Course 10
Embedded Options and Volatility – Understanding Callable Bonds and Prepayments

Lessons and Learning Objectives

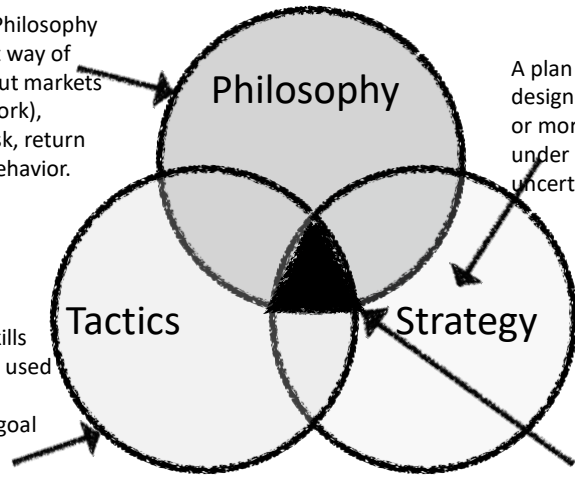
Course Description
Recognize how the embedded option in callable bonds impacts yields and prepayment risk. Consider the impact of embedded options on standard risk factors associated with bonds: interest rate risk, reinvestment risk, call risk, default (credit) risk.

Lessons and Learning Objectives

1. Option(s) Defined
2. Volatility Defined
3. Callable Bonds
   a) What is it?
   b) Why is it?
4. Analyzing Callable Bonds
   a) Yield Spread Analysis
   b) Option Adjusted Spread Analysis
5. Considerations
   a) Big Picture
   b) Just One Tool

Philosophy, Strategy & Tactics

Investment Philosophy is a coherent way of thinking about markets (how they work), efficiency, risk, return & Investor Behavior.



A plan of action or policy designed to achieve one or more goals usually under conditions of uncertainty.

Resources, skills and methods used to achieve or advance the goal of a strategy.

The intersection of Philosophy, Strategy & Tactics is the world of Portfolio Management.

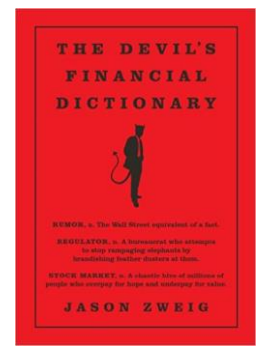
The difference between strategy and tactics: Strategy is done above the shoulders, Tactics are done below the shoulders.

What is an Option?

OPTION, n. The right to buy or sell a financial asset at a fixed price on or before a specific time, from the Latin optio, "I choose"; a boon for stockbrokers whose clients don't understand how options work and generate a fortune in commissions as they attempt to learn.

Explained Hugh Askin-Mee, a client of the brokerage firm Bourne, Rich & Howe: "I put two children through Harvard by trading options. Unfortunately, they were my broker's children."

Perhaps the earliest recorded options trade, according to Aristotle, was made by Thales of Miletus (ca. 624– 547 BC), one of the "Seven Sages of Greece," who put down deposits on all nearby olive-oil presses one winter when his knowledge of astronomy purportedly told him that the next year would bring a good olive crop. Thales paid almost nothing and profited hugely when the abundant harvest created high demand for presses— thus making him one of the first individual investors to make more money trading options than his brokers did. He was also one of the last.(1)

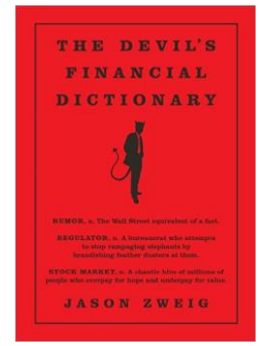


(1) Zweig, Jason. The Devil's Financial Dictionary (pp. 147-148). Kindle Edition.

What is Volatility?

VOLATILITY, n. The extent to which an investment's short-term returns differ from its long-term average returns, technically known as standard deviation and colloquially known as Oh my God!

When an investment has been making money, the people who own it say that they are comfortable with volatility. When it starts losing money, they suddenly will declare that they hate volatility. The investment hasn't changed; only their perceptions have. The most volatile element in financial markets is investors' own views of volatility. (1)

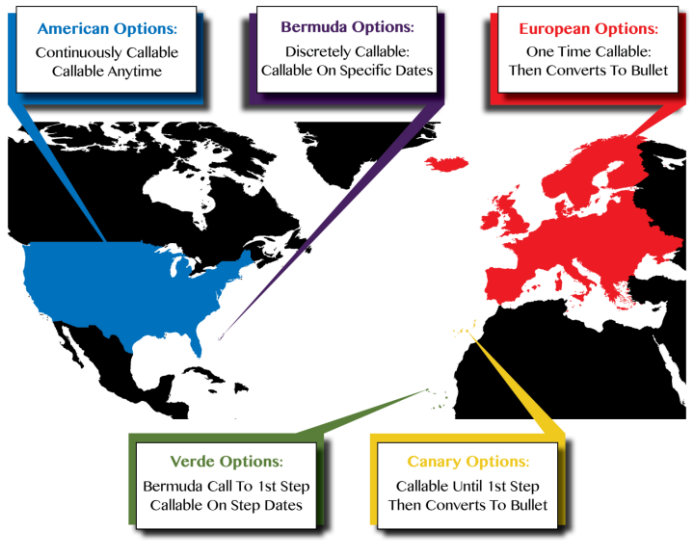


(1) Zweig, Jason. The Devil's Financial Dictionary (pp. 223-224). Kindle Edition.

