Prediction of derivatives prices using Greeks and investigation of the Malliavin Calculus method for the calculation of Greeks *

in collaboration with Credit Suisse

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Abstract

The Equity Structured Product Department in Credit Suisse Zürich is composed of two separated trading groups: the primary market and the secondary market. The primary market has to bare the risks and continuously hedge against their option positions. The options have been sold to clients with maturity running from three months to ten years. On the other hand, the secondary market is responsible of providing quotes of every derivative product sold by Credit Suisse worldwide, in case a client would like to sell back his structured product. It means that up-to-date prices of the derivatives need to be available as often as possible.

Due to the large number of options whose secondary market is responsible to quote for, and since most of the products are highly exotic and require calculations on a farm of computers, it is currently possible to update the price only every 5 min. Together with the calculation of simple risks as delta and gamma, the calculation time is approximately 10 min.

The purpose of this thesis is to develop an algorithm able to approximate the option prices instantly using live underlyings prices and the latest calculated value of the options, as well as the latest Greeks. Using historical data, different algorithms are tested and compared against each other. Another important issue is to rate the quality of the approximation without knowing the exact value. The errors may come from different factors, as the underlying movement, the quality of the Greeks, or the highly complicated payoff. A couple of error estimates are proposed to capture such errors. Furthermore, algorithms are implemented to predict the value of delta using second order Greeks.

Since the accuracy of the algorithms is dependent on the quality of the Greeks, a theoretical discussion about methods used to calculate the Greeks of options computed by Monte-Carlo methods, especially the so-called Malliavin Calculus method, composes the second part of the thesis. In the Equity Structured Product Department, the Greeks of Monte-Carlo products are currently calculated using a finite difference approximations. The Malliavin Calculus method is an alternative method useful especially for discontinuous payoff, such as binary options.

The theory of the Malliavin Calculus and the necessary tools to understand the Malliavin Calculus method to calculate Greeks of Monte-Carlo products are firstly presented. The calculation of the so-called "Malliavin weights" in the one and two-dimensional Black Scholes model are derived in details. The Malliavin weights for the Heston and CEV models follow. Numerical examples conclude the thesis.