

# MF796 Assignment 6

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## 1: Simulation in the Heston Model

(Q1)

I used the parameters from my previous homework which are 3.52, 0.052, 1.18, -0.77 and 0.034 for kappa, theta, sigma, rho and  $v_0$  respectively. It is reasonable because I use least square error to calibrate the parameters and it is suitable for market dynamics.

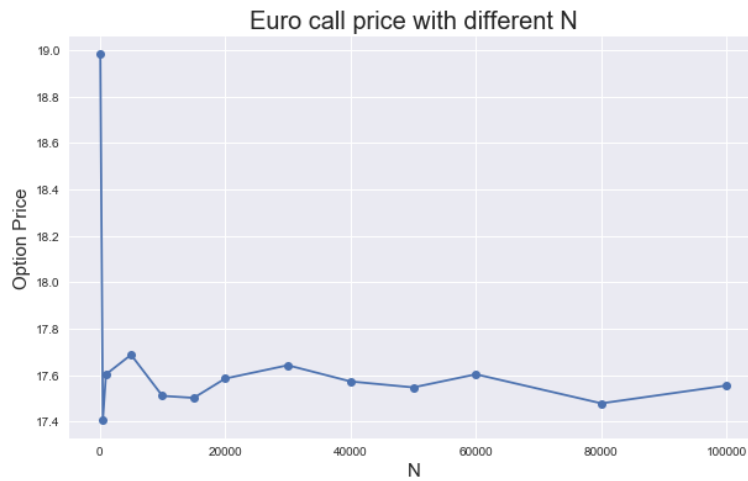
(Q2)

The  $dt$  is  $1/252$  for 252 trading days per year and  $N$  that I chose are from 100 to 100000 since I want the accuracy becomes powerful.

(Q3)

The European option price via FFT is 17.49672963. Then, the option price and difference between FFT and simulation becomes smaller and smaller as the number of simulation goes up.

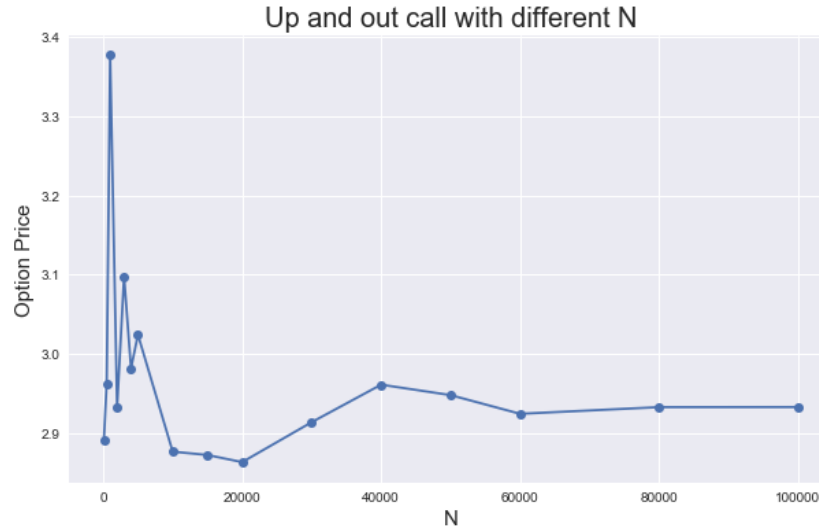
	Ns	Euro price	Error
0	100	18.98223	1.485495
1	500	17.40755	0.089178
2	1000	17.60372	0.106994
3	5000	17.6882	0.19147
4	10000	17.51111	0.014384
5	15000	17.50251	0.005779
6	20000	17.58563	0.088904
7	30000	17.64307	0.146337
8	40000	17.57332	0.076586
9	50000	17.54766	0.05093
10	60000	17.60409	0.107364
11	80000	17.47895	0.017777
12	100000	17.55584	0.059106



(Q4)

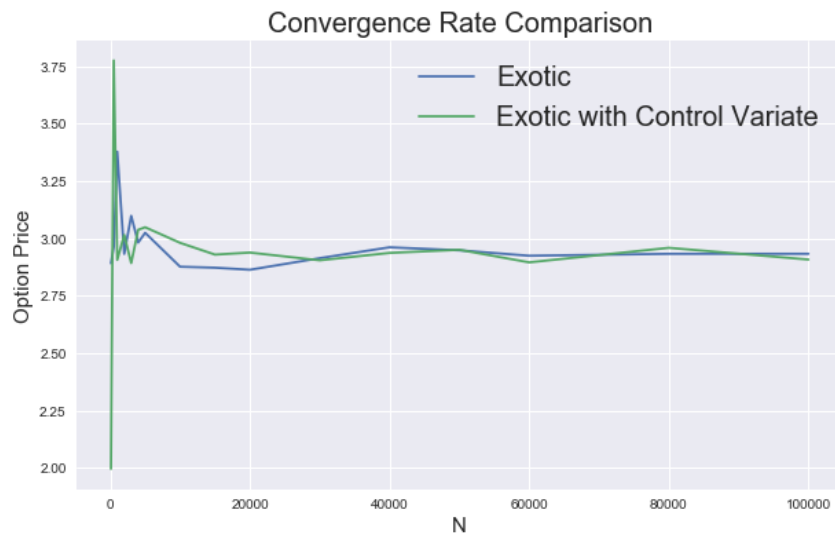
The price becomes accurate as N goes up gradually. For example, when the number of simulations is above 3000, the up and out call option price becomes stable.

	Ns	Up and out Price
0	100	2.891315
1	500	2.962532
2	1000	3.377155
3	2000	2.932053
4	3000	3.097927
5	4000	2.981482
6	5000	3.023981
7	10000	2.876285
8	15000	2.872053
9	20000	2.863039
10	30000	2.913489
11	40000	2.960904
12	50000	2.947719
13	60000	2.924092
14	80000	2.932519
15	100000	2.932618



(Q5)

Similarly, the price is getting stable after the number of simulations being greater than approximately 3000. Additionally, from the figure below, we can see that the convergence rate between control variate and non-control variate is not very clear but the price with control variate method converged a little bit faster than non-control variate scenario.



Ns		Exotic price with control variate
0	100	1.996276
1	500	3.774243
2	1000	2.905674
3	2000	3.014806
4	3000	2.892033
5	4000	3.037048

<b>6</b>	5000	3.048131
<b>7</b>	10000	2.980279
<b>8</b>	15000	2.929029
<b>9</b>	20000	2.937936
<b>10</b>	30000	2.904216
<b>11</b>	40000	2.93636
<b>12</b>	50000	2.950003
<b>13</b>	60000	2.895251
<b>14</b>	80000	2.958543
<b>15</b>	100000	2.907559