal returns from the open trades is more complicated. To do this, we use the estimates of the cumulative annualized compounded return for each of the open trades. Those values appear in the left columns of Figure 8 for the 2008-2011 portfolios and each return is added to the analogous T-bill return shown in Figure 7. For example, the discount factor for the 2008 trade is 3.79% is added to the 0.35% T-bill return for an overall rate of 4.14%. This value appears in the first row of Figure 12. Then, we estimate the cash value at the IRR for the four years of the trade prior to 2012 as:

$$10 = [55 * (1 + 0.0414)^4] - 55 \quad , \qquad (3)$$

where the value of 55 is the sum of the cash flows from all trades in 2007 as shown in the middle panel of Figure 11 and second column of Figure 12, the value of 0.0414 is the 4.14% IRR determined from the four years of the trade as described above, and 4 is the number of years over which the returns accrue. Then, the resulting value of 10 is entered in the last column of the lower table of Figure 11 for the year 2008. A similar procedure is then applied for the 2009, 2010 and 2011 portfolios, but using their different IRRs and number of years until 2012. Once values from the open trades are put in the last column of the table in Figure 11, they are summed with those of the closed trades to obtain the value of 252. Thus, \$252 is the cumulative value returned from the initial \$100 investment, for an overall return of the 11 years of the trade of 152%. Computing the IRR on the 152% for 11 years by applying the relations in Equation 2 gives an estimated annual return of 8.76% for the static double-B trade initiated in 2001.[19]

Total returns and IRRs with re-investment in similarly rated static portfolios were computed for each annual investment for each rating category.

Similar analyses to those illustrated in Figure 11 and Figure 12 for the double-B portfolio were performed for each annual initial investment for each rating category. For comparison, we computed analogous returns for the S&P500 equity index, the one-month US T-bill and five-year US Treasury note, all with rolling reinvestment of cash flows in the following year's analogous portfolio. Total returns for each strategy net of principal invested and their corresponding annualized IRRs appear in Figure 13. The left panel in the figure displays total returns net of principal invested for investments begun each year starting in 2001. The right panel Figure 13 shows annualized IRRs calculated by discounting the tabled values at the left over the horizon of each trade as in Equation 2.

[19] Note that unlike the previous IRRs for the five-year portfolios which are excess returns over the T-bill, the IRRs for the long-term buy-and-hold strategies in Figure 13 are absolute, not risk-adjusted.

Average IRRs for equities topped T-bills and matched T-notes at 2.7%, but with much higher volatility of annual returns.

Consider first the cumulative returns and annualized IRRs for the equity and Treasury investment as displayed in the left and right panels of Figure 13, respectively. For the S&P500, cumulative returns range from -15% in 2008 to 69% in 2003, with corresponding IRRs of -4.07% and 6.03% respectively. The wide fluctuation in equity returns demonstrates the importance of timing one's entry into long-term equity investments. This is reflected in the highest standard deviation of annual investment returns (see lower rows of right table in Figure 13) and an information ratio of 0.6, the smallest of all investment strategies. Investments in T-bills fared better, ranging from 0% for 2009 through 2011, owing to the Fed's easing policy, to 23% for the 2001 investment. The T-bills generated average annual IRRs of 1.16%, but with low volatility for an information ratio of 1.5. Meanwhile, average IRRs from the annual five-year US Treasury notes returned 2.70%, roughly matching the equity average IRR, but the much lower T-note volatility generated a much higher information ratio of 2.4.

Figure 13. Returns for Static Corporate Portfolios with Continuous Reinvestment in Next Year's Portfolio. Returns are Shown for Corporate Bonds, US Treasury Notes and Bills and the S&P 500 Equity Index. Left: Total Returns by Trade Initiation Date; Middle: Annualized Internal Rates of Return Computed from Total Returns

Total Return on Investment

	SPX	1M T-Bill	5Y UST	A	BBB	BB	B
2001	2%	23%	55%	85%	105%	152%	179%
2002	19%	19%	52%	74%	85%	115%	127%
2003	69%	17%	28%	60%	70%	104%	128%
2004	43%	16%	23%	51%	57%	72%	83%
2005	25%	14%	23%	37%	45%	59%	66%
2006	5%	11%	24%	40%	44%	56%	61%
2007	-1%	6%	24%	32%	36%	42%	47%
2008	-15%	1%	11%	20%	26%	31%	37%
2009	-9%	0%	3%	20%	25%	38%	63%
2010	27%	0%	2%	4%	9%	11%	13%
2011	8%	0%	0%	4%	4%	5%	6%

