The FRM Exam:
What to do?

Ahsan Ali, CFA FRM

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Agenda

1. Introduction – Ahsan Ali
2. FRM – About the exam
3. FRM – Tips & Tricks
    - Time management
    - Studying material
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    - Challenges
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    - Bond Valuation
    - Binomial trees

Introduction – Ahsan Ali

- Small time villager in the big bad world of finance
- Gypsy at heart - 12 years work experience spread across 8 geographies (Europe, UAE and Pakistan)
- Veteran of Citigroup, Standard Chartered, UBL and Noor Islamic Bank
- Exposure in – Risk Management (Corporate, SME , Consumer), Operational Risk, Strategy, Business management and Operations
- Learnt ‘**a bit’** through

Introduction – Ahsan Ali

<u>Educational Qualifications:</u>

Ms Financial Economics, School of Oriental and African Studies (SOAS), University of London (2003)

MBA Finance, Institute of Business Administration, University of Karachi (1997)

BBA Finance, Institute of Business Administration, University of Karachi (1996)

<u>Professional Certifications & Charters:</u>

Islamic Finance Qualification (**IFQ**), Chartered Institute for Securities & Investment (CISI) – UK (2009)

Financial Risk Manager (**FRM**), Global Association of Risk Professionals (GARP) - USA (2004)

CFA Charter Holder (**CFA**), CFA Institute - USA (2001)

Member of Chartered Institute for Securities & Investment (CISI) - UK (**MCSI**) (2005)

Member of the Society of Investment Professionals (**SIP**) (London, Zurich) (2003)

Securities & Financial Derivatives Representative (**SFDR**) Chartered Institute for Securities & Investment (CISI) - UK (2000)

Investment Administration Qualification (**IAQ**), Chartered Institute for Securities & Investment (CISI) - UK (2000)

Introduction – Ahsan Ali

- Learnt **'a lot'** through
  1. Teaching/training (**Mostly**)
     - Citigroup – Credit, investment analysis, modeling & advanced modeling
     - UBL – Credit, Operational Risk
     - SCB – Consumer credit techniques
     - NIB – Islamic banking, product structuring
     - CFA & FRM – Lectures, mentorship
  2. Seminars and workshops
     - 4th Annual Middle East Retail Banking Forum, "Evolution of Islamic Wealth Management", (Apr 2009)
     - Wealth Management Summit 2009, "Real Estate Investments - A wise Choice?", (Jan 2009)
     - SME Banking Forum, "Creating an aligned rating system for SME's", (Nov 2008)
     - Islamic Funds World. "Diversification of HNWI portfolio's through Islamic Allocation",(Nov 2008)

Introduction – Ahsan Ali

- Research work/publications
  - "Crucial Key - Risk Management Integral to the Future of Islamic", Business Islamica (Dec 2009)
  - "Gaining Access – A Finance Framework for MSME's in the GCC", Capital (Nov 2009)
  - "Real Value – Is real estate investment still a wise choice", Capital (May 2009)
  - "Risk Reward – Islamic Asset Allocation", Business Islamica (Mar 2009)

About the FRM Exam

- **The FRM exam covers 9 topics that gives a strong basis for quantitative and risk analysis and presents risk related events that have occurred in the 'real-world'**
- **The interesting (and easier!) topics that cover real world experiences include**
  - Foundations of Risk Management: risk management failures and case studies are analyzed
  - Current Issues in Financial Markets: discuss the causes and consequences of the credit crisis, liquidity crisis and other issues

About the FRM Exam

- **The more rigorous (and tougher!) topics include**
  - Quantitative analysis: Learn different distributions, linear regression, bond and option valuations, and simulation methods
  - Operational and Integrated Risk Management: which includes risk capital, performance evaluation of risk models, Basel II Accord, economic capital and other operational risk factors
- **Multiple choice 100 questions, passing grade ?**

Tips & Tricks - Time management

Before the exam

- Before you start studying, prepare a schedule and give yourself at least 2 weeks before the exam for a full review (including solving practice problems and exams)
- Make sure to factor in more time than needed to study. As many people tend to procrastinate, it is important to be able to flex your schedule in order to make up for lost time. People with demanding jobs should also factor additional time to make up for unexpected excess work load
- In the last week focus on your **STRENGTHS**