Callable Bonds: What is it?

- ***A bond where the issuer has the option to call (buyback) the bond*** from an investor at a pre-determined price on a pre-specified date.
- The option to call the bond is usually one of the following kind:
  - **European**: One time only
  - **Bermudan**: Multiple times quarterly or semi-annually usually on coupon payment dates
  - **American**: Any time after a specified date
- In return for the option to call, the issuer pays a higher coupon than a non-callable bond of similar maturity.
- **The value of the call option depends on**:
  - *How often* and at what price the issuer can call the bond (exercise option)
  - *Time to the call date*
  - ***Volatility of interest rates***

Callable Bonds: Nomenclature



Callable Bonds: Nomenclature

95) Actions | 96) Alerts | 97) Export | 98) Summary | 99) Set Homepag | New Issue Monitor

Selection *New Issue AgyClbls Only (KPW) | 1) Show Filters | 2) Clear Filters | Issues

	Date↑	Issuer	Coupon	Maturity	Spread	Curr	Outst	Book Mgr	Note
	9/15/		All	All	All	All	All		
101)	9/15	FREDDIE MAC	STEP	09/30/21		USD	25	STFL-sole	5-NC6MO BERM
102)	9/15	FREDDIE MAC	STEP	09/30/21		USD	25	STFL,SUN	5-NC6MO BERM
103)	9/15	FREDDIE MAC	STEP	09/30/21		USD	15	AP-sole	5-NC6MO BERM
104)	9/15	FREDDIE MAC	STEP	09/30/21		USD	15	AP,MSRW	5-NC6MO BERM
105)	9/15	FED HOME LN BANK	VAR	10/13/26		USD	25	BCLY-sole	10C CONT +
106)	9/15	FANNIE MAE	1.48	03/29/21		USD	40	RJA-sole	4.5-NC6MOINC
107)	9/15	FREDDIE MAC	2.7	09/29/36		USD	15	CITI-sole	20-NC1 BERM
108)	9/15	FED FARM CREDIT	2	09/23/24		USD	75	JOINT LEADS	8-NC3MO CONT
109)	9/15	FED FARM CREDIT	1.35	09/21/20		USD	168	JOINT LEADS	4-NC1 CONT
110)	9/15	FED FARM CREDIT	2.32	09/22/27		USD	50	JOINT LEADS	11-NC3MOCONT
111)	9/15	FED FARM CREDIT	1.16	09/26/19		USD	130	JOINT LEADS	3-NC1 CONT
112)	9/15	FREDDIE MAC	STEP	09/30/21		USD	25	JOINT LEADS	5-NC6MO BERM
113)	9/15	FED HOME LN BANK	1.825	09/26/23		USD	5	BMO-sole	7-NC1 CONT

Callable Bonds: Data

- FHLMC (Freddie Mac) Bond Data: http://www.freddiemac.com/debt/html/sactivitymain.html
- FNMA (Fannie Mae) Bond Data: http://www.fanniemae.com/portal/funding-the-market/debt/reports/
- FHLB (Federal Home Lone Bank) Bond Data: http://www.fhlb-of.com/ofweb_userWeb/pageBuilder/debt-securities-21
- FFCB (Federal Farm Credit Bank) Bond Data: https://www.farmcreditfunding.com/ffcb_live/activitySummary.html
- FRB (Federal Reserve Bank) Call Notices: https://www.frbservices.org/app/callnotices/CallNotices.action
- TRACE (FINRA Trade Reporting and Compliance Engine): http://finra-markets.morningstar.com/BondCenter/Default.jsp

Callable Bonds: Why is it?

- **Agencies buy mortgage loans** and assets backed by mortgage loans.
- **Home owners usually have the right to pre-pay** the mortgage loan at any time:
  - When rates drop home owners are likely to pre-pay loans and "re-finance" at lower rates.
  - When rates rise home owners are likely to keep the low rate loan rather "re-finance" with a higher rate loan.
- Therefore, Agencies are short options to homeowners
- **The issuance of callable bonds allows the Agencies to match the characteristics of the mortgage loan** (asset/liability management):
  - When interest rates drop, mortgage loans (assets) pre-pay, Agencies can redeem their callable bonds (liabilities).

What are Primary Risks with Bonds

- **Interest Rate Risk:** The risk that bond prices will fall as interest rates rise.
- **Reinvestment Risk:** The risk that proceeds from the bond will be reinvested at a rate lower than the yield when purchased.
- **Call Risk:** The risk that a bond with a call provision will be called (redeemed before the stated maturity date) by the issuer.
- **Default/Credit Risk:** The risk that the bond issuer will be unable to pay the interest and principal as promised.

Analyzing Bonds: Yield Spread

"Given that Treasury securities do not expose investors to credit risk, market participants look at the yield offered on an on-the-run Treasury security as the minimum interest rate required on a non-Treasury security with the same maturity. … it is commonplace to refer to the additional yield over the benchmark Treasury issue of the same maturity as the yield spread.

