Swaps Math:
What Are Your Swaps Worth?

Fall 2011
Webinar Series
November 30, 2011
10:00 AM - 11:15 AM PT

CDIAC provides information, education and technical assistance on public debt and investments to local public agencies and other public finance professionals.

Swaps Math:
What Are Your Swaps Worth?

Housekeeping

- Feedback Button
- Questions and Answers
- Polling Questions
- Certificate of Participation

Swaps Math:
What Are Your Swaps Worth?

- Introduction of Speakers

Eric Chu
Managing Director, BLX Group

Nathanial Singer
Managing Director, Swaps Financial Group

Eric Chu

Managing Director, BLX Group

- *Over 19 years of experience in Public Finance*
- *Has extensive experience in all facets of implementing swap transactions*
- *Lead author of the BLX Groups booklet, Interest Rate Swaps*

Nathanial Singer

Partner, Swap Financial Group

- *Over 24 years of experience in Municipal Finance*
- *Extensive experience in the design and implementation of innovative financial products*
- *A frequent speaker on topics relating to both the municipal & derivatives markets*

California Debt and Investment Advisory Commission

presents

Swap Math: What Are Your Swaps Worth?

November 30, 2011

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Overview

Interest rate swaps are financial tools used by many local government agencies to manage interest rate risk. The swap market at times provides issuers the opportunity to lower their cost of financing versus traditional alternatives in the bond market. Swaps remain an important tool in managing an issuer's debt service obligations and exposure to interest rate risk. For many, swap pricing is often viewed as a "black box". This webinar is intended to provide an understanding of swap math and includes:

- Information on the swap market
- Valuation methodologies
- Swap dealer's pricing conventions
- Formulas and examples of pricing
- Review of variables affecting market prices

Part I: Before we get started….why look at swaps at all?

- Issuer has two general choices when selling fixed rate debt
  - Option A: Sell traditional fixed rate bonds
  - Option B: Sell variable rate bonds and swap to a fixed rate

- Why is there a difference in fixed rates under options A and B?

- Structural imbalance in the tax-exempt market (the neighborhood theory)

  - Supply Side – Tax-exempt issuers are financing **long** lived assets (toll roads, office buildings, power plants, stadiums, etc.). The liability structure matches the average lives (i.e. 30 to 40 year amortization).
  - Demand Side – The largest buyers of long term fixed income products (pension funds and foreign sovereigns) don't buy tax-exempt bonds. "Mom and Pop" retail focus on **short** maturities.

Part I: Before we get started….why look at swaps at all?

Typical tax-exempt amortization

GRAB Muni CDRA
<MENU> to Return

97) Options — Page 1/1 NEGOTIATED

CA HLTH FACS FIN AUTH — ST: CA — TAX: FED & ST TAX-EXEMPT — View Attachments

Summary	
Amount	100,000,000.00
Sale Date	11/07/11
MGR	BANC OF AMERICA MERR
Bond Type	REVS
Dated	11/22/11
1st Coupon	02/15/12
Rating/Enhancement	
Moody's	A2
S&P	
Fitch	A+
ENH	
Schedules	
Prem Call	
Par Call	08/15/21 ERP
Other Notes	
1st Settle	11/22/11
BOOK-ENTRY,DTC	
PRICE STATUS	FINAL

	MATURITY	AMT(M)	CPN	P/Y	CUSIP
1)	08/13	1545.0	3.250	1.390	13033LUG0
2)	08/14	1565.0	3.500	1.760	13033LUH8
3)	08/15	1625.0	3.750	2.230	13033LUJ4
4)	08/16	1690.0	4.000	2.620	13033LUK1
5)	08/17	1760.0	5.000	2.950	13033LUL9
6)	08/18	1845.0	3.000	3.310	13033LUM7
7)	08/19	1905.0	4.750	3.550	13033LUN5
8)	08/20	1970.0	5.000	3.830	13033LUP0
9)	08/21	2130.0	5.000	3.970	13033LUQ8
10)	08/22	1140.0	4.000	4.140	13033LUR6
11)	08/22	1065.0	5.000	4.140	13033LUV7
12)	08/26	9985.0	5.500	4.780	13033LUS4
13)	08/31	17370.0	5.000	5.220	13033LUT2
14)	08/33	8820.0	5.500	5.230	13033LUW5
15)	08/41	45585.0	5.250	5.430	13033LUU9

