

Financial Mathematics

MATH 5870/6870¹
Fall 2021

Le Chen

lzc0090@auburn.edu

Last updated on
August 6, 2021

Auburn University
Auburn AL

¹Based on Robert L. McDonald's *Derivatives Markets*, 3rd Ed, Pearson, 2013.

Chapter 3. Insurance, Collars, and Other Strategies

Chapter 3. Insurance, Collars, and Other Strategies

§ 3.1 Basic insurance strategies

§ 3.2 Put-call parity

§ 3.3 Spreads and collars

§ 3.4 Speculating on volatility

§ 3.5 Problems

Chapter 3. Insurance, Collars, and Other Strategies

§ 3.1 Basic insurance strategies

§ 3.2 Put-call parity

§ 3.3 Spreads and collars

§ 3.4 Speculating on volatility

§ 3.5 Problems

Options can be

1. Used to insure long positions (floors)
2. Used to insure short positions (caps)
3. Written against asset positions (selling insurance)

Covered call writing

Covered put writing

Four positions

positions w.r.t. asset	put option	call option
long	purchased (<i>floor</i>)	written
short	written	purchased (<i>cap</i>)

Buying insurance

floor = buying a *put* option

cap = buying a *call* option

Selling insurance

Covered *put* writing

Covered *call* writing

We will work under the following setup

S&S index

index price today	\$1,000
6-month interest rate	2%
premium for 1000-strike 6-month call	\$93.809
premium for 1000-strike 6-month put	\$74.201

Insuring a long position

– Floors

owning a home	owning a stock index
insuring the house	buying a put (floor)

Goal: to insure against a fall in the price of the underlying asset.

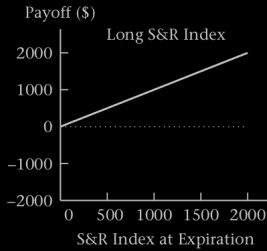
Example 3.1-1 Under the following scenario, compute the combined profit of insuring a long position via **buying a put** for the following S&R index.

index price today	\$1,000
6-month interest rate	2%
premium for 1000-strike 6-month put	\$74.201
index price at expiration	\$900

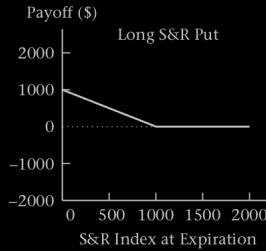
Solution.

$$\underbrace{\$900 - \$1,000 \times 1.02}_{\text{profit on S\&R index}} + \underbrace{\$1,000 - \$900 - \$74.201 \times 1.02}_{\text{profit on put}} = -\$95.68.$$

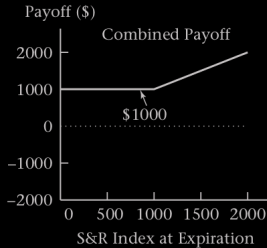




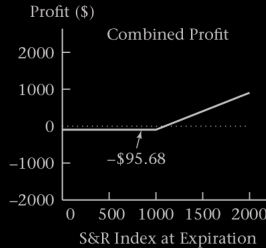
(a)



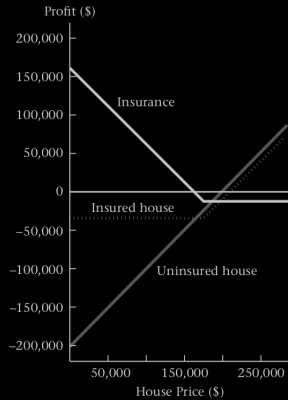
(b)



(c)



(d)



Insuring a short position

– Caps

If we have a short position in the S&R index, we experience a loss when the index rises.

We can insure a short position by purchasing a call option (cap) to protect against a higher price of repurchasing the index.

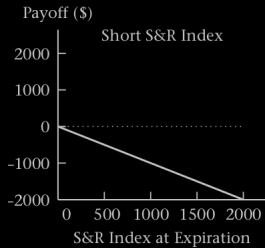
Example 3.1-2 Under the following scenario, compute the combined profit for insuring a short position via **buying a call** of the following S&R index.

index price today	\$1,000
6-month interest rate	2%
premium for 1000-strike 6-month call	\$93.809
index price at expiration	\$1,100

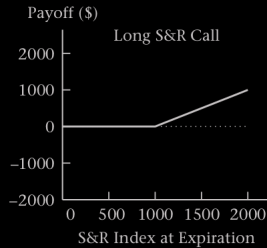
Solution.

