1 Economic Motivation

On April 2nd, 2025, U.S. President Donald Trump significantly expanded tariffs on imported goods, framing the policy as a "declaration of economic independence." While the measure aims to strengthen domestic industries, economists and analysts have raised concerns about its broader economic consequences.

Leading financial institutions predict negative repercussions. BlackRock estimates the tariffs could reduce U.S. economic growth by 2% to 2.5%, citing higher costs for businesses and potential retaliation from trade partners [1]. Similarly, Goldman Sachs warns that increased policy uncertainty may discourage business investment, slow hiring, and weaken consumer spending [2].

Early economic indicators already reflect these concerns. The S&P 500 has declined, signalling investor caution, while an inverted yield curve has emerged. Additionally, the Consumer Confidence Index has fallen sharply, suggesting growing public unease. As shown in Figures 1 to 3, these trends point to rising economic risks and a potential slowdown.

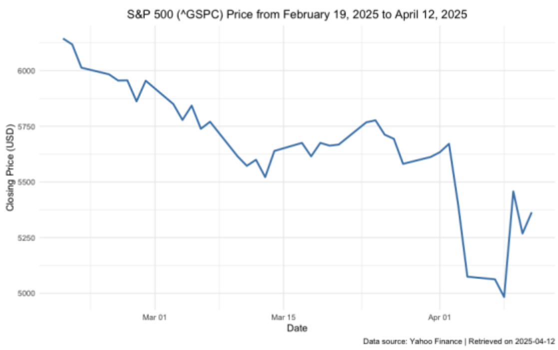

Figure 1: S&P500 Price plotted with R [3]

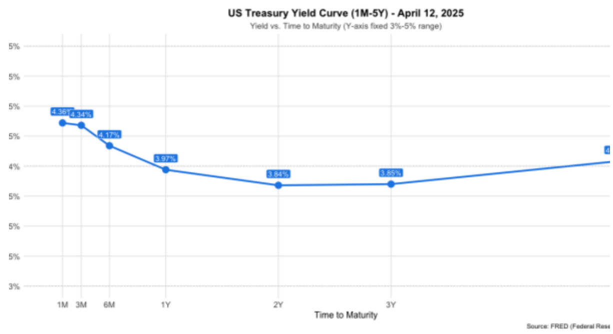

Figure 2: US Treasury Yield plotted with R [4]

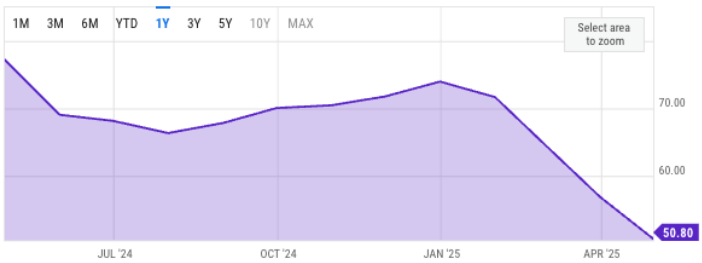

Figure 3: Consumer Confidence Index [5]

2 Design

Product Name	Make Recession Great Again
Structure Type	80% Principal Protected Note with Barrier Protection
Underlying	SPX
Automatic Exercise	Not available
Knock-in Barrier	4741.245
Knock-out Barrier	6156.939
Fixed Coupon Rate	2.0736%
Offer Period	Until 20-04-2025
Launch Date	21-04-2025
Maturity Date	21-04-2026
Base Currency	US Dollar

Minimum Investment	100,000
Management Fee	Up front 3.00%

Table 1: Structured Product Specification

The structured product specification is listed in table 1. At maturity of 1-year, the investor would receive a coupon of 2.0736%, the upside earnings from the barrier options and the principal amount, which is 80% protected. The participation ratio is 151.09%.

For a minimum investment of 100,000 USD, the below steps are taken at initiation:

1. Invest $100{,}000e^{-rT}$ USD in 1-year zero-coupon bond
2. Long down-and-in European barrier put with $100{,}000(1- e^{-rT})$
3. Short up-and-out European barrier call
4. Invest premium from the short call to 1-year zero-coupon bond in the initial

The barrier options are priced at the money (ATM), where the strike price equals the initial SPX index. The knock-in price of the down-and-in European barrier put is 0.9 times of the strike price.