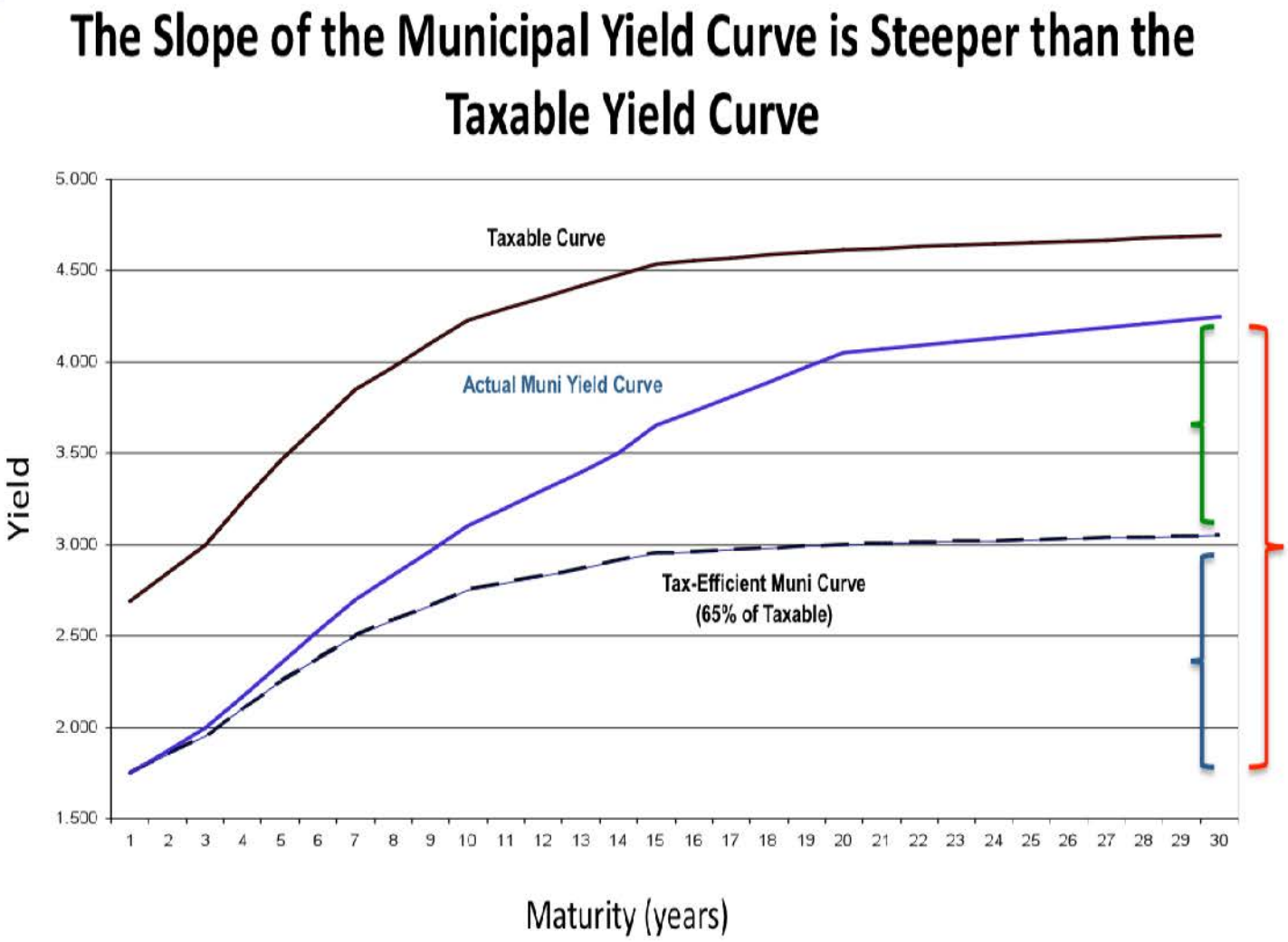
RADY CHILDRENS HOSPITAL
NOMS : $5M

Part I: Before we get started….why look at swaps at all?

- Result
  - Lots of long term supply and limited long term demand
  - Limited short term supply and lots of short term demand.

- Impact on Tax-Exempt Yield Curve: STEEP!
  - The tax-exempt yield curve has NEVER inverted and is consistently steeper than the taxable yield curve.
  - Short end of the tax-exempt yield curve is priced efficiently relative to the taxable yield curve and the long end of the tax-exempt yield curve is priced inefficiently when compared on a pre-tax equivalent basis.

Part I: Before we get started….why look at swaps at all?

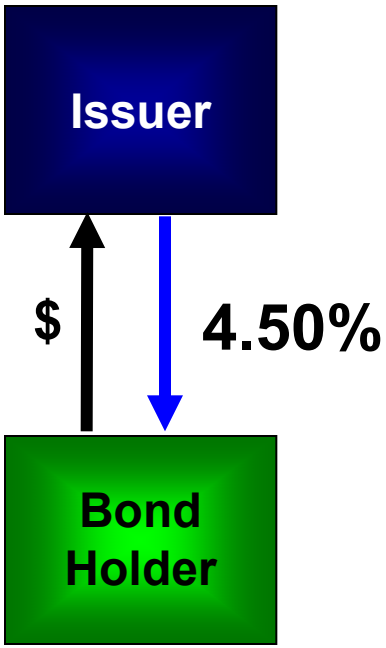


Part I: Before we get started….why look at swaps at all?

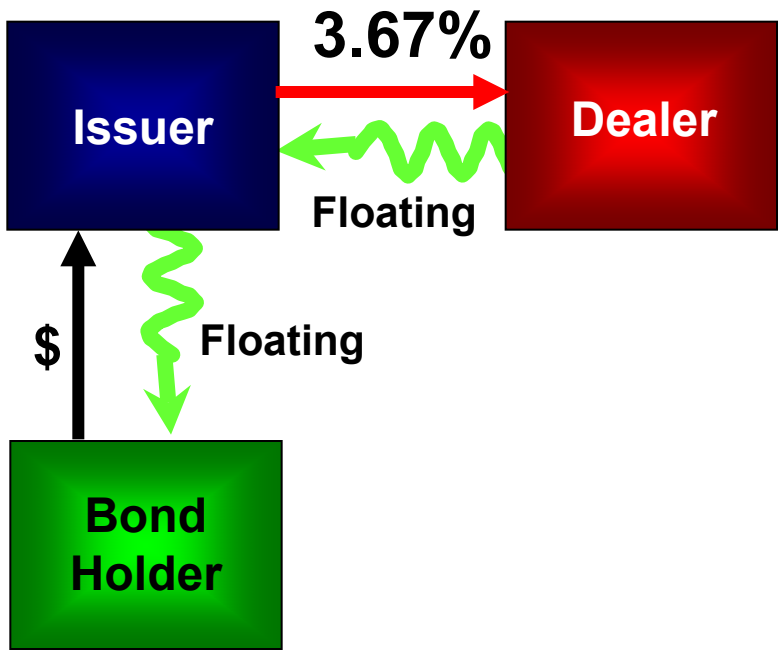
- Short Efficiency and Long Inefficiency results in swap opportunity
  - How do tax-exempt issuers capture the benefits associated with a swap based structure?
    - Issue efficiently priced variable rate bonds
    - Enter into fixed payer swaps

Why swap?

