EDIBLE WEDDING CAKE STRUCTURED NOTE (EWC)

Introduction to Financial Engineering

Final Project 2018

TEAM MEMBER

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AGENDA

EDIBLE WEDDING CAKE STRUCTURED NOTE (EWC)

- Background and motivation
- EWC on Geometric Brownian Motion (GBM)
- EWC on Heston Model

BACKGROUND

- Inspired from Multi-Double-Lock-Out Warrant
- By Warburg Dillon Read (1998)
- Known as Onion option / Wedding Cake
- → Edible Wedding Cake (EWC)

EWC'S CHARACTERISTICS

- Returns per period of Stock price
- Coupon paying bond
- Modify structure after paid coupon

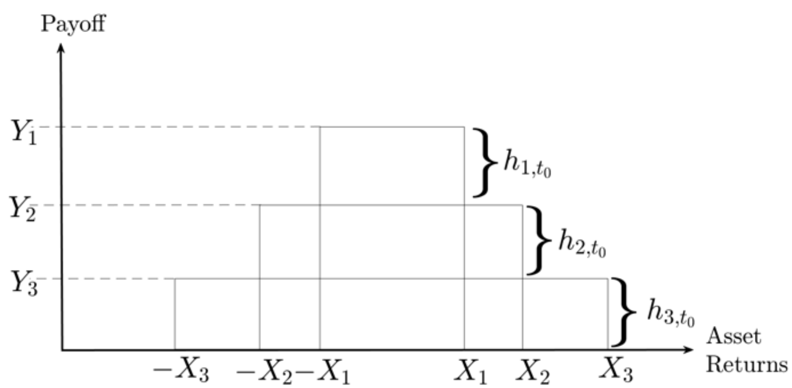
EWC'S PAYOFF

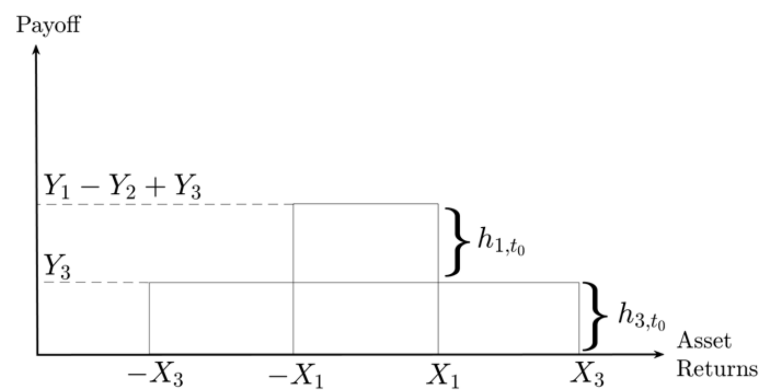
$$R_{t_i} = \frac{S_{t_i}}{S_{t_{i-1}}} - 1 \qquad P_{t_i}^{EWC} = \sum_{j=1}^{k} P_{j,t_i}^{L} \qquad P_{j,t_i}^{L} = \begin{cases} h_{j,t_i} & ; |R_{t_i}| \leq X_j \\ 0 & ; |R_{t_i}| > X_j \end{cases}$$

when

$$h_{j,t_i} = \begin{cases} 0 & ; \quad X_{j-1} < |R_\tau| \leq X_j \quad \exists \tau \in \{t_1, \ldots t_{i-1}\} \\ h_{j,t_{i-1}} & ; \quad otherwise \end{cases}$$

for $i > 1$





at t_1 with $h_{j,t_0} = Y_j - Y_{j+1}$

at t_2 when $|R_{t_1}| \in (X_1, X_2]$

MOTIVATIONS FOR EWC

- Volatility Strategy
- Discrete $\rightarrow$ Predictable
- Eating $\rightarrow$ Adaptable

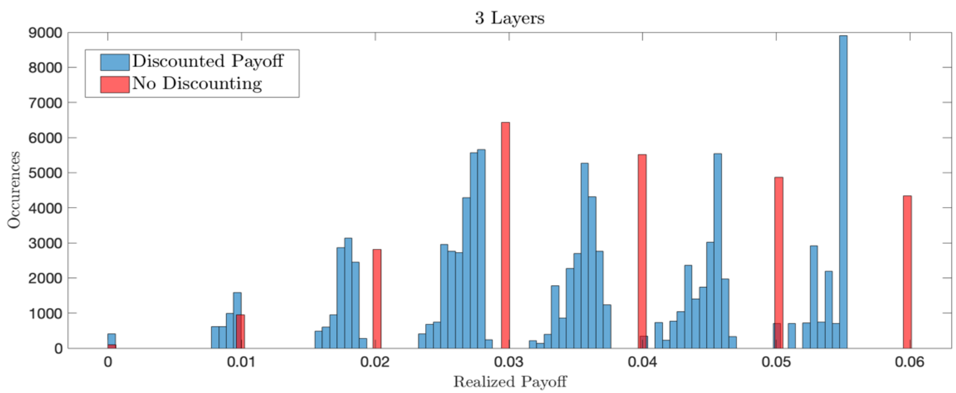
WHY ZERO-CENTERED LAYERS?

