

INSTRUCTOR SOLUTIONS MANUAL

An Introduction to Derivative Securities, Financial Markets, and Risk Management

Robert A. Jarrow

CORNELL UNIVERSITY

Arkadev Chatterjea

THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL



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CHAPTER 1

Derivatives and Risk Management

1.1. What is a derivative security? Give an example of a derivative and explain why it is a derivative.

ANSWER

A derivative security is a financial contract that derives its value from the price of an underlying asset such as a stock or a commodity, or from the value of an underlying notional variable such as a stock index or an interest rate (see Section 1.1).

Consider a forward contract to trade 50 ounces of gold three months from today at a forward price of $F = \$1,500$ per ounce. The spot price of the underlying commodity gold determines this derivative's payoff. For example, if the spot price of gold is $S(T) = \$1,510$ per ounce at time $T = 3$ months, then the buyer of this forward contract buys gold worth \$1,510 for \$1,500. Her profit is $[S(T) - F] \times \text{Number of units} = (1,510 - 1,500) \times 50 = \500 . This is the seller's loss because derivative trading is a zero-sum game; that is, for each buyer there is a seller.

1.2. List some major applications of derivatives.

ANSWER

Some applications of derivatives:

- They help generate a variety of future payoffs, which makes the market more “complete.”
- They enable trades at lower transactions costs.
- Hedgers can use them to cheaply reduce preexisting risk in their economic activities. Speculators can take leveraged positions without tying up too much capital.
- They help traders overcome market restrictions. For example, an exchange may restrict traders from short-selling a stock in a falling market, but a trader can adopt a similar position by buying a put option.
- They promote a more efficient allocation of risk by allowing the risk of economic transactions to be shifted to dealers who can better manage these risks.

- They facilitate the process of price discovery. For example, futures traders, by placing bids and offers to trade various quantities of the underlying commodity at different prices, reveal some of their information, which gets built into the market price of the underlying commodity. Many people watch the futures price to get a sense of the demand and supply situation in the months and years ahead.

1.3. Evaluate the following statement: “Hedging and speculation go hand in hand in the derivatives market.”

ANSWER

This statement provides a good description of derivatives market activity. Many traders buy or sell derivatives to hedge some preexisting risk in a portfolio or business. It is often very hard to find counterparties with exactly opposite hedging needs. For this reason, a speculator usually takes the other side of the hedger’s trade. Since derivatives trade in zero-supply markets, for each buyer there must be a seller. Speculators make the market more liquid.

Consider an example: A gold mining firm sells 100,000 ounces of gold through a forward contract. The gold mining firm may not find a jewelry manufacturer who wants to simultaneously buy the same quantity of gold on the same future date. So a speculator (who is often a dealer) steps in and becomes the counterparty to the trade providing liquidity to the forward market.

1.4. What risks does a business face?

ANSWER

A business may face a variety of risks such as credit risk, legal risk, operational risk, and regulatory risk. However, there are three major kinds of market risk that affect most businesses: currency risk, interest rate risk, and (in case of nonfinancial companies) commodity price risk (see Section 1.7).

1.5. Explain why financial futures have replaced agricultural futures as the most actively traded contracts.

ANSWER

Before the 1970s, governments succeeded in keeping many macroeconomic variables like exchange rates and interest rates relatively stable. Traders were mostly concerned about commodity price risk and they used agricultural futures to manage this risk.

During the 1970s, many of these macroeconomic variables became volatile. Dismantling of the Bretton Woods system (1971) made exchange rates more volatile. Oil shocks and other supply-side disturbances led to double-digit inflation. Inflation premiums soon got built into interest rates, which increased to double-digit levels and became more volatile.

Exchanges responded to this increased volatility by creating financial futures for hedging these risks. Many of these products became very popular and eventually replaced agricultural futures as the most actively traded contracts. Because the demand for hedging financial risks is larger than the demand for hedging price risks for agricultural commodities, financial futures have become the more actively traded contracts.