Fixed Rate Bond

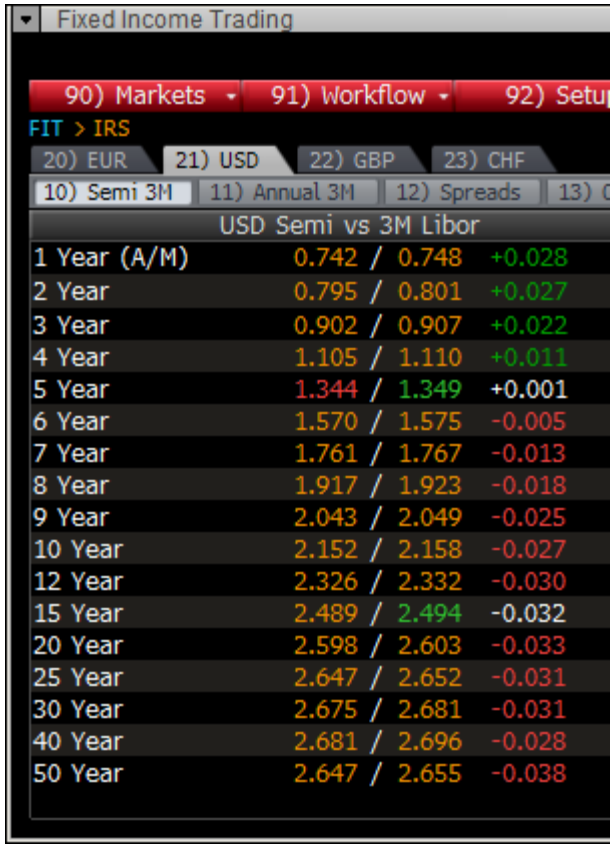


Synthetic Fixed Rate



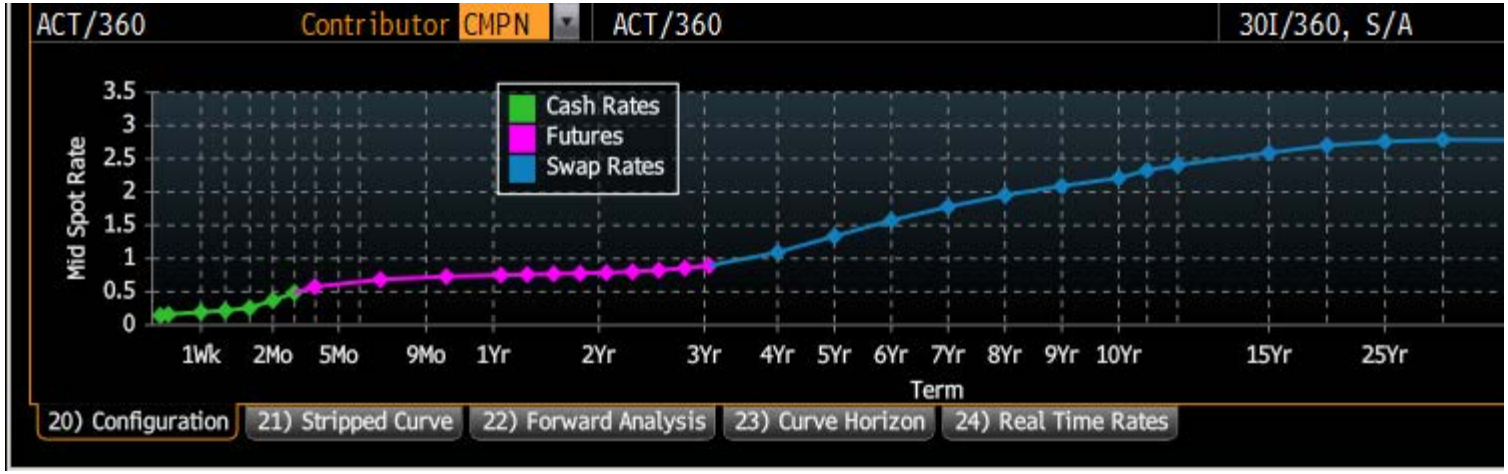
Part II: Where does the taxable swap curve come from?

- Broker/Dealers provide quotes, which are published real time through services such as Bloomberg.
- Bid Ask Quotations are for vanilla transactions (fully collateralized, standardized ISDAs).
- Swap Rate Quotes: Pay fixed | Receive floating 3 month LIBOR



Part II: Where does the taxable swap curve come from?

- Complete LIBOR swap curve is derived from:
  - LIBOR Fixings: Inter-bank lending rates up to 3 months
  - Eurodollar futures: greater than 3 months and up to 3 years
  - Quoted Swap rates: greater than 3 years
- Both new and existing swaps are priced and valued from the curve.
- Curve is constructed as 0% coupon, or 'spot' rates. Why?
  - Individual cash flows can be discounted
  - Forward rates can be extrapolated, or 'bootstrapped'



Part III: Pricing and Valuing Swaps

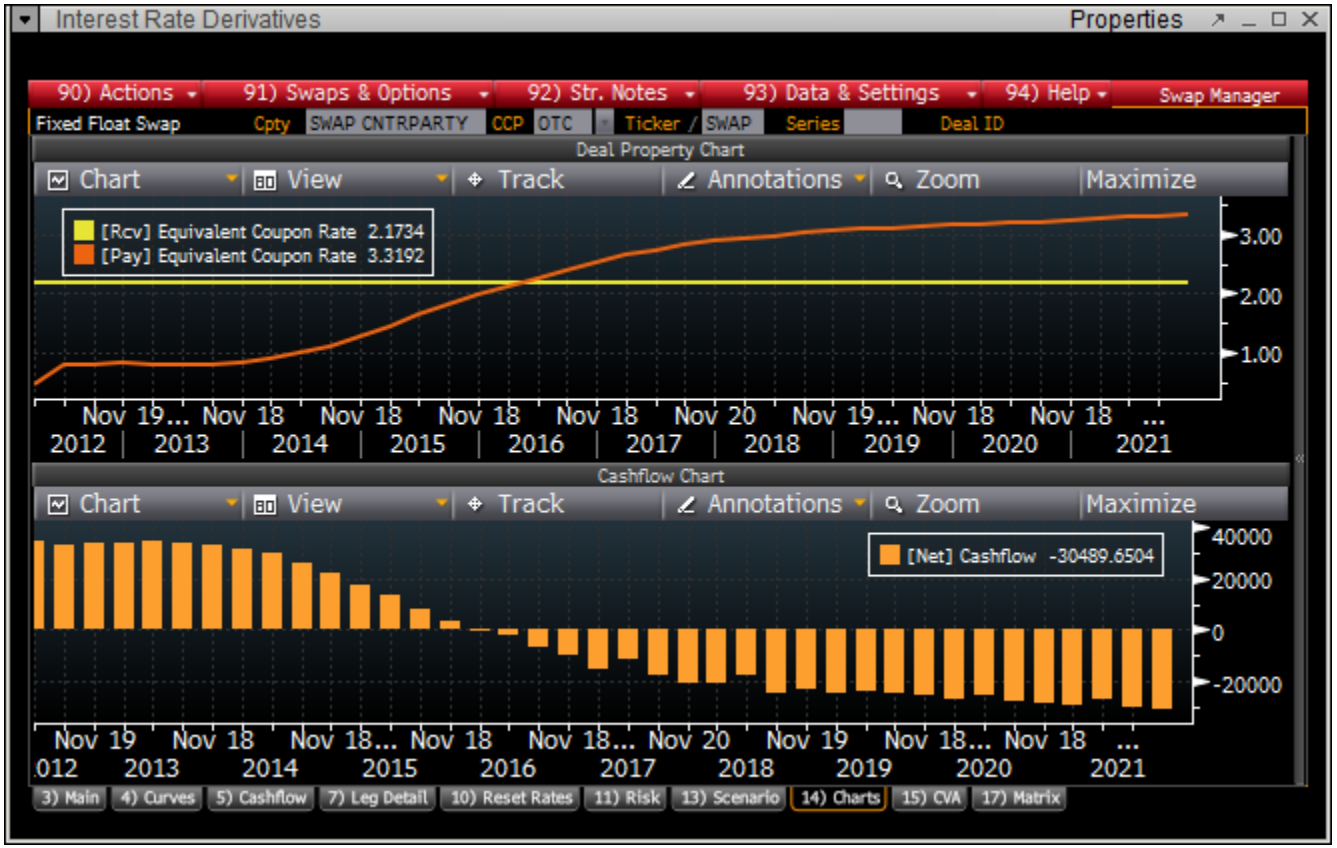
- Swaps are valued using the present value (PV) cash flow method
- Value of a swap as of any date is equal to the:
  - PV of the Future Fixed Cash Flows *minus*,
  - PV of the Future Floating Cash Flows
- Each (fixed or floating) cash flow is PV'd using discount factor derived from the 0% coupon or spot rate matching the date of the cash flow.
- I know the future fixed payments, but floating?
  - Future floating payments are also determined using the spot rates:
    - Future, or "forward" rates are mathematically 'bootstrapped'
  - Example: If one-month rates today are 0.26%, and two-month rates today are 0.37%...what are one-month rates one-month forward?

