

1.

比較固定模擬次數為100時，不同切分期數下Monte Carlo methods與black-scholes model的絕對誤差：

```
N = 100 M = 100
MC = 19.066849330376474
BL = 16.383741845158895
difference = 2.6831074852175796
```

```
N = 500 M = 100
MC = 15.959993807733774
BL = 16.383741845158895
difference = -0.42374803742512057
```

```
N = 1000 M = 100
MC = 16.573720389144086
BL = 16.383741845158895
difference = 0.1899785439851911
```

```
N = 5000 M = 100
MC = 12.26058733330628
BL = 16.383741845158895
difference = -4.123154511852615
```

```
N = 10000 M = 100
MC = 17.75099097495731
BL = 16.383741845158895
difference = 1.3672491297984166
```

嘗試不同的切分期數可以觀察到誤差跟切分期數的關聯不大，不太會受切分期數影響

比較固定切分期數為100時，不同模擬次數下Monte Carlo methods與black-scholes model的絕對誤差：

```
N = 100 M = 100
MC = 15.054824363969066
BL = 16.383741845158895
difference = -1.328917481189828
```

```
N = 100 M = 500
MC = 16.57359326187678
BL = 16.383741845158895
difference = 0.18985141671788597
```

```
N = 100 M = 1000
MC = 16.200882432970356
BL = 16.383741845158895
difference = -0.18285941218853807
```

```
N = 100 M = 5000
MC = 16.216373611349574
BL = 16.383741845158895
difference = -0.1673682338093201
```

```
N = 100 M = 10000
MC = 16.408219943617254
BL = 16.383741845158895
difference = 0.02447809845835991
```

因為蒙地卡羅公式中有用到常態分配，所以觀察到模擬越多次越能降低變異，誤差越小

2.

比較不同層數下，決策樹和black-scholes model的絕對誤差：

```
N = 100
BT = 16.380141010477193
BL = 16.383741845158895
difference = -0.0036008346817020254
```

```
N = 500
BT = 16.383716327780732
BL = 16.383741845158895
difference = -2.5517378162476234e-05
```

```
N = 1000
BT = 16.384089589872556
BL = 16.383741845158895
difference = 0.00034774471366105786
```

```
N = 5000
BT = 16.383699086264638
BL = 16.383741845158895
difference = -4.2758894256422764e-05
```

```
N = 10000
BT = 16.38377586961649
BL = 16.383741845158895
difference = 3.402445759448369e-05
```

可以觀察到二元樹的層數越多，誤差呈現遞減

3.

無風險利率使用台灣銀行一年期定存利率1.065%
共拿8口資料畫出的波動率曲線

