Wiley FRM Exam Review Study Guide 2016
Part I, Volume 2
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Part I, Volume 2

Financial Markets and Products,
Valuation and Risk Models

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Financial Markets and Products (FMP)


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**Valuation and Risk Models (VRM)**


How to Study for the Exam

The FRM Exam Part I curriculum covers the tools used to assess financial risk:

- Foundations of risk management—20%
- Quantitative analysis—20%
- Financial markets and products—30%
- Valuation and risk models—30%

It is important to focus only on the learning objectives as you are asked and pay close attention to the percentages of each section. That is the core of my focus through the text, the online lecture sessions, and with the practice questions. A study hour doesn’t count unless you are laser focused on specifically how GARP asks a learning objective.

Consistency is also key. Making a regular weekly study time is going to be important to staying on track. There is a reason: Only ~50% of the candidates pass the exam every year. It’s a tough exam. It also tests intuition, not just memorization. That is why I attempt at every opportunity to connect the dots across readings, teach how changing environments change both markets and the models we use to model them, as well as help you with the questions where GARP specifically wants you to calculate an outcome.

Calculator policy:

It is best to begin your study with one of the approved calculators. You will not be admitted to the exam without one of these approved calculators!

- Hewlett Packard 12C (including the HP 12C Platinum and the Anniversary Edition)
- Hewlett Packard 10B II
- Hewlett Packard 10B II+
- Hewlett Packard 20B
- Texas Instruments BA II Plus (including the BA II Plus Professional)

Every year, candidates are turned away from the exam site because of wrong calculators. Make sure you aren’t one of them.
ABOUT THE INSTRUCTOR

Christian H. Cooper is an author and trader based in New York City. He initially created the FRM program because, as a candidate, he was frustrated with the quality of study programs available. Writing from a practitioner’s point of view, Christian drew on his experience as a trader across fixed income and equity markets, most recently as head of derivatives trading at a bank in New York, to create a program that is very focused on exam results while connecting the dots across topics to increase intuition and understanding.

Christian is active with the Aspen Institute, a Truman National Security Fellow, and a term member at the Council on Foreign Relations.
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Part I, Volume 2
Financial Markets and Products (FMP)

This area tests your knowledge of financial products and the markets in which they trade, more specifically, the following knowledge areas:

- Structure and mechanics of OTC and exchange markets
- Structure, mechanics, and valuation of forwards, futures, swaps, and options
- Hedging with derivatives
- Interest rates and measures of interest rate sensitivity
- Foreign exchange risk
- Corporate bonds
- Mortgage-backed securities
- Rating agencies
After completing this reading you should be able to:

- Describe the over-the-counter market, distinguish it from trading on an exchange, and evaluate its advantages and disadvantages.
- Differentiate between options, forwards, and futures contracts.
- Identify and calculate option and forward contract payoffs.
- Calculate and compare the payoffs from hedging strategies involving forward contracts and options.
- Calculate and compare the payoffs from speculative strategies involving futures and options.
- Calculate an arbitrage payoff and describe how arbitrage opportunities are temporary.
- Describe some of the risks that can arise from the use of derivatives.

Learning objective: Describe the over-the-counter market, distinguish it from trading on an exchange, and evaluate its advantages and disadvantages.

The key advantages of over-the-counter instruments is the fact that you can almost customize the instrument to anything that you need. In other words, if you need to have a particular instrument that starts and settles and extends to a particular date and time for cash flow management purposes, that can be structured within the over-the-counter market. However, the over-the-counter market exposes you to counterparty risk that you are not exposed to while trading on an exchange. By contrast, exchange-traded contracts are not customizable.

Learning objective: Differentiate between options, forwards, and futures contracts.

A derivative instrument is a security whose value is derived from, and therefore depends upon, the value of some underlying asset(s). The major derivatives considered here are forward contracts, futures contracts, options contracts, and swap contracts. Financial derivatives offer numerous benefits to risk managers compared with the underlying assets. Examples of underlying assets are a stock, commodity, or index.