$$\left(1+.\frac{.26\%}{12}\right)^{1} \times \left(1+.\frac{x\%}{12}\right)^{1} = \left(1+\frac{.37\%}{12}\right)^{2}$$

  - Solving for *x,* tells us that the forward rate is .48%
  - This process is repeated to compute all forward rates under a swap

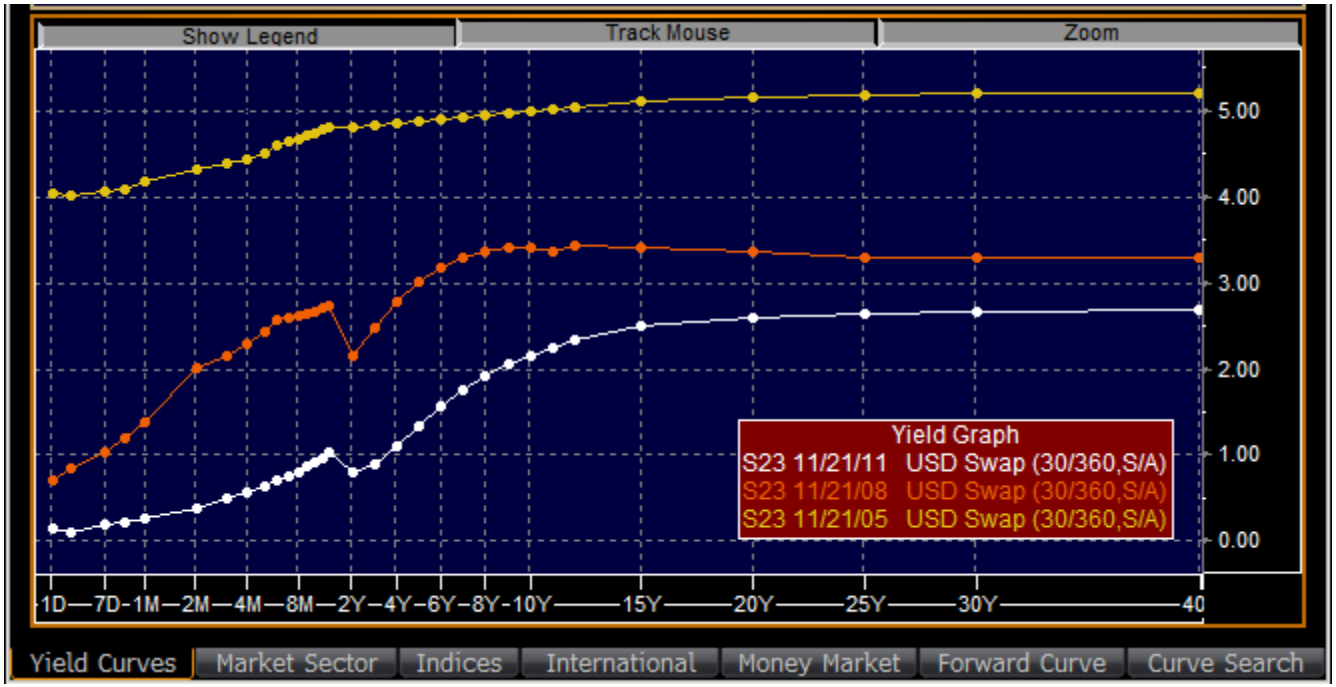
Part III: Pricing and Valuing Swaps

- Example: 10,000,000 | 10 Year Swap | 2.173% Fixed Rate vs. 3M LIBOR
  - Forward rates and net swap cash flows are highlighted below



Part III: Pricing and Valuing Swaps

- On-Market vs. Off-Market Swap
  - New swaps are generally 'on-market', where you solve for the fixed rate in order to make the value (the MTM) of the swap equal to $0 (ignoring the dealer's 'spread')
  - 10 Yr. Swap example has a fixed rate of 2.173%, which causes the PV of the fixed leg to equal the floating leg, hence is the on-market rate.
  - Off-market swaps are new swaps that have up-front payments. Also, as of any date, virtually every swap entered into previously is now 'off-market'.
- Historical Rates: LIBOR swap curve today, 3 yrs. ago, and 6 yrs. ago



Part III: Pricing and Valuing Swaps

- How do interest rate changes affect my swap?
  - Assume pay 2.173% fixed rate, receive 3M LIBOR floating rate swap
  - On valuation date, assume our previously highlighted historical yield curves

Curve Date	Change in Rates	Change in Value	On Market Rate	Off Market Rate Portion
Nov 2011	None 	None	2.173	0.000
Nov 2008	Higher 	+$1,388,000	3.818	1.645
Nov 2005	Higher, Flatter 	+$2,229,000	5.010	2.837

  - Conversely, if rates were lower on any of these dates, the change in value would be negative. (No examples since rates never been lower than today!)