2.1 Payoff

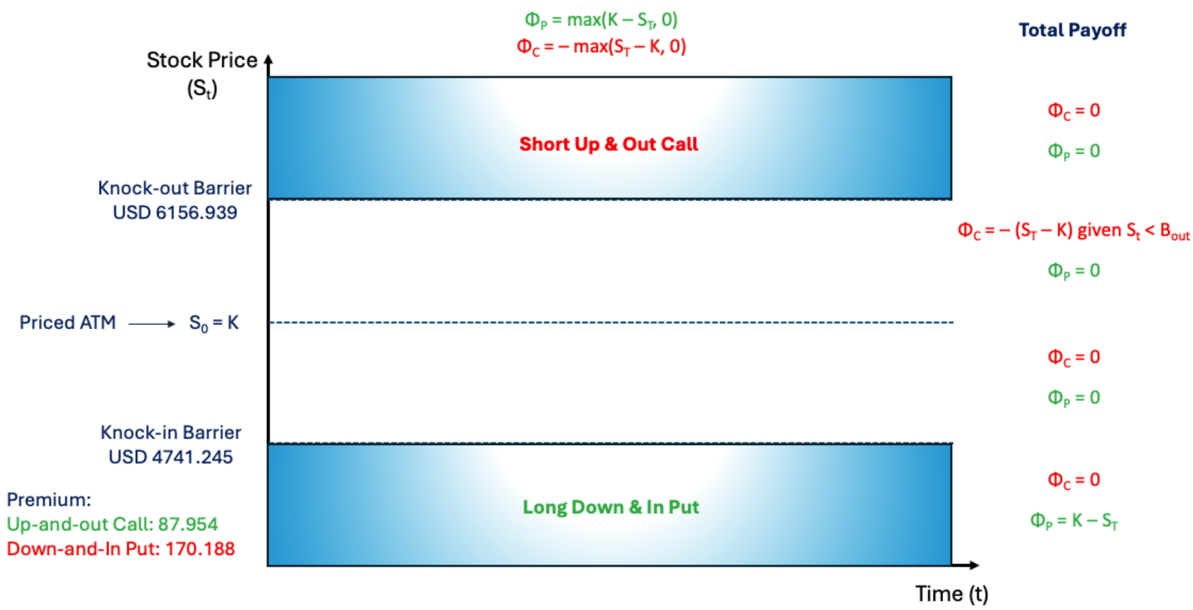

Figure 4: Payoff Possibilities

Figure 4 illustrates the payoff possibilities for different values of SPX index price at maturity. The knock-out barrier (B_{out}), strike price (K) and knock-in barrier (B_{in}) segregates 4 stock price regions. The payoff of long put is given by $\Phi_P = \max(K - S_T, 0)$ and short call is given by $\Phi_C = -\max(S_T - K, 0)$.

<u>$S_T \geq B_{out}$</u>

If SPX index rises past 6156.939 USD any time before or at maturity, the call option will be voided. In this region, the stock price is outside the knock-in barrier, the put option will be voided. Therefore, the payoffs of both the call and put will be 0, $\Phi_C = 0$ and $\Phi_P = 0$.

<u>$B_{out} > S_T \geq K$</u>

If the SPX index is above the strike price, but below the knock-out barrier, hence the call option will be exercised, whilst the put option will be voided. Therefore, the payoff of the call option will be $\Phi_C = -(S_T - K)$ and that of the put option will be $\Phi_P = 0$.

<u>$K > S_T \geq B_{in}$</u>

If the SPX index is below the strike price, but outside the knock-in barrier, the call option will not be exercised, whilst the put option will be voided. Therefore, the payoffs of both the call and put will be 0, $\Phi_C = 0$ and $\Phi_P = 0$.

<u>$S_T < B_{in}$</u>

If SPX index drops below 4741.245 USD, the put option is exercised, but not the call option. Therefore, the payoff of the put option is will be $\Phi_P = K - S_T$ and that of the call option will be $\Phi_C = 0$.

3 Pricing Methodology

Monte Carlo Simulation was done using R. The following assumptions are held in the pricing methodology, SPX trend simulation and pricing of barrier options follow Geometric Brownian Motion (GBM), and there are no arbitrage opportunities for pricing barrier options. There are 5 functions used in total, A function to compute the implied volatility of SPX with historical data, a function to calculate the historical annualised return of SPX over the last 20 years, a function to generate stochastic standard normal variables, a function to price the up-and-out European call option and a function to price the down-and-in European put option.

The volatility measured with historical periods of 2 years and 20 years are 0.1404 (barrier option pricing) and 0.1935 (SPX trend simulation) respectively. The following simulation parameters were set, initial investment of 1,000,000 USD, time-to-maturity of 1-year, economic environment of no recession, slight recession or high recession, simulation trails of 20,000, fed fund rate of 4.32% [4] and 1-year zero coupon bond rate of 3.92% [4].