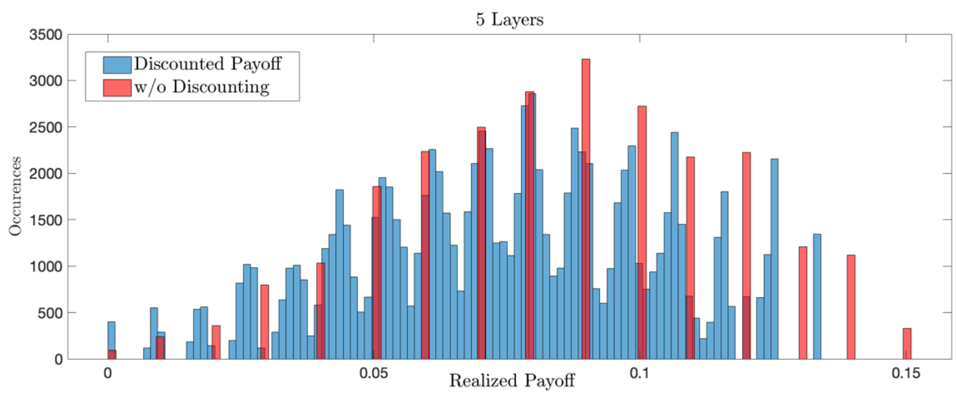
- Historical reason
- To study growth rate vs volatility
- To offset Leverage Effect / Panic Selling

GEOMETRIC BROWNIAN MOTION (GBM)

PAYOFF

- For EWC with few layer → cluster of discounted payoff

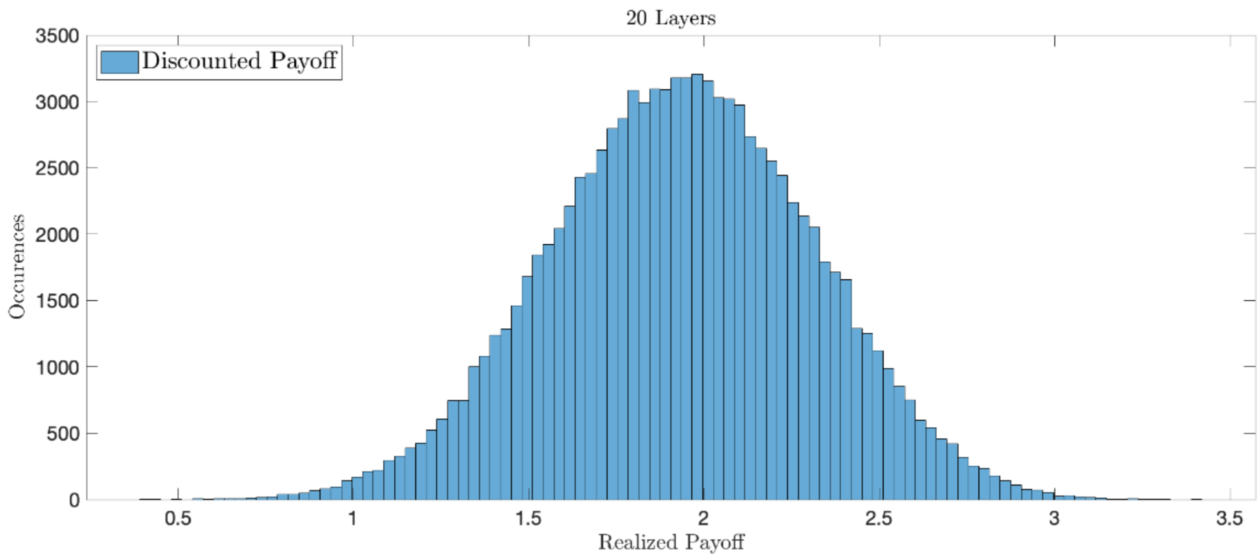




GEOMETRIC BROWNIAN MOTION (GBM)