1.6. Explain why derivatives are zero-sum games.

ANSWER

A derivative obtains its value from something else: a stock price, an exchange rate, an interest rate, or even an index. Unlike a stock or a bond, a derivative does not have a preexisting supply. Hence, it is described as a “zero-supply” contract. It gets created the moment a trader decides to trade a derivative and another trader accepts the opposite side of the transaction. These traders are called counterparties. Consequently, one counterparty’s gain creates a loss of equal magnitude for the other counterparty. Their payoffs, being of equal magnitude, add up to zero. Hence, trading derivatives is a zero-sum game (see Example 1.1).

1.7. Explain why all risks cannot be hedged. Give an example of a risk that cannot be hedged.

ANSWER

Not all risks can be hedged because of moral hazard. For example, a trader would not like to be in a situation where a counterparty’s actions affect the outcome. Thus, it is very hard to hedge operational risk, which is the risk of a loss due to events like human error, faulty management, and fraud. Because of moral hazard, no trader (visualize, as an example, an insurance company insuring a bank against operational risk) would trade a “derivative” that pays the counterparty for mistakes like pressing the wrong computer button and entering the wrong trade (see Section 1.7).

1.8. What is a notional variable, and how does it differ from an asset’s price?

ANSWER

Notional variables are notions (computed variables) based on asset prices and other quantities. Examples include interest rates, inflation rates, stock indexes, and weather indices. A traded asset, such as a stock, has a price at which it trades in the market. By contrast, a computed stock index, which is an average of stock prices, does not directly trade and does not have its own market price.

1.9. Explain how derivatives give traders high leverage.

ANSWER

A derivative’s payoff is determined by the evolution of some commodity’s price over a predetermined future time period. One can collect these payoffs by paying a premium in case of options or by posting collaterals or margin deposits in case of forwards and futures. The premium is usually a small fraction of the commodity’s price. Collaterals and margins are also a small fraction of the commodity’s price because they depend on the past price volatility—an exchange may set the margin for a future contract at less than 5 percent of the commodity price. For these reasons, derivatives provide leverage because these transactions are significantly cheaper or require far less capital commitment than an outright purchase or short sale of the commodity. Leverage is the amount of borrowing implicit in a derivative position. This leverage implies that for small changes in the underlying security’s price, large changes in the derivative security’s price results.

1.10. Explain the essence of Merton Miller’s argument explaining what spurs financial innovation.

ANSWER

Merton Miller argued in a 1986 article that *regulations and taxes cause financial innovation*. The reason is that derivative securities are often created to circumvent government regulations that prohibit otherwise lucrative transactions. And because most countries tax income from different sources (and uses) at different rates, financial innovations are often designed to save tax dollars as well. He cites examples like Eurodollars, Eurobonds, and Swaps that were initiated to circumvent restrictive regulations and taxes (see Section 1.2 and Extension 1.1).

1.11. Explain the essence of Ronald Coase’s argument explaining what spurs financial innovation.

ANSWER

Ronald Coase argued in the article, “The Nature of the Firm” (1937), that transactions incur costs, which come from “negotiations to be undertaken, contracts . . . to be drawn up, inspections . . . to be made, arrangements . . . to be made to settle disputes, and so on,” and firms often appear to lower these transactions costs. With respect to financial markets, market participants often trade where they can achieve their objectives at minimum costs. Financial derivatives are often created so that these costs are minimized as well.

An example is the migration of traders during the 1990s from Treasury securities and their associated derivatives to Eurodollars and their related derivatives that are free from Fed regulations, are unaffected by peculiarities of the Treasury security auction cycle, and have lower liquidity costs.

Another example would be exchange-traded funds (ETFs), which are securities giving the holder fractional ownership rights over a basket of securities. An ETF’s structure allows it to lower many kinds of transactions costs vis-à-vis a mutual fund with a similar investment objective. Unlike a mutual fund, which has daily or (at the most) hourly pricing, an ETF behaves much like a common stock—it trades continuously during trading hours, it can be shorted, it may be traded on margin, and it can even have derivatives (such as calls and puts) written on them.

1.12. Does more volatility in a market lead to more use of financial derivatives? Explain your answer.

ANSWER

Yes, increased volatility leads to more use of financial derivatives. More volatility increases the risk of a trader’s portfolio or a firm’s balance sheet. This risk is often unwanted, and it can be hedged with derivatives. This hedging motive in the presence of volatile prices generates the demand for the trading of derivatives. Examples of this include options trading on stock market indexes, foreign currencies, interest rates, and commodities. Without price volatility, the vast derivatives market would disappear leaving behind just credit derivatives for managing credit risk. Note, however, that although volatility is the lifeblood of derivatives trading, extreme volatility sometimes destroys markets (as it happens during times of market crashes).

