Valuation risk adjusted deposit insurance on heston model

N Hariati, M Yunus and E R M Putri

Department of Mathematics, Faculty of Mathematics, Computation and Data Sciences, Institut Teknologi Sepuluh Nopember, Sukolilo- Surabaya 60111, Indonesia

Abstract. Deposit insurance is a tool to stabilize the banking system. In managing deposit insurance in Indonesia, deposit insurance agency applies the flat rate premium system which is the same premium imposition system for each bank without taking into account the different risk levels of each bank. The implementation of the flat rate, it can still cause moral hazard which can trigger the monetary crisis. To anticipate this problem, it is necessary to design a risk adjusted premium. One of method that can be used in determining deposit insurance premium is Fourier transform. In this study, we analyzed analytical solutions to determine risk adjusted deposit insurance premiums on Heston Model by using Fourier transforms. Based on the simulation results, it was found that the amount of volatility caused the value of deposit insurance premiums getting bigger, the smaller value of interest rates so the greater value of deposit insurance premiums. The high value of deposit insurance premiums is also influenced by the value of debt obligations and dividends value.

1. Introduction

The monetary crisis occurred in the last two decades, namely the monetary crisis that occurred in Southeast Asia and the global monetary crisis. One of the causes of the monetary crisis in various countries is the presence of moral hazard actions from the banking owners. The condition of the banking system is an important factor in the economy of a country. The bank functions as an institution that absorbs public funds in the form of savings, deposits, and so on and distributes these funds in the form of credit, working capital, investment credit, and consumption [1]. At the time of the Southeast Asian monetary crisis, Indonesia bank closed 16 small banks during the 1997 monetary crisis without guarantee of customer deposits. This triggered the occurrence of bank runs in several private banks. To anticipate this, the government established a blanket guarantee policy. The blanket guarantee policy can increase public confidence in bank storage, but it imposes a state budget due to unlimited guarantees. The Government prepares the implementation of the Deposit Insurance System (DIS) on the date through the Deposit Insurance Corporation. Deposit insurance agency applies a flat rate premium system, namely the same premium imposition system for each bank without taking into account the different levels of risk of each bank. The application of flat rate premiums in deposit insurance still poses a burden on the state that must be borne by the government. This is because the amount of premium received by the government is not proportional to the number of guarantee claims that must be paid.

Research on determining deposit insurance premiums was initiated by Merton using option theory but, in his research determining flat premiums [2]. Research on deposit insurance premiums was also carried out by Ronn and Verma using an isomorphic relationship between insurance and put options on the Black-Scholes model [3]. In the Black-Scholes model the underlying asset volatility of option prices is constant during the option period. According to Heston [4] the underlying asset volatility of option...
prices is not constant but follows a stochastic process with different forms. Therefore, a study was conducted on the determination of risk adjusted deposit insurance premiums in the Heston model.

2. Heston Model

The Heston model is a volatility stochastic model that was first introduced by (Steven L Heston, 1993) [4]. The stochastic process in the Heston model is given as follows:

\[ dS(t) = \mu S(t) \, dt + \sqrt{\nu(t)} \, S(t) \, dW(t) \]

The volatility following the CIR process (Cox-Ingersoll-Ross) as follows:

\[ dv(t) = k(\theta - v(t)) \, dt + \sigma \sqrt{v(t)} \, dZ(t) \]

Where \( W(t) \) and \( Z(t) \) are standard Wiener process,

\[ dW(t) \, dZ(t) = \rho \, dt \]

The partial differential equations of Heston model in general are as follows:

\[ \frac{1}{2} v S^2 \frac{\partial^2 v}{\partial S^2} + \rho \sigma v S \frac{\partial^2 v}{\partial S \partial v} + \frac{1}{2} \sigma^2 v \frac{\partial^2 v}{\partial v^2} + r S \frac{\partial v}{\partial S} + \left( k(\theta - v) - \lambda(S, v, t) \right) \frac{\partial v}{\partial t} - rU + \frac{\partial u}{\partial t} = 0 \]

where model parameters:

- \( U \) = option price at the time \( t \in [0, T] \)
- \( \sigma \) = volatility of volatility
- \( \theta \) = long-term variance
- \( \nu \) = volatility
- \( k \) = rate of reversion to the long-term price variance
- \( \rho \) = correlation coefficient of Wiener prossis is \([-1, 1]\)

3. Risk Adjusted Deposit Insurance

Deposit insurance is one of tools used to stabilize the banking system [5]. In mechanism of deposit insurance, the insured risk is the risk of the bank's failure to fulfill its obligations to the customer at maturity date. The bank's failure can be identified from the value of a bank asset that is smaller than a debt obligation.