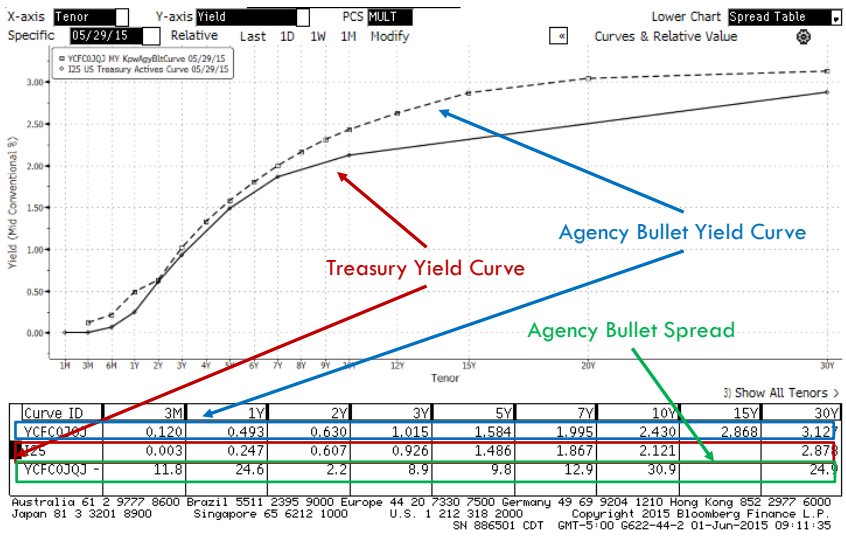
yield spread = yield on bond X - yield on bond Y

where bond Y is considered the reference bond (or benchmark) against which bond X is measured.

When a yield spread is computed in this manner it is referred to as an absolute yield spread and it is measured in basis points."

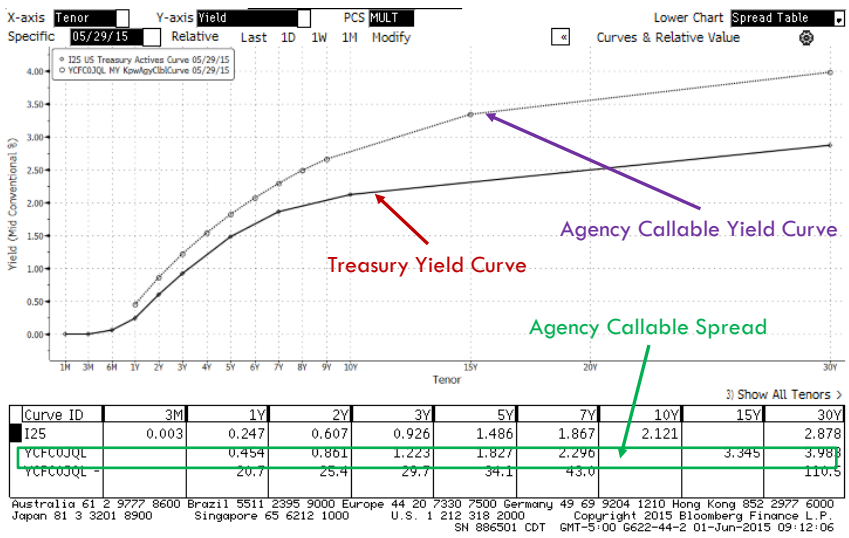
[Fabozzi CFA, Frank J. (2010-05-13). Fixed Income Analysis (CFA Institute Investment Series) (Kindle Locations 1590-1591, 1673, 1676-1678). Wiley. Kindle Edition]

Yield Spread: Agency Bullet(s)



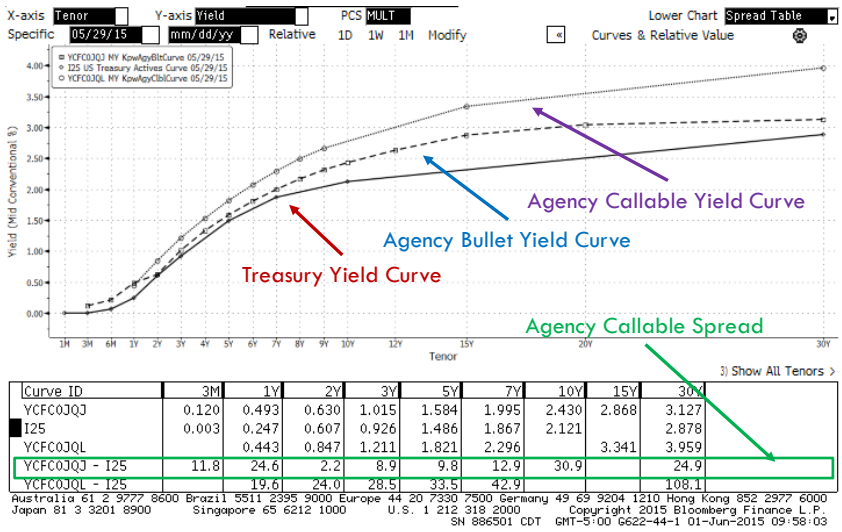
Curve ID	3M	1Y	2Y	3Y	5Y	7Y	10Y	15Y	30Y
YCFC0JQJ	0.120	0.493	0.630	1.015	1.584	1.995	2.430	2.868	3.127
I25	0.003	0.247	0.607	0.926	1.486	1.867	2.121		2.878
YCFC0JQJ -	11.8	24.6	2.2	8.9	9.8	12.9	30.9		24.9