A financial derivative is a financial contract. The payoffs from this contract depend on another financial instrument, security, asset, or contract, known as the underlying asset. Typically, the underlying asset trades in a market in which its price is determined on a regular basis. The current price of the underlying asset is known as the cash or spot price. Also, a derivative has a specific and limited life. The contract begins on one date and ends on a future date.
For example, IBM shares trade on the New York Stock Exchange and the spot price of IBM shares is determined by investors buying and selling on the exchange. The value of an option on a share of IBM depends on the value of the IBM share. A share of IBM stock has an unlimited life, while an option on a share of IBM stock has a fixed life.

Derivatives trade in two types of markets. They can be exchange-traded contracts or they can trade over-the-counter. Contracts that trade on an organized exchange have standardized terms that are set by the exchange or by the clearinghouse. Over-the-counter derivatives result from agreements between two parties who can negotiate whatever contract terms are mutually acceptable. Derivatives also can be divided into two types, forward commitments and contingent claims.

When two entities choose to transact with each other, one party agrees to pay a negotiated price while the other party agrees to deliver the asset underlying the transaction. Typically, the transaction occurs immediately. However, one can envision situations where the entities do not wish to transact immediately. Instead, they negotiate the terms of the transaction, the price, and the underlying asset, but perform the transaction at a later date. Such an agreement, where the transaction is delayed until some pre-specified future point in time, is designated a forward commitment. In contrast, a contingent claim is an asset, such as an option, whose payoff and, therefore, whose value is contingent or depends on the value of some other underlying asset.

FORWARDS AND FUTURES
The three primary types of forward commitments are forward contracts, futures contracts, and swaps, and are defined as follows:

A forward contract is a commitment whereby the two parties to the contract negotiate the price, underlying asset, and future point in time at which the transaction will occur.

A futures contract is a type of forward contract distinguished by having highly standardized contract terms.

In a swap contract, two parties agree to exchange sets of cash flows at several future points in time.

A forward contract is the most basic form of a forward commitment. An example of a forward contract would be as follows: A mining company and jewelry manufacturer agree in March that the mining company, in October, will sell 1,000 ounces of gold to the jewelry company at a price of $325 per ounce with delivery to take place at the jewelry manufacturer’s plant. Both parties in a forward commitment face the possibility that the other party will default if the price of the underlying asset moves against them. The mining company might be tempted to default if the spot price of gold in October is more than $325 per ounce. If, for example, the spot price of gold is $350 per ounce in October, then the mining company would prefer to sell its gold in the spot market for $350 per ounce rather than to the jewelry company at $325 per ounce. On the other hand, if the spot price of gold in October is only $300 per ounce, then the jewelry manufacturer might be tempted to default.

Although there are well-developed forward markets with standardized market features for many goods, forward contracts are typically unique. An attractive feature of a forward contract is the flexibility afforded by custom tailoring the terms of the agreement. Because all of the terms of a forward contract are negotiable, forward contracts are customized agreements.
The parties to a futures contract also agree to the exchange of some underlying asset at a future date for cash. Like a forward contract, the agreement takes place today, but the payment occurs at that future date. The purchaser of a futures contract agrees to take delivery of the good and pay for it. It is the obligation of the seller to deliver the good and receive payment.

Two characteristics distinguishing futures contracts from other forward contracts are:

1. Futures contracts are exchange traded. Forward contracts are not. Exchange traded means the contracts have standardized terms such as expiration date, strike, and settlement.
2. Participation in a futures exchange is government regulated. There is no similar regulation for forward contracts because the contracts are negotiated between two parties. This is what is called the OTC market.

A party to a futures contract does not face significant credit risk, because if the counterparty fails to satisfy the counterparty’s obligations, these obligations are guaranteed. The guarantor is a financial clearinghouse associated with the exchange on which the futures contracts trade. There is no similar guarantee associated with a forward contract; hence a party to a forward contract can face significant credit risk.

The terms associated with futures contracts are standardized. The terms associated with forward contracts are based on the negotiations between the two parties.

*Parties to a futures contract are required to place collateral into an account to ensure that they have the funds available to cover any obligations they may face in the future.* The name of this account is the margin account. Further, *adjustments are made to this account on a frequent basis, such as daily, to reflect any losses that the party may have incurred.* The process through which these adjustments are made is designated ‘marking-to-market.’

Forward contracts are structured so that each party’s obligation to the other lasts until the contract expires. However, with futures contracts, a party’s obligation can be terminated early by entering into an offsetting transaction.

