FORWARD CLIQUET OPTION FOR GUARANTEED INDEX-LINKED LIFE INSURANCE

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Abstract

The market risk contained in guaranteed index-linked life insurance products can be managed with options. To prevent premature cancellation, a profit structure is chosen which corresponds to forward cliquet options. The pricing of these options is computed for a variety of payoff patterns. When the profit from the index contributes additively to the benefits, then a closed form is possible for prices.

Keywords: guaranteed index-linked life insurance, forward cliquet options

A. INTRODUCTION

The distinguishing feature of the guaranteed index-link life insurance with a traditional life insurance policy is that the benefit obligation at maturity depends on the market value of some reference portfolio. While in traditional life insurance policies provide benefits remain, or policies that may participate in the benefits of loosely associated with the performance of the investment and mortality experience of the insurer. Thus policy-guaranteed life insurance index imposes on policyholders full investment risk, ie the risk that the equity-linked life products with a certain "lock in" feature in the equity-profit part. We shall derive prices for the corresponding options under the Black and Scholes model with constant interest rate.

B. FORWARD CLIQUET OPTION

Cliquet options are essentially a series of forward-starting at the money options with a single premium determined up front, that locks in any gains on specific dates. Floors and caps are then added to fix the minimum and maximum returns. Hence, by construction, cliquet options protect against downside risk, yet they are affordably priced, since the payoff is locally capped, hence never too extreme (e.g. [13]). Payoff from cliquet call option at maturity $T = t_n$

$$\max \left\{ \left( S_0 , S_t , ..., S_t \right) - S_b \right\}$$

(2.1)

and Payoff from cliquet put option at maturity $T = t_n$

$$\max \left\{ S_b - \left( S_b, S_t, ..., S_t \right) \right\}$$

(2.2)

(e.g. [12]).

The profit from European call option which at maturity pays

$$B = K \left( \frac{S(T)}{S(0)} - 1 \right)^+$$

(1)
$K$ is the fixed sum which participates in the index. And for payoff pattern from sequence of $T$ forward options on $S(t)$ which are at the money $(x = s)$

$$B = K \sum_{t=1}^{T} \left( \frac{S(t)}{S(t-1)} - 1 \right)^+$$  \hspace{1cm} (2)

For the cases in which the annual profits bear interest or are compounded, we assume that the interest rate $r$ is nonrandom and constant. The payoff at maturity in the case with interest rate $r$ equals:

$$B = K \sum_{t=1}^{T} \left( \frac{S(t)}{S(t-1)} - 1 \right)^+ (1 + r)^{T-t}$$  \hspace{1cm} (3)

If profit is compounded, i.e. if $K$ is adjusted each year such that all earlier profits are included, then the payoff at expiration:

$$B = K \prod_{t=1}^{T} \max \left( \frac{S(t)}{S(t-1)} - 1, 0 \right) - K$$

$$= Ke^{\sum_{t=1}^{T} \left[ \log(S(t)) - \log(S(t-1)) \right]} - K$$

$$= K \left( e^{\left( \sum_{t=1}^{T} [\log(S(t)) - \log(S(t-1))] \right)} - 1 \right)$$  \hspace{1cm} (4)

A payoff yielding a minimal interest rate of $r_0$ which might be called compounded with floor is the following:

$$B = K \prod_{t=1}^{T} \max \left( \frac{S(t)}{S(t-1)} - 1, r_0 \right) - K$$  \hspace{1cm} (5)