Yield Spread: Agency Callable(s)



Curve ID	3M	1Y	2Y	3Y	5Y	7Y	10Y	15Y	30Y
I25	0.003	0.247	0.607	0.926	1.486	1.867	2.121		2.878
YCFC0JQL		0.454	0.861	1.223	1.827	2.296		3.345	3.988
YCFC0JQL -		20.7	25.4	29.7	34.1	43.0			110.5

Yield Spread: Tsy-Bullet-Callable



Curve ID	3M	1Y	2Y	3Y	5Y	7Y	10Y	15Y	30Y
YCFC0JQJ	0.120	0.493	0.630	1.015	1.584	1.995	2.430	2.868	3.127
I25	0.003	0.247	0.607	0.926	1.486	1.867	2.121		2.878
YCFC0JQL		0.443	0.847	1.211	1.821	2.296		3.341	3.959
YCFC0JQJ - I25	11.8	24.6	2.2	8.9	9.8	12.9	30.9		24.9
YCFC0JQL - I25		19.6	24.0	28.5	33.5	42.9			108.1

Yield Spread: Problem/Solution

"Since callable bonds have more than one possible redemption date (their call dates and maturity), the collection of future cash flows contributing to their overall return is not clearly defined. … an issue's incremental risks are evaluated relative to its incremental return. When the return measure itself is flawed, the possibility of drawing catastrophically incorrect conclusions about risk and return becomes very real. …

A more complete measure of return should fulfill the following requirements:

1. It should account for the risks posed by an uncertain redemption date by providing an objective measure of performance that is independent of any assumed redemption date.
2. It should provide a means of assessing the incremental return contained in the security relative to a riskless benchmark."

[(2010-05-18). Introduction to Option-Adjusted Spread Analysis (Bloomberg Financial) (Kindle Locations 227-228, 240-242, 281-285). Wiley. Kindle Edition.]

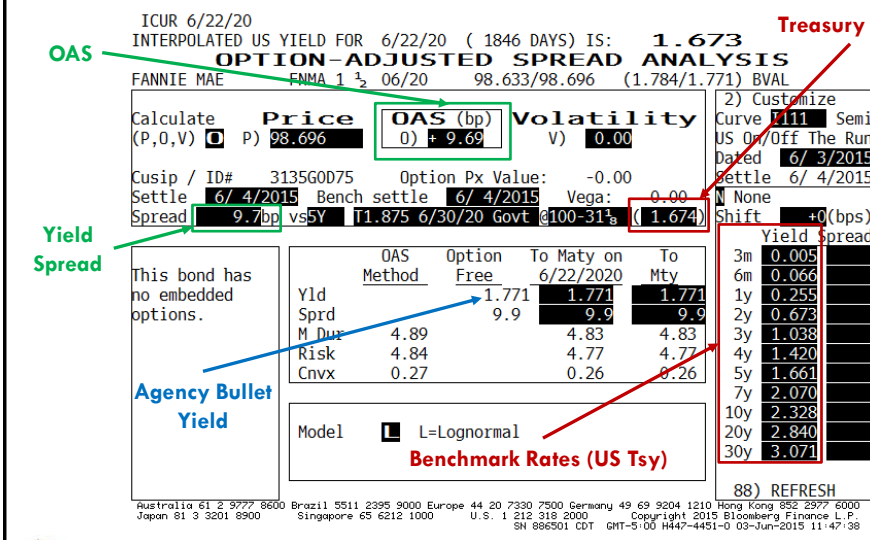
Spread Analysis: Two Approaches

Yield Spread Analysis:
Usually quoted in basis points (1/100th of 1%) by subtracting a benchmark bond yield (usually a US Treasury of similar maturity) from the yield of the bond being analyzed. The spread represents the incremental return over the benchmark the investor earns for taking on Interest Rate Risk, Reinvestment Risk, Call Risk and Credit Risk. This incremental return is to a specific date (usually maturity) and does not take into account the possibility of an early redemption.

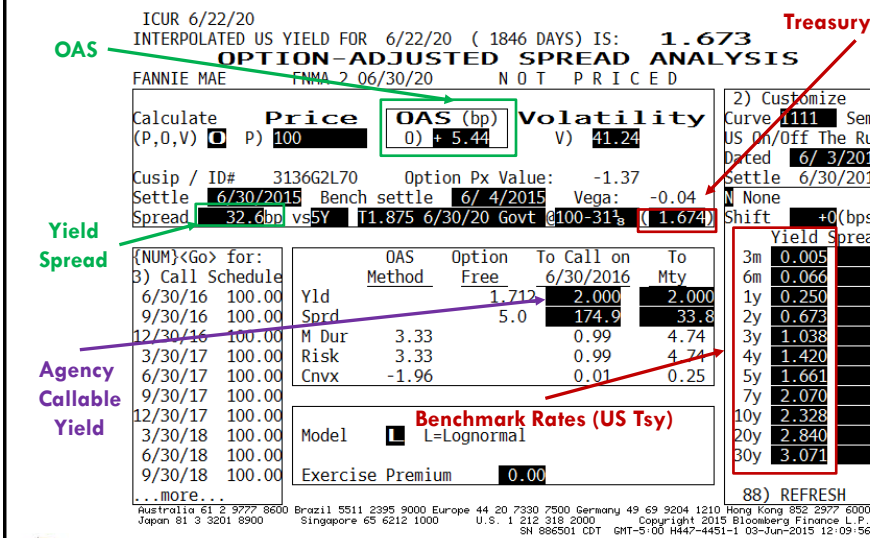
Spread Analysis: Two Approaches

Option Adjusted Spread Analysis:
A financial-analysis method that analyzes the impact of any options embedded in a bond's structure and measures the issue's expected incremental return. Quoted in basis points, the OAS represents the constant spread applied to the benchmark rates in a fixed-income option model to recover the price of the bond being analyzed. The measure is called OAS because (1) it is a spread and (2) it adjusts the cash flows for the option when computing the spread to the benchmark interest rates.