1.13. When the international banking regulators defined risk in their 1994 report, what definition of risk did they have in mind? How does this compare with the definition of risk from modern portfolio theory?

ANSWER

The international regulators wanted to cover all aspects of risk associated with security trading: market risk, credit risk (including settlement risk), liquidity risk, operational risk, and legal risk. The last four definitions of risk deal with the nitty-gritty real-world problems of implementing a derivatives trade.

The definition of risk given in connection with the capital asset pricing model and modern portfolio theory looks at portfolio risk, both diversifiable and nondiversifiable, caused by the randomness in asset prices. The randomness in asset prices usually considered is that due to market risk, which is essential for understanding an investor's risk-return trade-off. This definition is more restrictive than the regulators' definition.

1.14. What's the difference between real and financial assets?

ANSWER

Real assets include land, buildings, machines, and commodities. Financial assets include stocks, bonds, currencies, which are claims on real assets. Both real and financial assets have tangible values. Both real and financial assets have derivatives traded on them.

1.15. Explain the differences between market risk, credit risk, liquidity risk, and operational risk.

ANSWER

See the Basel Committee's *Risk Management Guidelines for Derivatives* (July 1994) for definitions of these risks:

- *Market risk* is the risk to an institution's financial condition resulting from adverse movements in the level or volatility of market prices.
- *Credit risk* (including settlement risk) is the risk that a counterparty will fail to perform on an obligation.
- *Liquidity risk* can be of two types: one related to specific assets and the other related to the general funding of the institution's activities. The former is the risk that an institution may not be able to easily unwind a particular asset position near the previous market price because of market disruptions. Funding liquidity risk is the risk that the institution will be unable to meet its payment obligations in the event of margin calls.
- *Operational risk* (also known as operations risk) is the risk that deficiencies in information systems or internal controls will result in unexpected loss. This risk is associated with human error, system failures, and inadequate procedures and controls. (*Legal risk* is the risk that contracts are not legally enforceable or documented correctly. We include this as part of operational risk.)

1.16. Briefly present Warren Buffett's and Alan Greenspan's views on derivatives.

ANSWER

Although supportive of plain vanilla derivatives that are used by farmers and other economic agents to hedge input and output price risks, Warren Buffett expressed a strong dislike for complex over-the-counter derivatives. In 2002, he even characterized them as “time bombs, both for the parties that deal in them and the economic system.” This prophecy proved to be correct in light of large derivatives-related losses suffered by financial institutions during 2007 and 2008, which contributed to the severe economic downturn. Interestingly, in 2008 Buffett's company sold 251 long dated European put options in the over-the-counter market because they were attractively priced.

By contrast, former Fed chairman Alan Greenspan (served 1987–2006) opined in a 1999 speech that derivatives “unbundle” risks by carefully measuring and allocating them “to those investors most able and willing to take it,” a phenomenon that has contributed to a more efficient allocation of capital. Greenspan reversed his position somewhat before Congress in 2008 when he testified that he “had put too much faith in the self-correcting power of free markets and had failed to anticipate the self-destructive power of wanton mortgage lending.”

1.17. Consider the situation in sunny Southern California in 2005, where house prices have skyrocketed over the last few years and are at an all-time high. Nathan, a software engineer, buys a second home for \$1.5 million. Five years back, he bought his first home in the same region for \$350,000 and financed it with a thirty-year mortgage. He has paid off \$150,000 of the first loan. His first home is currently worth \$900,000. Nathan plans to rent out his first home and move into the second. Is Nathan speculating or hedging?

ANSWER

Nathan is speculating. He has assumed the price risk on two properties whose total value is \$1.5 million plus \$0.9 million, or \$2.4 million.

