

Seminar on Case Studies in Operations Research (Mat-2.4177)

The pricing of Asian commodity options

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1 Project status

The main project goal of producing pricing models for the Asian commodity options has not changed greatly, but for the two asset classes we have selected oil and electricity. At this stage, we have created some preliminary pricing models mainly for oil. The models have been fitted only to European options data as we have not received prices of Asian options for which there is little data available. Thus for the time being we are missing the Asian option aspect. That is, although we could price Asian options with our models, we cannot fit or validate them against real Asian options data at the moment. Because it might be that we do not have Asian option data at the end, we have also considered other derivative options, but in those also there is a problem of data availability. Nonetheless, we will wait and see if our client can provide us with new data of other derivative options and continue modelling process in the meantime.

2 Tasks update

Project planning, background learning and data preparation tasks are now completed. Even though background learning part was done a while ago, we had to revise and look more closely into the material as we made progress. However, we learned the basics quite well during the task. Data preparation was a minor phase as only data processing of converting data to workable format was done. The sub-tasks of further data preparation are insignificant and can be thought of as part of the overall modelling process and therefore the task does not have more time requirements in our schedule.



Progress has been made in the following – yet to be completed – tasks: literature review, choosing model structure, implementation, estimation, interim reporting and verification. Main part of the literature review was ready early on. When we began studying pricing models more closely we found interesting sources and hence it was natural to extend the literature review. We will continue developing pricing models a bit farther which also means that the literature review remains open. In the overlapping tasks of choosing model structure, implementation and estimation we have made a lot of progress. We started from many different models from which we can easily narrow down to only few well-functioning models. We have developed several different pricing models for oil ranging from basic Black-Scholes model to stochastic volatility model. Also, a model for electricity is being developed which uses moment-matching. We are still looking for ways of fine-tuning our models, but the choosing model structure task should be completed in a few weeks. The implementation and estimation are projected to take longer, because we presumably create a pricing model also for the third asset class: wheat. Additionally, we have performed checks on our implementations, but further verification is still needed and must be done also for each new model.

The tasks which have not begun are validation and final reporting. We expect that the validation task to be different from what we thought at the beginning. This is due to the lack of suitable data. We will explore other ways of executing the task and will decide later which way would be reasonable. No changes are needed for final reporting.

3 Updated schedule

The updated schedule is shown in Table 1. Small light blue bars represent progress in tasks. It can be observed that we kept on our initial schedule in project planning, background learning, data preparation and interim reporting. These tasks were quite well defined and thus it was not too difficult to keep to the schedule. However, many tasks were delayed including literature review, choosing model structure, implementation and estimation. Some delays were expected, but the tasks overlapped more than we

thought. Updates to the initial schedule are shown in larger shaded dark blue colour bars. Possible extensions to the initial schedule are made according to task updates described above.

Table 1. The updated project schedule ( : progress bar &  : Update bar)

| | Jan. | February | | | | March | | | | April | | | | May | |
|--------------------------|------|----------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Task | wk 5 | wk 6 | wk 7 | wk 8 | wk 9 | wk 10 | wk 11 | wk 12 | wk 13 | wk 14 | wk 15 | wk 16 | wk 17 | wk 18 | wk 19 |
| Project planning | | | | | | | | | | | | | | | |
| Background learning | | | | | | | | | | | | | | | |
| Literature review | | | | | | | | | | | | | | | |
| Data preparation | | | | | | | | | | | | | | | |
| Choosing model structure | | | | | | | | | | | | | | | |
| Implementation | | | | | | | | | | | | | | | |
| Estimation | | | | | | | | | | | | | | | |
| Interim reporting | | | | | | | | | | | | | | | |
| Verification | | | | | | | | | | | | | | | |
| Validation | | | | | | | | | | | | | | | |
| Final reporting | | | | | | | | | | | | | | | |

4 Initial results

We have complete implementations ready for many price processes in Matlab. We also have routine for fitting our implied volatility surface – which represents the option prices for different maturities and strikes – to the market implied volatility. Below we have two example figures in which one can observe the market implied volatility surface – reflecting reality – and our implied volatilities for a certain pricing process that has been calibrated according to the market implied volatilities. Figures show implied volatilities for different maturities and strike prices. In the Figure 1, we have implied volatility surface produced by Black-Scholes process fitted to the market implied volatility surface and in the Figure 2 are the respective surfaces for Heston (stochastic volatility) process. Both of these are for oil. We can observe that the pricing processes fit quite well to the market implied volatilities, but for example in the case of BS-process implied volatilities do not correspond to reality in the edge of the surface. With the stochastic volatility model the produced implied volatility surface does not fit well in short maturities. Thus, there is room for fine-tuning the existing models or even testing new pricing processes if time permits.

