

FINANCIAL DERIVATIVE

by

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(An ISO 9001:2008 Certified Company)

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2/25, Ansari Road, Darya Ganj, New Delhi-110 002

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ISBN: 978-93-83758-40-1

First Edition: 2014

Price: ` 250/-

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Published by:

VAYU EDUCATION OF INDIA

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PREFACE

It can be used on advanced undergraduate courses when students have good quantitative skills. Also, many practitioners who want to acquire a working knowledge of how derivatives can be analyzed find the book useful.

One of the key decisions that must be made by an author who is writing in the area of derivatives concerns the use of mathematics. If the level of mathematical sophistication is too high, the material is likely to be inaccessible to many students and practitioners. If it is too low, some important issues will inevitably be treated in a rather superficial way. I have tried to be particularly careful about the way I use both mathematics and notation in the book. Nonessential mathematical material has been either eliminated or included in end-of-chapter appendices. Concepts that are likely to be new to many readers have been explained carefully, and many numerical examples have been included.

The book covers both derivatives markets and risk management. It assumes that the reader has taken an introductory course in finance and an introductory course in probability and statistics. No prior knowledge of options, futures contracts, swaps, and so on is assumed. It is not therefore necessary for students to take an elective course in investments prior to taking a course based on this book. There are many different ways the book can be used in the classroom. Instructors teaching a first course in derivatives may wish to spend most time on the first half of the book.

Instructors teaching a more advanced course will find that many different combinations of the chapters in the second half of the book can be used.

I also gratefully acknowledge the help and support of My Parents My big Brother Mr. Bhanu Pratapsingh Solanki and My Younger Sister. Sincere thanks are also due to the publishers for their effective cooperation in the early release of this book. Perfection cannot be achieved in a single literature, but there is always scope for improvement. Hence the author invites suggestions from the readers to further improve the book.

—Sandhya Singh

*Dedicated to
My Parents
&
My lovely Daughter
Yashi Thakur*

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SECTION-1

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CHAPTER 3: CEV Model, Jump, Diffusion

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CHAPTER-1

EXTENSION OF BLACK-SCHOLES

1.1 FINANCIAL DERIVATIVES

1. Financial derivatives are financial instruments that are linked to a specific financial instrument or indicator or commodity, and through which specific financial risks can be traded in financial markets in their own right. Transactions in financial derivatives should be treated as separate transactions rather than as integral parts of the value of underlying transactions to which they may be linked. The value of a financial derivative derives from the price of an underlying item, such as an asset or index. Unlike debt instruments, no principal amount is advanced to be repaid and no investment income accrues. Financial derivatives are used for a number of purposes including risk management, hedging, arbitrage between markets, and speculation.
2. Financial derivatives enable parties to trade specific financial risks — such as interest rate risk, currency, equity and commodity price risk, and credit risk, etc — to other entities who are more willing, or better suited, to take or manage these risks, typically, but not always, without trading in a primary asset or commodity. The risk embodied in a derivatives contract can be traded either by trading the contract itself, such as with options, or by creating a new contract which embodies risk characteristics that match, in a countervailing manner, those of the existing contract owned. This latter activity is termed offsetability¹, and occurs in forward markets. Offsetability means that it will often be possible to eliminate the risk associated with the derivative by creating a new, but “reverse”, contract that has characteristics that countervail the risk of the first derivative. Buying the new derivative is the functional equivalent of selling the first derivative, as the result is the elimination of risk. The ability to offset the risk on the market is therefore considered the equivalent of tradability in demonstrating value. The outlay that would be required to offset the existing derivative contract represents its value — actual offsetting is not required to demonstrate value.

3. Financial derivatives contracts are usually settled by net payments of cash, often before maturity for exchange traded contracts such as commodity futures. Cash settlement is a logical consequence of the use of financial derivatives to trade risk independently of ownership of an underlying item. However, some financial derivative contracts, particularly involving foreign currency, are associated with transactions in the underlying item.
4. The value of the financial derivative derives from the price of the underlying item: the reference price. Because the future reference price is not known with certainty, the value of the financial derivative at maturity can only be anticipated, or estimated. The reference price may relate to a commodity, a financial instrument, an interest rate, an exchange rate, another derivative, a spread between two prices, an index or basket of prices. An observable market price or index for the underlying item is essential for calculating the value of any financial derivative — if there is no observable prevailing market price for the underlying item, it cannot be regarded as a financial asset. Transactions in financial derivatives should be treated as separate transactions, rather than as integral parts of the value of underlying transactions to which they may be linked. This is because a different institutional unit will be the party to the derivative transaction from that for the underlying transaction. However, embedded derivatives (see below para.5) should not be separately identified and valued from the primary instrument.

