



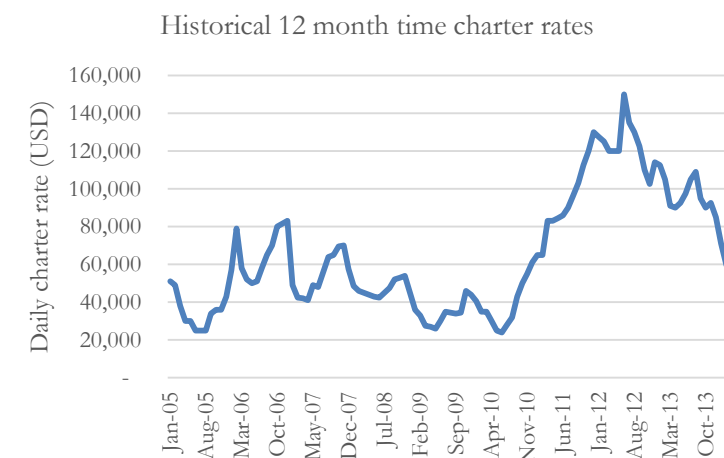
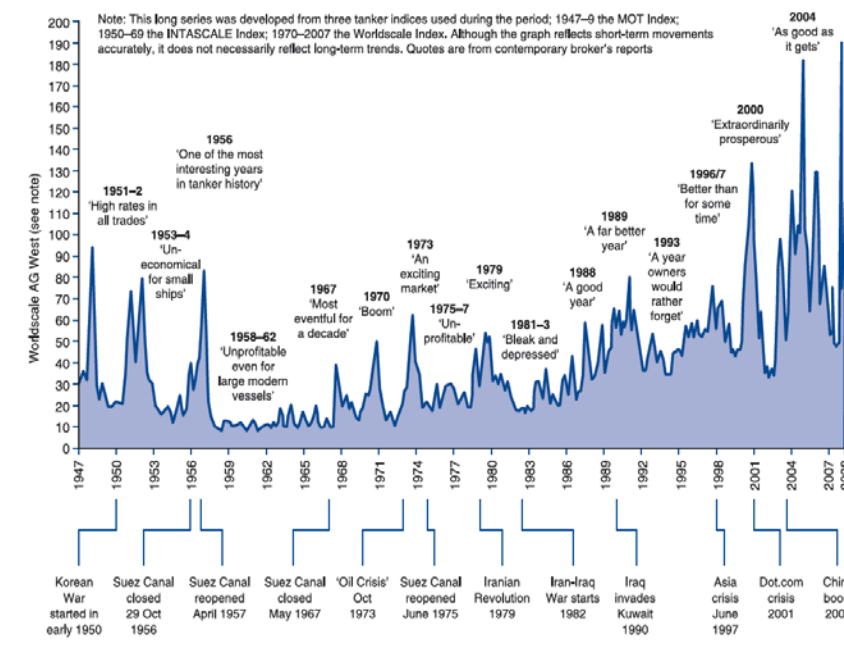
Strategic investment and asset optimisation in the LNG shipping industry:

A framework for the real options analysis of vessel chartering arrangements under stochastic freight rates