Part III: Pricing and Valuing Swaps

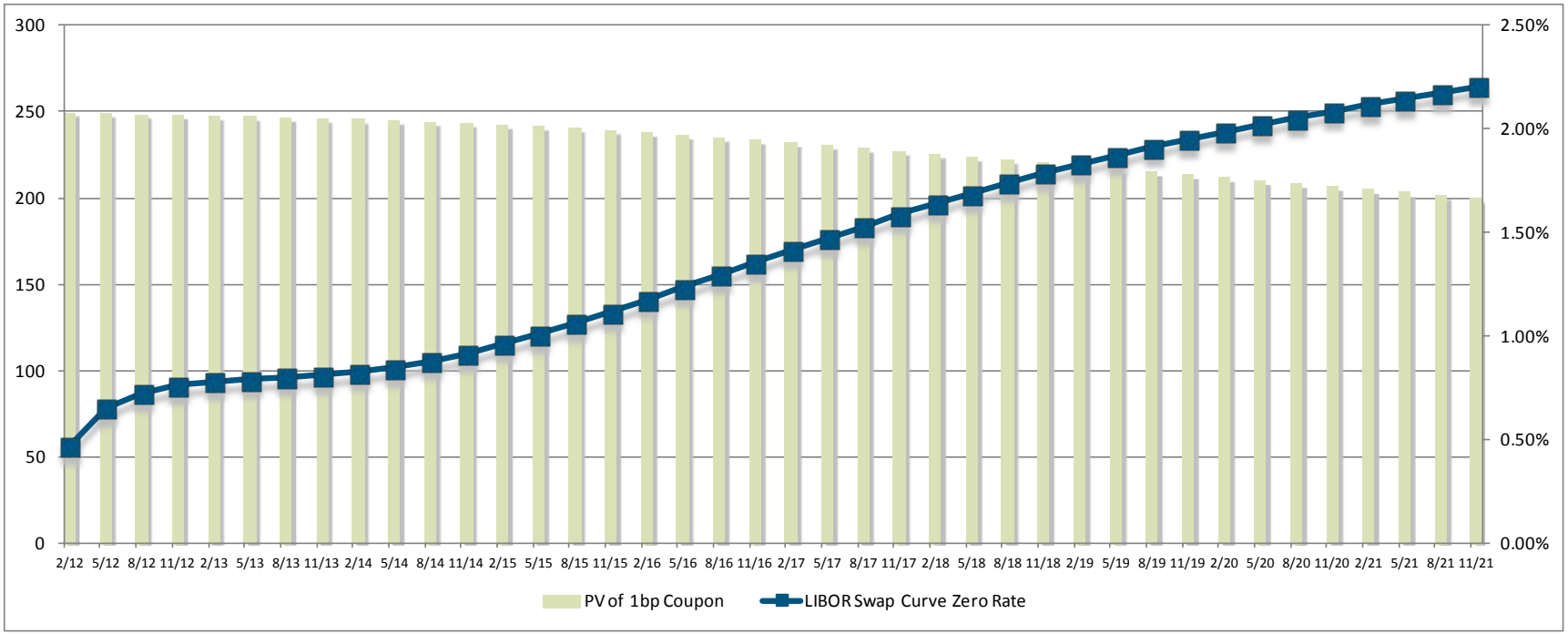
- PV01: A revealing and important data point….
  - PV01 is the present value of a fixed leg with a .01% coupon. Since discount rates used (recall spot rates), PV01 for a given swap is yield curve dependent.
    - In our example, as of November 2011, the PV01 equal to $9,193
    - November 2008 , $8,439 and as of November 2005, $7,858.
- For a given swap:

$$\frac{\text{MTM}}{\text{PV01}} = \text{Off Market Rate (in bp)} \quad \text{and} \quad \text{Fixed Rate} + \text{Off Market Rate} = \text{On Market Rate}$$

- In our example, assuming November 2008, then
  - $\frac{1{,}388{,}000}{8{,}439} = 164.5$ $\qquad 2.173\% + 1.645\% = 3.818\%$
  - Note, if MTM was negative, on-market rate would be less than fixed rate
- PV01 also known simply as a 'basis point'. This is the term a dealer will use to express the dealer spread, or compensation (e.g., 15bps) . Knowing the PV01 allows the spread to be expressed in present value dollars, e.g., 15 X $9,193 = $137,895

Part III: Pricing and Valuing Swaps

- Illustration of PV01 calculation:



PV01 = ∑ 249.69+ 249.21 … + 199.85 = 9,193.04

Part III: Pricing and Valuing Swaps

- Estimating the Change in Value for Your Swaps From PV01 and DV01
  - PV01 = PV of .01% coupon
  - DV01 = Change in value for a .01% parallel shift in yield curve.
- What's the difference?
  - For a vanilla swap, where the floating leg is 1M LIBOR or 3M LIBOR (not a % of 1M or 3M), then PV01 and DV01 are in fact the same.
  - Therefore, if you know the PV01, and the average life of the swap, then you can estimate the change value given a change in the LIBOR swap curve.
    - In our example, if 'rates are up today by 2bp', then you could estimate that the swap increased in value by $18,386 (2 X $9,193)
  - However, if the swap floating leg is 67% (or other percentage) of 1M/3M LIBOR, then DV01 = 67% X PV01.
    - If our example was a 67% LIBOR swap , then if rates up by 2bp, change in value equal to $12,318 (67% X 18,386).
    - Note, you can ignore the floating leg margin (or spread) if one exists

Part III: Pricing and Valuing Swaps

- Practical Application of Pricing Tools
  - Ask swap provider for the PV01. This is a noncontroversial figure- it's just math.
  - Find swap rates at www.wsj.com or www.federalreserve.gov

- Know limitations of PV01 and estimating values and/or on-market rates
  - Average life is reasonable but imperfect measurement of a swap's amortization.
  - Standard quotes from subscription services (e.g., Bloomberg, Reuters, etc.) as well as from public sources (e.g., WSJ, Fed) are semi-Annual, 30/360 fixed and quarterly, act/360 3M LIBOR floating
  - Any differences will cause the on-market rate of your swap to be different.
  - For example, impact of changing from act/360 to act/act reduces the fixed rate by about 1.3% (simply, 1- $\frac{360}{365}$), or about 4bp if the fixed rate were 3% otherwise
  - Compounding: The more frequent the payment, the lower the nominal fixed rate
  - 1M vs 3M LIBOR: Different pricing for 1M LIBOR.

Part IV: How does a dealer manage their swap position?

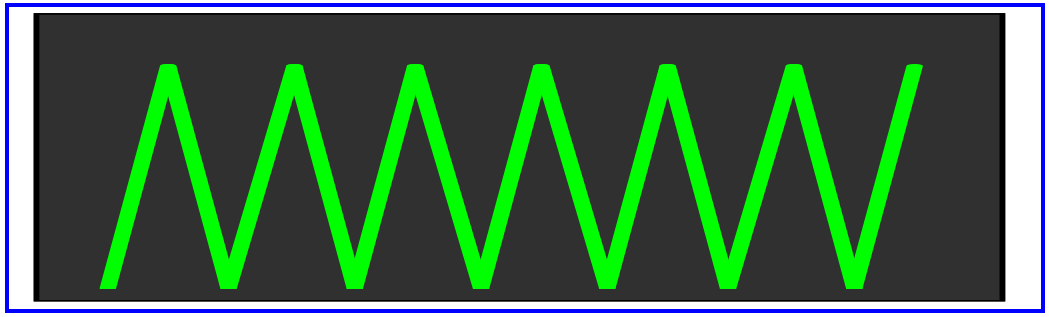
- Governmental issuers are ‘end users’ while broker/dealers and banks are generally and financial intermediaries
    - As an end-user, the governmental is typically using the swap as a tool to hedge a bond or similar debt, or asset.
    - A broker/dealer typically does not have a natural use for the swap and so will enter into an offsetting transaction (a “Matched Book”)
        - Not interested in taking on interest rate risk
        - Hedges on a portfolio basis, not a one to one basis.
        - Stays in business by charging a spread on each swap, as mentioned earlier