PAYOFF

- For EWC with large number of layer → Gaussian

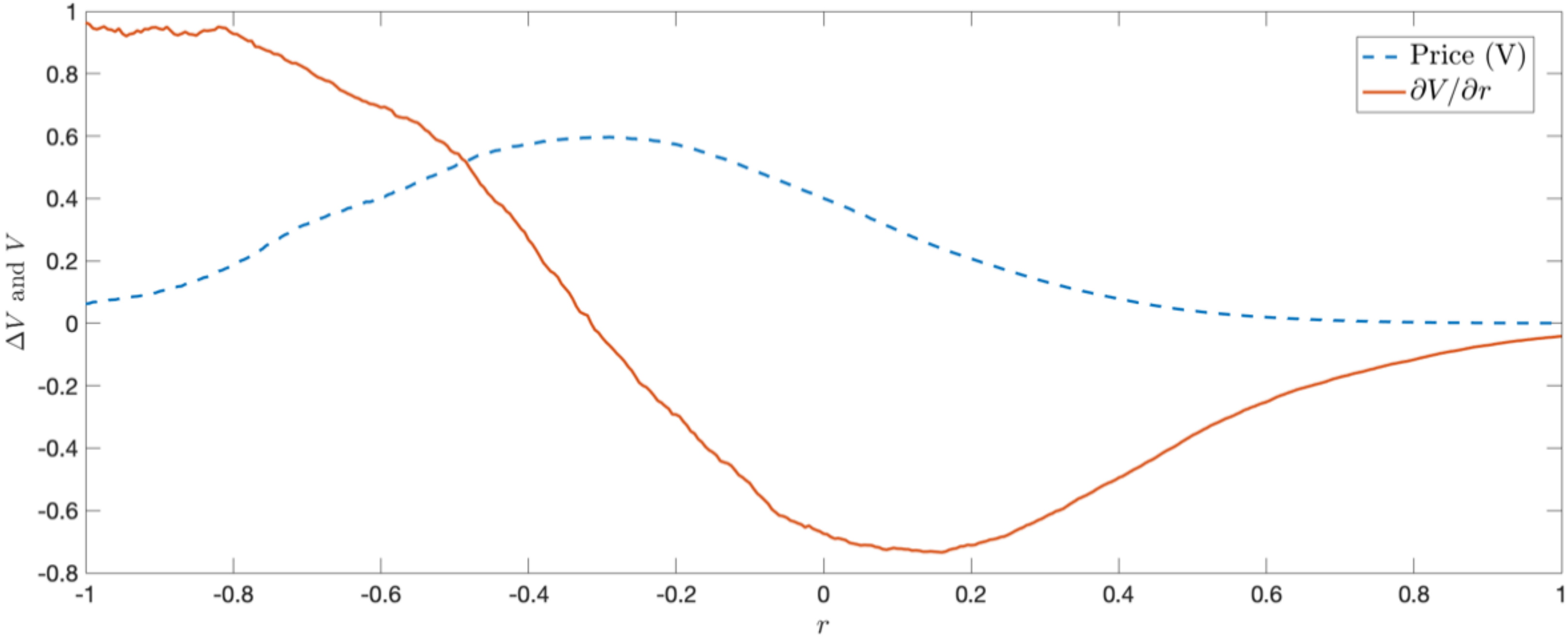


GEOMETRIC BROWNIAN MOTION (GBM)

DELTA

$$R_t = e^{\left(\mathrm{r}-\frac{\sigma^2}{2}\right)+\sigma(W_t-W_{t-1})} - 1 \sim Lognormal\left(\mathrm{r}-\frac{\sigma^2}{2}, \sigma^2\right) - 1$$

$$\mathbb{E}[R_t] = e^r - 1, Var(R_t) = (e^{2\sigma} - 1)e^{2r}$$



GEOMETRIC BROWNIAN MOTION (GBM)

VEGA AND OPTIMAL VOLATILITY

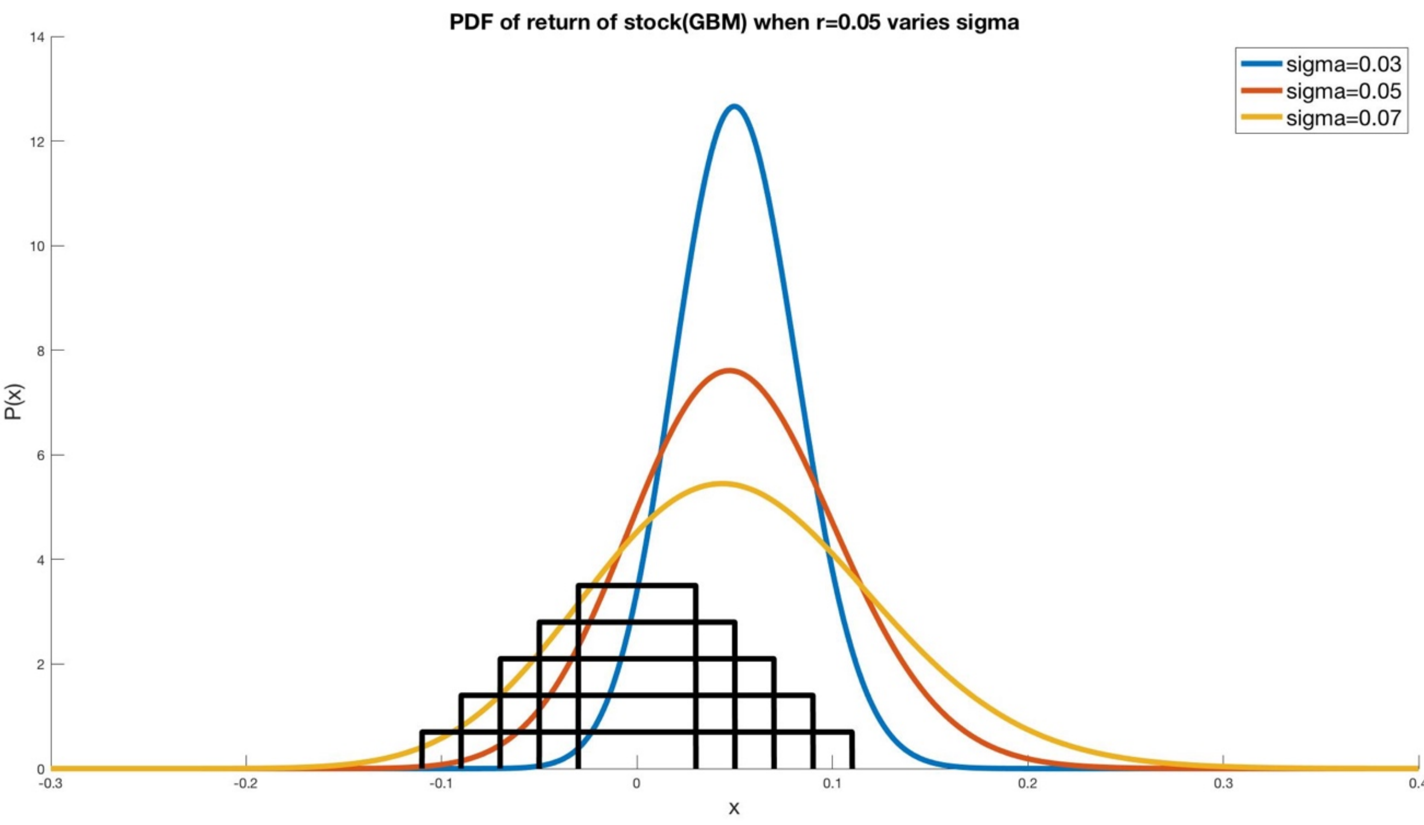
$$R_t = e^{\left(0.05-\frac{\sigma^2}{2}\right)+\sigma(W_t-W_{t-1})} - 1 \sim Lognormal\left(0.05-\frac{\sigma^2}{2},\sigma^2\right) - 1$$