When a bank asset is less than debt obligations, the bank sells all of their assets. In this case, the guarantor can fulfill the payment promised by the bank to the customer and the bank must hand over the asset to the guarantor. For this opportunity, the guarantor charges a fee for the bank to be insured or premium. According to deposit insurance agency there are two types of premiums that must be paid by the bank, namely risk adjusted premium and premium flat rate. There are 32% of countries that have used a risk adjusted premium system while 68% of countries still use premium flat rate systems, including Indonesia [6]. Economists support the existence of deposit insurance that includes risk because it is considered more equitable and efficient than flat premiums (Ronn and Verma, 1986) [3].

Mechanism for determining the value of deposit insurance is isomorphic correspondence with a European put option [2]. One of model that can be used in calculating option values is the Heston model. Research conducted by Paolo Vanini also aims to determine the price of an option using the Heston model [7]. The stochastic process in the Heston model is given as follows:

\[ dS(t) = \mu S(t) \, dt + \sqrt{\nu(t)} \, S(t) \, dW(t) \]

\[ dv(t) = k(\theta - v(t)) \, dt + \sigma \sqrt{v(t)} \, dZ(t) \]

Next, a portfolio consist of a deposit insurance \( G \), a unit of \( V \) which is a bank asset with risk factors \((1 - \delta)^n\), \( \delta \) is dividents value, \( \phi \) unit value of the other derivative product used to protect volatility, and \( U \) is the value of derivative products whose movements are equal to \( G \). The risk factor for assets is the distribution of dividends to shareholders. The company uses net income and retained earnings to distribute dividends to shareholders, resulting in reduced asset value. Asset value decreases by \( V\delta \) for \( n \) periods so the bank asset value is equal to \( V(1 - \delta)^n \), so the portfolio is
The change in portfolio value is
\[ d\Pi = dG - d\Delta V(1-\delta)^n + d\phi U \]
\[ d\Pi = \left[ \frac{\partial G}{\partial t} + \frac{1}{2} \frac{\partial^2 G}{\partial V^2} \nu (V(1-\delta)^n)^2 + \frac{\partial^2 G}{\partial V \partial \nu} \rho \sigma \nu V(1-\delta)^n + \frac{1}{2} \frac{\partial^2 G}{\partial \nu^2} \sigma^2 \nu \right] + \phi \left[ \frac{\partial U}{\partial t} + \frac{1}{2} \frac{\partial^2 U}{\partial V^2} \nu (V(1-\delta)^n)^2 + \frac{\partial^2 U}{\partial V \partial \nu} \rho \sigma \nu V(1-\delta)^n + \frac{1}{2} \frac{\partial^2 U}{\partial \nu^2} \sigma^2 \nu \right] dt \]
\[ d\Pi = [A + \phi B]dt \]

By assuming the portfolio in any bank must be the same with rate of return of a short-term-risk-free bank’s assets with interest rate \( r \), and substituting \( d\Pi \) it follows that,
\[ [A + \phi B]dt = r(G - \Delta V(1-\delta)^n + \phi U)dt \]
and implies,
\[ \frac{\partial G}{\partial t} + \frac{1}{2} \frac{\partial^2 G}{\partial V^2} \nu (V(1-\delta)^n)^2 + \frac{\partial^2 G}{\partial V \partial \nu} \rho \sigma \nu V(1-\delta)^n + \frac{1}{2} \sigma^2 \nu \frac{\partial^2 G}{\partial \nu^2} - rG + rV(1-\delta)^n \frac{\partial G}{\partial \nu} + k(\theta - \nu) \frac{\partial G}{\partial \nu} = 0 \]
(1)

Ronn and Verma [3] assume that in deposit insurance that includes risk, customers will be entitled to the future value of their deposits, or to a prorated fraction of the value, should the value be less than total debt. In other words, they will receive \( F_v(B_1) \) after maturity. With \( F_v(B_1) \) is the operator of future values and \( \frac{V_{TB_1}}{B_1+B_2} \) is the terminal value of the bank assets recorded. The value of deposit insurance at maturity is max \( \{0, F_v(B_1) - \frac{V_{TB_1}}{B_1+B_2} \} \).