A Matched Book

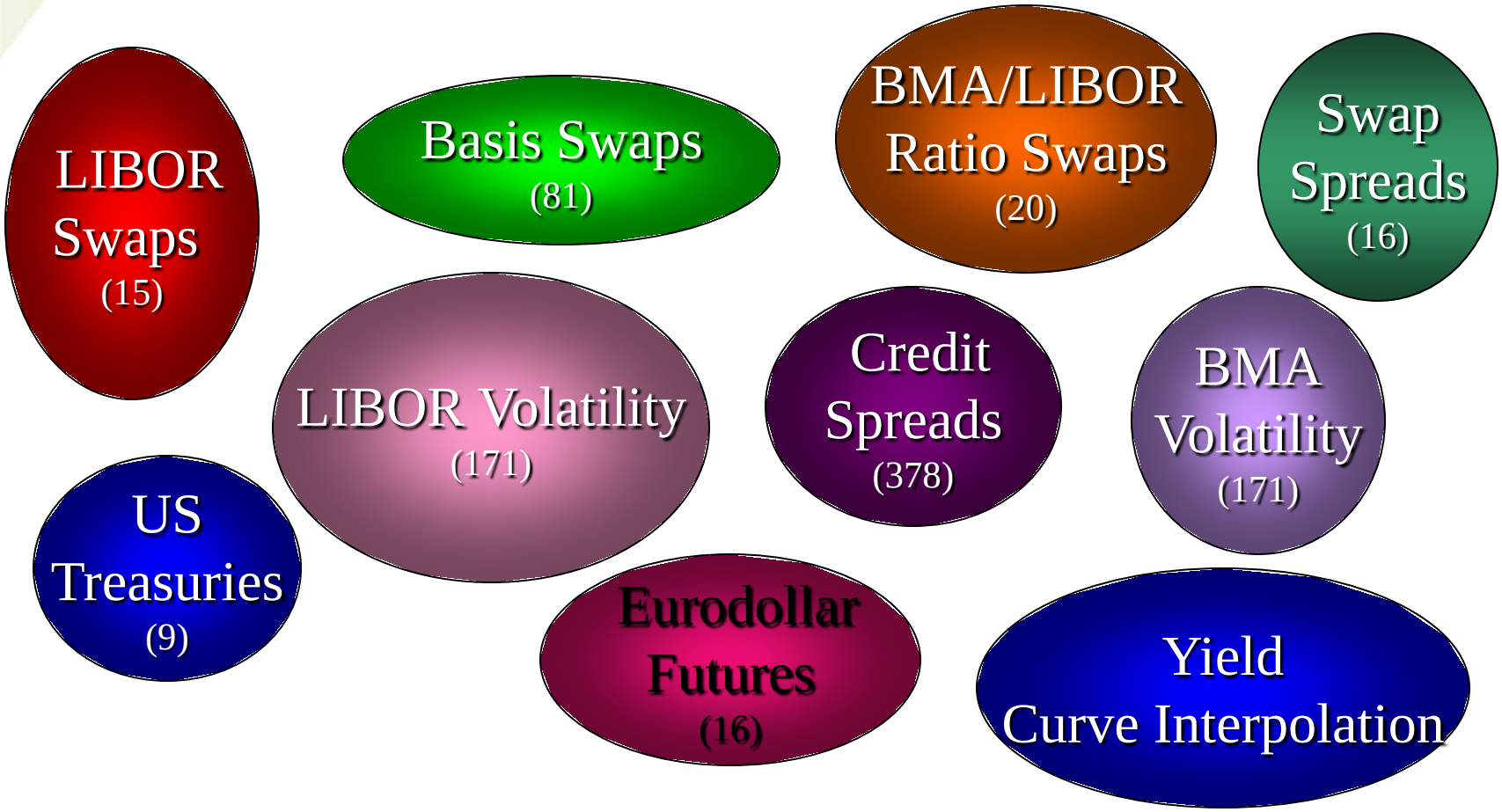
How Does Market Volatility Affect a Portfolio?

