# Corporate Finance

Part 1. Applying deep learning to structural corporate finance model

Consider the basic model in section 3.1 of Strebulaev(12). Assume the external shock to be a simple AR(1) process as shown in equation 3.9 of the paper. As explained in section 3.1.2 of the paper, finding the solution of the **value function** in equation 3.10 of the paper is difficult. However, recently, Maliar(21) has developed a deep learning method to solve similar types of problems.

1. Implement the model and the Maliar method in Tensorflow.
2. Generate a set of synthetic data to test the effectiveness of your solution method. Please define effectiveness and clearly state measures for it.
3. What are the issues to consider when designing the neural network and the training algorithm?
4. Can the method be applied to the more sophisticated models such as the one in Section 3.6 with risky debt? If so, please show the effectiveness of the solution with synthetically generated data.

Part 2: Estimation and Application of the structural corporate finance model

1. Section 4 of the paper introduced two types of estimation methods, **GMM** and **SMM**. Please implement the two types of estimation methods in Tensorflow and compare the effectiveness of two methods. Again, you can start by discussing how effectiveness is defined and what measures can be used to evaluate effectiveness.
2. What are the potential applications of the risky debt corporate finance model in section 3.6 of Strebulaev(12)?
3. For the applications you mentioned in b), what are the defects of the model? Can you provide a literature survey on potential solutions to the defects identified?

Bonus Question 1.

Instead of GMM and SMM, please develop a Bayesian estimation using Hamiltonian Monte Carlo or other MCMC methods (for sampling from the posterior distribution) together with filtering (for computing the likelihood).

1. What are your prior assumptions on the parameters?
2. What filtering method have you chosen? What are the pros and cons of your algorithm vs other algorithms?
3. Please implement your Bayesian estimation method using TensorFlow Probability (TFP). Many estimation methods (e.g., HMC) are already supported in TFP and can be called directly. (Hint: Several additional methods are available in the tfp.experimental section; however, these methods are unstable and may contain bugs, so use them with caution.) For methods that are not supported, please implement them in a style consistent with TFP.
4. What tests can you design to assess the validity of your estimation method?
5. How does this Bayesian estimation method compare to GMM and SMM?

Bonus Question 2.

In Section 5.3.2 of Cronqvist(24), the CEO of the firm chooses the effort level, manipulation and risk level. The board chooses the compensation structure of the CEO.

1. What are the key problems that the authors try to illustrate with the model?
2. How can we change our models in part 1 to capture similar behaviors? Can we add a CEO and a board to the simple model in section 3.1 of Strebulaev(12)? What about the Risky Debt model in section 3.6?
3. Can you estimate your new model with the additional agents, the CEO and the board?

Bonus Question 3.

Consider the paper Nikolov(21). We would like to conduct the same set of estimations of different models for listed companies in Hong Kong, China, Japan, Korea, Taiwan, India or Singapore.

1. Choose any one of the above markets to replicate the results.
2. How can you get the relevant data sets?
3. In comparison to the USA data used by the authors, are there substantial data issues in your data set that were not considered by the authors of the paper?
4. Can you estimate the models as the authors did and comment on the similarities and differences of your results versus that of the authors?

# References

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