### C. Pricing of Forward Cliquet Option

Pricing of the forward cliquet options under the different payoff patterns under the Black and Scholes model for the index:

$$dS(t) = \mu S(t) dt + \sigma S(t) dW(t), 0 \leq t \leq T, S(0) = x_0 > 0.$$  Here, $W(t), 0 \leq t \leq T,$ is a standard Wiener process. The pricing of a contingent claim paying an amount $C$ at $T$ which depends on $S(t), 0 \leq t \leq T,$ is then done using this equivalent martingale measure $\tilde{P}$. The price for $C$ equals

$$C = e^{-\delta T} \tilde{E}B$$

### The Option Price for Single Premium Payment with Additive Benefit

We defined that:

$$C_{16}(x) = x\Phi \left( \frac{\log(x)}{\sigma \sqrt{T}} + \frac{\delta - \sigma^2/2}{\sigma \sqrt{T}} \right) - e^{\sigma \sqrt{T}} \Phi \left( \frac{\log(x)}{\sigma \sqrt{T}} + \frac{\delta + \sigma^2/2}{\sigma \sqrt{T}} \right)$$

$$C_{16}(s) = x\Phi \left( \frac{\delta + \sigma^2/2}{\sigma} \sqrt{T} \right) - e^{\sigma \sqrt{T}} \Phi \left( \frac{\delta - \sigma^2/2}{\sigma} \sqrt{T} \right)$$
where \( C_{BS}(s, x, \tau) \) is the classical Black and Scholes price for a European call with exercise price \( x \), when the underlying has value \( s \), and time to maturity is \( \tau \), and \( C_{BS}(s, \tau) \) is the value at the money (i.e. \( x = s \)), with \( \Phi(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{-\frac{t^2}{2}} \, dt \) the standard normal distribution function. Now, we will derive the options price for the fifth payoff.

For \( B = K \left( \frac{S(t)}{S(0)} - 1 \right)^{\gamma} \), the price of forward cliquet option that corresponding with payoff (1) is:

\[
C = e^{(-\delta T)} \mathbb{E}[B]
\]

\[
= e^{(-\delta T)} \mathbb{E} \left( K \left( \frac{S(t)}{S(0)} - 1 \right)^{\gamma} \right)
\]

\[
= Ke^{(-\delta T)} \mathbb{E} \left( \frac{S(t)}{S(0)} - 1 \right)^{\gamma}
\]

\[
= Ke^{(-\delta T)} \mathbb{E} \left[ \left( \frac{S(t)}{S(0)} - 1 \right)^{\gamma} \right]
\]

\[
= Ke^{(-\delta T)} \int \left\{ \exp \left( \delta - \frac{\sigma^2}{2} t + \sigma \sqrt{t} Z \right) \right\} - Ke^{(-\delta T)} \mathbb{E}[I]
\]

We will try to find solution from \( \mathbb{E} \left[ I \left\{ \exp \left( \delta - \frac{\sigma^2}{2} T + \sigma \sqrt{T} Z \right) \right\} \right] \), with assumed that

\[
\mathbb{E} \left[ I \left\{ \exp \left( \delta - \frac{\sigma^2}{2} T + \sigma \sqrt{T} Z \right) \right\} \right] = e^{\frac{\delta}{2}} \left( \frac{\sigma^2}{2} \right) e^{\frac{\sigma^2}{2}} \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}} dy
\]

\[
= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{\frac{\delta}{2}} \left( \frac{\sigma^2}{2} \right) e^{\frac{\sigma^2}{2}} e^{-\frac{y^2}{2}} dy
\]

\[
c = \sigma \sqrt{T} - \omega
\]

\[
= \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{\frac{\delta}{2}} \left( \frac{\sigma^2}{2} \right) e^{\frac{\sigma^2}{2}} e^{-\frac{y^2}{2}} dy
\]

\[
= e^{\frac{\delta}{2}} \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-\frac{y^2}{2}} dy
\]

\[
= e^{\frac{\delta}{2}} P(Z > -\omega)
\]

\[
= e^{\frac{\delta}{2}} \Phi(\omega)
\]
\[ C = Ke^{(-\delta T)} E \left[ I \left\{ \exp \left( -\frac{\sigma^2}{2} T + \sigma \sqrt{T} \right) \right\} - Ke^{(-\delta T)} E[I] \right] \]

For payoff (1), we obtain the price:

\[ C = KC_{BS}(1,T) \]