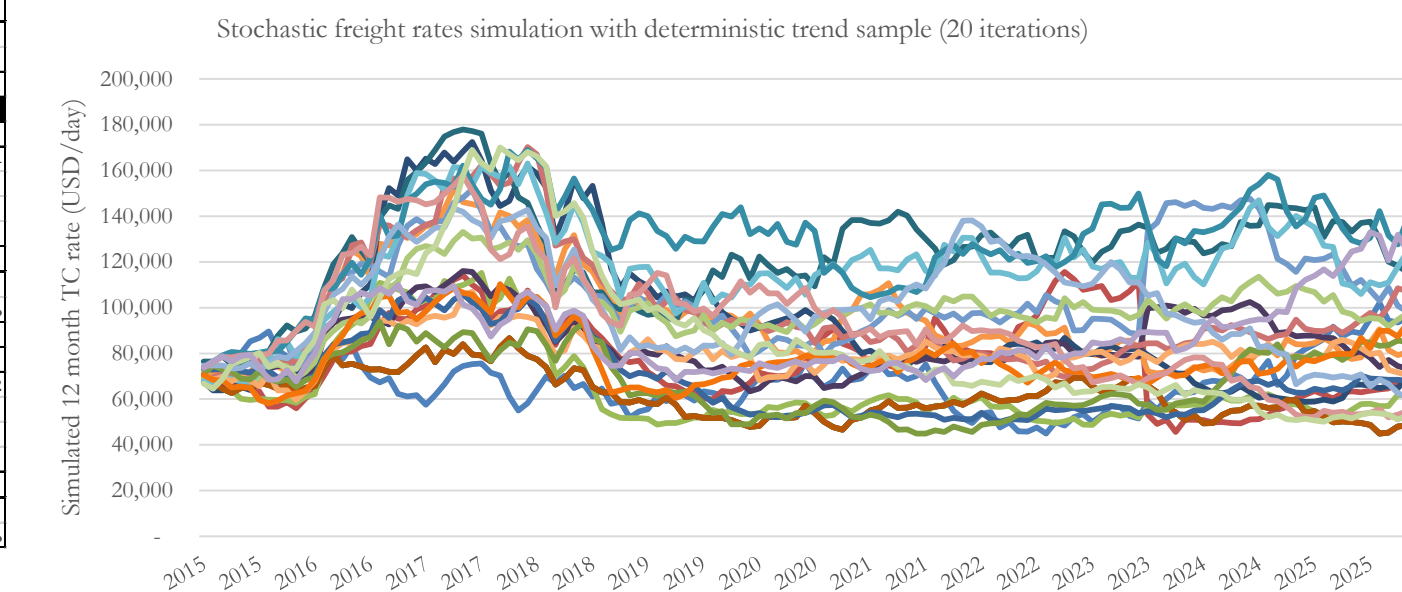
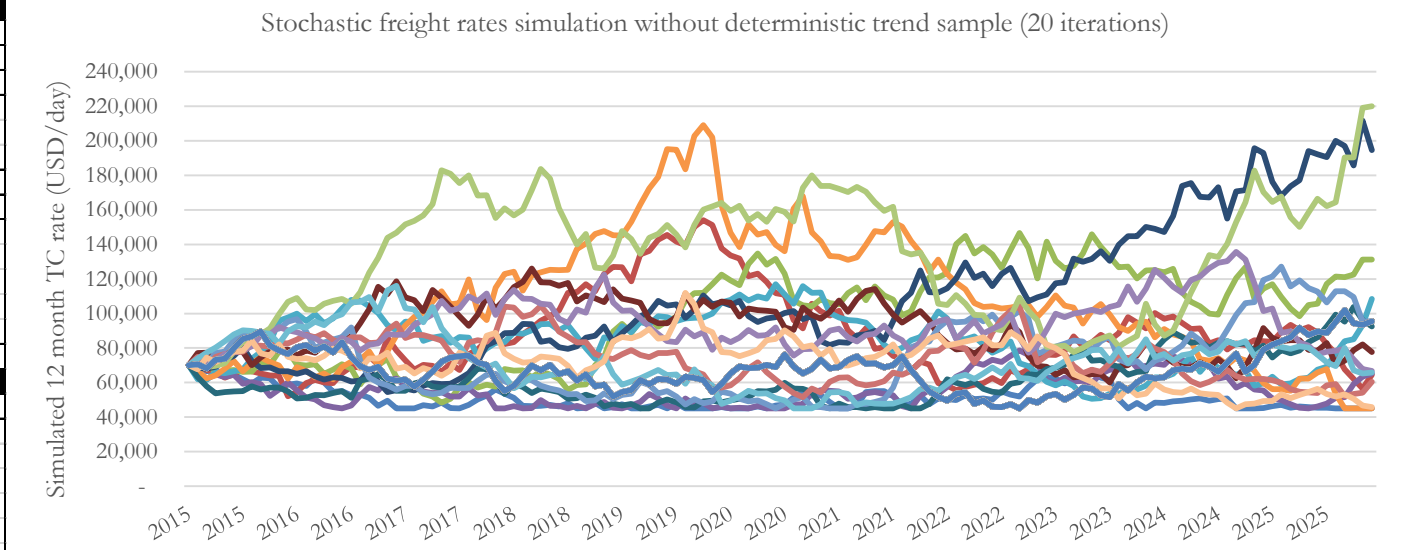
Name: Doug Thomson