$$\mathbb{E}[R_t] = e^{0.05} - 1, Var(R_t) = (e^{2\sigma} - 1)e^{0.1}$$

$$S_{t_0} = 100, r = 0.05, t_N = 5$$

$$\{X_j\} = \{0.03, 0.05, 0.07, 0.09, 0.11\}$$

$$\{h_{j,t_0}\} = \{0.15, 0.13, 0.11, 0.09, 0.07\}$$



GEOMETRIC BROWNIAN MOTION (GBM)

VEGA AND OPTIMAL VOLATILITY

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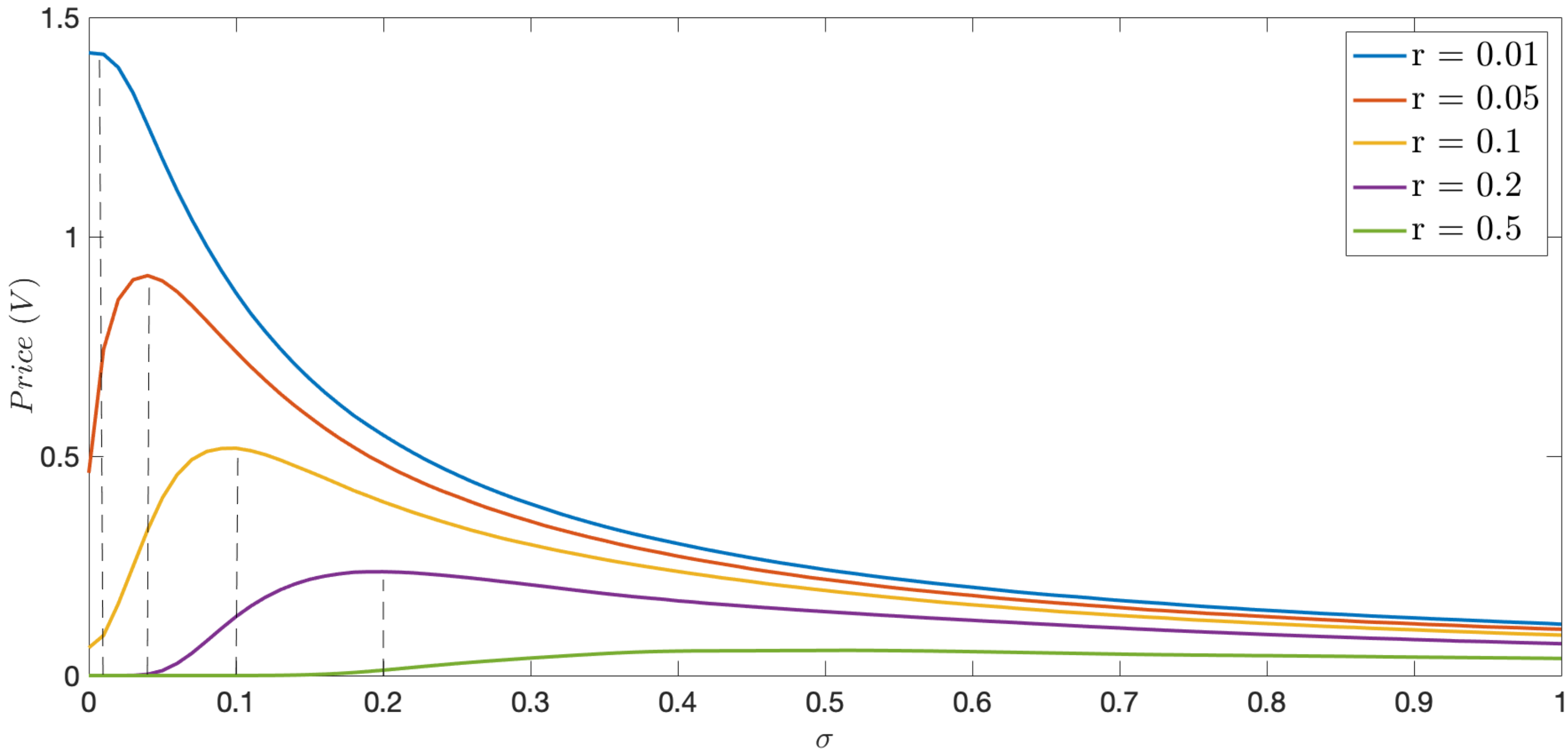
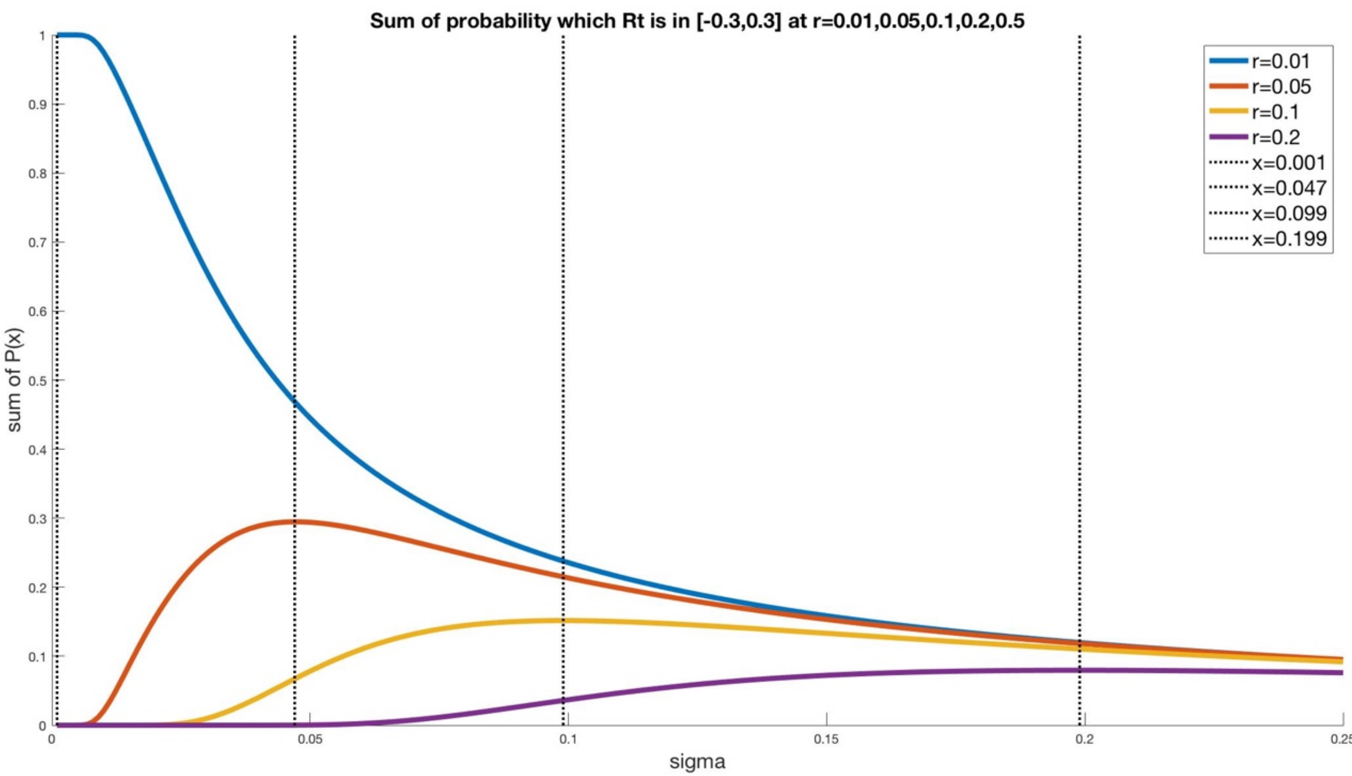