For payoff (2), the price is:

\[ C = e^{(-\delta T)} EB \]

\[ = e^{(-\delta T)} \left( \sum_{t=1}^{T} \left( \frac{S(t)}{S(t-1)} - 1 \right) \right)^{+} \]

\[ = Ke^{(-\delta T)} \sum_{t=1}^{T} E \left( \frac{S(t)}{S(t-1)} - 1 \right)^{+} \]

Where \( S(t) = S_0 e^{\left[ \left( \frac{1}{2} \delta^2 \right) \sigma W(t) \right]} \) and \( S(t-1) = S_0 e^{\left[ \left( \frac{1}{2} \delta^2 \right) \sigma W(t-1) \right]} \)

Then

\[ S(t) = S_0 e^{\left[ \left( \frac{1}{2} \delta^2 \right) \sigma W(t) \right]} \]

\[ S(t-1) = S_0 e^{\left[ \left( \frac{1}{2} \delta^2 \right) \sigma W(t-1) \right]} \]

\[ = S_0 e^{\left[ \left( \frac{1}{2} \delta^2 \right) \sigma W(t) \right]} \]

\[ = S_0 e^{\left[ \left( \frac{1}{2} \delta^2 \right) \sigma \sqrt{Z} \right]} \]

Then

\[ C = Ke^{(-\delta T)} \sum_{t=1}^{T} \left( e^{\left( \frac{1}{2} \delta^2 \right) \sigma \sqrt{Z}} \right)^{+} \]

\[ = Ke^{(-\delta T)} \sum_{t=1}^{T} \left( e^{\left( \frac{1}{2} \delta^2 \right) \sigma \sqrt{Z}} \right)^{+} \cdot E[I] \]

We will try to find solution from \( E\left[ I \left\{ \exp \left( -\frac{\sigma^2}{2} T + \sigma \sqrt{T} \right) \right\} \right] \), with assumed \( c = \sigma \sqrt{1 - \omega} \)
\[
\hat{E}\left[ I \exp\left( \frac{\delta - \sigma^2}{2} + \sigma \sqrt{t} Z \right) \right] = \int_c^\infty e^{\left( \frac{\delta - \sigma^2}{2} + \sigma \sqrt{t} x \right)} \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} \, dx \\
= \frac{1}{\sqrt{2\pi}} e^{\left( \frac{\delta - \sigma^2}{2} \right)} \int_c^\infty e^{-\frac{(x - \sigma)^2}{2}} \, dx \\
= \frac{1}{\sqrt{2\pi}} e^{\left( \frac{\delta - \sigma^2}{2} \right)} \int_{c-\sigma}^{\infty} e^{-\frac{y^2}{2}} \, dy \\
= e^{\delta} \frac{1}{\sqrt{2\pi}} \int_{-\omega}^{\infty} e^{-\frac{y^2}{2}} \, dy \\
= e^{\delta} P \{ Z > -\omega \} \\
= e^{\delta} \Phi \left( \omega \right) \\
\]

Then

\[
C = Ke^{-\delta T} \sum_{t=1}^{T} \hat{E}\left[ I \left( e^{\left( \frac{\delta - \sigma^2}{2} + \sigma \sqrt{t} Z \right)} \right) - 1 \right] \\
= Ke^{-\delta T} \sum_{t=1}^{T} \hat{E}\left[ I \left( e^{\left( \frac{\delta - \sigma^2}{2} + \sigma \sqrt{t} \sqrt{1} \right)} \right) - \hat{E}[I] \right] \\
= Ke^{-\delta T} \left[ \sum_{t=1}^{T} \left( e^{\delta \Phi \left( \omega \right)} - \Phi \left( \omega - \sigma \sqrt{1} \right) \right) \right] \\
= Ke^{-\delta T} \left[ \sum_{t=1}^{T} e^{\delta} \left( \Phi \left( \omega \right) - e^{-\delta} \Phi \left( \omega - \sigma \sqrt{1} \right) \right) \right] \\
= Ke^{-\delta T} \sum_{t=1}^{T} e^{\delta} C_{BS} \left( 1,1 \right) \\
= Ke^{-\delta T} TC_{BS} \left( 1,1 \right) \\
= K(1 + r)^{-t+1} TC_{BS} \left( 1,1 \right) \\
\]