Yield Spread vs OAS: Bullet



Yield Spread vs OAS: Callable



Yield Spread vs OAS: Duration

Bond Description	Purchase Yield [1.694]	Modified Duration [4.846]	Effective Duration [3.679]	OAS [(4.18)]
1.012MM 3135G0D75: FNMA1.50 06/22/20 (5.05Yrs)	**1.572**	**4.851**	**4.894**	**9.694**
1.000MM 3134G7AD3: FHLMC1.25 06/25/20 (5.0YrsNc3.0Mos-DqSu)	1.25	4.893	1.643	(31.492)
0.983MM 912828VJ6: T1.875 06/30/20	**1.952**	**4.828**	**4.848**	**0.02**
1.000MM 3136G2L70: FNMA2.00 06/30/20 (5.0YrsNc1.0Yrs-Dq)	2.00	4.811	3.331	5.056

Duration
Interpretation: Generic description of the sensitivity of a bond's price (as a percentage of initial price) to a change in yield

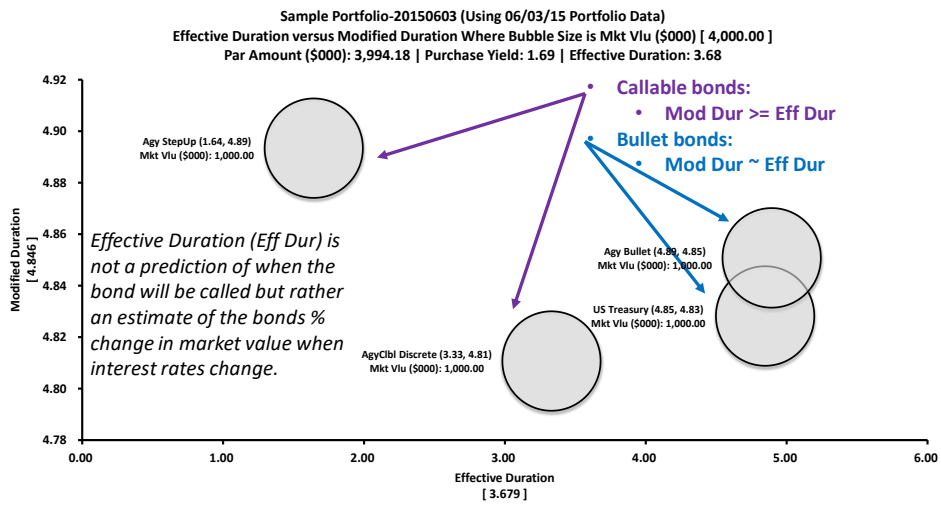
Modified Duration
Duration measure in which it is assumed that yield changes do not change the expected cash flows

Effective Duration
Duration measure in which recognition is given to the fact that yield changes may change the expected cash flows

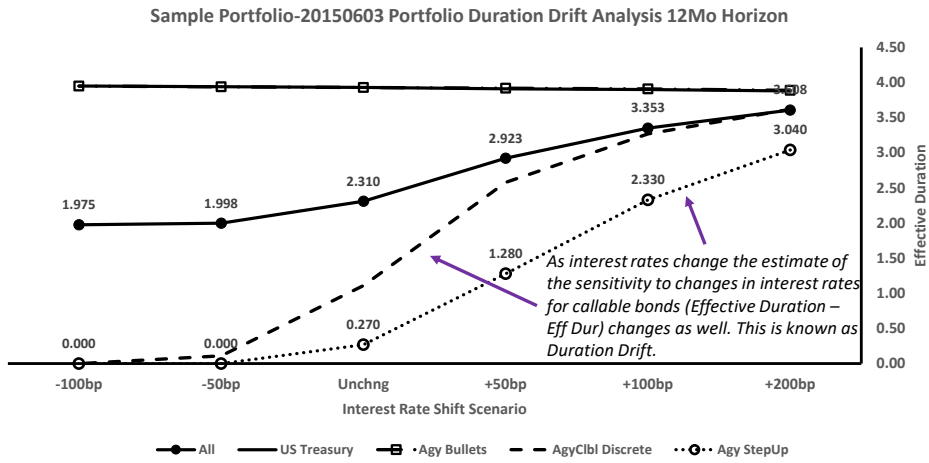
A.K.A: Option Adjusted Duration or OAS Duration.

[Definitional Diagram from: Frank J. Fabozzi. Fixed Income Analysis (Kindle Locations 3020-3021). Kindle Edition.]