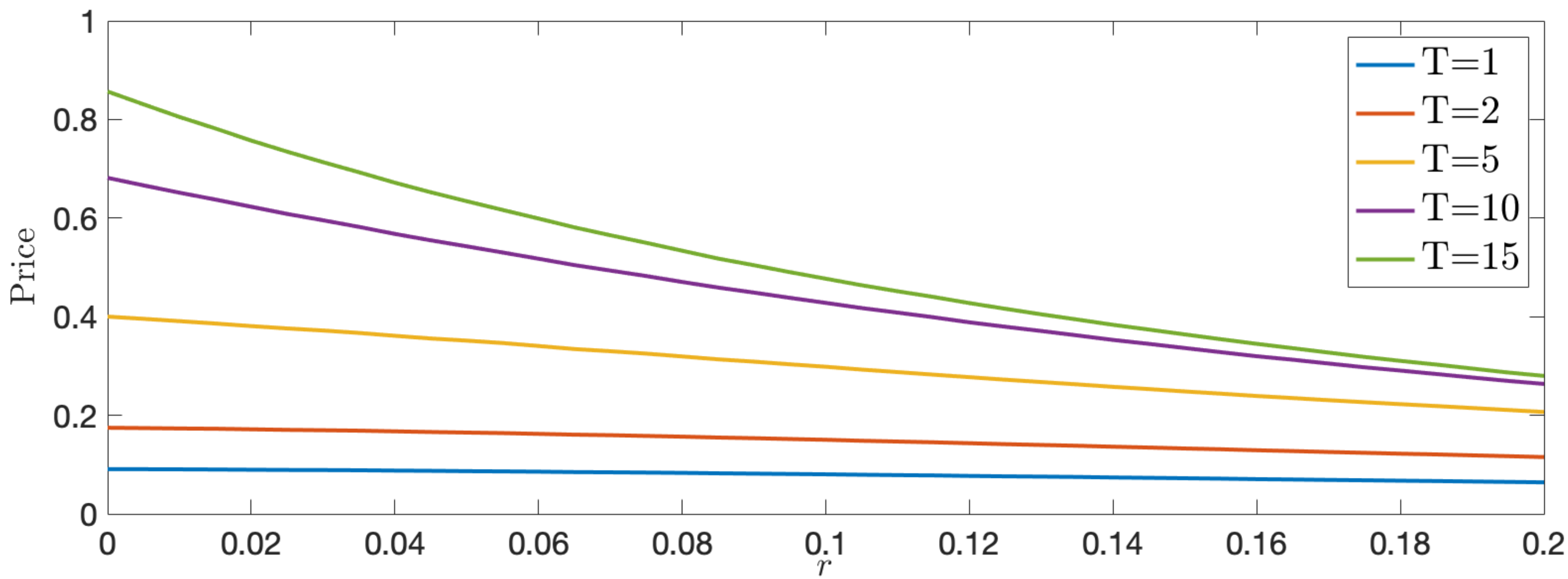
GEOMETRIC BROWNIAN MOTION (GBM)