The following types of instruments are not financial derivatives for balance of payments purposes.

- A fixed price contract for goods and services is not a financial derivative instrument, unless, the contract is standardized so that the market price risk therein can be traded in financial markets in its own right.
- Timing delays arising in the normal course of business, which may entail exposure to price movements, do not give rise to transactions and positions in financial derivatives in the balance of payments. Such timing delays include normal settlement periods for spot transactions in financial markets, and those that arise in the normal course of trade in goods and services.
- Insurance is not a form of financial derivative. Insurance contracts provide individual institutional units exposed to certain risks with financial protection against the consequences of the occurrence of specified events, many of which cannot be expressed in terms of market prices. Insurance is a form of financial intermediation in which funds are collected from policyholders and invested in financial or other assets which are held as technical reserves to meet future claims arising from the occurrence of the events specified in the insurance policies: that is, insurance manages event risk primarily by the pooling, not the trading, of risk.

- Contingencies, such as guarantees and letters of credit are not financial derivatives. The principal characteristic of contingencies is that one or more conditions must be fulfilled before a financial transaction takes place. Typically, these contingencies are not instruments that facilitate the trading of specific financial risks.
- Derivative features embedded in standard financial instruments and inseparable from the underlying instrument are not financial derivatives for balance of payments purposes because the financial derivative element is an integral part of the instrument such that the underlying instrument and the derivative element involve the same counterparties. So, if a primary instrument such as a security or loan contains an embedded derivative, the instrument should be valued and classified according to its primary characteristics, such as a security or loan, even though the value of that security or loan may well be different from comparable securities and loans because of the embedded derivative.

Examples are bonds that are convertible into shares and securities that carry the option of repaying the principal in a different currency from that of issuance.

1.2 CLASSES OF FINANCIAL DERIVATIVES

There are two broad types of financial derivatives as described in paragraphs 1 to 2, and provided that they can be valued separately from the underlying item to which they are linked, they should be included in the financial account of the balance of payments and in the international investment position, regardless of whether they are "traded" on- or off-exchange.

The two broad classes of financial derivatives are: forward-type contracts, including swaps, and option contracts.

Under a forward contract, the two counterparties agree to exchange a specified quantity of an underlying item (real or financial) at an agreed contract price – strike price—on a specified date. Futures contracts are forward contracts traded on organized exchanges. Futures and other forward contracts are typically, but not always, settled by the payment of cash or the provision of some other financial instrument rather than the actual delivery of the underlying item and therefore are valued and traded separately from the underlying item. If the forward-type contract is a swap contract, the counterparties exchange cash flows based on the reference prices of the underlying items in accordance with pre-arranged terms. Interest-rate, currency, and cross-currency interest-rate swaps are common types of swap contracts. (See paragraphs 25 and 26 for further discussion)

A forward contract is an unconditional financial contract that represents an obligation for settlement on a specified date. At the inception of the contract, risk exposures of equal market value are exchanged. Both parties are potential debtors, but a debtor/creditor

relationship can be established only after the contract goes into effect. Thus, at inception, the contract has zero value. However, during the life of a forward contract, the market value of each party's risk exposure may differ from the zero market values at the inception of the contract as the price of the underlying item changes. When this occurs, an asset (creditor) position is created for one party and liability (debtor) position for the other. The debtor/creditor relationship may change both in magnitude and direction over the life of the forward contract.

Under an option-type contract, the purchaser of the option, in return for an option premium, acquires from the writer of the option, the right but not the obligation to buy (call option) or sell (put option) a specified underlying item (real or financial) at an agreed contract price — strike price — on or before a specified date. A major difference between forward and options contracts is that, whereas either party to a forward is a potential debtor, the buyer of an option acquires an asset, and the option writer incurs a liability. However, the option may expire worthless; the option will be exercised only if settling the contract is advantageous to the buyer. The buyer may make gains of unlimited size, and the option writer may experience losses of unlimited size. Options are written on a wide variety of underlying items such as equities, commodities, currencies, and interest rates (including cap, collar, and floor). Options are also written on futures, and swaps (known as swaptions), and other instruments such as caps (known as captions).

