

Towards Financial Cloud Framework - Modelling and Benchmarking of Financial Assets in Public and Private Clouds

Victor Chang, Gary Wills, David De Roure
School of Electronics and Computer Science, University of Southampton,
Southampton SO17 1BJ. United Kingdom
{vic1e09, gbw, dder}@ecs.soton.ac.uk

Abstract

Literature identifies two problems in clouds: (i) there are few financial clouds and (ii) portability of financial modelling from desktop to cloud is challenging. To address these two problems, we propose the Financial Cloud Framework (FCF), which contains business models, forecasting, sustainability, modelling, simulation and benchmarking of financial assets. We select Monte Carlo Methods for pricing and Black Scholes Model for risk analysis. Our objective is to demonstrate portability, speed, accuracy and reliability of financial models in the clouds, and present how modelling, simulation and benchmarking fit into FCF. Experiments and benchmark are performed in public and private clouds, where portability, speed, accuracy and reliability from desktop to clouds are successfully demonstrated.

1. Introduction

The Global economic downturn triggered by finance sector presents an interdisciplinary research question that the use of Cloud resources can improve accuracy of risk analysis, and knowledge sharing in an open and professional platform. There are two problems in cloud computing. Firstly, literature reviews all suggest there are few financial clouds available in the market. Despite Salesforce offers CRM [1], it is not directly related to financial modelling. Secondly, portability of financial modelling from desktop to cloud is challenging [2]. To address both issues, we propose the Financial Cloud Framework (FCF), which contains business models, forecasting, sustainability, modelling, simulation and benchmarking of financial assets. Monte Carlo Methods (MCM) and Black Scholes Model (BSM) are selected respectively as they are standard models for pricing and risk analysis. Our objective is to demonstrate portability, speed, accuracy and reliability of financial models in the public and private clouds. Modelling, simulation and experiments are used for methodologies.

2. Monte Carlo Methods (MCM)

A number of methods for calculating prices include MCM, Capital Asset Models and Binomial Model.

However, the most commonly used method is MCM. Hence, MCM is used for this portability demonstration. MCM is used in stochastic and probabilistic financial models, and provides data for investors' decision-making [3]. MATLAB is used due to its ease of use with relatively good speed. While the volatility is known and provided, prices for buy and sale can be calculated. The following code demonstrates calculation of prices. Call prices are for buy and put prices are for sale. The program calculates the lower limit, ideal value and the upper limit for each buy and sale category.

> fareastmc

[LowerLimit MCPrice UpperLimit]

Call Prices: [4.196694 4.248468 4.300242]

Put Prices: [7.610519 7.666090 7.721662]

3. Black Scholes Model (BSM)

Methods such as Fourier series, stochastic volatility and BSM are used for volatility. As a main stream option, BSM is selected for risk analysis in this paper, since BSM has finite difference equations to approximate derivatives. We write fdcall.m to calculate call price and also risk analysis based on BSM, and contain key values such as

- strike price: the price targeted for sale.
- upper boundary: the highest possible range a price or risk can reach
- risk free rate: interest an investor would expect from an absolutely risk-free investment over a period of time.
- maturity: the loan is due to be repaid on a fixed date.
- volatility: used to quantify the risk of assets.
- dividend yield: the return on investment for an asset.
- asset steps: a specific BSM method called explicit time steps. The more steps, the more accurate the analysis.

This allows us to calculate and track call prices if variations for maturity, risk free rate and volatility change. Similarly, we can modify our code to track volatility for risk analysis when other variables are changed.

4. Experiment and Benchmark in the Clouds

Code was written for Variance-Gamma (VG) Processes (a specific technique in MCM) to be used for experiments

and benchmark in the clouds, since VG processes are suitable in reducing errors [4]. Methodologies include simulations, modelling and experiments. The hardware descriptions are as follows.

Desktop	2.67 GHz Intel Xeon Quad Core and 4 GB of memory (800 MHz)	32-bit Windows XP
Public cloud	A large resource instance of dual core CPU, with 2.33 GHz speed and 7.5GB of memory.	Amazon EC2, 64-bit Ubuntu 8.04
Private cloud	2 cores of 2.67 GHz and 4GB of memory at 800 MHz.	32-bit Windows XP virtual server
Private cloud	2.8GHz Quad Core Xeon, 16 GB of memory	64-bit Windows server

Table 1: Hardware and operating systems comparisons

All these four settings have installed Octave 3.2.3, an open source compiler equivalent to MATLAB. 5000, 10,000 and 15,000 MCM simulations are performed three times, and the time taken at each of a desktop, private clouds and Amazon EC2 public clouds are recorded and averaged with three attempts. Private cloud (rack server) has the best hardware configuration with the fastest download speed and unlimited bandwidth, thus it runs faster than the rest.