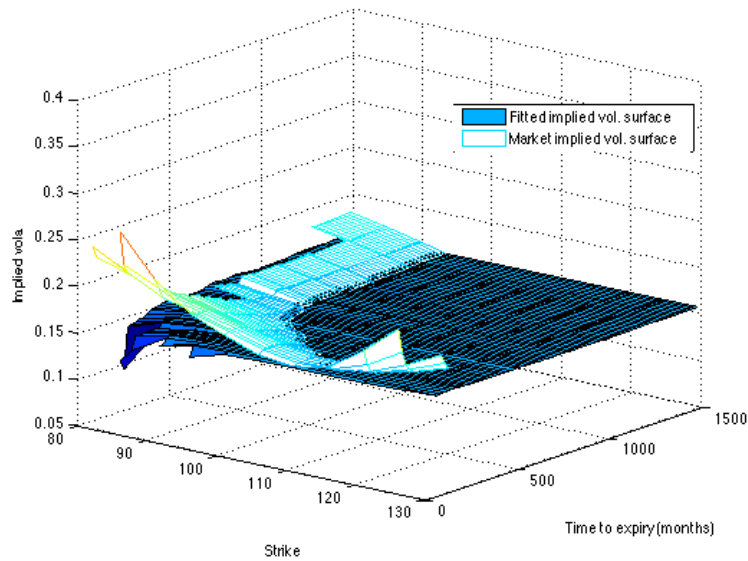


Figure 1. Black-Scholes process implied volatilities fitted to the market implied volatilities.

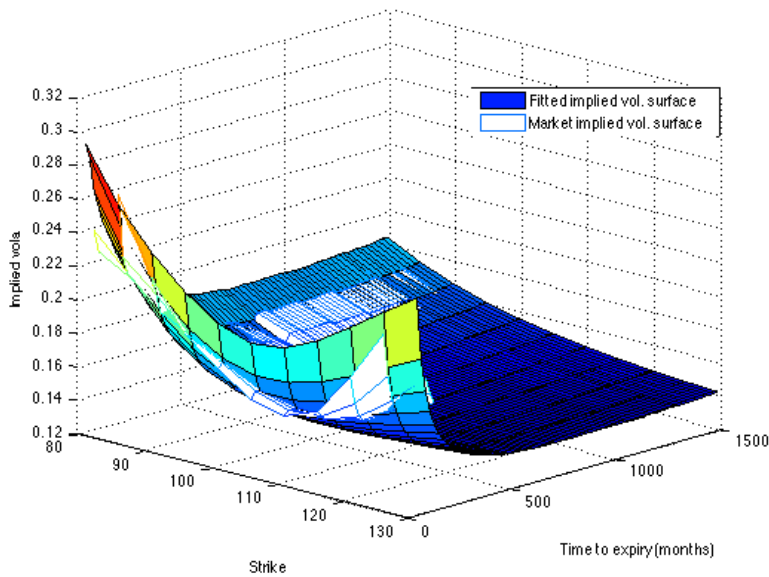


Figure 2. Heston process implied volatilities fitted to the market implied volatilities.

5 Risks

1. Delays due to sickness and other unfortunate causes
 - The risk has been realized, but only on part of one team member. Therefore the effect was minimal and it did not really hinder our progress. However, we will still recognize this risk and the effect is now a little bit higher than before due to one of our team member – Tuomas – beginning his exchange studies. We expect the probability to stay the same.

2. Individual resources prove to be insufficient for the workload
 - Concerning our project plan, we have followed the initial task allocation quite accurately. In a few sub-task cases, we had to allocate more human resources to sub-task than we previously intended. Hence this risk has been realized for a minor part. Also for this case there is a slightly increased effect from the risk as justified above. Nevertheless, the increase should be quite small and no update to our risk table is needed. The risk probability is expected to be approximately the same as before.

3. Results do not meet the client's expectations
 - Though main goals are clear, the way to achieve those goals is largely up to us. Our client has given us data and guidance, and we have been able to produce pricing models already although they still need improvements. The client has been satisfied with our progress. This risk has not and will be unlikely to be realized. Therefore the initial risk table does not need an update.