On organized markets, option contracts are usually settled in cash, but some option-type contracts are normally settled by the purchase of the underlying asset. For instance, warrants are financial contracts that give the holder the right to buy, under specified terms, a certain number of the underlying asset, such as equity shares and bonds. If warrants are exercised the underlying asset is usually delivered. Warrants can be traded apart from the underlying securities to which they are linked.

Recording of Financial Derivative Transactions and Positions

The statistical treatment of financial derivatives in the balance of payments involves four steps:

- Recognizing that the exchange of claims and obligations at the inception of a derivative contract is a true financial transaction that creates asset and liability positions that have, at inception, a zero value in the case of forward instruments, and a value equal to the premium in the case of options;

Treating any changes in the value of derivatives as holding gains or losses.

- Recording transactions in secondary markets of marketable derivatives, such as options, as financial transactions;
- Recording any payments at settlement as transactions in financial derivative assets or liabilities, as appropriate (i.e., no income arises from settlement of financial derivatives).

1.3 VALUATION OF POSITIONS

A key characteristic of most derivative contracts is that transactors commit themselves forward to an agreed price at which they will or are willing to transact in an underlying item. From this the value of the financial derivative derives from the difference between the agreed contract price of the underlying item and the prevailing, or expected prevailing, market price, appropriately discounted, of that item, and in the case of options taking into account the potential volatility of the price of the underlying instrument, the time to maturity and interest rate. In the specific case of a swap contract based on a notional principal amount, its value derives from the difference between the expected gross receipts and gross payments, appropriately discounted: that is, its net present value.

Financial derivatives are valued at their market price on the recording date. Changes in prices between balance sheet recording dates are classified as revaluation gains or losses. If market value data are unavailable, other fair value methods to value derivatives, such as options models or discounted present values, may be used.

Payments at Inception

Purchasers of options pay a premium to the seller. The full price of the premium is recorded as acquisition of a financial asset by the buyer and incurrence of a liability by the seller. In some instances, the premium may be paid at after the inception of the derivative contract. In this case, the value of the premium payment is recorded as an asset at the time the derivative is purchased, financed by an imputed loan from the writer.

The creation of a forward-type contract does not involve the recording of a financial account transaction in financial derivatives as risk exposures of equal value are being exchanged, i.e., there is zero exposure and hence zero value for both sides.

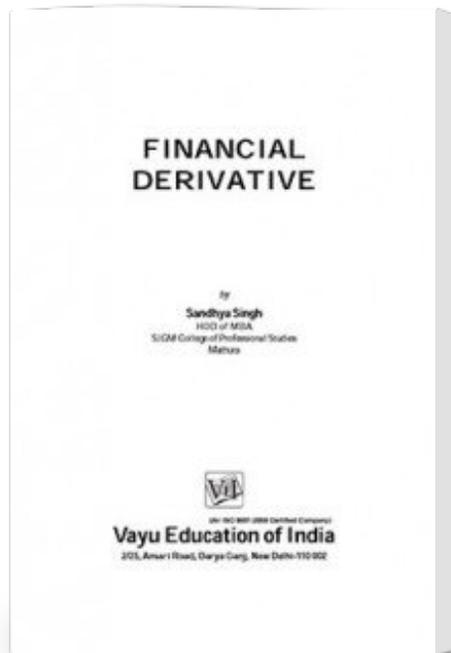
Commissions and fees paid at inception or during the life of the derivative to banks, brokers, and dealers, are classified as payments for services. These are payments rendered for service activities provided within the current period, and are independent of the asset and liability relationships that are created by the derivative.

Resale of Derivatives in Secondary Markets

Resale of derivatives in secondary markets, whether exchange-traded or over-the-counter, are recorded as financial transactions at the market price. Net settlement payments are financial transactions, similar to transactions at maturity of other financial instruments. At settlement, either a net cash payment is made, or the underlying item is delivered.

- When a financial derivative is settled in cash, a transaction in the derivative is recorded equal to the cash value of the settlement. No transaction in the underlying item is recorded. In most instances, the receipt of cash is recorded as a reduction in financial derivative assets, and the payment of cash is recorded as a reduction in financial derivative liabilities. However, when a contract involves on-going settlement, such as with an interest rate swap, a receipt of cash can be recorded as an increase in financial derivative liabilities if, at the time of the settlement payment,

Financial Derivative By Sandhya Singh



Publisher : **Vayu Education**

ISBN : **9789383758401**

Author : **Sandhya Singh**

Type the URL : <http://www.kopykitab.com/product/3382>



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