Tips & Tricks - Time management

During the exam

- **Do Not** take more than 90 seconds per question in the first round. If you cannot solve it LEAVE IT
- Take stock – calculate how many you answered in the first round multiply by 80%. This is your minimum score.
- Now solve the rest, starting with areas of **STRENGTH**
- Where confused (especially combinations of statements) use logic (AND/OR/NOT) to eliminate

Tips & Tricks – Study Material

- The 'FRM Handbook' can be purchased when registering for the exam; however this book does not cover all topics
- The list of readings that should be studied for the exam are provided in the FRM Study Guide. The FRM Handbook is meant to be used **only as a review** to these readings
- People who have demanding schedules and do not have time to study all the readings **SHOULD** resort to other material providers such as Schweser
  - Schweser notes condense the material into 3 books for Level 1 (another 3 books for Level 2) and includes all critical information from the FRM curriculum
  - Schweser also provide weekly online programs, a practice exam book, QBank and other material which can be used for review

Tips & Tricks – Practice Questions

- The Schweser QBank is an online database of questions and is a great place to review the material
  - *Using Qbank, you can create your own exam by selecting the types of questions which are organized by topic and by difficulty*
- QBank is a good place to review topics, but does not represent a good mock exam. For a better representation of the exam, Schweser also have a practice exam book. It includes 2 complete exams and reflect the types of questions that have appeared on recent exams
- Take as many practice exams as possible. Don't get thrilled by good mock scores- consider high stress and distraction factor of actual exam and deduct 10%!
- Don't be surprised if the exam has 30% to 50% of questions <u>almost</u> identical to recent exams/mock exams.

Tips & Tricks – Challenges

- Understand which formulas to remember, you do not need to know everything by heart
- The conceptual questions are more difficult than the quant ones
- Quant can be a challenge practice in the last week
- If you have not completed the studying material, do not skip the exam. It will be a good learning experience for your second try, and you can always get lucky! (depending on who the other candidates are)

Yield to Maturity

Yield to Maturity

The **yield to maturity**, or YTM, of a fixed-income security is equivalent to its internal rate of return.

The YTM is the discount rate that equates the present value of all cash flows associated with the instrument to its price.

Yield to Maturity (continued)

For a security that pays a series of known annual cash flows, the computation of yield uses the following relationship:

$$P = \frac{C_1}{(1+y)^1} + \frac{C_2}{(1+y)^2} + \frac{C_3}{(1+y)^3} + \ldots + \frac{C_N}{(1+y)^N}$$

where:

P = the price of the security

C_k = the annual cash flow in year k

N = term to maturity in years

y = the annual yield or YTM on the security

Yield to Maturity: Example

What rate of return must be earned on an account in order to pay out $885 at the end of each year for the next 10 years? Assume the account is worth $5,000 today and the entire amount (plus compound interest) will be paid out.

A. 10.5%.

B. 11%.

C. 12%.

D. 15%.

Answer

PV = 5,000; PMT = –885; FV = 0; N = 10

A. 10.5%.

B. 11%.

C. 12%.

D. 15%.

Calculating the Price of a Perpetuity

The **perpetuity** formula is straightforward and does not require an iterative process:

$$\text{PV of a perpetuity} = \frac{C}{y}$$

where:

C = the cash flow that will occur every period into perpetuity

y = yield to maturity

Par Value, Coupon Rate, and Price

- If **coupon rate > YTM**, the bond will sell for more than par value, or at a premium
- If **coupon rate < YTM**, the bond will sell for less than par value, or at a discount
- If **coupon rate = YTM**, the bond will sell for par value

Pull-to-Par and Coupon Effect

- Over time, the price of premium (discount) bonds will gradually fall (rise) until they trade at par value at maturity. This converging effect is known as **pull to par**.
- If two bonds are identical in all respects except their coupon, the bond with the smaller coupon will be more sensitive to interest rate changes.
  - The lower the coupon rate, the greater the interest-rate risk.
  - The higher the coupon rate, the lower the interest-rate risk.

