**Problem Set # 4**

1. **Swaption Pricing and Risk Management under the SABR Model:**

(a) Here’s the result of these forward rates:

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(b) Here’s the results of these annuities:

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(c) The premium of each swaptions shown below:

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(d) Using the package scipy.optimize in python, I got the result of these parameters:

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(e) Here’s a plot of these parameters:

图表

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From the plot we can see that sigma0 and alpha have a trend in rising while the rho is decreasing as the expiries become longer. But for the degree, the change of sigma0 is obviously larger than the others, alpha and rho are not so sensitive to the change of expiry.

(f) Here’s the results of volatilities and prices with strikes equal to ATM - 75 and ATM + 75:

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(g) The equivalent Black volatilities are:

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(h) The delta under BS model:

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(i)The adjust delta are calculated below:

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From the data we can conclude that SABR delta is larger than BS’s delta. However, they have the same tendency with the respect with expiry and strike. To be specific, longer expiry leads to lower delta and lower strike leads to lower delta.