3.1 Pricing Equations

(1) Monte Carlo Simulation of SPX Index in real-world (Simulate SPX trend):

$$S_{t+1} = S_t e^{\left(\mu_{20\,year} - 0.5\sigma_{20\,year}^2\right)dt + \sigma\sqrt{dt}Z}$$

where S_t is the stock price, $\mu_{20\,year}$ is the 20-year historical return of SPX, $\sigma_{20\,year}$ is the 20-year volatility of SPX and Z is the standard random normal variable.

(2) Monte Carlo Simulation for SPX index in risk-neutral world (Option pricing):

$$S_{t+1} = S_t e^{\left(r_f - 0.5\sigma_{2\,year}^2\right)dt + \sigma\sqrt{dt}Z}$$

where r_f is the risk-free rate.

(3) Number of down-and-in put options invested (same as number of up-and-out call options):

$$N = \frac{I - B}{P_P}$$

where I is the initial investment, B is the initial investment in zero-coupon bond, P_P is the down-and-in put premium.

(4) Knock-out Price of Up-and-out Call:

$$P_{knock\ out} = K + \frac{0.2 \times I}{N}$$

where K is the strike price (ATM) and $0.2 \times I$ is to ensure the maximum loss of the product does not exceed 20% of initial investment.

(5) Participation Ratio:

$$r_{PR} = \frac{N(P_P + P_C)}{I - B}$$

where P_C is the up-and-out call premium.

(6) Fixed Coupon

$$C_{fixed} = \frac{(B + N \times P_C)e^{r_f T}}{I} - 1$$

where T is the time-to-maturity.

(7) Potential and Total Return

$$R_{potential} = \frac{\Phi_P - \Phi_C - N \times P_P}{I}$$

$$R_{total} = C_{fixed} + R_{potential}$$

where Φ_P is the payoff of the down-and-in put option and Φ_C is the payoff of the up-and-out call option.

3.2 Pricing Results

Market Condition	Drift and Standard deviation	$S_T \geq B_{out}$	$B_{out} > S_T \geq K$	$K > S_T \geq B_{in}$	$S_T < B_{in}$	Average Potential Return + Fixed coupon
High Recession	Drift: -μ SD: 2σ	-3.8292% 22.105%	-5.1196% 13.465%	1.8133% 10.470%	35.7101% 53.960%	**17.92% + 2.07%**
Slight Recession	Drift: -0.5μ SD: 1.5σ	-3.8293% 21.385%	-5.8011% 18.320%	1.4804% 14.215%	28.2084% 46.080%	**11.33% + 2.07%**
No Recession	Drift: μ SD: σ	-3.8292% 30.86%	-7.3728% 30.90%	0.5625% 17.76%	18.5259% 20.48%	**0.43% + 2.07%**
Annualised Return of SPX (20-year historical data)						**7.4573%**

Table 2: Returns under different market condition

Table 2 shows the mean potential return (blue) and the probability of the occurrence (red) of the market condition in 3 different market conditions. The maximum return is 118.75% in the extreme scenario of SPX dropping to 0. The participation ratio is 151.09%.

4 Investment and Hedging Strategy

4.1 Investment Advice to Retail Investors

Retail investors should be comfortable with 1-year of illiquidity, since the structured product cannot be early exercised. Investors must be clear be the risk associated with this structured product, market risk from investment in derivative correlated to SPX, liquidity risk from no early exercising and inflation risk from decrease in purchasing power.

4.2 Dynamic Delta Hedging

Delta hedging is performed instead of trading derivatives as derivatives give a non-linear payoff, it could result in result in larger, unmanageable risks.

The bank should long the same amount of 1-year zero-coupon bond as required for the structure product at initiation. They should also simultaneously short 10N units of SPY and undergo dynamic hedging. SPX is a cash index, that cannot be traded directly, hence SPY (SPDR S&P 500 ETF Trust) is used instead. SPY is an ETF tracking the performance of SPX, trading at 1/10 of the price of SPX.

Feature	Down-and-In Put	Up-and-Out Call
Initial Δ	Δ=0	Δ is positive (acts like vanilla call)
Approaches Barrier	Δ turn negative (pre-hedge)	Δ approach 0 (unwind hedge)
Post-Barrier	Turns into vanilla put (delta hedging needed)	Option dies (unwind hedge)

Table 3: Hedging at different stages

To calculate delta for the structure product, decompose into 2 options as shown in table 3. The second row, initial Δ shows the delta hedge position at initiation. The third and fourth row shows how delta changes as SPX price changes through time.

To perform dynamic hedging, sum up delta for both barrier options and hedge delta. If delta is positive, the bank should sell SPY ETF to hedge. Similarly, if delta is negative, the bank should buy SPY ETF to hedge. Undergo rebalancing as SPX price changes through time.

5 Reference

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