Reinvestment Risk

When a bondholder receives coupon payments, the investor runs the risk that these cash flows will be reinvested at a rate of return, or yield, that is lower than the promised yield on the bond. This is known as **reinvestment risk**.

Reinvestment risk is a major threat to the bond's computed YTM, as it is assumed in such calculations that the coupon cash flows can be reinvested at a rate of return that's equal to the computed yield.

One-Factor Measures of Price Sensitivity

Dollar Value of a Basis Point

The **price value of a basis point** (PVBP) [a.k.a. the **dollar value of a basis point** (DV01)] is the absolute change in bond price from a one basis point change in yield.

$$\text{DV01} = |\text{ price at YTM}_0 - \text{price at YTM}_1\ |$$

where:

$| \ |$ = the absolute value

YTM_0 = the initial yield to maturity

YTM_1 = the yield to maturity one basis point above or below YTM_0 $(\text{YTM}_1 = \text{YTM}_0 \pm 0.0001)$

Application to Hedging

The goal of a hedge is to produce a combined position (the initial position combined with the hedge position) that will not change in value for a small change in yield. This is expressed as:

$$HR = \frac{\text{DV01 (per \$100 of initial posting)}}{\text{DV01 (per \$100 of hedging instrument)}}$$

Duration

- Duration is the most widely used **measure of bond price volatility**
- A bond's price volatility is a function of its coupon, maturity, and initial yield. Duration captures the impact of all three of these variables in a single measure.
- A bond's duration and its price volatility are directly related

Duration (continued)

The formula for **effective duration**, more commonly referred to as duration, is:

$$\text{duration} = \frac{BV_{-\Delta y} - BV_{+\Delta y}}{2 \times BV_0 \times \Delta y}$$

where :

$BV_{-\Delta y}$ = estimated price if yield decreases by a given amount, Δy

$BV_{+\Delta y}$ = estimated price if yield increases by a given amount, Δy

BV_0 = initial observed bond price

Δy = change in required yield, in decimal form

Duration: Example

Suppose there is a 15-year option-free noncallable bond with an annual coupon of 7% trading at par.

Compute the bond’s duration for a 10 basis point increase and decrease in yield.

Answer

If interest rates rise by 10 basis points (0.10%), the estimated price of the bond falls to 99.095%.

(N = 15; PMT = 7.00; FV = 100; I/Y = 7.10%;

CPT → PV = –99.095)

If interest rates fall by 10 basis points, the estimated price of the bond is 100.917%

$$\text{Duration} = \frac{(100.917 - 99.095)}{(2 \times 100 \times 0.001)} = 9.11$$

Convexity

- Duration is a good approximation of price changes for an option-free bond, but it is only good for relatively small changes in interest rates
- As rate changes grow larger, the curvature of the bond price/yield relationship becomes more important, meaning that a linear estimate of price changes will contain errors

Convexity

Convexity captures the curvature of the bond price/yield relationship

$$\text{convexity} = \frac{BV_{-\Delta y} + BV_{+\Delta y} - 2 \times BV_0}{BV_0 \times \Delta y^2}$$

$BV_{-\Delta y}$ = estimated price if yield decreases by a given amount, Δy

$BV_{+\Delta y}$ = estimated price if yield increases by a given amount, Δy

BV_0 = initial observed bond price

Δy = change in required yield, in decimal form

Convexity: Example

Suppose there is a 15-year option-free noncallable bond with an annual coupon of 7% trading at par.

If interest rates rise by 10 basis points, the estimated price of the bond is 99.095.

If interest rates fall by 10 basis points, the estimated price of the bond is 100.917.

Calculate the convexity of this bond.

Answer

$$\text{Convexity} = \frac{(100.917 + 99.095 - 2 \times 100)}{100 \times 0.001^2} = 120$$

Combining Duration and Convexity

By combining duration and convexity, a far more accurate estimate of the percentage change in the price of a bond can be obtained.

$$\text{percentage price change} \approx \text{duration effect} + \text{convexity effect}$$

$$= \left[-\text{duration} \times \Delta y \times 100\right] + \left[\left(\frac{1}{2}\right) \times \text{convexity} \times \left(\Delta y\right)^2 \times 100\right]$$

Estimating Price Change: Example

Use the duration/convexity approach to estimate the effect of a 150 basis point increase and decrease on a 15-year, 7%, option-free bond currently trading at par.