Annualized IRR

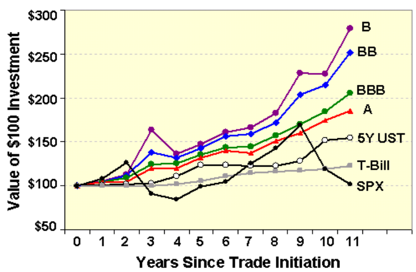
	SPX	1M T-Bill	5Y UST	A	BBB	BB	B
2001	0.20%	1.90%	4.04%	5.77%	6.75%	8.76%	9.79%
2002	1.74%	1.76%	4.27%	5.71%	6.32%	7.94%	8.56%
2003	6.03%	1.77%	2.82%	5.37%	6.05%	8.23%	9.60%
2004	4.57%	1.87%	2.59%	5.29%	5.79%	7.00%	7.81%
2005	3.24%	1.95%	2.95%	4.61%	5.41%	6.83%	7.54%
2006	0.74%	1.76%	3.60%	5.74%	6.22%	7.74%	8.21%
2007	-0.15%	1.15%	4.40%	5.67%	6.28%	7.33%	8.02%
2008	-4.07%	0.35%	2.53%	4.67%	5.90%	7.07%	8.12%
2009	-3.08%	0.09%	1.03%	6.19%	7.70%	11.27%	17.76%
2010	12.61%	0.08%	1.04%	2.05%	4.61%	5.55%	6.10%
2011	8.04%	0.05%	0.40%	4.32%	4.41%	4.77%	5.85%
Mean	2.72%	1.16%	2.70%	5.04%	5.95%	7.50%	8.85%
StdDev	4.57%	0.75%	1.14%	1.12%	0.77%	1.43%	3.03%
Ratio	0.6	1.5	2.4	4.5	7.7	5.2	2.9

Source: Citi Research

Total returns and IRRs for the long-term buy-and-hold corporate portfolios are impressive.

Total returns and IRRs for the long-term buy-and-hold corporate portfolios are impressive, both in absolute terms and in comparison with the equity and Treasury returns described above. First, average annual IRRs are positive for all years for all credit rating categories. Also, average annual IRRs for single-A portfolios, the lowest of the corporate portfolios, are nearly double those of the S&P500 and T-notes, with an information ratio of 4.5. For triple-B- and double-B-rated portfolios, average annual IRRs and information ratios are even larger; at 5.95% and 7.7 and 7.50% and 5.2, respectively. The single-B portfolios posted the largest average annualized IRRs at 8.85%, but the information ratio was the lowest of the corporate portfolios as 2.9, owing to the higher volatility of the annual investments.

Figure 14. Plot of Total Returns by Rated Portfolio for Each Length of Investment Holding Period



Source: Citi Research

Figure 14 is a plot of the value of a $100 investment in each of the annual portfolios for each asset type in Figure 13 plotted by years since trade inception. Thus, the values at year 1 are for 2011, year 2 for 2010, and so on. For example, the 179% return for the 2001 single-B corporate bond trade shown in Figure 13 appears as $279 at year 11 in Figure 14. The curves in Figure 14 illustrate graphically the huge advantage of the corporate bond buy-and-hold strategies over similar buy-and-hold investments in equities or US Treasuries. Interestingly, the single-B-rated portfolios, the riskiest of those examined, generate the largest returns, but the plot reveals that market timing is becoming more important than for higher quality portfolios. The plot also illustrates the importance of timing the market when entering into long-term equity trades; large losses early in the investment period can be hard to overcome. Also, the T-bill, while offering steady returns, at least prior to 2009, generates little absolute return. Although safer than corporate credits, average returns from the T-note are only half those of the slightly-riskier single-A corporates, but the volatilities of annual investment IRRs are similar. Finally, the curves for corporate bonds in Figure 14 demonstrate the beneficial effects on portfolio value from the compounding of returns for investments generating consistent positive cash flows, such as the corporate bond investments.