- EKG of an ideal derivative portfolio

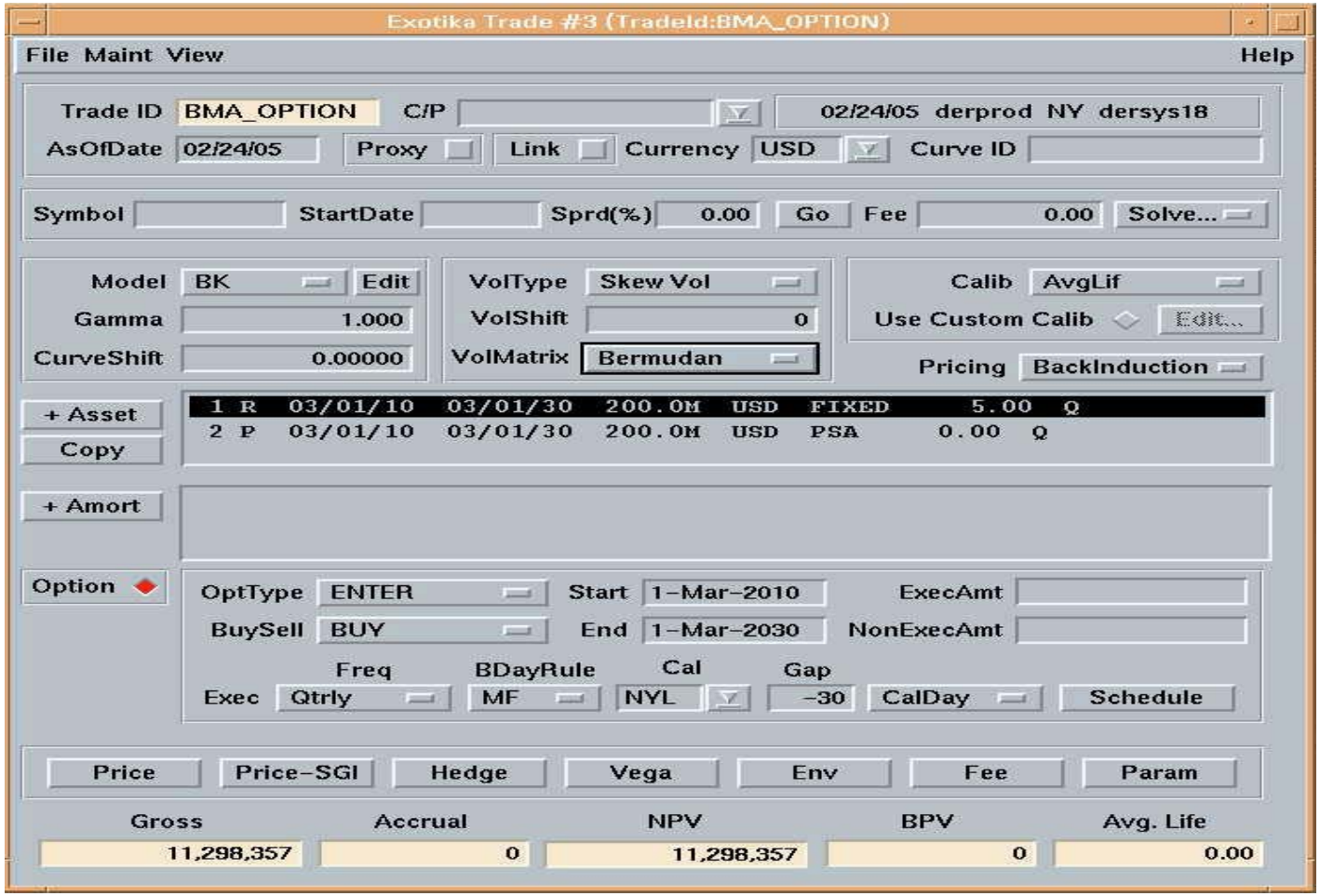
- EKG of a typical derivative portfolio



Value of a derivative contract/portfolio = *f* (underlying hedges)



Part IV: How does a dealer manage their swap position?



Part IV: How does a dealer manage their swap position?

Part IV: How does a dealer manage their swap position?

Exotika Report Text Window

File Name: /a/akuhns/spool/hedge_iloggui_0224.001

1.0BP	01 Value	Theoretical Hedge	Actual Hedge	EU$ Strip For Treas	Difference
2D	-1.11	-17.32			17.32
1W	-1.94	0.00			-0.00
1M	-8.57	0.00			-0.00
3M	-25.18	3.30			-3.30
SubTotal		-14.02			
MAR05	-25.00	2.68			-2.68
JUN05	-25.00	5.19			-5.19
SEP05	-25.00	4.27			-4.27
DEC05	-25.00	3.80			-3.80
MAR06	-25.00	3.79			-3.79
JUN06	-25.00	3.32			-3.32
SEP06	-25.00	2.73			-2.73
DEC06	-25.00	2.71			-2.71
MAR07	-25.00	2.02			-2.02
JUN07	-25.00	1.89			-1.89
SEP07	-25.00	1.32			-1.32
DEC07	-25.00	1.31			-1.31
MAR08	-25.00	0.64			-0.64
JUN08	-25.00	0.53			-0.53
SEP08	-25.00	0.02			-0.02
DEC08	-25.00	-1.05			1.05
SubTotal		35.18			
5Y	-444.17	64.54			-64.54
6Y	-525.07	6.51			-6.51
7Y	-599.63	-1.44			1.44
8Y	-670.32	-1.93			1.93
9Y	-737.21	-2.28			2.28
10Y	-794.85	-3.69			3.69
11Y	-863.94	-1.33			1.33
12Y	-925.28	-8.52			8.52
15Y	-1,081.86	-18.49			18.49
20Y	-1,300.56	-32.15			32.15
25Y	-1,467.37	-22.84			22.84
30Y	-1,564.90	2.16			-2.16
35Y	-1,699.46	-0.46			0.46
40Y	-1,784.99	0.09			-0.09
45Y	-1,852.65	-0.01			0.01
SubTotal		-19.83			
SubTotal		0.00			
Total		1.33			
BPV		-75,358.55			

Close

Part IV: How does a dealer manage their swap position?

Exotika Report Text Window

File Name: /a/akuhns/spool/hedge_iloggui_0224.001

02/24/05 BSC Run at 14:03

Interest Rate: USD/PSA, Date: 02/24/05

Selected Trades Are:
BSO in ILOGGUI book
Status:

1.0BP	01 Value	Theoretical Hedge	Actual Hedge	EU$ Strip For Treas	Difference
3M	-73.29	0.00			-0.00
6M	-157.31	0.00			-0.00
1Y	-340.67	-0.00			0.00
2Y	-732.67	0.00			-0.00
3Y	-1,128.59	0.00			-0.00
4Y	-1,520.12	0.00			-0.00
5Y	-1,907.10	-74.96			74.96
6Y	-2,293.22	-7.22			7.22
7Y	-2,669.36	-2.59			2.59
8Y	-3,035.32	-0.37			0.37
9Y	-3,390.41	1.29			-1.29
10Y	-3,733.83	0.25			-0.25
12Y	-4,383.95	4.02			-4.02
15Y	-5,252.36	18.63			-18.63
20Y	-6,403.94	35.65			-35.65
25Y	-7,248.20	27.59			-27.59
30Y	-7,887.56	0.01			-0.01
SubTotal		2.30			
Total		2.30			
BPV		381,561.56			

*** End of Report ***
/usr/derivs/prod/apps/bin/exotika 02/24/05 -ALL -RECALIB -F ILOGGUI -M SGI16 -PORT 7999

Close

Part IV: How does a dealer manage their swap position?

p. 31

Exotika Report Text Window

File Name: /a/akuhns/spool/vega2_iloggui_0224.001

Interest Rate Products Group
Vega Risk Report for Account ILOGGUI (CvId:)
AsOf: 02/24/05

Volatility: USD/PSA

Exec Date	3M	1Y	2Y	3Y	4Y	5Y	7Y	10Y	15Y	20Y	30Y	Total
2D	0	0	0	0	0	0	0	0	0	0	0	0
1M	0	0	0	0	0	0	0	0	0	0	0	0
3M	0	0	0	0	0	0	0	0	0	0	0	0
6M	0	0	0	0	0	0	0	0	0	0	0	0
9M	0	0	0	0	0	0	0	0	0	0	0	0
1Y	0	0	0	0	0	0	0	0	0	0	0	0
18M	0	0	0	0	0	0	0	0	0	0	0	0
2Y	0	0	0	0	0	0	0	0	0	0	0	0
3Y	0	0	0	0	0	0	0	0	0	0	0	0
4Y	0	0	0	0	0	0	0	0	0	0	0	0
5Y	0	0	0	0	0	0	0	229,546	148,922	0	0	378,468
7Y	0	0	0	0	0	0	1,045	103,551	10,044	0	0	114,640
10Y	0	0	0	0	0	(440)	(10,200)	15,098	0	0	0	4,458
15Y	0	0	0	2,133	34,512	27,561	(17,344)	(1,212)	0	0	0	45,651
20Y	0	0	0	8,646	29,509	21,115	(383)	0	0	0	0	58,888
Total	0	0	0	10,780	64,021	48,236	(26,881)	346,983	158,966	0	0	602,104