$$\underbrace{\$1,000 \times 1.02}_{\text{future value of short S\&R index}} - \underbrace{\$93.809 \times 1.02}_{\text{FV of premium for call}} - \underbrace{\$1,000}_{\text{exercise the call option}} = -\$75.685.$$

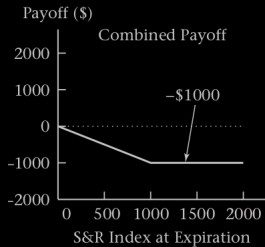




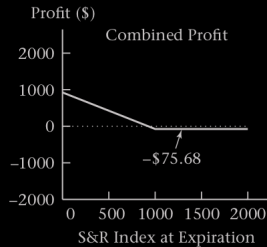
(a)



(b)



(c)



(d)

Selling insurance

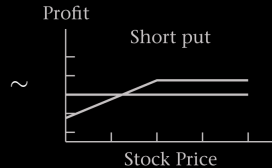
For every insurance buyer there must be an insurance seller

Strategies used to sell insurance

- ▶ **Covered writing** (option overwriting or selling a covered call) is writing an option when there is a corresponding long position in the underlying asset.
- ▶ **Naked writing** is writing an option when the writer does not have a position in the asset.

Covered call writing

Long position of the asset + Sell a **call** option



Covered put writing

Short position of the asset + Sell a **put** option



Covered call writing

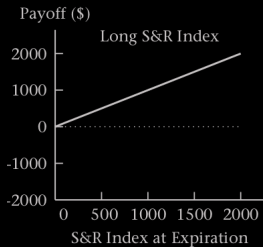
Example 3.1-3 Under the following scenario, compute the combined profit for writing a **covered call** for S&R index.

index price today	\$1,000
6-month interest rate	2%
premium for 1000-strike 6-month call	\$93.809
index price at expiration	\$1,100

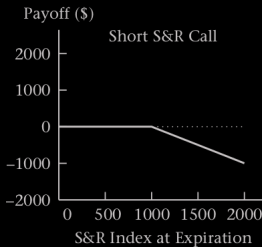
Solution.

$$\underbrace{\$1,100 - \$1,000 \times 1.02}_{\text{profit on S\&R index}} + \underbrace{\$1,000 - \$1,100 + \$93.809 \times 1.02}_{\text{profit on written call}} = \$75.68.$$

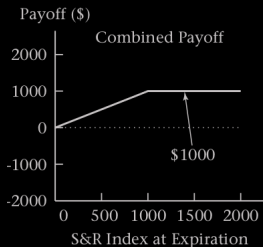




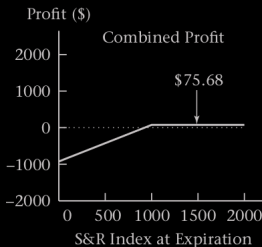
(a)



(b)



(c)



(d)

Covered put writing

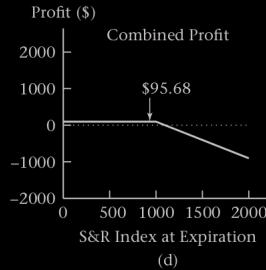
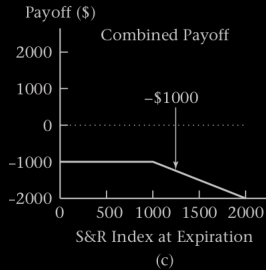
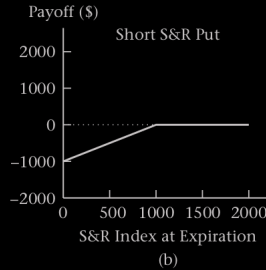
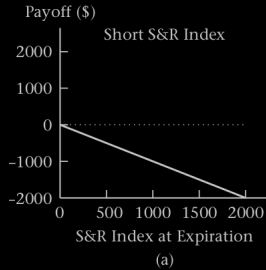
Example 3.1-4 Under the following scenario, compute the combined profit for writing a covered put for S&R index.

index price today	\$1,000
6-month interest rate	2%
premium for 1000-strike 6-month put	\$74.201
index price at expiration	\$900

Solution.

$$\underbrace{\$1,000 \times 1.02 - \$900}_{\text{profit on selling S\&R index}} + \underbrace{+\$900 - \$1,000 + \$74.201 \times 1.02}_{\text{profit on written put}} = \$95.685.$$





Chapter 3. Insurance, Collars, and Other Strategies

§ 3.1 Basic insurance strategies

§ 3.2 Put-call parity

§ 3.3 Spreads and collars

§ 3.4 Speculating on volatility

§ 3.5 Problems

It is possible to mimic a long forward position on an asset by
buying a call + selling a put,
with each option having the same strike price and expiration time.