Modified Duration/OAS Duration



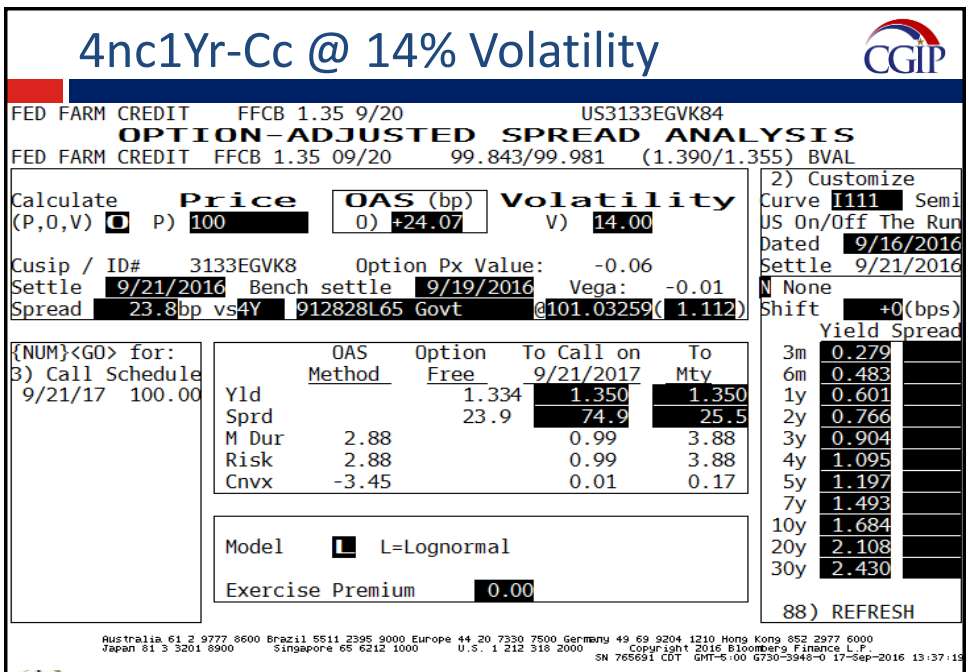
OAS Duration Drift



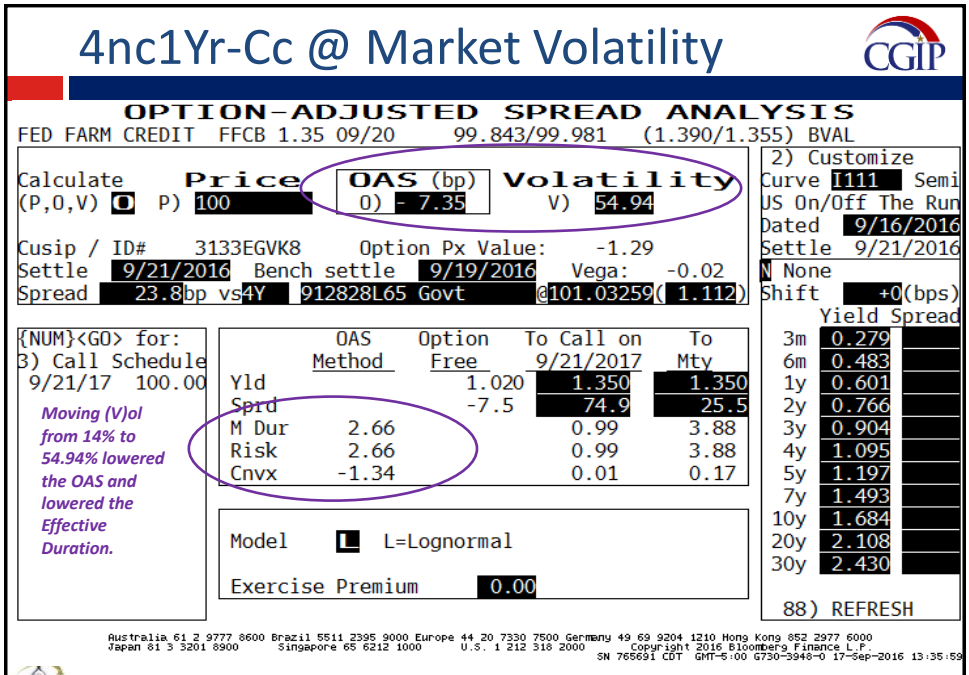
A Digression on OAS/Vol

- **It has become a common practice to use a 14% volatility** assumption for the Bloomberg OAS1 function.
- The default model for the OAS1 function on Bloomberg is the (L)ognormal model. This model is a single volatility parameter model which assumes that all points along the curve have the same volatility.
- **The 14% volatility assumption can lead to erroneous relative value comparisons when the actual volatility differs.**
- As of the recording of this presentation **the 14% volatility assumption is well below market levels and thus overstates the Option Adjusted Spread.**