4. Solution by Using Fourier Transform

In this section discuss the solution of Heston partial differential equations to obtain a risk adjusted deposit insurance analytic solution using Fourier transforms. To simplify the work, transformation will be carried out using non-dimensional variables as follows:

\[ e^{-x} = \left( \frac{V_{TB_1}}{B_1+B_2} \right) = \left( \frac{V(1-\delta)^n B_1}{B_1+B_2} \right) \]
\[ -x = \ln \left( \frac{V(1-\delta)^n}{B_1+B_2} \right) \]

where:

- \( V \) = value of bank assets
- \( V_T \) = the terminal value of the bank’s assets
- \( F_v(B_1) \) = future value dari B1
- \( B = B_1 + B_2 \)
- \( B_1 \) = the face value of the insured deposits
- \( B_2 \) = the face value of all debt liabilities other than the insured deposits
- \( \delta \) = dividend payment period
- \( n \) = dividend payment period
- \( T \) = time until the next bank asset audit
- \( r \) = interest rate

After transformation, use the non-dimensional variable in equation (1) so that it is obtained,
\[ -\frac{\partial G}{\partial t} = \frac{1}{2} \nu \frac{\partial^2 G}{\partial x^2} + \left( \frac{1}{2} \nu - r \right) \frac{\partial G}{\partial x} - \rho \sigma \nu \frac{\partial^2 G}{\partial \nu \partial x} + \frac{1}{2} \sigma^2 \nu \frac{\partial^2 G}{\partial \nu^2} - rG + k(\theta - \nu) \frac{\partial G}{\partial \nu} = 0 \]
(2)

Before applying the Fourier transform, the boundary conditions in Equation (2) must be fulfilled as follows,
\begin{align*}
max\{0, B - V\} & \leq G(x,v,t) \leq V \\
\text{By using dimensionless no transformation, inequality can be written as follows,}
max\left\{0, \frac{B_1 e^{-x B}}{V(1 - \delta)^n} - B_1 e^{-x}\right\} & \leq G(x,v,t) \leq B_1 e^{-x} \\
\text{(3)} \\
\text{Based on the assumption that the total debt obligation is greater than the bank asset value } B > V, \text{ then the x value to be proven is only at } x > 0. \text{ The inspection of the boundary conditions is as follows:}
\lim_{x \rightarrow 0} G_{(x,v,t)} = 0 \\
\lim_{x \rightarrow 0} G'_{(x,v,t)} = 0 \\
(a). \text{ Lim } G_{(x,v,t)} = 0 \\
\text{Based on Equation (3) and t It follows from Squeeze Theorem in Real Analysis, obtained:}
\lim_{x \rightarrow 0} \max\left\{0, \frac{B_1 e^{-x B}}{V(1 - \delta)^n} - B_1 e^{-x}\right\} & \leq \lim_{x \rightarrow 0} G_{(x,v,t)} \leq \lim_{x \rightarrow 0} B_1 e^{-x} \\
\text{Because}
\lim_{x \rightarrow 0} \max\left\{0, \frac{B_1 e^{-x B}}{V(1 - \delta)^n} - B_1 e^{-x}\right\} = 0, \text{ and } \lim_{x \rightarrow 0} B_1 e^{-x} = 0, \text{ so } \lim_{x \rightarrow 0} G_{(x,v,t)} = 0. \\
(b). \text{ Lim } G'_{(x,v,t)} = 0 \\
\text{Based on Equation (3) and t It follows from Squeeze Theorem in Real Analysis, obtained:}
\lim_{x \rightarrow 0} \max\left\{0, -\frac{B_1 e^{-2x B}}{V(1 - \delta)^n} + B_1 e^{-2x}\right\} & \leq \lim_{x \rightarrow 0} G'_{(x,v,t)} \leq \lim_{x \rightarrow 0} -B_1 e^{-2x} \\
\text{Because}
\lim_{x \rightarrow 0} \max\left\{0, -\frac{B_1 e^{-2x B}}{V(1 - \delta)^n} + B_1 e^{-2x}\right\} = 0, \text{ and } \lim_{x \rightarrow 0} -B_1 e^{-2x} = 0, \text{ so } \lim_{x \rightarrow 0} G'_{(x,v,t)} = 0. \\
\text{Following are the general equations of Fourier transforms,}
\hat{f}(\omega, v, \tau) = \int_{x=0}^{\infty} e^{i\omega x} f(x,v,t)dx \\
\text{where } \hat{f}(\omega, v, \tau) \text{ is the result of Fourier transformation. In solving the problem using Fourier transformation, the application of inverses plays an important role. Based on (Rouah F.D., 2013) [8] the inverse Fourier transformation with the fundamental transform is obtained from the multiplication of the pay off transformation with the fundamental solution namely,}
\hat{f}(\omega, v, 0) = \int_{\iota \xi = -\infty}^{\iota \xi = \infty} e^{-i\omega x} \hat{f}(\omega, v, 0) d\omega \\
\text{\hat{f}(\omega, v, 0) is pay off transform and } \hat{f}(\omega, v, \tau) \text{ is fundamental transform. Following are the general equations of Fourier transforms,}
\hat{f}_{(\xi, v, \tau)} = \int_{\iota \xi = -\infty}^{\iota \xi = \infty} e^{i\xi x} F_{(x,v,t)}dx \\
\text{Next, a Fourier transformation will be applied to in Equation (2) using the properties of Fourier transformation, then obtained,}
\mathcal{F}\left\{-\frac{\partial G}{\partial t}\right\} = -\int_{-\infty}^{\infty} e^{i\omega x} \frac{\partial G}{\partial t} dx = -\frac{\partial \hat{G}}{\partial \tau}, \quad \mathcal{F}\{G\} = \int_{-\infty}^{\infty} e^{i\omega x} G(x,v,t)dx = \hat{G}, \\
\mathcal{F}\left\{\frac{\partial G}{\partial x}\right\} = \int_{-\infty}^{\infty} e^{i\omega x} \frac{\partial G}{\partial x} dx = -i\omega \hat{G}, \quad \mathcal{F}\{\partial^2 G/\partial x^2\} = \int_{-\infty}^{\infty} e^{i\omega x} \frac{\partial^2 G}{\partial x^2} dx = -\omega^2 \hat{G}, \\
\mathcal{F}\left\{\frac{\partial^2 G}{\partial x \partial v}\right\} = -i\omega \frac{\partial \hat{G}}{\partial \tau}, \quad \mathcal{F}\left\{\frac{\partial^2 G}{\partial v^2}\right\} = \frac{\partial^2 \hat{G}}{\partial \tau^2}, \quad \mathcal{F}\{\frac{\partial G}{\partial v}\} = \frac{\partial \hat{G}}{\partial \tau}.
\end{align*}
Based on Lewis [9] the results of Fourier transforms on $\mathcal{G}(x, v, t)$ are fundamental solutions that can be written in the following form,