The bond has a duration of 9.11 and a convexity of 120.

Answer

$$\Delta V_{-}\% \approx (-9.11 \times -0.015 \times 100) + (0.5 \times 120 \times -0.015^2 \times 100)$$
$$\approx 13.665\% + 1.35\% = 15.015\%$$

$$\Delta V_{+}\% \approx (-9.11 \times 0.015 \times 100) + (0.5 \times 120 \times 0.015^2 \times 100)$$
$$\approx -13.665\% + 1.35\% = -12.315\%$$

Portfolio Duration

The **portfolio duration**, D_{Port}, of a bond portfolio is simply the value-weighted average of the durations of the bonds in the portfolio.

$$D_{Port} = \sum_{j=1}^{K} w_j \times D_j$$

where:

D_j = duration of bond j

w_j = market value of bond j divided by the market value of entire portfolio

K = the number of bonds in the portfolio

Determinants of Duration

- Effective duration is a function of the bond’s maturity, yield, and credit rating. In general, **the longer the term to maturity, all else equal, the greater the bond’s duration** and interest rate risk exposure.
- **The greater the yield to maturity, all else equal, the lower the bond’s duration**.
- In addition, the bond’s yield is negatively related to its credit rating. Therefore, a credit rating upgrade will decrease the yield and increase the bond's duration.

Negative Convexity

- With **callable debt**, the upside price appreciation in response to decreasing yields is limited (sometimes called price compression).
- For example, a bond is callable at 102. The fact that the issuer can call the bond at any time for $1,020 per $1,000 of face value puts an effective upper limit on the value of the bond.
- When the price begins to *rise at a decreasing rate* in response to further decreases in yield, the price-yield curve “bends over” to the left and exhibits **negative convexity**.

Binomial Trees

Binomial Trees

A **one-step binomial model** is best described within a two-state world where the price of a stock will either go up once or go down once, and the change will occur one step ahead at the end of the holding period.

Binomial Trees (continued)

In the **two-period** and **multi-period models**, the *tree* is expanded to provide for a greater number of potential outcomes.

As the length of the *next period* is made smaller and smaller and the number of periods is increased, the binomial tree should produce an accurate estimate of the stock option price.

The Binomial Model

- **Binomial**: Next period, variable will change to one of two possible values
- On the next slide: Binomial stock option model example
- **Intuition question**: Will call value be higher or lower if size of up-move (U) is smaller?