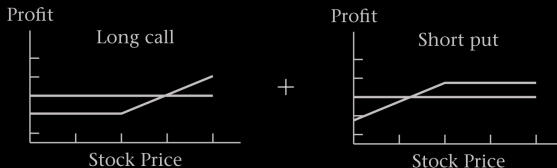
||

A synthetic forward

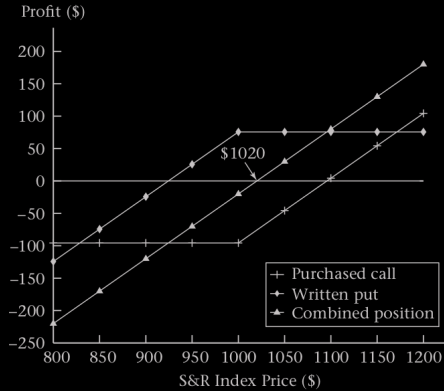
Example 3.2-1 Working with the S&R index. Suppose that

6-month interest rate	2%
premium for 1000-strike 6-month call	\$93.809
premium for 1000-strike 6-month put	\$74.201

Draw profit diagram for the combined position of a purchased call with a written put, namely,



Solution.



A synthetic long forward contract

We pay the net option premium

We pay the strike price

The actual forward

We pay zero premium

We pay the forward price

Basic Assumption

The net cost of buying the index using options
must equal
the net cost of buying the index using a forward contract.

NO ARBITRAGE!

The Put-Call parity equation

$$\text{Call}(K, T) - \text{Put}(K, T) = \text{PV}(F_{0,T} - K)$$

- ▶ K : strike price
- ▶ T : expiration date
- ▶ $\text{Call}(\cdot, \circ)$: the premium for call.
- ▶ $\text{Put}(\cdot, \circ)$: the premium for put.
- ▶ $F_{0,T}$: the forward price at time T if one enters at time 0 into a long forward position.
- ▶ $\text{PV}(\cdot)$: the present value function.

Example 3.2-2 Check Example 3.2-1 to see if the put-call parity equation is satisfied.

Solution. We need to check:

$$\$93.809 - \$74.201 \stackrel{?}{=} \text{PV}(\$1,000 \times 1.02 - \$1,000)$$

Clearly, LHS = \$19.61. On the other hand, the RHS is equal to

$$\begin{aligned}\text{PV}(\$1,000 \times 1.02 - \$1,000) &= \text{PV}(1,000 \times (1.02 - 1)) \\ &= \text{PV}(1,000 \times 0.02) \\ &= \frac{1,000 \times 0.02}{1.02} \\ &= \$19.61.\end{aligned}$$

Hence, the put-call parity equation is satisfied. □

$$\text{Call}(K, T) - \text{Put}(K, T) = \text{PV}(F_{0,T} - K)$$



$$\text{PV}(F_{0,T}) + \text{Put}(K, T) = \text{Call}(K, T) + \text{PV}(K)$$

Buying the index and buying the put

generate the same payoff as

buying the call and buying a zero-coupon bond (i.e. lending) $\text{PV}(K)$

$$\text{Call}(K, T) - \text{Put}(K, T) = \text{PV}(F_{0,T} - K)$$

$$\Updownarrow$$

$$\text{PV}(F_{0,T}) - \text{Call}(K, T) = \text{PV}(K) - \text{Put}(K, T)$$

Writing a covered call

has the same profit as

lending $\text{PV}(K)$ and selling a put

Chapter 3. Insurance, Collars, and Other Strategies

§ 3.1 Basic insurance strategies

§ 3.2 Put-call parity

§ 3.3 Spreads and collars

§ 3.4 Speculating on volatility

§ 3.5 Problems

Chapter 3. Insurance, Collars, and Other Strategies

§ 3.1 Basic insurance strategies

§ 3.2 Put-call parity

§ 3.3 Spreads and collars

§ 3.4 Speculating on volatility

§ 3.5 Problems

Chapter 3. Insurance, Collars, and Other Strategies

§ 3.1 Basic insurance strategies

§ 3.2 Put-call parity

§ 3.3 Spreads and collars

§ 3.4 Speculating on volatility

§ 3.5 Problems