$$\mathcal{G}(x, v, t) = e^{(-r+ri\omega)t} \mathcal{H}(\omega, v, t)$$

where $\tau = T - t$ is the time to maturity date. Function $\mathcal{H}$ is obtained as the solution of partial differential equations (3). Next, a derivation in the equation $G(x, v, t) = e^{(-r+ri\omega)t}$ is expressed as the form of $\mathcal{H}(\omega, v, t)$.

$$-\frac{\partial \mathcal{G}}{\partial t} = \frac{\partial \mathcal{G}}{\partial \tau} = (-r + ri\omega)e^{(-r+ri\omega)t} \mathcal{H}(\omega, v, t) + e^{(-r+ri\omega)t} \frac{\partial \mathcal{H}}{\partial \tau}$$

Next, substitution the results of $\mathcal{G}$ which is constructed by $\mathcal{H}$ in equation (4) as follows,

$$\frac{\partial \mathcal{H}}{\partial \tau} = \frac{1}{2} \sigma^2 v \frac{\partial^2 \mathcal{H}}{\partial v^2} + (k(\theta - v) + \rho \sigma v i \omega) \frac{\partial \mathcal{H}}{\partial v} - vc \mathcal{H}$$

where $c = \frac{1}{2}(\omega^2 + i\omega)$.

Next, a solution will be obtained from equation (4). Equation (4) must be changed into a general form of the Riccati equation, defined $t = \frac{1}{2} \sigma^2 \tau$,

$$\frac{\partial \mathcal{H}}{\partial \tau} = \frac{\partial \mathcal{H}}{\partial \tau} = \frac{\partial^2 \mathcal{H}}{\partial v^2}$$

Equation (6) is substituted in equation (5) so that it is obtained

$$\frac{\partial \mathcal{H}}{\partial \tau} = v \frac{\partial^2 \mathcal{H}}{\partial v^2} + \tilde{k}(\tilde{\theta} - v) \frac{\partial \mathcal{H}}{\partial v} - \tilde{c} v \mathcal{H}$$

where $\tilde{k} = \frac{2(k - \omega \rho \sigma)}{\sigma^2}$, $\tilde{c} = \frac{2c}{\sigma^2} = \frac{\omega^2 + \omega^2}{\sigma^2}$, $\tilde{\theta} = \frac{k \theta}{k - \omega \rho \sigma}$.