1.18. During the early years of the new millennium, many economists described the past few decades as the period of the Great Moderation. For example,

- an empirical study by economists Olivier Blanchard and John Simon found that “the variability of quarterly growth in real output (as measured by its standard deviation) had declined by half since the mid-1980s, while the variability of quarterly inflation had declined by about two thirds.”
- an article titled “Upheavals Show End of Volatility Is Just a Myth” in the *Wall Street Journal*, dated March 19, 2008, observed that an important measure of stock market volatility, “the Chicago Board Options Exchange's volatility index, had plunged about 75% since October 2002, the end of the latest bear market, through early 2007”; the article also noted that “in the past 25 years, the economy has spent only 16 months in recession, compared with more than 60 months for the previous quarter century.”

- a. What were the explanations given for the Great Moderation?
- b. Does the experience of the US economy during January 2007 to December 2010 still justify characterizing this as a period of Great Moderation?

Report (1) quarterly values for changes in the gross domestic product, (2) quarterly values for changes in the inflation rate, and (3) the volatility VIX Index value during this period to support your answer.

ANSWER

a. The chairman of the Federal Reserve System, Ben Bernanke, in a 2004 speech provided three explanations for the Great Moderation: structural change (changes in economic institutions, technology, or other features of the economy), improved macroeconomic policies, and good luck (“the shocks hitting the economy became smaller and more infrequent”).

b. Data presented in the following table suggests that January 2007 to December 2010 cannot be considered a period of “Great Moderation”; rather, this period is considered to belong to the “Great Recession.” The table reports:

1. Quarterly values for changes in the gross domestic product.
2. Quarterly values for changes in the inflation rate (which we have calculated from the CPI values, assuming $1982-84 = 100$).
3. Volatility index VIX’s value at the end of each quarter during January 2007 to December 2010.

Quarters	GDP Percent Change (based on current dollars)	GDP Percent Change (based on chained 2005 dollars)	Consumer Price Index	Annual Inflation Rate (measured over each quarter)	Date	VIX at Close on the Last Trading Day of the Quarter
			201.8			
2007q1	5.2	0.5	205.352	7.0406	3/30/2007	14.64
2007q2	6.5	3.6	208.352	5.8436	6/29/2007	16.23
2007q3	4.3	3.0	208.49	0.2649	9/28/2007	18
2007q4	3.6	1.7	210.036	2.9661	12/31/2007	22.5
2008q1	0.6	-1.8	213.528	6.6503	3/31/2008	25.61
2008q2	4.0	1.3	218.815	9.9041	6/30/2008	23.95
2008q3	-0.6	-3.7	218.783	-0.0585	9/30/2008	39.39
2008q4	-8.4	-8.9	210.228	-15.6411	12/31/2008	40
2009q1	-5.2	-6.7	212.709	4.7206	3/31/2009	44.14
2009q2	-1.1	-0.7	215.693	5.6114	6/30/2009	26.35
2009q3	1.9	1.7	215.969	0.5118	9/30/2009	25.61
2009q4	4.9	3.8	215.949	-0.0370	12/31/2009	21.68
2010q1	5.5	3.9	217.631	3.1156	3/31/2010	17.59

Quarters	GDP Percent Change (based on current dollars)	GDP Percent Change (based on chained 2005 dollars)	Consumer Price Index	Annual Inflation Rate (measured over each quarter)	Date	VIX at Close on the Last Trading Day of the Quarter
2010q2	5.4	3.8	217.965	0.6139	6/30/2010	34.54
2010q3	3.9	2.5	218.439	0.8699	9/30/2010	23.7
2010q4	4.2	2.3	219.179	1.3551	12/31/2010	17.75

The data was retrieved on March 8, 2012, from the following sources:

1. Gross Domestic Product: percent change from preceding period, from www.bea.gov/national/index.htm#gdp. (*Chain-weighted indexes* use “up-to-date weights in order to provide a more accurate picture of the economy, to better capture changes in spending patterns and in prices, and to eliminate the bias present in fixed-weighted indexes,” from “Chained-Dollar Indexes: Issues, Tips on Their Use, and Upcoming Changes,” by J. Steven Landefeld, Brent R. Moulton, and Cindy M. Vojtech in *Survey of Current Business* [Nov 2003].)
2. Consumer Price Index History Table: table containing history of CPI-U in the United States, retrieved from www.bls.gov/cpi/tables.htm; All Urban Consumers (CPI-U) US city average (1982–84 = 100).
3. VIX Historical Price Data from New Methodology: VIX data for 2004 to present (updated daily); retrieved from www.cboe.com/micro/vix/historical.aspx.

