

# Pricing of the Callable Range Accruals using Longstaff Schwartz algorithm

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**Abstract**—The Callable Range Accrual is one of the most widely used derivatives. The aim of this paper is to model this product under the Libor Market Model.

The first step of the work is the mathematical modeling of the Callable Range Accrual. To do this, we used the method of Longstaff Schwartz method (Longstaff-Schwartz) to determine the sequence of optimal stopping times.

The second step of the work consists of using both stock price and rates as the underlyings of Callable Range Accrual. To do so, we will use Black Scholes model for stock prices and LMM model for LIBOR rates. We will then calibrate the LMM to the market data and then implementing the C++ program allowing the pricing of the model. To do so, we used the financial open source library Quantlib.

In the last step of this work, we will address the application of a corrective measure to the model in order to reduce the gap between the market price and the model price and to correct the relative pricing error due to the calibration.

## I. INTRODUCTION

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### A. Black Scholes formula

The Blac

### B. libor rate

blablabla

### C. Libor Market Model

blablabla

### D. Callable Range Accruals

#### • Range accruals:

A range accrual, or range accrual note, is a type of financial derivative product where one party pays a fixed coupon<sup>1</sup> to a second party and receives a variable coupon from it.

The variable coupon depends on the value of an index. This index could be an interest rate, currency exchange rate, the price of a commodity, or stock index. If the index value falls within a specified range, the coupon

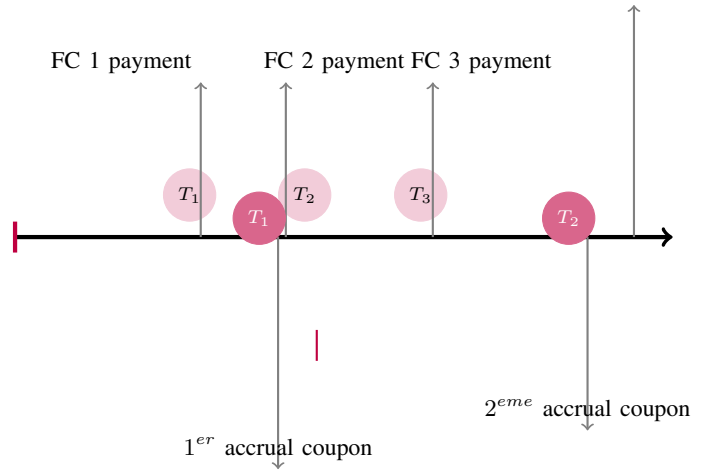
accrues or is credited interest. If the index value falls outside the specified range, the coupon rate does not accumulate.

#### • The callable aspect:

A callable (or cancellable) instrument gives the exotic interest rate payer (variable leg payer) the option to terminate the contract prior to its maturity, and on pre-determined dates.

## II. CASH FLOWS OF A CALLABLE RANGE ACCRUAL

Figure 1. cash flows



The cash flows  $Z_i$  of a callable range accrual can be modeled as follows:

$$Z_i = \frac{\delta_{T_i} \cdot C_i - \delta'_{T_i} \cdot F_i}{B(T_i)} \quad (1)$$

$C_i$  are the variable leg coupons.

$Z_i$  are the fixed leg coupons.

$[T_1, T_2, \dots, T_n]$  are the fixed tenor dates: the dates in which we pay the fixed leg coupons  $Z_{ii \in [1, n]}$ .

$[T'_1, T'_2, \dots, T'_n]$  are the variable tenor dates: the dates in which we pay the variable leg coupons  $C_{ii \in [1, n]}$ .

<sup>1</sup>rate of interest that a bondholder receives

$$\delta_i = T_{i+1} - T_i, \forall i \in [1, n]$$

$$\delta_i' = T_{i+1}' - T_i', \forall i \in [1, n]$$

$$C_j = \sum_{i \in [T_j, T_{j+1}]} \mu_i$$

O les  $\mu_i$  doivent être calculés chaque jour  $t_i \in [T_j, T_{j+1}]$  avec:

$$\mu_{i,j} = \frac{\alpha_j \cdot R_{fix}}{M_j} \cdot (F_{dig}(t_i, t_i, R_{j,max}) - F_{dig}(t_i, t_i, R_{j,min})) \quad (2)$$

- $\alpha_j$  tant le payout sur la période  $[T_j, T_{j+1}]$ .
- $R_{fix}$  est un taux de revient déterminé dès le début du contrat (Généralement égal 5%).
- $M_j$  est le nombre de jours sur la période  $[T_j, T_{j+1}]$ .
- Et  $F_{dig}(t_i, t_i, R_{max})$  tant la valeur d'un floorlet digital pris en  $t_i$  et ayant pour maturité le même jour  $t_i$ . i.e:

$$F_{dig}(t_i, t_i, K) = \begin{cases} 1 & \text{si } L(t_i) \leq K \\ 0 & \text{sinon} \end{cases} \quad (3)$$

### III. CALLABLE RANGE ACCRUAL PRICING

#### A. State of the art

blabla

#### B. Longstaff Schwartz algorithm

blabla

#### C. computing the conditional expectancy

blabla

### IV. EXPERIMENTS

#### A. Data

blablabla

#### B. Results

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### V. CONCLUSIONS

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

### APPENDIX

Appendices should appear before the acknowledgment.

### ACKNOWLEDGMENT

The preferred spelling of the word acknowledgment in America is without an e after the g. Avoid the stilted expression, One of us (R. B. G.) thanks . . . Instead, try R. B. G. thanks. Put sponsor acknowledgments in the unnumbered footnote on the first page.

References are important to the reader; therefore, each citation must be complete and correct. If at all possible, references should be commonly available publications.

### REFERENCES

- [1] G. O. Young, Synthetic structure of industrial plastics (Book style with paper title and editor), in *Plastics*, 2nd ed. vol. 3, J.