4nc1Yr-Cc @ 14% Volatility

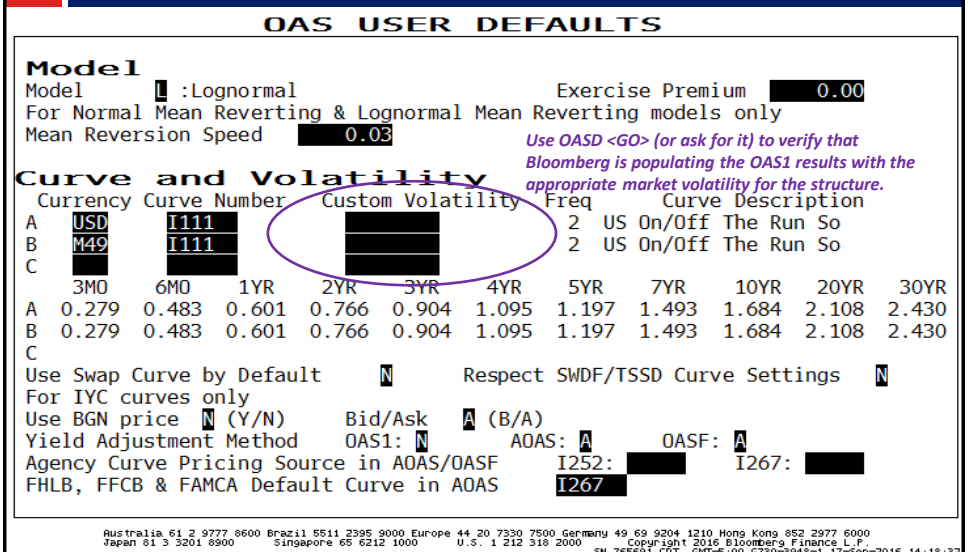


4nc1Yr-Cc @ Market Volatility



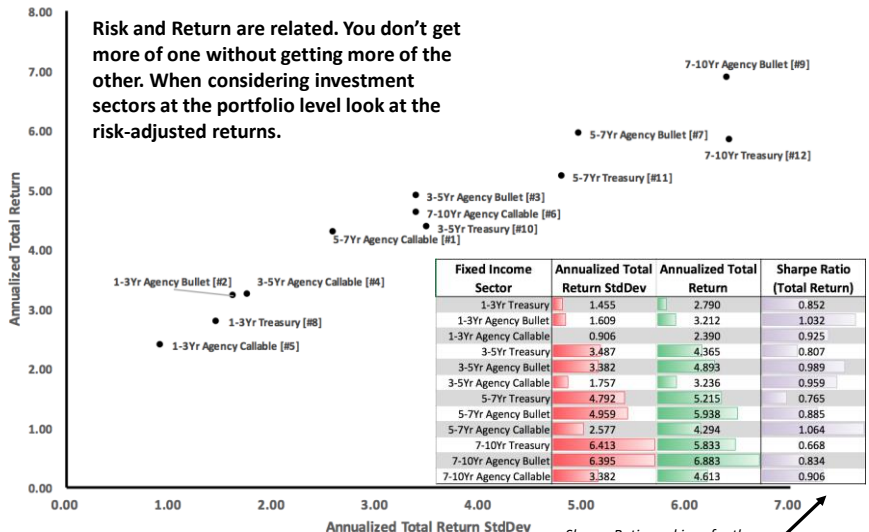
4nc1Yr-Cc Volatility History

OASD<GO>: OAS Defaults



The Big Picture: 12/00 – 08/16

Risk and Return are related. You don't get more of one without getting more of the other. When considering investment sectors at the portfolio level look at the risk-adjusted returns.



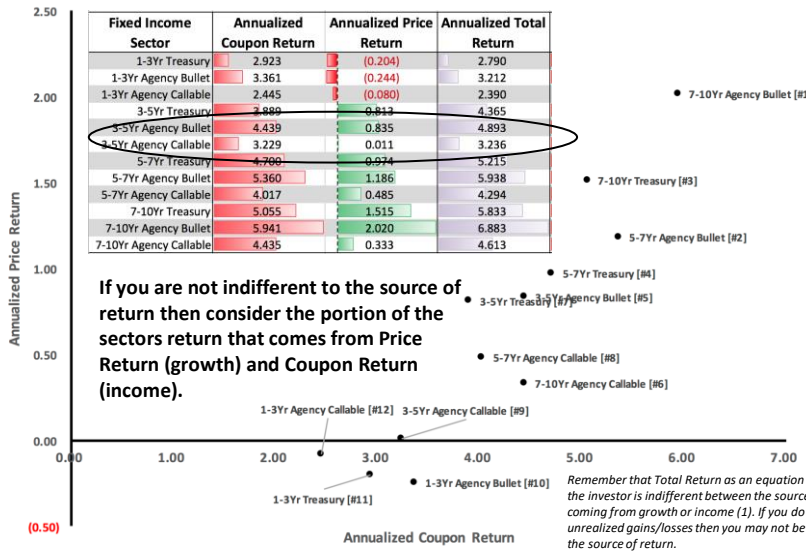
Fixed Income Sector	Annualized Total Return StdDev	Annualized Total Return	Sharpe Ratio (Total Return)
1-3Yr Treasury	1.455	2.790	0.852
1-3Yr Agency Bullet	1.609	3.212	1.032
1-3Yr Agency Callable	0.906	2.390	0.925
3-5Yr Treasury	3.487	4.365	0.807
3-5Yr Agency Bullet	3.382	4.893	0.989
3-5Yr Agency Callable	1.757	3.236	0.959
5-7Yr Treasury	4.792	5.215	0.765
5-7Yr Agency Bullet	4.959	5.938	0.885
5-7Yr Agency Callable	2.577	4.294	1.064
7-10Yr Treasury	6.413	5.833	0.668
7-10Yr Agency Bullet	6.395	6.883	0.834
7-10Yr Agency Callable	3.382	4.613	0.906

Sharpe Ratio rankings for the Treasury, Agency Bullet and Agency Callable sectors from 12/00-08/16 are in brackets.