**Learning objective:** Identify and calculate option and forward contract payoffs.

A forward is a contract between two parties, where one (the long position) has the obligation to buy, and the other (the short position) an obligation to sell the underlying asset at a specified price (established at the inception of the contract) at a future date.

**PRICING AND VALUATION OF FORWARD CONTRACTS**

The price of a forward contract is the fixed price or rate at which the underlying transaction will occur at contract expiration. The forward price is agreed upon at initiation of the forward contract. Pricing a forward contract means determining this forward price. The value of a forward contract is the amount that a counterparty would need to pay, or would expect to receive, to get out of the (already-assumed) forward position. We will first work
with a generic example to introduce you to the concepts and mechanics behind pricing and valuing forward contracts.

- The contract initiation date is denoted by \( t = 0 \).
- The contract expiration date is denoted by \( t = T \).
- Any point in time between the contract initiation and expiration dates is denoted by \( t = t \).

The forward price \( (F) \) is determined at contract initiation. It does not change over the term of the contract. The term \( F(0,T) \) is used to refer to the forward price for a contract that was initiated at \( t = 0 \) and expires at \( t = T \). See Example 1.

The value \( (V) \) of the forward contract changes over the term of the contract as the price of the underlying asset changes:

- \( V_0(0,T) \) refers to the value of a forward contract (initiated at \( t = 0 \) and expiring at \( t = T \)) at initiation \( (t = 0) \).
- \( V_t(0,T) \) refers to the value of a forward contract (initiated at \( t = 0 \) and expiring at \( t = T \)) at a point in time during the term of the contract \( (t = t) \).
- \( V_T(0,T) \) refers to the value of a forward contract (initiated at \( t = 0 \) and expiring at \( t = T \)) at expiration \( (t = T) \).

The spot price \( (S) \) of the underlying asset also changes over the term of the contract.

- \( S_0 \) refers to the spot price at initiation of the forward contract \( (t = 0) \).
- \( S_t \) refers to the spot price at a point in time during the term of the forward contract \( (t = t) \).
- \( S_T \) refers to the spot price at expiration of the forward contract \( (t = T) \).

In the following sections, we illustrate how forward contracts are valued at various points in time and I will keep this notation through the program.

Note that we will be taking the perspective of the long position on the contract when valuing a forward. Once the value of the long position has been determined, the value of the short can be determined by simply changing the sign. Further, we will be assuming that the underlying asset entails no storage or carrying costs, and makes no payments to the owner of the asset over the term of the forward contract.

**VALUING A FORWARD CONTRACT AT EXPIRATION \( (t = T) \)**

The long position on the forward has an obligation to buy the underlying asset for the agreed upon (at contract initiation) price of \( F(0,T) \) at contract expiration. The price of the underlying asset at expiration of the forward equals \( S_T \). Therefore, the value of the long position on the forward contract at expiration equals the difference between:

- The current worth of the asset, \( S_T \), which represents the price at which the underlying asset can be sold; and
- The price that the long position in the forward must pay to acquire the asset \( F(0,T) \).

\[
V_T(0,T) = S_T - F(0,T)
\]
If the value at expiration does not equal this amount, arbitrage profits can be made. For example, if the forward price established at contract initiation equals $30 and the spot price at contract expiration equals $35, then the value of the forward contract must equal $35 – $30 = $5 at expiration. See Example 1.

- If the contract value at expiration were greater than $5, it would mean that someone is willing to pay more than $5 to obtain an obligation to buy something worth $35 for $30, which wouldn’t make sense.
- If the contract value were less than $5, it would mean that someone is willing to accept less than $5 to give up an obligation to buy something worth $35 for $30, which wouldn’t make sense either.

**VALUING A FORWARD CONTRACT AT INITIATION**

Now let’s work with a forward contract that has a term of 1 year. The price \((S_0)\) of the asset underlying the contract is currently $100 and the risk-free rate \((r)\) is 8%. Determine the value of the contract at initiation, \(V_0(0,1)\), given that:

1. The forward price, \(F(0,1)\) equals $110
2. The forward price, \(F(0,1)\) equals $106

Note that no money changes hands at origination of the forward contract.