VEGA AND OPTIMAL VOLATILITY



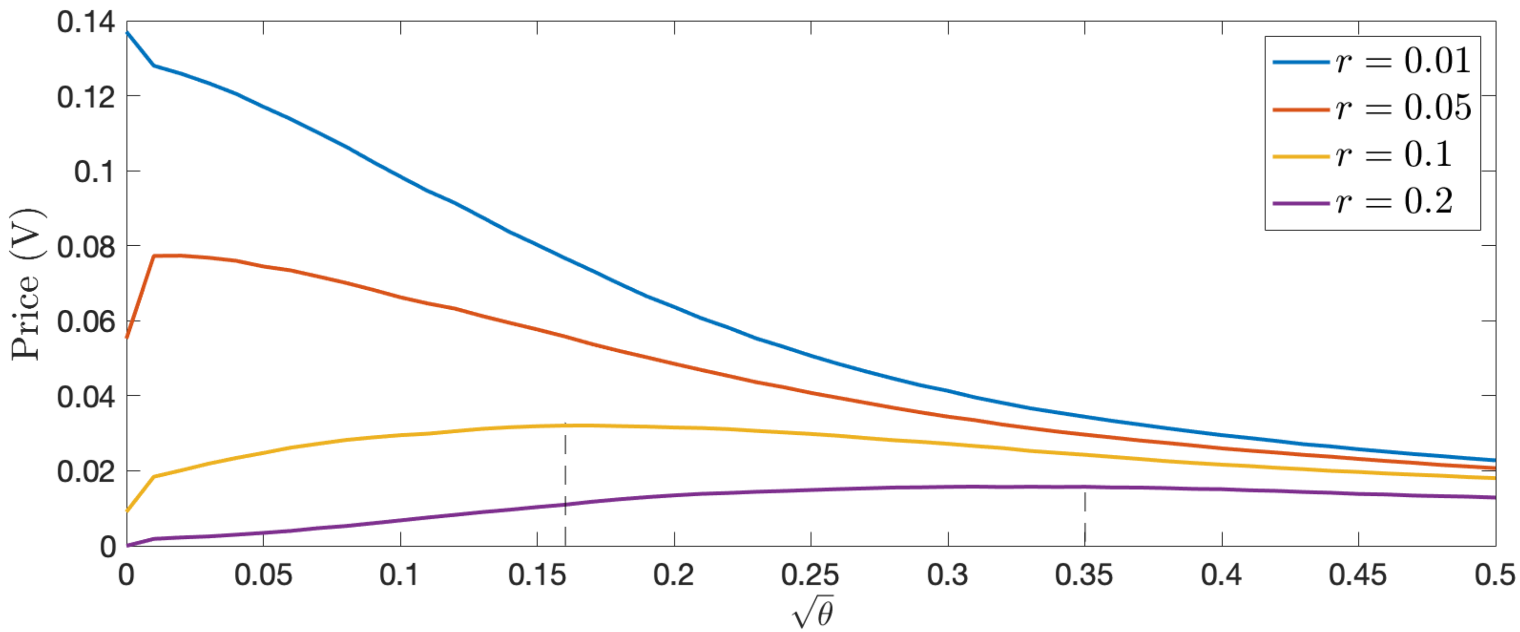
GEOMETRIC BROWNIAN MOTION (GBM)