Explanation:

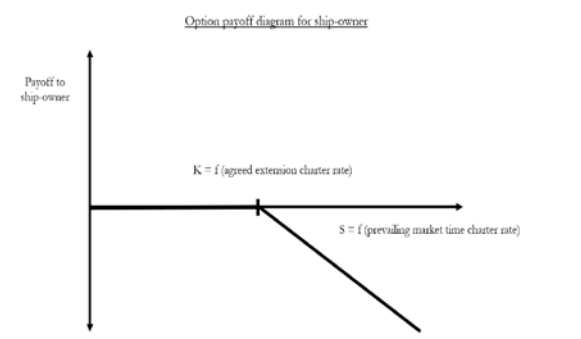
- The LNG shipping industry remains a highly undeveloped niche of the shipping industry, characterised by extremely high levels of capital investment and correspondingly high levels of risk aversion.
- This is at odds with the traditional buccaneering approaches taken in other sectors of the shipping industry which are well suited to the super-cyclical characteristics of the market.
- LNG ship owners regularly offer highly flexible chartering (leasing) arrangements to charterers without adequate compensation.
- This study suggests that this flexibility is of substantial value and ship-owners would benefit from its explicit valuation through the application of real options valuation techniques.
- To this end an intuitive valuation framework is established which is built upon the tools readily available to all market practitioners.



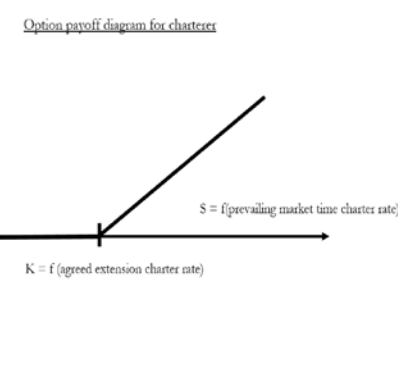
Comprehensive summary of results		
Option	1	2
Option criteria		
TC length (months)	6	24
Extension length	3	6
Exercise notice period	1	2
Common inputs		
TC rate (USD/day)	70,000	
Extension rate (USD/day)	85,000	
Discount rate	10%	
Historical Annual Volatility (σ)	25.99%	
Historical Monthly Volatility (σ)	7.50%	
Black-Scholes methodology valuation inputs and calculation results		
Inputs		
K (Strike Price)	7,080,213	11,801,036
S (PV of underlying asset)	7,258,197	12,348,437
T (years)	0.42	1.83
t (months)	5	22
d1	0.15	0.41
d2	0.02	0.06
Call option value	571,704	1,964,569
Option value to TC value ratio	0.0788	0.042577641
Boyle et al. (1997) methodology - Monte Carlo simulation of option prices under stochastic TC rates		
Without deterministic trend		
Monthly volatility of simulated rates	0.0687	0.0694
Simulated TC rate (mean)	81,352	70,612
Extension E(PV) at t = 5/22 (mean)	7,118,342	14,865,704
Time charter NPV	12,410,523	46,140,862
Call option value estimate (mean)	128,236	3,091,476
Option value to TC value ratio	1.03%	6.7%
With deterministic trend		
Monthly volatility of simulated rates	0.0748	0.0812
Simulated TC rate (mean)	83,824	123,145
Extension E(PV) at t = 5/22 (mean)	7,528,530	22,473,915
Time charter NPV	12,410,523	46,140,862
Call option value estimate (mean)	648,231	10,673,168
Option value to TC value ratio	5.22%	23.13%