**Scenario 1: \(F(0,1) = $110\)**

In this scenario, arbitrage profits can be made through cash and carry arbitrage by undertaking the following steps:

- Borrow $100 at 8%.
- Purchase the underlying asset at the current spot price of $100.
- Sell the underlying asset forward by taking the short position on the forward contract at a forward price of $110.

The table below illustrates the computation of arbitrage profits from this strategy:

<table>
<thead>
<tr>
<th>(t = 0) (At Contract Origination)</th>
<th>(t = T) (At Contract Expiration)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transaction</strong></td>
<td><strong>Cash Flow</strong></td>
</tr>
<tr>
<td>Borrow $100 @8%</td>
<td>$100</td>
</tr>
<tr>
<td>Buy asset at current price (S_0)</td>
<td>($100)</td>
</tr>
<tr>
<td>Take the short position in a forward contract on the asset with a forward price, (F(0,1)), of $110</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Net Cash Flow</strong></td>
<td>0</td>
</tr>
</tbody>
</table>

**Scenario 2: \(F(0,1) = $106\)**

In this scenario arbitrage profits can be made through reverse cash and carry arbitrage by undertaking the following steps:

- Short the underlying asset at the current spot price of $100.
- Invest the proceeds at 8%.
• Buy the underlying asset forward by taking the long position on the forward contract at the forward price of $106.

The table below illustrates the computation of arbitrage profits from this strategy:

<table>
<thead>
<tr>
<th>t = 0 (At Contract Origination)</th>
<th>t = T (At Contract Expiration)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transaction</strong></td>
<td><strong>Cash Flow</strong></td>
</tr>
<tr>
<td>Short the underlying asset at $S_0</td>
<td>$100</td>
</tr>
<tr>
<td>Invest $100 @8%</td>
<td>($100)</td>
</tr>
<tr>
<td>Take the long position in a forward contract on the asset with a forward price, $F(0,1)$, of $106</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Net Cash Flow</strong></td>
<td>$0</td>
</tr>
</tbody>
</table>

Now let’s understand the value of a forward contract. Recall that we are taking the perspective of the long position.

• The long position has the obligation to pay the forward price, $F(0,T)$, and take delivery of the underlying asset at contract expiration.
  ○ The value of this obligation at contract initiation equals $F(0,T)/(1+r)^T$

• At expiration, the long position will receive the underlying asset, which will be worth $S_T$.
  ○ The value of this underlying asset at contract initiation equals $S_0$

• Therefore, the value of the forward contract to the long position at contract initiation equals the current worth of the asset minus the present value of the obligation.
  ○ $V_0(0,T) = S_0 - [F(0,T)/(1+r)^T]$

In Scenario 1, the value of the forward contract at initiation is calculated as:

$V_0(0,T) = S_0 - [F(0,T)/(1+r)^T]$
$V_0(0,1) = 100 - [110/(1+0.08)^1] = -$1.85

In Scenario 2, the value of the forward contract at initiation is calculated as:

$V_0(0,T) = S_0 - [F(0,T)/(1+r)^T]$
$V_0(0,1) = 100 - [106/(1+0.08)^1] = $1.85

These non-zero values at initiation would entice traders to engage in arbitrage until the price of the forward contract equals the no-arbitrage forward price.

Forward contracts are typically priced to have zero value at origination, $V_0(0,T) = 0$. Therefore, we can express the forward price in terms of the spot price of the asset as:

$V_0(0,T) = S_0 - [F(0,T)/(1+r)^T] = 0$

$F(0,T) = S_0(1+r)^T$
Valuing a Forward Contract During Its Life
By now you should have digested that the value of the forward contract to the long position equals the asset’s current price minus the present value of the forward price. We now use this logic to derive the expression for the value of the forward contract at any point in time (t) during its life. See Example 1.

• The long position has an obligation to pay the forward price, F(0,T), and take delivery of the underlying asset at contract expiration.
  ○ The value of this obligation at any point in time during the term of the contract equals $F(0, T)/(1+r)^{T-t}$
• At expiration, the long position will receive the underlying asset, which will be worth $S_T$.
  ○ The value of this asset at any point in time during the term of the contract equals $S_t$.
• Therefore, the value of the forward contract to the long position at any point in time during the term of the contract equals the current value of the asset minus the present value of the obligation.
  ○ $V_{l}(0, T) = S_t - [F(0, T)/(1+r)^{T-t}]$

Just one more thing that we need to reemphasize before moving on: $F(0, T)$ represents the forward price that is agreed upon at the inception of the contract. Both spot and forward prices continue to fluctuate after inception of the contract, but for our purposes (to determine the value of a particular forward contract at any point in time) we compare the “then-current” spot price of the underlying asset to the present value of the initially agreed-upon (or fixed) forward price to determine how much value a position on the particular forward holds to the long or short.