For payoff (3) we obtain the following price:

\[
C = e^{(-\delta T)} \hat{E}K \sum_{t=1}^{T} \left( \frac{S(t)}{S(t-1)} - 1 \right) \left( 1 + r \right)^{T-t} \\
= K \sum_{t=1}^{T} \left( 1 + r \right)^{-T} \left( 1 + r \right)^{T-t} \hat{E} \left( \frac{S(t)}{S(t-1)} - 1 \right)^T \\
= K \sum_{t=1}^{T} \left( 1 + r \right)^{-T} \hat{E} \left( e^{\left( \frac{\delta - \sigma^2}{2} + \sigma \sqrt{1} \right)} \right)^T \\
= K \sum_{t=1}^{T} \left( 1 + r \right)^{-T} e^{\delta} C_{BS} \left( 1,1 \right) \\
\]
Also for payoff (4) we obtain a closed form for the price. The exponent in the payoff
\[ \sum_{t=1}^{T} \left( \log(S(t)) - \log(S(t-1)) \right)^{+} = \sum_{t=1}^{T} \left( e^{-\frac{1}{2}\sigma^2} - e^{\delta - \frac{1}{2}\sigma^2}(W(t) - W(t-1)) \right)^{+} \]
is the sum of iid random variables, and therefore
\[
C = e^{-\delta T} K \left[ \hat{E} \left( \prod_{t=1}^{T} \max \left( \frac{S(t)}{S(t-1)}, 1 \right) - K \right) \right]
\]
\[
= e^{-\delta T} K \left( \hat{E} \left( \sum_{t=1}^{T} \left( e^{-\frac{1}{2}\sigma^2} - e^{\delta - \frac{1}{2}\sigma^2}(W(t) - W(t-1)) \right)^{+} \right) - 1 \right)
\]
\[
= e^{-\delta T} K \left( \hat{E} \left( \sum_{t=1}^{T} \left( e^{-\frac{1}{2}\sigma^2} - e^{\delta - \frac{1}{2}\sigma^2}(W(t) - W(t-1)) \right)^{+} \right) \right) - 1
\]
\[
= e^{-\delta T} K \left( \hat{E} \left( \sum_{t=1}^{T} \left( e^{-\frac{1}{2}\sigma^2} - e^{\delta - \frac{1}{2}\sigma^2}(W(t) - W(t-1)) \right)^{+} \right) \right) - e^{-\delta T} K
\]
\[ C = Ke^{-\delta T} \left( e^{\delta} \left( 1 + e^{\delta} C_{BS} (1,1) \right) \right)^T - Ke^{-\delta T} \]

\[ = K \left( e^{\delta} \left( 1 + C_{BS} (1,1) \right) \right)^T - Ke^{-\delta T} \]

\[ = K \left( \frac{1}{1+r} + C_{BS} (1,1) \right)^T - K (1+r)^{-T} \]

With \( S = \delta - \frac{1}{2} \sigma^2 + \sigma W (1) \), we obtain

This yields the price

\[ \widehat{e}^{(S)^T} = \widehat{e}^{(S)(t=0)} + P(S \leq 0) \]

\[ = \widehat{e}^{(S)-1} \mathbb{1}_{(S > 0)} + 1 \]

\[ = \widehat{e} \left[ I \left( e^{(S)} - 1 \right) \right] + 1 \]

\[ = \widehat{e} \left[ I \left( e^{(S)} \right) \right] - \widehat{e} \left[ I \right] + 1 \]

\[ = \left( e^{\phi} - \Phi (\omega - \sigma) \right) + 1 \]

\[ = 1 + e^{\delta} C_{BS} (1,1) \]

for the corresponding option with payoff pattern (4). Similarly, for payoff (5)