Equation (7) has a solution with the following form $\mathcal{H}(\omega, v, t) = e^{\mathcal{C}(t) + \mathcal{D}(t)v}$ [8]. Next, find the derivatives of $\mathcal{H}(\omega, v, t)$ and then substitute derivatives of $\mathcal{H}(\omega, v, t)$ in equation (6), and divide the two segments obtained by $\mathcal{H}(\omega, v, t)$ so produce,

$$\begin{align*}
\frac{\partial \mathcal{C}}{\partial t} + \frac{\partial \mathcal{D}}{\partial t} v
&= \tilde{k}\tilde{\theta} \mathcal{D} + (D^2 - \tilde{k}D - \tilde{c}) v
\end{align*}$$

From equation (8) is obtained

$$D \frac{\partial \mathcal{D}}{\partial t} = D^2 - \tilde{k}D - \tilde{c} \quad \text{and} \quad \frac{\partial \mathcal{C}}{\partial t} = \tilde{k}\tilde{\theta}$$

The first equation at (8) is the Riccati equation with $P(t) = -\tilde{c}$, $Q(t) = -\tilde{k}$, and $R(t) = 1$. This equation can be solved by reducing to second order linear ordinary differential equations for $w(t)$ as follows,

$$w''(t) + \tilde{k}w'(t) - \tilde{c}w(t) = 0$$

From equation (10) is obtained $\alpha = \frac{-k + j}{2}$ and $\beta = \frac{-k - j}{2}$, where $j = \sqrt{k^2 + 4\tilde{c}}$, the solution to the Riccati equation at (8) is as follows,

$$D = -\frac{\left(Ke^{\alpha t} + \beta e^{\beta t}\right)}{\left(Ke^{\alpha t} + e^{\beta t}\right)}$$

The initial condition $D(0) = 0$ implies that $t = 0$ in the numerator so that it produces $K = -\frac{\beta}{\alpha} = \frac{(k + j)}{(k + j)}$ so that solution $D$ is,

$$D = \tilde{k} + j \left(1 - e^{it}\right)$$

After obtaining the value $D$, then the value of $\mathcal{C}$ will then be sought for the value $\mathcal{C}(t)$ can be obtained by integrating $D(t)$. 

5
\[
\int_0^\gamma D(t) \, dt = \frac{\bar{k} + j}{2} t - \ln \left( \frac{1 - g e^{j t}}{1 - g} \right)
\]

So that \( C(t) \) is obtained, that is,
\[
C(t) = \bar{k} \hat{\theta} \left( \frac{\bar{k} + j}{2} t - \ln \frac{1 - g e^{j t}}{1 - g} \right)
\]  \hspace{2cm} (11)

After obtaining the values \( D(t) \) and \( C(t) \), the Fourier transform from the payoff function will be searched as follows,
\[
\hat{G}(\omega, v, 0) = \int_{-\infty}^{\infty} e^{i\omega x} (B_1 - B_2 e^{-x}) \, dx = \frac{-B_1}{\omega^2 + i\omega}
\]  \hspace{2cm} (12)

The final step in calculating the value of deposit insurance premiums is to inverse the Fourier transform which can be done by multiplying the transformation results of the payoff function with the basic solution as follows,
\[
G(x, v, t) = -\frac{1}{2\pi} \int_{-\infty}^{\infty} e^{i\kappa x} \frac{B_1}{\kappa^2 + i\kappa} e^{-(t+\kappa)\kappa} \hat{H}(\omega, v, t) \, d\omega
\]
\[
= -\frac{B_1 e^{-\tau \kappa}}{\pi} \int_{0}^{\infty} \Re \left[ \frac{1}{\omega^2 + i\omega} \hat{H}(\omega, v, t) \right] \, d\omega
\]  \hspace{2cm} (13)

where \( P = \ln \frac{v(1-\delta)^n}{B} \).