Option examined

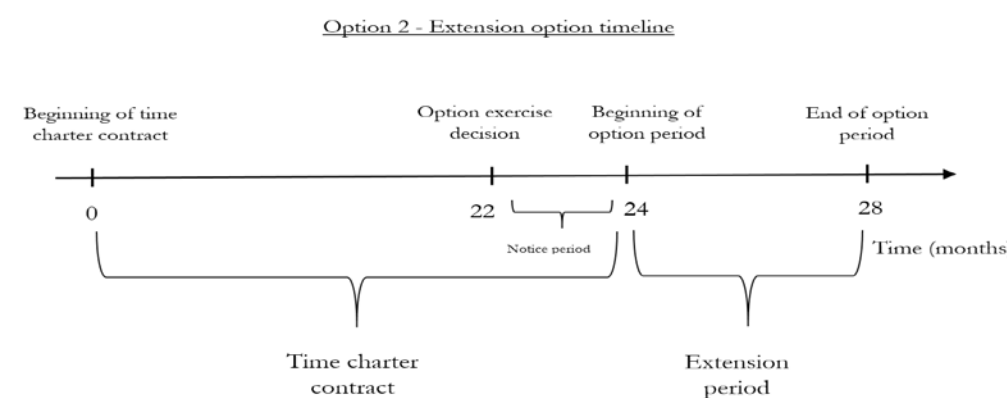
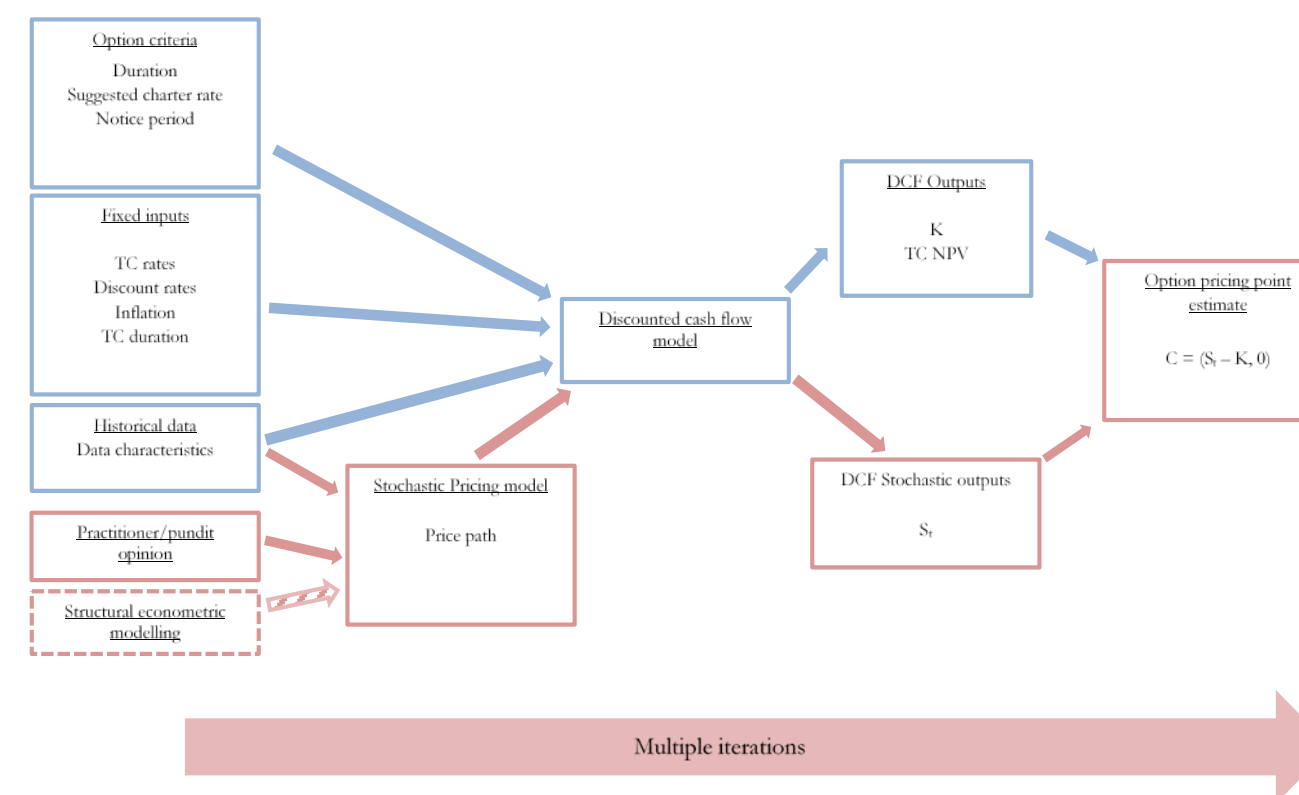