\[ B = K \prod_{t=1}^{T} \max \left( \frac{S(t)}{S(t-1)} \cdot 1 + r_0 \right) - K \], we obtain the option price

\[ C = e^{-\delta T} \left[ K \prod_{t=1}^{T} \max \left( \frac{S(t)}{S(t-1)} \cdot 1 + r_0 \right) - K \right] \]

\[ = e^{-\delta T} K \prod_{t=1}^{T} \max \left( \frac{S(t)}{S(t-1)} \cdot 1 + r_0 \right) - e^{-\delta T} K \]

\[ = Ke^{-\delta T} \left( \widehat{e} \exp \left( \delta - \frac{\sigma^2}{2} + \sigma W (1) \right) \right)^T - Ke^{-\delta T} \]
With $S = \delta - \frac{1}{2} \sigma^2 + \sigma W (1)$, we obtain

$$
\hat{e}^{(s)} = \hat{E} \left[ e^{(s)(1+r_0)\lambda_{s=0}} \right] + P(S \leq 0)
$$

$$
\hat{E} \left[ e^{s} \right] = (1 + r_0) \hat{E} [e] + (1 + r_0)
$$

$$
\hat{E} \left[ I \left( e^{(s)} \right) \right] = (1 + r_0) \hat{E} [I] + (1 + r_0)
$$

$$
\hat{E} \left[ I \left( e^{(s)} \right) \right] - (1 + r_0) \hat{E} [I] = (1 + r_0)
$$

$$
(1 + r_0) = e^\delta \Phi(\omega - (1 + r_0) \Phi(\omega - \sigma)) + (1 + r_0)
$$

$$
(1 + r_0) = e^\delta \Phi(\omega - (1 + r_0) \Phi(\omega - \sigma)) + (1 + r_0)
$$

This yields the price

$$
C = K \left( e^{-sT} \left( (1 + r_0) + e^\delta C_{B} (1,1 + r_0,1) \right) \right) - Ke^{-sT}
$$

$$
= K \left( \frac{1 + r_0}{1 + r} + C_{B} (1,1 + r_0,1) \right) - K (1 + r)^{-T}
$$

D. STUDY CASE

Data that used in this paper to derived the options price from the fifth payoff is based on daily closing prices of historical index DOW, DAX, FTSE, Nasdaq, and S&P500, which run from time 10 May 2008 to time 10 May 2014 (see [http://finance.yahoo.com/](http://finance.yahoo.com/)).

By the standard estimator of volatility

$$
\sigma = \sqrt{\frac{\sum_{t=1}^{n}(R_t - \bar{R})^2}{n - 1}}
$$

using microsoft Excel software, we find:

<table>
<thead>
<tr>
<th>No</th>
<th>Index</th>
<th>Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DOW</td>
<td>0.5386</td>
</tr>
<tr>
<td>2</td>
<td>DAX</td>
<td>0.6185</td>
</tr>
<tr>
<td>3</td>
<td>FTSE</td>
<td>0.5604</td>
</tr>
<tr>
<td>4</td>
<td>Nasdaq</td>
<td>0.6166</td>
</tr>
<tr>
<td>5</td>
<td>S&amp;P 500</td>
<td>0.1169</td>
</tr>
</tbody>
</table>

Based on United States current interest rate from time 16 May 2008 to time 10 May 2014 accessed from [http://www.fxstreet.com/fundamental/interest-rates-table/](http://www.fxstreet.com/fundamental/interest-rates-table/), is 0.25 %. Then $r = 0.0025$. Then $r = 0.0025$. Then $r = 0.0025$
To find payoff that derived from *Forward-Cliquet Options* for single premium payment with additive benefit and finding the options price, needed some informations; i.e constant interest rate \( r \), guaranteed interest rate \( r_0 \), participation \( K \), volatility \( \sigma \), and time to maturity \( T \).