Table 1 summarises the timing benchmark result while running the modelling of assets (MoA) code.

Number of simulations and time taken (sec)	5,000	10,000	15,000
Desktop	11.08	11.92	12.71
Public cloud (large instance)	11.95	12.30	13.15
Private cloud (virtual server)	11.31	12.13	12.90
Private cloud (rack server)	9.63	10.51	11.48

Table 1: Timing benchmark to run MoA code on Octave 3.2.3

All hardware infrastructures would ideally have the same CPU speed and operating system (with variations in memory) but it was difficult to synchronise since those hardware were from different sources.

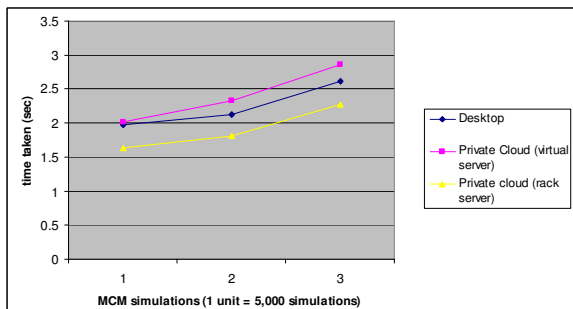


Figure 1: Timing benchmark comparison for MATLAB 2007

Figure 1 refers to benchmark results if using MATLAB 2007, which compile faster than Octave, are only available on desktop, private cloud (virtual server) and private cloud (rack server) hosted on Windows. The same code runs faster on MATLAB 2007, but it comes with higher prices.

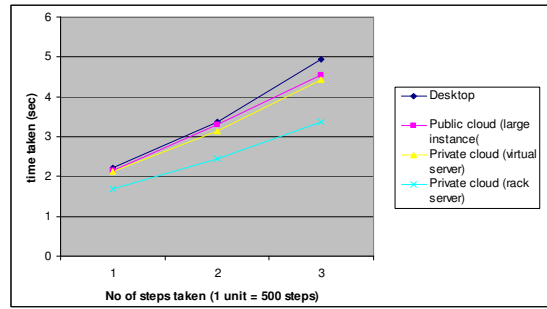


Figure 2: Timing benchmark comparison for Octave 3.2.3

Figure 2 shows benchmark results while running BSM. 500, 1,000 and 1,500 BSM simulations are performed three times, and the time taken at each of a desktop and two private clouds are recorded and averaged with three attempts. Time series used in BSM can take accommodate up to 1,500 simulations. Private cloud (rack server) has the best hardware configuration with the fastest network speed and unlimited bandwidth, thus it runs the fastest.

Benchmark results show pricing and risk analysis can be calculated rapidly with accurate outcomes. Portability is achieved with a good reliable performance in clouds. These experiments demonstrate portability, speed, accuracy and reliability from desktop to clouds.

5. Conclusion and Future Work

Literature identifies two problems in clouds: (i) there are few financial clouds and (ii) portability of financial modelling from desktop to cloud is challenging. Clouds must facilitate an easy way for users and developers, without rewriting additional APIs like several practices do. Monte Carlo Methods and Black Scholes Model are used to demonstrate how portability, speed, accuracy and reliability can be achieved while moving financial modelling from desktop to cloud environments including public and private clouds. This well fits-in our objective in the Financial Cloud Framework (FCF) to provide portable, secure, fast, accurate and reliable clouds in particular for Platform as a Service and Software as a Service.

6. References

- [1] TSP White papers, "CRM at a Glance: Salesforce.com vs. Siebel", available on <http://www.tsgonestop.com/sfdevssiebel.pdf>
- [2] Patterson D, Armbrust M et al, "Above the Clouds: A Berkeley View of Cloud computing". Technical Report No. UCB/ECS-2009-28, UC Berkeley, Feb 2009.
- [3] Hull J C, "Options, Futures, and Other Derivatives", Seventh Edition, Pearson, Prentice Hall, 2009.
- [4] Rebeiro C, Webber N (2002), "Valuing Path Dependent Options in the Variance-Gamma Model by Monte Carlo with a Gamma Bridge", <http://depts.washington.edu/sce2003/Papers/04.pdf>