Payoff to ship-owner at expiry = $-\max(S_t - K, 0)$

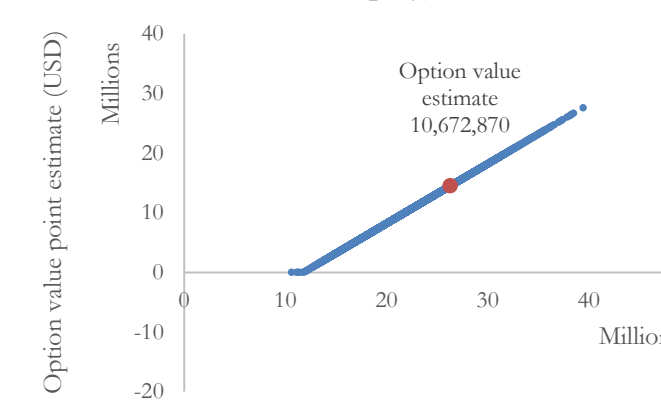


Payoff to charterer at expiry = $\max(S_t - K, 0)$

The framework:



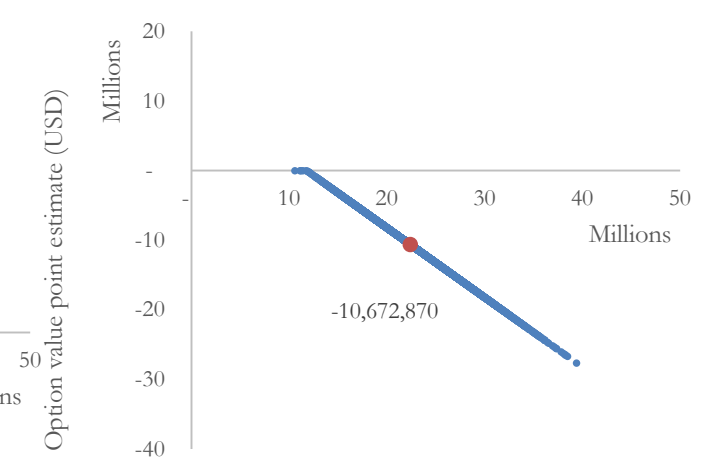
Monte Carlo simulation results scatter plot (charterer's estimated 'payoff' at expiry)



Value of underlying asset at expiry (t = 22) (USD)

• Extension PV at t=5 vs. option point estimate scatter
● Mean option value

Monte Carlo simulation results scatter plot (ship-owners estimated 'payoff' at expiry)



Value of underlying asset at expiry (t = 22) (USD)

• Extension PV at t=5 vs. option point estimate scatter
● Mean option value estimate