For the index DOW, DAX, FTSE, Nasdaq, and S&P500; where guaranteed interest rate \( r_0 = 0.001 \) and participation in the index \( K = 0.9 \); the payoffs are:

**Table 4.2.** Payoffs For Single Premium Payment

<table>
<thead>
<tr>
<th></th>
<th>DOW</th>
<th>DAX</th>
<th>FTSE</th>
<th>Nasdaq</th>
<th>S&amp;P500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payoff 1</td>
<td>1,1859</td>
<td>1,1473</td>
<td>1,1757</td>
<td>1,1482</td>
<td>1,3701</td>
</tr>
<tr>
<td>Payoff 2</td>
<td>2,0387</td>
<td>2,0387</td>
<td>2,0387</td>
<td>2,0387</td>
<td>2,0387</td>
</tr>
<tr>
<td>Payoff 3</td>
<td>2,0664</td>
<td>2,0664</td>
<td>2,0664</td>
<td>2,0664</td>
<td>2,0664</td>
</tr>
<tr>
<td>Payoff 4</td>
<td>8,2383</td>
<td>8,9683</td>
<td>8,4330</td>
<td>8,9504</td>
<td>5,1143</td>
</tr>
<tr>
<td>Payoff 5</td>
<td>8,2522</td>
<td>8,9837</td>
<td>8,4473</td>
<td>8,9658</td>
<td>5,1222</td>
</tr>
</tbody>
</table>

And the options price for each payoff is

**Table 4.3.** Stock Index Option Price for Dow

<table>
<thead>
<tr>
<th>Stock Index Option</th>
<th>Payoff 1</th>
<th>Payoff 2</th>
<th>Payoff 3</th>
<th>Payoff 4</th>
<th>Payoff 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>0.1920</td>
<td>0.1920</td>
<td>0.1920</td>
<td>0.1920</td>
<td>0.1920</td>
</tr>
<tr>
<td>Year 2</td>
<td>0.2686</td>
<td>0.3830</td>
<td>0.3834</td>
<td>0.4239</td>
<td>0.4252</td>
</tr>
<tr>
<td>Year 3</td>
<td>0.3254</td>
<td>0.5730</td>
<td>0.5744</td>
<td>0.7043</td>
<td>0.7066</td>
</tr>
<tr>
<td>Year 4</td>
<td>0.3715</td>
<td>0.7621</td>
<td>0.7650</td>
<td>1.0432</td>
<td>1.0471</td>
</tr>
<tr>
<td>Year 5</td>
<td>0.4107</td>
<td>0.9502</td>
<td>0.9550</td>
<td>1.4532</td>
<td>1.4590</td>
</tr>
<tr>
<td>Year 6</td>
<td>0.4449</td>
<td>1.1375</td>
<td>1.1446</td>
<td>1.9491</td>
<td>1.9576</td>
</tr>
</tbody>
</table>
Figure 4.1. Price Option Based on Payoff 1 s / d 5 in stock DOW

Table 4.4. Stock Index Option Price For Dax

<table>
<thead>
<tr>
<th>Stock Index Option</th>
<th>Payoff 1</th>
<th>Payoff 2</th>
<th>Payoff 3</th>
<th>Payoff 4</th>
<th>Payoff 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>0.2194</td>
<td>0.2194</td>
<td>0.2194</td>
<td>0.2194</td>
<td>0.2200</td>
</tr>
<tr>
<td>Year 2</td>
<td>0.3058</td>
<td>0.4378</td>
<td>0.4383</td>
<td>0.4913</td>
<td>0.4927</td>
</tr>
<tr>
<td>Year 3</td>
<td>0.3690</td>
<td>0.6550</td>
<td>0.6567</td>
<td>0.8282</td>
<td>0.8307</td>
</tr>
<tr>
<td>Year 4</td>
<td>0.4198</td>
<td>0.8712</td>
<td>0.8745</td>
<td>1.2458</td>
<td>1.2501</td>
</tr>
<tr>
<td>Year 5</td>
<td>0.4624</td>
<td>1.0863</td>
<td>1.0917</td>
<td>1.7637</td>
<td>1.7703</td>
</tr>
<tr>
<td>Year 6</td>
<td>0.4991</td>
<td>1.3003</td>
<td>1.3084</td>
<td>2.4060</td>
<td>2.4159</td>
</tr>
</tbody>
</table>

