Forwards and Futures

Introduction to Forwards and Futures

Forwards and futures are derivatives contracts that allow two parties to agree on the price at which an asset will be bought or sold at a future date. Unlike options, **forwards and futures represent an obligation**, meaning both parties are required to fulfill the contract terms at expiration.

Key Differences from Options

- **Obligation**: In a forward or futures contract, both parties are obligated to complete the transaction. In contrast, an option gives the holder the right, but not the obligation, to buy or sell.
- **Customization and Trading Venue**: Forwards are customized and traded over-the-counter (OTC), while futures are standardized and traded on exchanges.

This notebook explores types of forwards and futures, their payoff structures, and practical applications.

1. Types of Forwards and Futures

There are various types of forwards and futures contracts, each serving different markets and purposes.

Commodity Futures

Commodity futures are contracts to buy or sell physical commodities (e.g., oil, gold) at a specified price and date in the future.

Currency Forwards

Currency forwards allow parties to lock in an exchange rate for a specified amount of foreign currency on a future date.

Equity Futures

Equity futures are contracts based on stock indices (e.g., S&P 500) or individual stocks, allowing speculation on the future price of an equity or index.

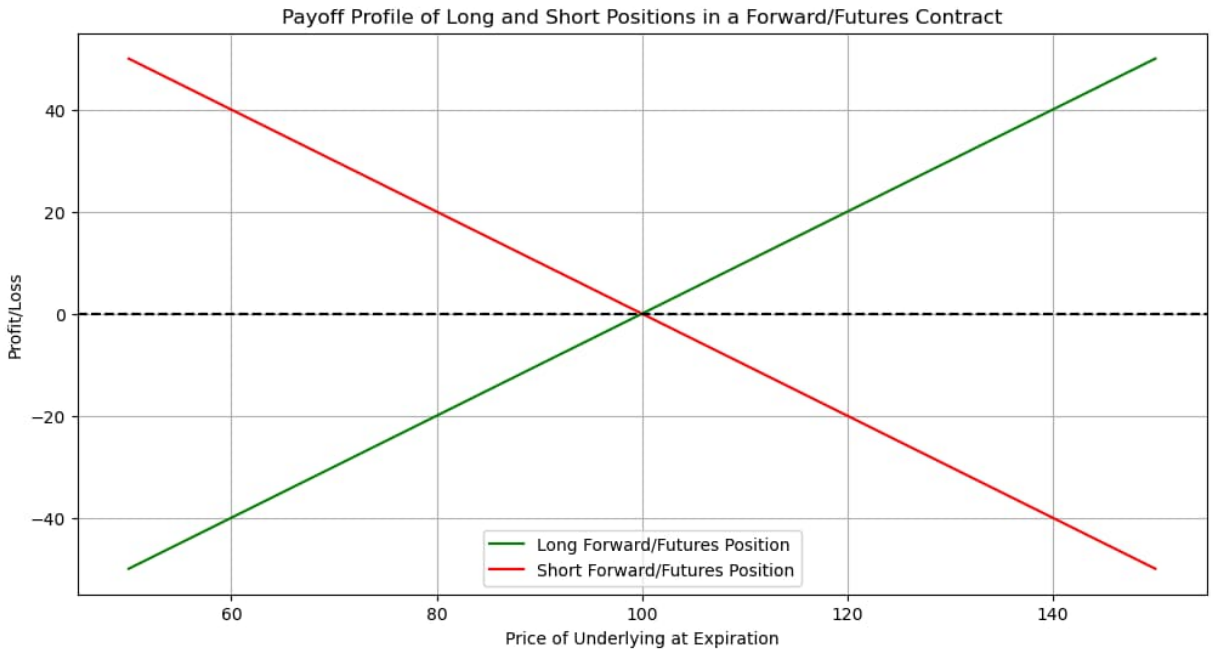
Below is a visualization showing the payoff profile for a forward/futures contract, highlighting how profits or losses depend on the underlying asset's price at expiration.

In [1]:
```
import numpy as np
import matplotlib.pyplot as plt

# Define parameters for payoff profile
K = 100  # Agreed price (strike price in the forward/futures contract)
S_range = np.linspace(50, 150, 100)  # Range of possible prices at expiration

# Calculate payoff profiles for long and short positions
long_payoff = S_range - K
short_payoff = K - S_range

# Plotting the payoff profiles
plt.figure(figsize=(12, 6))
plt.plot(S_range, long_payoff, label="Long Forward/Futures Position", color="green"
plt.plot(S_range, short_payoff, label="Short Forward/Futures Position", color="red"
plt.axhline(0, color="black", linestyle="--")
plt.xlabel("Price of Underlying at Expiration")
plt.ylabel("Profit/Loss")
plt.title("Payoff Profile of Long and Short Positions in a Forward/Futures Contract
plt.legend()
plt.grid(True)
plt.show()
```



2. Conceptual Flow of a Forward/Futures Contract

To further understand forwards and futures, let's consider the timeline of such contracts:

1. **Contract Initiation**: The buyer and seller agree on a price (forward price) for the transaction at expiration.

2. **Periodic Updates (for Futures)**: Futures contracts are marked-to-market daily, meaning gains and losses are settled each day. This is different from forwards, which settle only at expiration.
3. **Expiration**: At expiration, the contract is settled, either through physical delivery of the asset or cash settlement based on the difference between the asset's spot price and the agreed-upon price.

This timeline helps highlight the **obligatory nature** of these contracts, as both parties are committed to the terms from initiation to expiration.

3. Pricing and Valuation of Forwards and Futures

The pricing of forwards and futures is based on the concept of the **cost of carry**, accounting for costs and benefits of holding the asset until expiration.

Forward Pricing Formula

The price of a forward contract is given by:

$$F = S_0 \cdot e^{(r-q)\cdot T}$$

where:

- S_0: Spot price of the underlying asset
- r: Risk-free interest rate
- q: Dividend yield (or storage costs for commodities)
- T: Time to maturity (in years)

Below is an example calculating the forward price for a stock index with dividends.

In [2]:
```
# Parameters for forward price calculation
S0 = 100  # Spot price
r = 0.05  # Risk-free interest rate
q = 0.02  # Dividend yield
T = 1     # Time to maturity in years

# Calculate forward price
F = S0 * np.exp((r - q) * T)
F
```

Out[2]:
```
103.0454533953517
```

4. Uses and Strategies for Forwards and Futures

Forwards and futures are versatile instruments used in various strategies:

Hedging

Used to protect against adverse price movements in commodities, currencies, or interest rates.

Speculation

Traders take positions in futures to speculate on market direction, using leverage for potential gains.

Arbitrage

Arbitrageurs exploit price discrepancies between spot and futures markets or between futures with different maturities.

Below is a simple visualization illustrating a futures hedge for an investor with commodity price exposure.

In [3]:
```
# Hypothetical hedge illustration
hedge_periods = np.arange(1, 13)  # 12 months
commodity_exposure = [120 - (5 * i) for i in hedge_periods]  # Reducing exposure ov
futures_position = [5 * i for i in hedge_periods]  # Increasing futures position ov

plt.figure(figsize=(12, 6))
plt.plot(hedge_periods, commodity_exposure, label="Commodity Exposure", color="brow
plt.plot(hedge_periods, futures_position, label="Futures Hedge Position", color="bl
plt.xlabel("Month")
plt.ylabel("Position Size")
plt.title("Conceptual Futures Hedge for Commodity Exposure")
plt.legend()
plt.grid(True)
plt.show()
```