The Big Picture: 12/00 – 08/16

Fixed Income Sector	Annualized Coupon Return	Annualized Price Return	Annualized Total Return
1-3Yr Treasury	2.923	(0.204)	2.790
1-3Yr Agency Bullet	3.361	(0.244)	3.212
1-3Yr Agency Callable	2.445	(0.080)	2.390
3-5Yr Treasury	3.889	0.813	4.365
3-5Yr Agency Bullet	4.439	0.835	4.893
3-5Yr Agency Callable	3.229	0.011	3.236
5-7Yr Treasury	4.700	0.974	5.215
5-7Yr Agency Bullet	5.360	1.186	5.938
5-7Yr Agency Callable	4.017	0.485	4.294
7-10Yr Treasury	5.055	1.515	5.833
7-10Yr Agency Bullet	5.941	2.020	6.883
7-10Yr Agency Callable	4.435	0.333	4.613

If you are not indifferent to the source of return then consider the portion of the sectors return that comes from Price Return (growth) and Coupon Return (income).

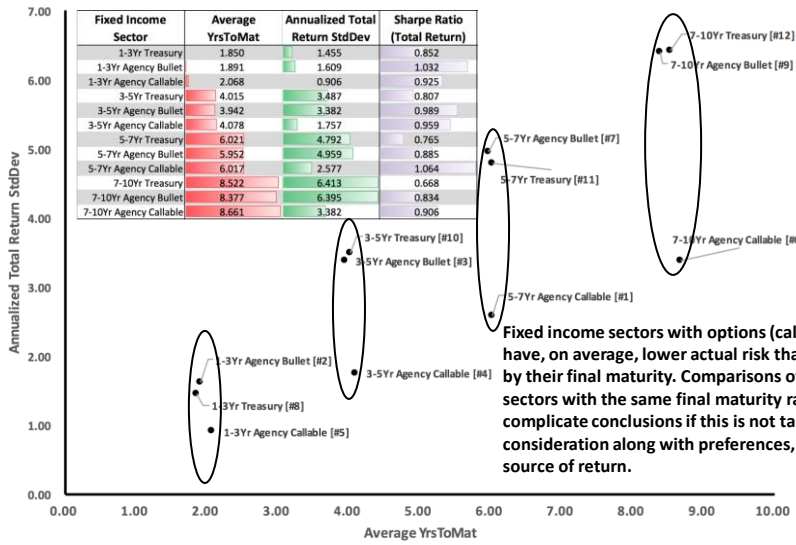


Remember that Total Return as an equation assumes that the investor is indifferent between the source of return coming from growth or income (1). If you do not budget unrealized gains/losses then you may not be indifferent to the source of return.

(1) Managing Investment Portfolios: A Dynamic Process (CFA Institute Investment Series) (p. 723). Wiley. Kindle Edition.

The Big Picture: 12/00 – 08/16

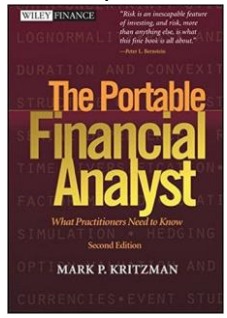
Fixed Income Sector	Average YrsToMat	Annualized Total Return StdDev	Sharpe Ratio (Total Return)
1-3Yr Treasury	1.850	1.455	0.852
1-3Yr Agency Bullet	1.891	1.609	1.032
1-3Yr Agency Callable	2.068	0.906	0.925
3-5Yr Treasury	4.015	3.487	0.807
3-5Yr Agency Bullet	3.942	3.382	0.989
3-5Yr Agency Callable	4.078	1.757	0.959
5-7Yr Treasury	6.021	4.792	0.765
5-7Yr Agency Bullet	5.952	4.959	0.885
5-7Yr Agency Callable	6.017	2.577	1.064
7-10Yr Treasury	8.522	6.413	0.668
7-10Yr Agency Bullet	8.377	6.395	0.834
7-10Yr Agency Callable	8.661	3.382	0.906

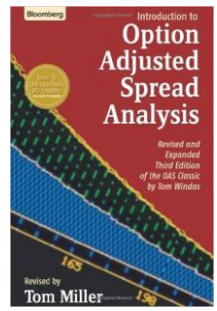


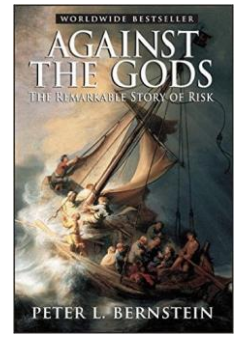
Fixed income sectors with options (callable bonds) have, on average, lower actual risk than suggested by their final maturity. Comparisons of fixed income sectors with the same final maturity ranges can complicate conclusions if this is not taken into consideration along with preferences, if any, for the source of return.

Just One Tool

- Remember: **Risk & Return are related**
  - You only get more of one with more of the other
- **OAS is just one tool/measure** among many.
  - Use OAS in conjunction with others to determine suitability
- Single security analysis second to **big picture analysis**
  - **Everything in context of Investment Policy/Plan**
- Dive deeper and learn more with these…







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