DURATION

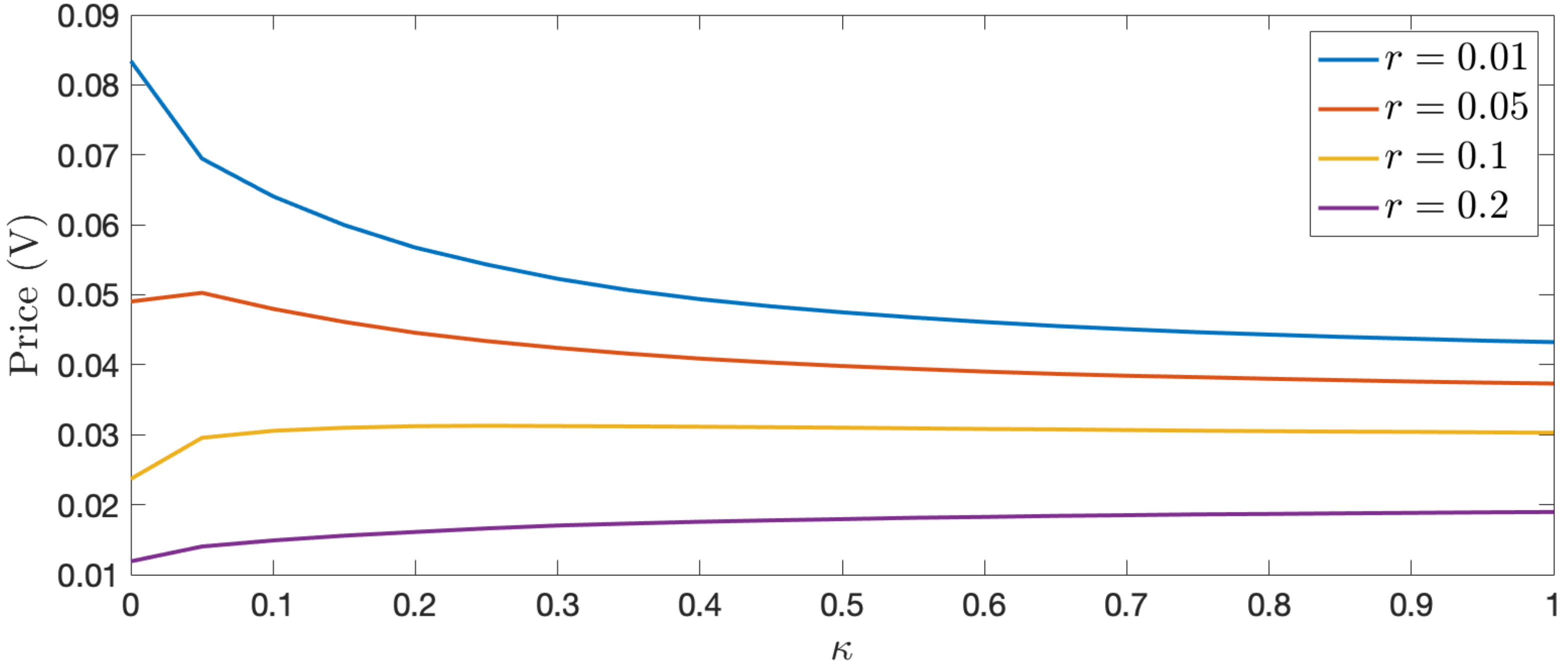


HESTON MODEL

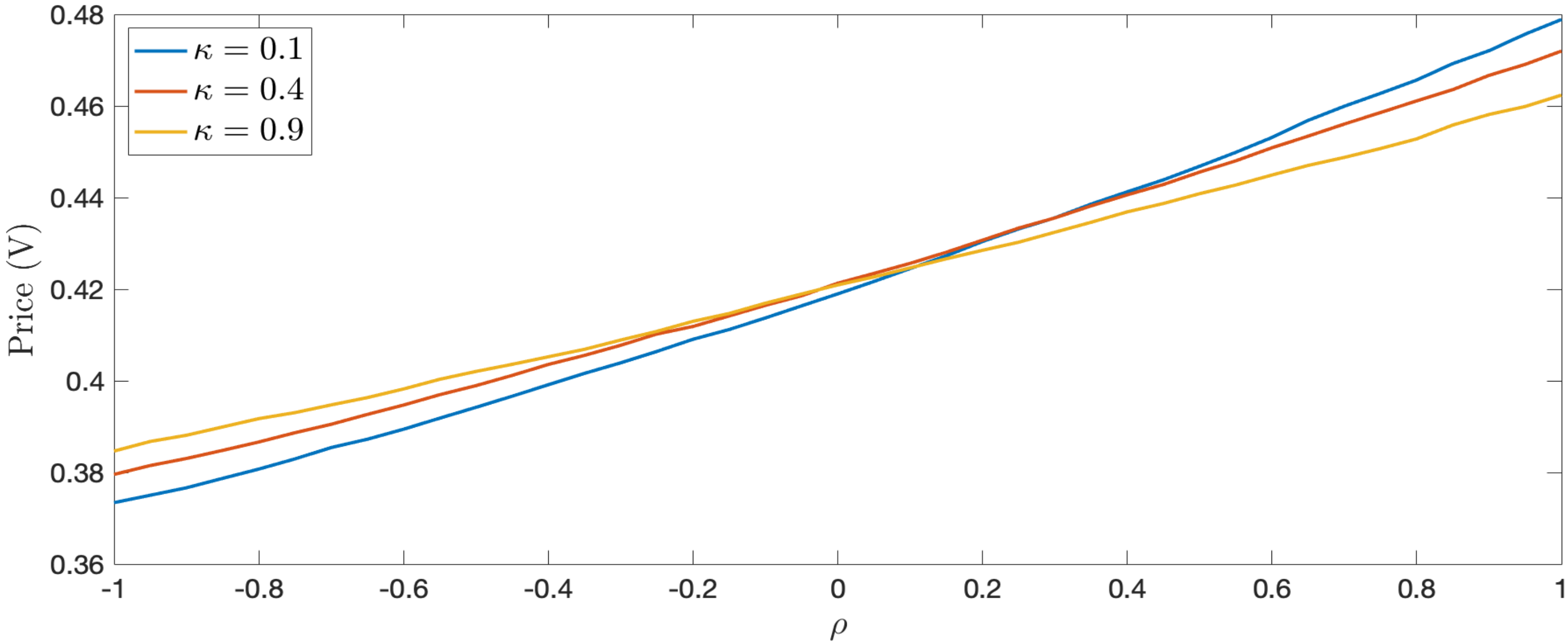
PAYOFF VS THETA



HESTON MODEL
PAYOFF VS KAPPA



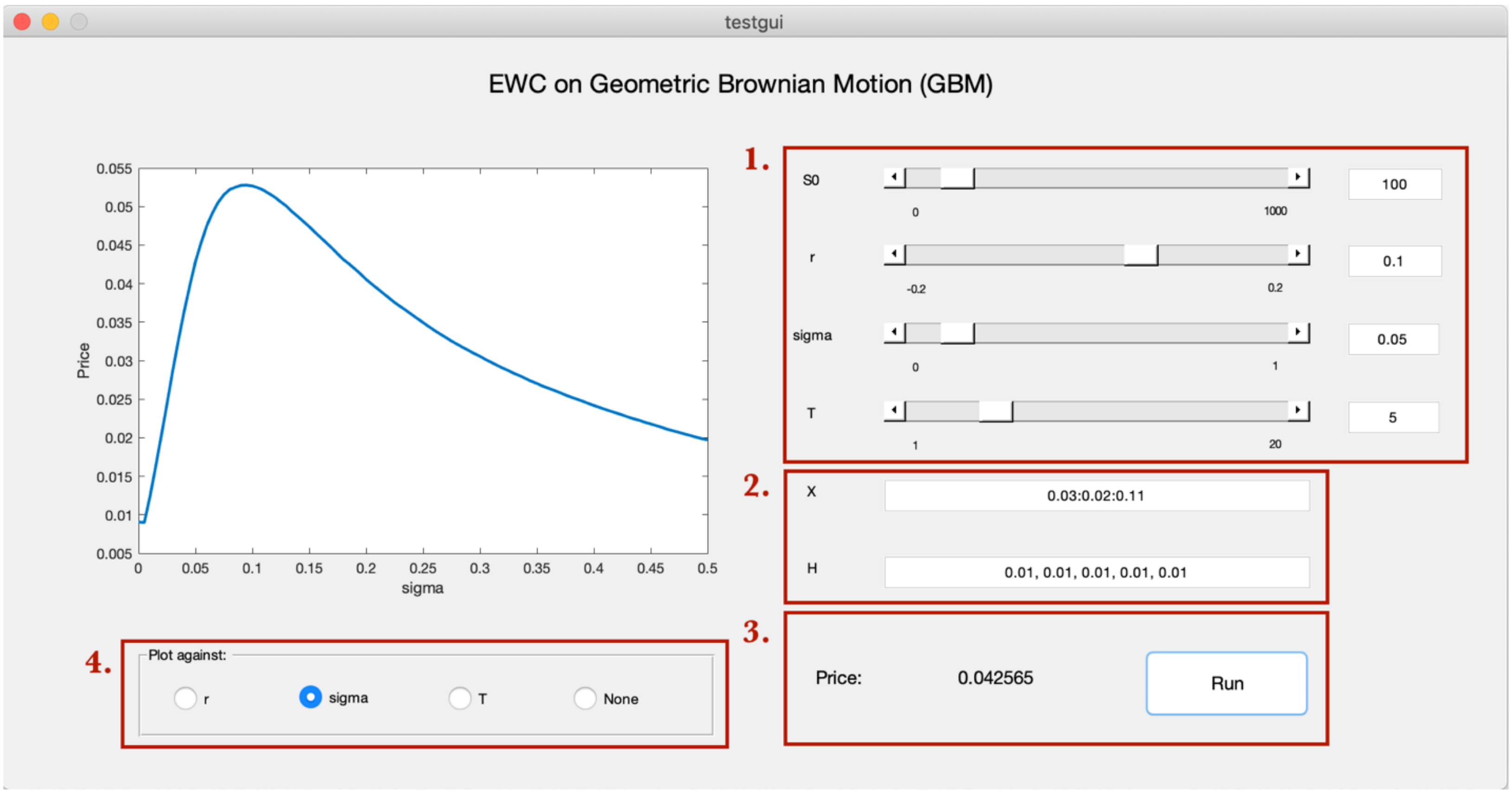
HESTON MODEL
PAYOFF VS RHO



REAL-WORLD IMPLICATIONS

- Risk-Neutral Measure $\rightarrow$ Actual Measure
- Implied Volatility of stock price

DEMO



testgui
EWC on Geometric Brownian Motion (GBM)
Price
sigma
0.055
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
1.
S0
0
1000
100
r
-0.2
0.2
0.1
sigma
0
1
0.05
T
1
20
5
2.
X
0.03:0.02:0.11
H
0.01, 0.01, 0.01, 0.01, 0.01
3.
Price:
0.042565
Run
4.
Plot against:
r
sigma
T
None