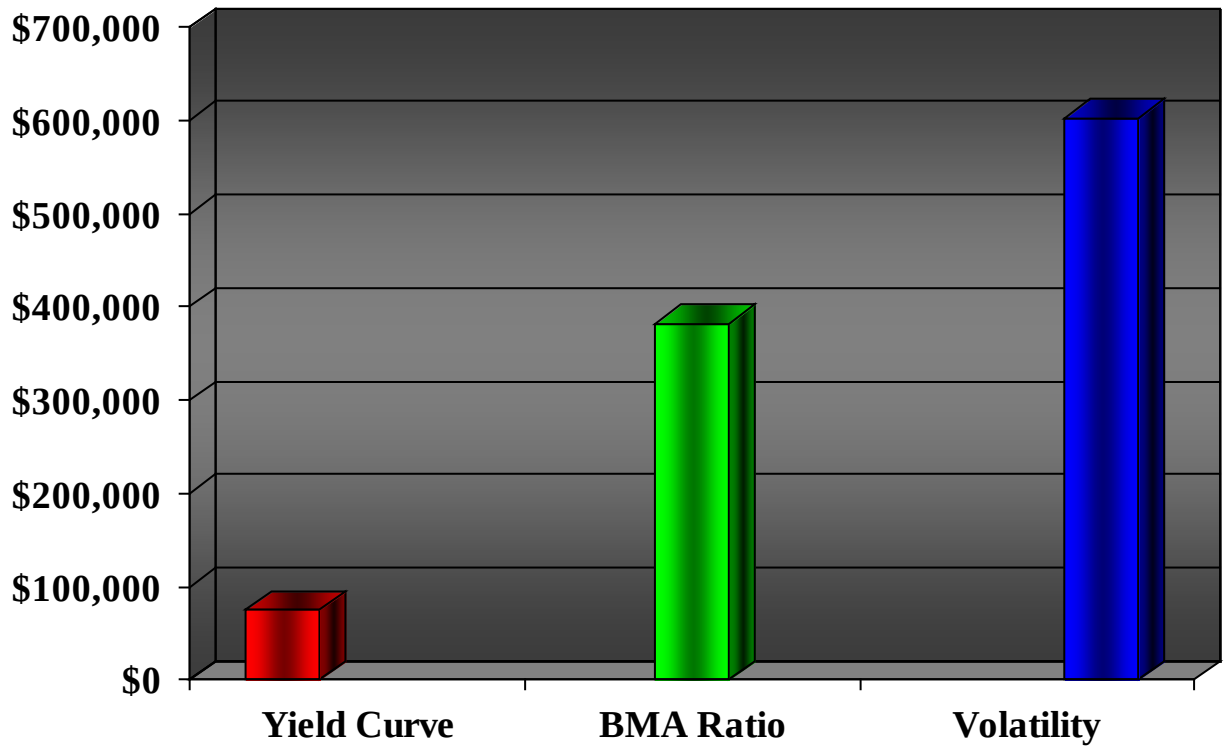
Flat Vega: 0

Total Vega (Flat + Curve) 602,104

Close

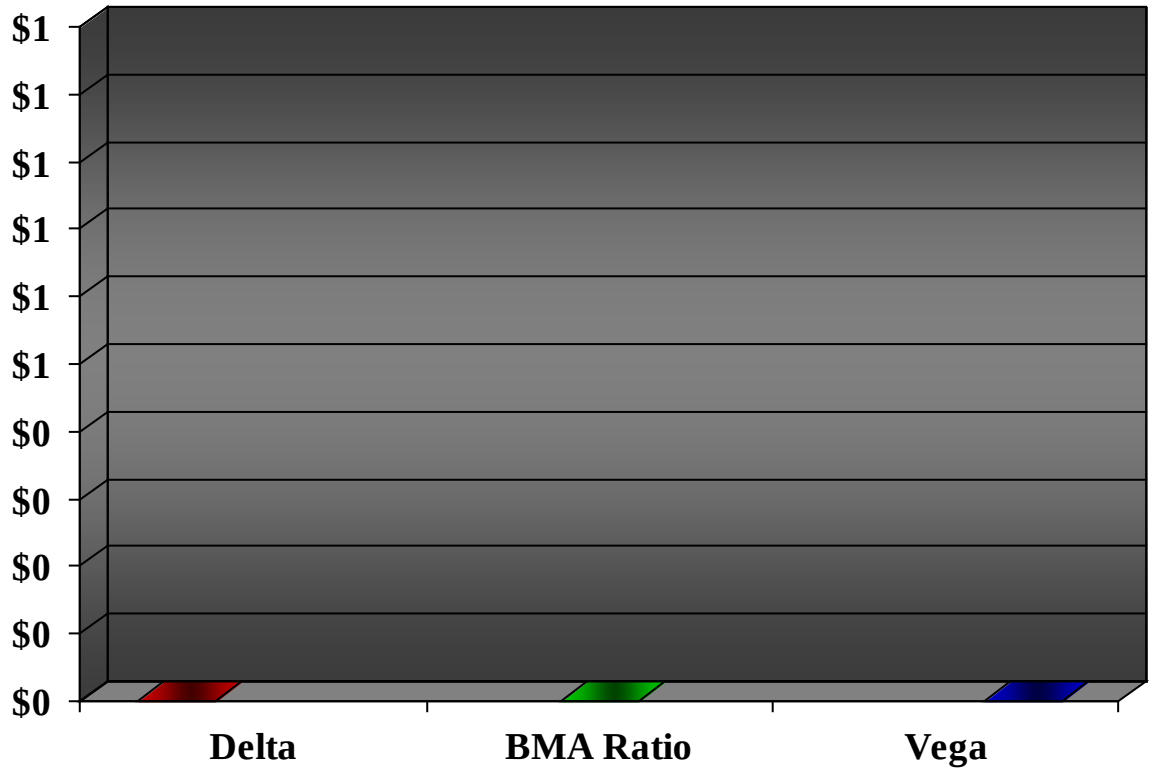
Trade Example: Trading System Output

- Exposure to Parallel Shift of Underlying Variables



Trade Example: Trading System Output after Hedging

- Exposure After Hedging



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