SAMSI FMSE Compuational Issues Subgroup

Minutes - 10/12/05

On the financial engineering side it was decided the about 5 problems would be defined that have significant computational issues associated with them. To limit the scope of the inquiry, these problems would be ones in which the risk-neutral process is given (with known parameter values) and the valuation problems should be defined given complete observability of the state variables.

Gerald, Moustapha and I will make a stab at defining the specific problems more precisely. Among the suggestions are a high dimensional (100+ asset) portfolio or basket derivative problem, a moderate (about 10) dimensional stochastic control problem, a derivative pricing problem with significant non-smoothness (e.g., American, barrier, digital options) in several dimensions (at least three). Also Ron Gallant suggested a problem that arises in his econometric work (see below) which arises in a discrete time intertemporal optimization problem.

There was also some discussion of broadening the inquiry to involve a journal sponsor contest along the lines of the contest sponsored by the JBES in the early 1990s to address computational issues facing economic growth modelers. The Journal of Computation Finance and Computational Economics were suggested as possibilities. Several econometrics oriented journals were also suggested.

If you have other suggestion for problems of journal please send them to me ASAP.

On the financial econometrics side, Ron Gallant presented the group with an example of the kind of problem he has been wrestling with. The slides for his discussion were already sent out and will also be on the group web site (if you're reading this you should have gotten these). I will paraphrase the problem that he presented.

An econometrician has data y and a model that suggests that y is generated through some equilibrium condition that can be written an $f(y; \theta) = 0$, where θ is a vector of parameters to be estimated. The estimation problem is to find a value for θ that fits observed data well.

The computational problem is that it may be difficult to solve for y as a function of θ. In Ron's example the function f involves an expression like $V(S_t) = E_t[g(S_{t+1}, V(S_{t+1}))]$, where V is an unknown function to be determined. The dynamics of S are known and hence S could be simulated (for a given value of θ) but one still needs to solve for V. Ron's approach has been to simulate S and to use the approximation $V(S) \approx \phi(S)c$. One then has the unconditional expectation condition

$$0 = E[\phi(S_t)\alpha - g(S_{t+1}, \phi(S_{t+1})\alpha)]$$

This implies that

$$0 = E\Big[\phi(S_t)\Big(\phi(S_t)\alpha - g(S_{t+1}, \phi(S_{t+1})\alpha\Big)\Big]$$

Ron uses this condition to attempt to determine the value of α, replacing the expectation operator with a sample average using simulated values of S.

For simple problems this seems to work ok but when S is multidimensional and V is less well behaved, Ron has experienced convergence problems. Note that this is a subproblem which represents the inner loop of a larger problem and thus it is critical that this problem be solvable quickly and efficiently.

Ron agreed to write up the details of a specific model (more complicated than the one presented in talk) so the group could examine the computational issues more carefully.

Finally, I am posting several papers or URLs to papers that arose in the discussion.