Tax Considerations

We consider some of the differing tax implications with respect to investments in the various strategies described above.

A detailed quantitative evaluation of the relative tax implications of the strategies is beyond the scope of this report and can vary widely for different investors. For example, the tax implications of the various strategies will differ based an investor's geographical location (different tax rates and laws in different jurisdictions), their type (insurance companies and institutions versus private investors), gains and losses from other investments, and other factors. Nevertheless, a few general observations seem worthy of discussion. Clearly, the tax implications of the various strategies will differ in general ways. For example, interest received on US Treasury securities is tax-exempt at the state and local level, thereby apparently increasing the attractiveness of US Treasuries relative to corporates that have no such tax break. In fact, that advantage is probably less than it might appear because the corporate bond portfolios will have losses that are not present for US Treasuries. That is, even a single default in a corporate bond portfolio, and defaults occur relatively frequently for credits rated below double-A, will result in a huge capital loss on that bond of about 60% on average (see Figure 9). Thus, the tax effects of those capital losses could counter the tax burden of interest income from those trades.

These portfolio trades could easily be constructed to return coupon income to investors, while reinvesting returned principal prior to maturity in T-notes or subsequent buy-and-hold portfolios.

One potential concern from investors is the lack of receipt of any cash flows over the investment period. That is, no cash is available to pay any taxes or provide any other usable income during the course of these five-year holding periods and the long-term investments. Of course, this is not a problem for the static portfolio investments under conditions of no reinvestment whose returns appear in the left columns of Figure 10. In fact, even without reinvestment, these buy-and-hold strategies offer attractive absolute and risk-adjusted returns. One potential solution for the more profitable portfolio trades that allow reinvestment is to pass coupon income received from the bonds back to investors in the year they are paid. This would enable investors to cover all taxes from payouts on the investment and, while decreasing total returns somewhat, still allow those investors to capture the benefits of reinvestment of principal received prior to maturity.

Summary

Results confirm that buy-and-hold investments in default-risky portfolios offer attractive risk-reward characteristics, both in absolute terms and relative to alternatives such as US Treasuries and equities.

Examination of the credit risk premium and a preliminary analysis of default rates and returns suggested that a static investment in default-risky portfolios of a single rating category might offer attractive risk-reward characteristics. We confirmed this in a series of simulations on historical data of buy-and-hold portfolios of single-rated bonds under several strategies for reinvestment of cash flows received prior to the maturity of the trades. To do this, portfolios were constructed annually from 2001 until 2011 for bonds of single rating categories ranging from single-A through single-B, with bonds in all portfolios having maturities of five-years or less. For comparison, we examined similar investments in one-month T-bills, five-year T-notes, and the S&P500 equity index. Average annual excess (over one-month T-bills) internal rates of return (IRRs) were computed for the annual five-year trades with reinvestment of early proceeds in either T-bills or T-notes until maturity. For the T-note reinvestment, average IRRs for trades initiated annually from 2001 to 2011 ranged from 2.5% for single-A to 3.8% for double-B portfolios with Sharpe ratios of 1.7 for single-As and 1.1 for single-Bs. From the five-year trades, we simulated annual trades with longer-horizons, with simulation periods ranging from one year for portfolios assembled in 2011, to eleven-year trades begun in 2001. For those simulations, all proceeds during a year from each trade were reinvested in the next year's corresponding portfolio from initiation until 2012. Average annualized IRRs for the corporate bond portfolios ranged from 5.0% for single-A bonds to 8.9% for single-B-rated portfolios. These results are particularly impressive in comparison with corresponding investments in the S&P500 equity index and the five-year US Treasury note, both of which produced average annualized IRRs of 2.7%.

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Appendix 1: The Credit Risk Premium

A major difficulty in inferring PDs from bond prices is that bond spreads contain a *credit risk premium*.