Why We Would Need to Determine the Value of a Forward Contract

• To measure credit exposure.
• To mark-to-market for financial statement purposes or to adhere to the terms of the forward agreement.
• To determine how much money would need to be paid to terminate the contract.

Table 1 summarizes what we have learned so far.

Table 1: Value of a Forward Contract

<table>
<thead>
<tr>
<th>Time</th>
<th>Long Position Value</th>
<th>Short Position Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>At initiation</td>
<td>Zero, as the contract is priced to prevent arbitrage</td>
<td>Zero, as the contract is priced to prevent arbitrage</td>
</tr>
<tr>
<td>During life of the contract</td>
<td>$S_t - \left[ \frac{F(0, T)}{(1+r)^{T-t}} \right]$</td>
<td>$\left[ \frac{F(0, T)}{(1+r)^{T-t}} \right] - S_t$</td>
</tr>
<tr>
<td>At expiration</td>
<td>$S_T - F(0, T)$</td>
<td>$F(0, T) - S_T$</td>
</tr>
</tbody>
</table>

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Example 1: Calculating the Forward Price

Amanda holds an asset worth $250, which she plans to sell in 6 months. To eliminate the price risk, she decides to take the short position in a forward contract on the asset. Given an annual risk-free rate of 5%, calculate the no-arbitrage forward price of the contract.

Solution

Forwards are priced to have zero value to either party at origination. Therefore, the forward price is calculated as:

\[ F(0, T) = S_0 (1 + r)^T \]
\[ F(0, 6/12) = 250 \times (1 + 0.05)^{6/12} = $256.17 \]

Example 2: Calculating the Value of a Forward Contract During Its Life

In Example 1, we calculated the forward price as $256.17. Suppose that 2 months into the term of the forward the spot price of the underlying asset is $262. Given an annual risk-free rate of 5%, calculate the value of the long and short positions in the forward contract.

Solution

The value of the long position in the forward contract is calculated as:

\[ V(L, 0, T) = S_T - [F(0, T)/(1 + r)^T] \]
\[ V_{2/12}(0, 6/12) = 262 - [256.17/(1+0.05)^{6/12-2/12}] = $9.96 \]

The value of the short position is just the opposite of the value of the long position. Therefore, the value of the short position equals −$9.96.

Example 3: Calculating the Value of a Forward Contract at Expiration

Continuing from Example 1, suppose that the spot price of the underlying asset at contract expiration is actually $247. Given an annual risk-free rate of 5%, calculate the value of the long position.

Solution

At expiration, the value of the long position in a forward contract is calculated as:

\[ V_L(0, T) = S_T - F(0, T) \]
\[ V_L(0, 6/12) = 247 - 256.17 = −$9.17 \]
For the next three learning objectives, none of this is actually covered anywhere in this reading. This is important and we will do this, but it is out of place here.

- Calculate and compare the payoffs from hedging strategies involving forward contracts and options.
- Calculate and compare the payoffs from speculative strategies involving futures and options.
- Calculate an arbitrage payoff and describe how arbitrage opportunities are temporary.

Also note that that payoff profile is not dependent upon strategy. Whether hedging, speculation, or an arbitrage, the payoffs of futures versus options are all the same. We will calculate these in the future. With respect to arbitrage being temporary, if “free money” exists between two markets—for example, a large price difference in oil between London and New York—cost and location being ignored, the market will buy one and sell the other until the arbitrage opportunity is gone. With high-frequency trading and electronic markets, this almost never happens in the real world.

**Learning objective: Describe some of the risks that can arise from the use of derivatives.**

Just know that derivatives can be either negotiated or exchange-traded contracts. With exchange-traded contracts, it is more difficult to hide large positions when you have a negotiated contract. You can face many counterparties, and no one knows the impact should one of the dominoes fall.