5. Simulation

In this section numerical simulations will be carried out to find solutions to equation (13) that can be solved by using trapezoidal rules and then simulated using matlab software to represent a general picture of the value of deposit insurance premiums that must be paid by a bank.

5.1. Effects of Volatility on Deposit Insurance Premium Value

Suppose the bank's assets of \( V = 100 \), interest rate \( r = 0.05 \), \( B_1 = 60 \) and dividends \( \delta = 0.001\% \) obtained the value of risk adjusted deposit insurance premiums with volatility \( \nu_1 = 0.01 \), \( \nu_2 = 0.03 \), \( \nu_3 = 0.05 \), \( \nu_4 = 0.07 \), \( \nu_5 = 0.09 \) as presented in Table 1.

| \( B_1 \) | \( B_2 \) | \( \nu_1 = 0.01 \) | \( B_2 = 0.03 \) | \( B_3 = 0.05 \) | \( \nu_4 = 0.07 \) | \( \nu_5 = 0.09 \) |
|---|---|---|---|---|---|---|
| 60 | 25 | 4.2958 | 4.5518 | 4.8030 | 5.0495 | 5.2912 |
| 60 | 40 | 7.3755 | 7.6517 | 7.9189 | 8.1777 | 8.4288 |
| 60 | 55 | 10.7448 | 10.9978 | 11.2416 | 11.4773 | 11.7054 |
| 60 | 70 | 14.0792 | 14.2872 | 14.4887 | 14.6843 | 14.8747 |

In this case, there are three conditions; \( B < V \) the face value of total debt liabilities is greater than the assets of bank, \( B = V \) the face value of total debt liabilities equals to the assets of bank, \( B > V \) the face value of total debt liabilities is smaller than assets bank. From Table 1, it can be seen that the value of deposit insurance premiums increases with the amount of the total debt obligation \( B \) and the amount value of volatility \( \nu \). Figure 1 displays a visualization image of the effect of volatility on the value of deposit insurance premiums with \( B_1 \) of 30 and \( B_2 \) of 50.
5.2. Effect of Interest Rate on Deposit Insurance Premium Value

Interest rate is one of the factors that can affect the value of insurance premiums of deposits from a bank. The following will be presented the effect of interest rate on the value of deposit insurance premiums. Suppose a bank's assets are $V = 100$, dividends $\delta = 0.001\%$, $v = 0.05$, and interest rate values are $r_1 = 5\%$, $r_2 = 10\%$, and $r_3 = 15\%$ as Figure 2:

In Figure 2, the greater interest rate causes the value of deposit insurance premiums decrease. Conversely, if the smaller interest rate is causes the value of deposit insurance premiums increase. In 15% interest rate the increase in the value of deposit insurance premium is not too significant when compared to the interest rate 10%. So, it can be said that the value of deposit insurance premiums is inversely proportional to the amount of interest rate.

5.3. Effect of Dividends on Deposit Insurance Premium Value

Dividend is a factor that causes a bank asset to be at risk, so that dividends from banks to shareholders can affect the value of deposit insurance premiums. The following will be shown a description of the effect of dividends on the value of deposit insurance premiums on dividends with the taking of fixed.
asset V values and different total debt values. Suppose a bank's assets amounting to $V = 100$, interest rate $r = 0.05$, volatility $v = 0.05$ obtained by the value of deposit insurance premiums that include risks with dividends $\delta_1 = 1\%$, $\delta_2 = 5\%$, and $\delta_3 = 10\%$, as Figure 3:

![Figure 3. The Effect of Dividends on Deposit Insurance Premium](image)

In Figure 3, in the distribution of dividends of 10%, the value of deposit insurance premiums is greater than the distribution of dividends of 5% and 1%. The greater dividend value causes the value of deposit insurance premiums increase. The greater dividend distributed can caused he greater the reduction in assets so that the value of deposit insurance premiums increases. This is because dividend distribution affects the assets of a bank.

6. Conclusion

Based on the results and discussion can be concluded that the risk adjusted deposit insurance premium value solution is an analytical solution. Based on the simulation it can be concluded that the amount of volatility ($v$) causes the value of deposit insurance premiums getting bigger. The more debt obligations also causes the value of deposit insurance premium increase. In determining the value of deposit insurance premium, the nominal value of the insured deposit ($B_1$) is more influential than the nominal of the uninsured debt obligation ($B_2$). The value of deposit insurance premiums is inversely proportional to the amount of interest rate. The value of deposit insurance premiums increases with the amount of dividends distributed by the bank.

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