Figure 4.2. Price Option Based on Payoff 1 s / d 5 in stock DAX
### Table 4.5. Stock Index Option Price for Ftse

<table>
<thead>
<tr>
<th>Stock Index Option</th>
<th>Payoff 1</th>
<th>Payoff 2</th>
<th>Payoff 3</th>
<th>Payoff 4</th>
<th>Payoff 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>0.1995</td>
<td>0.1995</td>
<td>0.1995</td>
<td>0.1995</td>
<td>0.2000</td>
</tr>
<tr>
<td>Year 2</td>
<td>0.2788</td>
<td>0.3980</td>
<td>0.3985</td>
<td>0.4422</td>
<td>0.4435</td>
</tr>
<tr>
<td>Year 3</td>
<td>0.3374</td>
<td>0.5955</td>
<td>0.5970</td>
<td>0.7376</td>
<td>0.7400</td>
</tr>
<tr>
<td>Year 4</td>
<td>0.3849</td>
<td>0.7920</td>
<td>0.7950</td>
<td>1.0972</td>
<td>1.1012</td>
</tr>
<tr>
<td>Year 5</td>
<td>0.4251</td>
<td>0.9875</td>
<td>0.9925</td>
<td>1.5352</td>
<td>1.5412</td>
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<tr>
<td>Year 6</td>
<td>0.4601</td>
<td>1.1821</td>
<td>1.1895</td>
<td>2.0687</td>
<td>2.0775</td>
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</table>

### Figure 4.3. Price Option Based on Payoff 1 s / d 5 in stock FTSE

### Table 4.6. Stock Index Option Price For Nasdaq

<table>
<thead>
<tr>
<th>Stock Index Option</th>
<th>Payoff 1</th>
<th>Payoff 2</th>
<th>Payoff 3</th>
<th>Payoff 4</th>
<th>Payoff 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>0.2188</td>
<td>0.2188</td>
<td>0.2188</td>
<td>0.2188</td>
<td>0.2193</td>
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<td>Year 2</td>
<td>0.3049</td>
<td>0.4365</td>
<td>0.4370</td>
<td>0.4897</td>
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<td>Year 3</td>
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<td>0.6531</td>
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<td>Year 4</td>
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<td>0.8719</td>
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<tr>
<td>Year 5</td>
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<td>1.0885</td>
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<td>1.7626</td>
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<tr>
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<td>1.2964</td>
<td>1.3045</td>
<td>2.3946</td>
<td>2.4044</td>
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Figure 4.4. Price Option Based on Payoff 1 s / d 5 in stock NASDAQ

Table 4.7. Stock Index Option Price for S&P500

<table>
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<th>Stock Index Option</th>
<th>S&amp;P500</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Payoff 1</td>
</tr>
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<td>Year 1</td>
<td>0.0430</td>
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<tr>
<td>Year 2</td>
<td>0.0614</td>
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<td>Year 5</td>
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<tr>
<td>Year 6</td>
<td>0.1085</td>
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</tbody>
</table>

Figure 4.5. Price Option Based on Payoff 1 s / d 5 in stock S&P500
E. CONCLUSIONS

1. Forward cliquet option is one option that is used to anticipate the cancellation of the contract of the policyholder because the market risk inherent in guaranteed index-linked life insurance products.

2. In cliquet forward option, the annual profit lock-in in the index. The profit will not be lost if the losses in the index occur in the future.

3. The price for payoff (1) is not always smaller than the price for the forward cliquet option (2). Even more surprisingly, the price of the forward cliquet option is not increasing in time. This is due to the fact that the profit is not included in the number K.

F. REFERENCES


http://yahoo.finance.com