The Binomial Model: Example

$$U = \text{size of up-move} = 1.15$$

$$D = \text{size of down-move} = \frac{1}{U} = 0.87$$

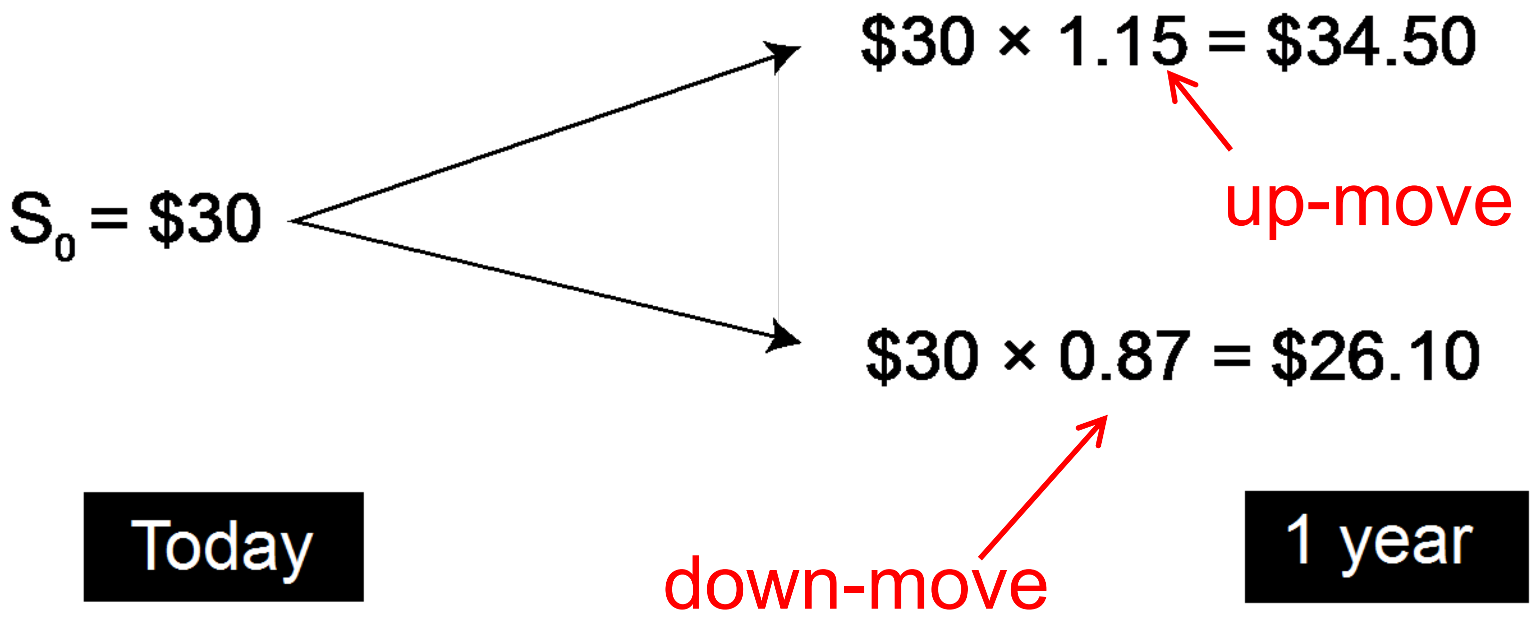
$$\pi_u = \text{probability of up-move} = \frac{e^{rt} - D}{U - D} = 0.715$$

$$\pi_D = \text{probability of down-move} = 1 - \pi_u = 0.285$$

$$r = 6.8\%;\ t = 1;\ S_0 = \$30$$

The Binomial Model: Example (continued)

One-period binomial tree for stock price



The Binomial Model

- Given the evolution of the stock price, we can determine the payoff to an option in the two states
- Example continued:
  - Consider a one-period option with an exercise price of **$30**
  - What is the value of the option in each state of the world?

The Binomial Model (continued)

- In the up-state:
  - Stock increases to $34.50
  - Payoff to call with $30 strike = $4.50
  - Remember: S – X = $34.50 – $30 = $4.50
- Likewise, in the down state:
  - Stock falls to $26.10
  - Option will pay $0 (option out of the money)

The Binomial Model (continued)

$S_0 = \$30$

$p_U = 0.715$

$S_1^+ = \$30 \times 1.15 = \$34.50$

$C_1^+ = \max(0, \$34.50 - \$30) = \$4.50$

$p_D = 0.285$

$S_1^- = \$30 \times 0.87 = \$26.10$

$C_1^- = \max(0, \$26.10 - \$30) = \$0$

Today

1 year

The Binomial Model (continued)

$$c_0 = \frac{(\$4.50 \times 0.715) + (\$0 \times 0.285)}{1.068}$$

$$= \frac{\$3.22}{1.068} = \$3.01$$

Impact of Dividends

- Binomial option pricing model also has the ability to value a stock that pays a **dividend yield**
- Total return in risk-neutral setting: risk-free rate, r
- Dividends provide a positive yield, so capital gains must be equal to r – q

$$\pi_u = \frac{e^{(r-q)t} - D}{U - D}$$

$$\pi_D = 1 - \pi_u$$

American Options

- Valuing American options in a binomial framework requires the consideration of the ability of the holder to exercise early
- In the case of a two-step model, that means determining whether early exercise is optimal at the end of the first period
- If the payoff from early exercise (the intrinsic value of the option) is greater than the option's value (the present value of the expected payoff at the end of the second period), then it is **optimal to exercise early**