1.19. Drawing on your experience, give examples of two risks that one can easily hedge and two risks that one cannot hedge.

ANSWER

A gold mining company can easily hedge the output price risk of its gold by selling gold futures. A manufacturer of silver jewelries can hedge input price risk by buying silver futures.

A cell phone manufacturer cannot hedge the risk that a new model of mobile phones that it developed will sell well. A firm cannot hedge operational risks like the risk of a loss due to human error, faulty management, and fraud.

1.20. Download Form 10-K filed by P&G from the company’s website or the US Securities and Exchange Commission’s website. Answer the following questions based on a study of this report:

- a. What are the different kinds of risks to which P&G is exposed?
- b. How does P&G manage its risks? Identify and state the use of some derivatives in this regard.
- c. Name some techniques that P&G employs for risk management.
- d. Does P&G grant employee stock options? If so, briefly discuss this program.
What valuation model does the company use for valuing employee stock options?

ANSWER

The 2011 Annual Report was retrieved on March 11, 2012, from the Procter & Gamble (P&G) website: www.pg.com/en_US/investors/index.shtml. Information provided on page 50 under section “Other Information,” subsection “Hedging and Derivative Financial Instruments” and on page 60, “Note 5: Risk Management Activities and Fair Value Measurements,” helps answers these questions.

a. Being a “multinational company with diverse product offerings,” P&G is exposed to “market risks, such as changes in interest rates, currency exchange rates and commodity prices.” And it is exposed to risks that hinder smooth completion of a transaction like credit risk. As with all firms, it is also exposed to operational risk.

b. P&G manages its risks by:

- Evaluating exposures on a “centralized basis to take advantage of natural exposure correlation and netting.”
- Except within financing operations, leveraging its “broadly diversified portfolio of exposures as a natural hedge” and prioritizing “operational hedging activities over financial market instruments.”
- Entering into different financial transactions (read: derivatives) in case it decides to “further manage volatility associated with the net exposures.” It accounts for these transactions by “using the applicable accounting guidance for derivative instruments and hedging activities.”
- Monitoring interest rate, currency rate, and commodity derivatives positions using CorporateManager™ value-at-risk model using a one-year horizon and a 95 percent confidence level.
- Controlling credit risk by following its “counterparty credit guidelines” and trying to trade only with “investment grade financial institutions”; it monitors counterparty exposures daily and reviews “downgrades in counterparty credit ratings” on a timely basis.

Some of the derivatives used by P&G for risk management purposes are:

- Interest rate risk management. P&G manages interest cost by using a combination of fixed-rate and variable-rate debt. It uses interest rate swaps to hedge risks on these debt obligations.
- Foreign currency risk management. Because P&G has operations in many nations, its revenue and expenses are impacted by currency exchange rates. The primary objective of the company’s currency hedging activities is “to manage the volatility associated with short-term changes in exchange rates.” P&G primarily uses forward contracts with maturities of less than eighteen months. It also uses some currency options and currency swaps with maturities of up to five years for managing foreign exchange risk.
- Commodity risk management. P&G spends significant amounts on raw materials whose prices can become volatile due to “weather, supply conditions, political and economic variables and other unpredictable factors.” It manages volatility by using fixed price contracts and also by trading futures, options, and swap contracts.

c. P&G uses market valuation, sensitivity analysis, and value-at-risk modeling for risk management.

d. P&G grants stock options and restricted stock awards to key managers and directors and to a small number of employees.

Some key features of the employee stock options program are:

- Option's exercise price is set at the market price of the underlying shares on the date of the grant.
- Key manager stock option awards: Such awards granted since September 2002 are vested after three years and have a ten-year life.
- Company director stock option awards. Such awards are in the form of restricted stock and restricted stock units.
- Employee stock option awards. P&G also gives some employees minor stock option grants and RSU grants with substantially similar terms.

To calculate the compensation expense for stock options granted, P&G utilizes a binomial lattice-based valuation model. (These models are discussed in chapters 17 and 18.)