Bond spreads contain a *credit risk premium* that is not related to default, per se (Elton, Gruber, Agrawal and Mann, 2001).[20] Accordingly, one can decompose a spread into components due to default and the risk premium such that $s = s_d + s_\lambda$, where s_d is the compensation for default or *rock-bottom spread* and s_λ is the credit risk premium.[21] Briefly, for a bond of duration *T,* we can approximate the spread compensation for default, s_d, as:

$$s_d = -\frac{1}{T}\ln\left[1-\left(p_t * LGD\right)\right] \quad , \qquad \text{(A1)}$$

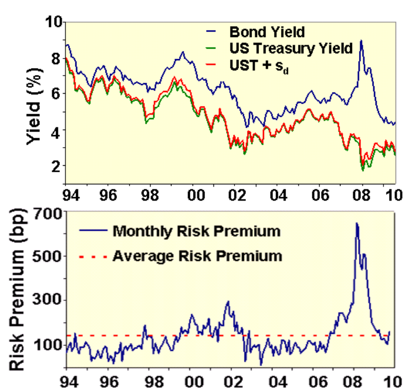
where *LGD* is *loss-given-default* or *1-R*, where *R* is the recovery value in default. The value of s_d can be thought of as the amount of spread necessary to break even with a similar investment in Treasuries given expected default and recovery for the risky bond. Also, since $s = s_d + s_\lambda$, if we use the credit spreads along with estimates of default probabilities we can solve for the risk premium, defined as s_λ , using the following relation:

$$s = s_\lambda - \left\{\frac{1}{T}\ln\left[1-\left(p_T * LGD\right)\right]\right\} \quad , \qquad \text{(A2)}$$

where *LGD* is the *loss given default* equal to one minus the recovery value in default, *1-R* and *T.*[22]

The right panel of Figure 4 in the text shows average monthly credit spreads by rating category for agency ratings from triple-A to triple-C, the calculated spread compensation for default using Equation A1, and the residual non-default spread implied by Equation A2. For these calculations, we used the spreads in Figure 4, a value of *T=4.5,* roughly the average duration of the bonds in question, and *R=40%* of face value. Notice that for all rating categories the break-even compensation for default is a small fraction of the overall spread compensation. In fact, nearly all of the spread for investment-grade bonds (ratings >= triple-B-minus) are due to the credit risk premium, rather than default. For high yield, default plays a greater relative role, but the average risk premium can be as large as 700bp.

Figure 15. Top: Treasury Yields, Compensation for Default and Corporate Bond Yields; Bottom: The Credit Risk Premium. 1994-2010



Source: Citi Investment Research and Analysis

Our calculations reveal that the credit risk premium varies over time. For example, the top panel of Figure 15shows monthly values of 4.5 year duration U.S. Treasury bond yields (green lines) and corresponding average investment-grade bond yields (blue line) since 1994.[23] The red line is the estimated yield compensation for default obtained using average PDs for the bonds from Citi's HPD credit model.[24] The lower plot shows the difference between the corporate bond yield curve and the U.S. Treasury plus compensation for default yields. That is, the lower plot is the average monthly credit risk premium for investment-grade bonds. Figure 15 reveals that the average investment-grade risk premium is about 125bp, very close to the

[20] It may also contain a premium for liquidity/illiquidity. For now, we use the term *credit risk premium* to refer to the entire spread compensation over and above that necessary for the present value of expected cashflows to equal that of an equal-duration US Treasury security.

[21] The *rock-bottom spread* can be viewed as the spread compensation necessary to compensate for the loss of cash flows. That is, an investor who receives an expected value equal to the rock-bottom spread receives an amount equal to the expected return from an equivalent-duration US Treasury security.

[22] The derivation of the spread approximation in Equation A1 follows directly from the price-yield relationship and risk-neutral pricing theory (see Benzschawel and Lee, 2011).

[23] The bond yields are those from the corporate bonds in Citi's Broad Investment Grade (BIG) Index.

[24] HPD stands for *Hybrid Probability of Default,* as the model is a combination of a structural Merton-type model and an Altman-type statistical model (see Sobehart and Keenan, 2003).

average investment-grade credit spread over that period. However, the risk premium varies considerably around that value, having been below 50bp during high liquidity periods of the mid-1990s and mid-2000s. During the recent credit/liquidity crisis, that risk premium was roughly 650bp, but has returned to near-average levels by 2010. Finally, Figure 15 shows the monthly non-default risk premiums by rating category for investment-grade (left panel) and high yield (right panel) corporate bonds since 1995. Consistent with the results in Figure 4 and Figure 15, the credit risk premium increases with decreasing credit quality and changes with the credit cycle.

Appendix A-1

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