Derivatives Settled on the Blockchain

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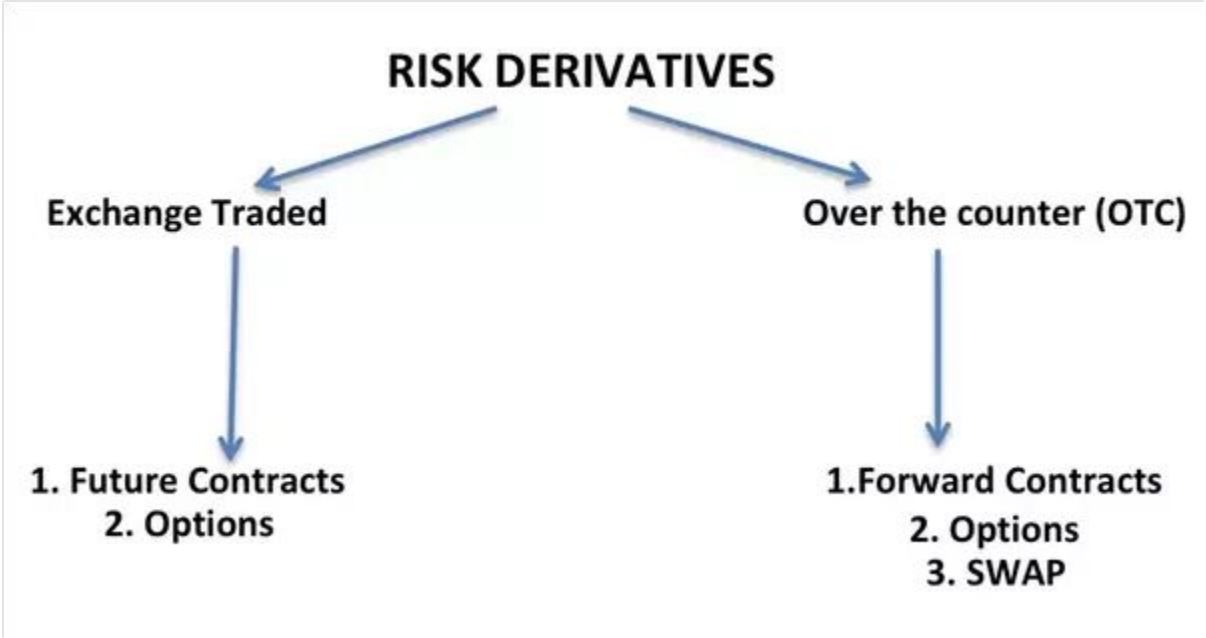
What are derivatives?

- Complex financial products
- Used to isolate and hedge specific kinds of risk
- Invented for commodity based businesses to hedge risk



Types of Risk Derivatives

$$C(S,t) = N(d_1)S - N(d_2)Ke^{-r(T-t)}$$

$$d_1 = \frac{1}{\sigma\sqrt{T-t}}\left[\ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)(T-t)\right]$$

$$d_2 = \frac{1}{\sigma\sqrt{T-t}}\left[\ln\left(\frac{S}{K}\right) + \left(r - \frac{\sigma^2}{2}\right)(T-t)\right]$$

$$= d_1 - \sigma\sqrt{T-t}$$

$$F_t = S_t * e^{(r_f - q)*(T-t)}$$

where:

F_t: Theoretical price of contract

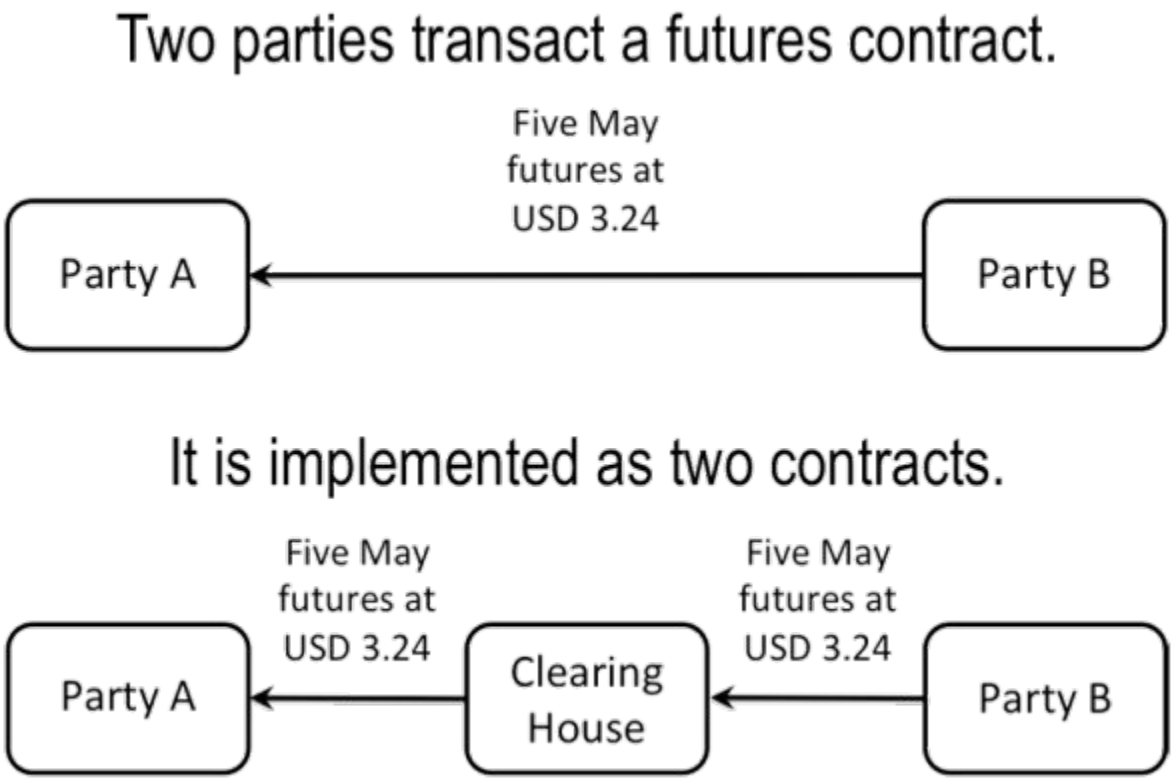
S_t: Spot price of underline asset

r_f: Risk free rate

q: Dividend yield

T-t: Time until maturity of the contract

Relevant Equations for Derivative Contract Values

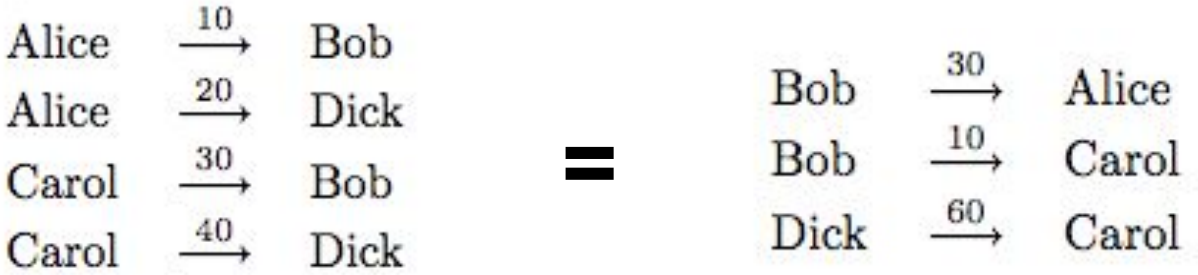


State of the Art Central Counterparty Workflow

$10 billion

Transaction Fees that could be saved per year by a Blockchain Settlement System
as according to Goldman Sachs, 2017

Multi-Agent System Complexity: Netting Settlement



Multi-Agent System Complexity: Netting Settlement (continued)

Step 1. Determine the balance for each person.

Observe that the sum of all balances equals zero.
Let P be the total amount of positive balances, and N the total amount of negative balances. Hence, $P = -N$.
The minimum total amount to be transferred equals P.

Step 2. While there is still someone with a nonzero balance, do:

Step 2a. Select a person A with a negative balance $S < 0$, and a person B with a positive balance $T > 0$ (these exist).

Step 2b. Let M be the minimum of $-S$ and T. Hence, $M > 0$.

Step 2c. Include the transfer $A \xrightarrow{M} B$ in the settlement.

Step 2d. Increase the balance of A by M and decrease the balance of B by M (the total balance remains zero).

Observe that after Step 2d, at least one of A and B now has balance zero.

Step 3. All balances are zero, hence the included transfers settle all debts.

The total amount transferred equals P, and hence is minimal. The repetition of Step 2 terminates, because in each iteration at least one nonzero balance is reduced to zero. Therefore, the number of transfers is at most N. In fact, it is at most $N - 1$, because the final two nonzero balances cancel each other in a single transfer.

Clearinghouse Workflow

- Start of Trading Day
  - “Prune” contracts
- Throughout Trading Day
  - Log orders
- End of Trading Day
  - Mark contracts
    - Pair orders
    - Re-evaluate contracts
  - Settlements
  - Netting

Hyperledger Infrastructure

- Assets
  - Orders
  - Contracts

- Participants and Transactions
  - Traders
    - CreateOrder()
  - Admin
    - SOD()
    - AcceptOrders()
    - EOD()

Related Work

- DTCC- Derivative Blockchain Settlement using Solidity
- Fordham Law- “ Off the Chain! A Guide To Blockchain Derivatives Markets And The Implications On Systemic Risk”

DTCC

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Goals

Goals	Deadlines
Low-Hanging	April 27th
Margining	May 4th
Insurance Fund	May 4th
Exchange	May 7th