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Metodología para la estimación de la dependencia de las tasas de cambio en Colombia

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Introducción

Cuando se está pensando en realizar una inversión, una de las primeras preguntas que surge es ¿Cuánto puedo llegar a perder con esta inversión?. De manera intuitiva, el valor en riesgo (VaR, por sus siglas en inglés) trata de responder esta pregunta y establece la pérdida máxima de las inversiones en determinado horizonte temporal con algún nivel de confianza.

La Superintendencia Financiera de Colombia (SFC), en su Circular Básica Contable y Financiera establece que este valor en riesgo debe ser calculado diariamente utilizando un intervalo de confianza de 99 % en un extremo de la distribución, donde el período de tenencia a emplear será de mínimo 10 días y será de 20 días hábiles de negociación para las entidades de seguros generales. Para esta estimación pueden adoptarse tanto enfoques paramétricos, como no paramétricos, las bases de datos deben estar actualizadas y se debe considerar un período de observación efectivo de por lo menos un año. La SFC también permite el uso de correlaciones entre los diferentes factores de riesgo de mercado siempre y cuando la metodología de estimación sea técnicamente consistente y las pruebas de backtesting corroboren los resultados obtenidos.

En este trabajo se mide la dependencia entre las tasas de cambio del dólar y del euro con respecto al peso colombiano. Esta medida se realiza por el método de cópulas luego de establecer el modelo GARCH que mejor se ajuste a ambas series. Una vez establecida la cópula se realiza el pronóstico de los siguientes 60 días, es decir desde el 31 de enero de 2019 hasta el 31 de marzo de 2019, con el fin de medir el VaR de un portafolio ficticio que varía la proporción de sus inversiones tanto en dólares como en euros.

En los primeros tres capítulos del documento se realiza una introducción a los conceptos básicos de cópulas, series de tiempo y solvencia y riesgo de mercado, en el cuarto capítulo se presenta el anális gráfico de datos, se muestran los resultados, la metodología y un caso práctico sobre la estimación del VaR de un portafolio ficticio.

1. Cópulas, medidas de correlación, concordancia y dependencia.

El término cópula nace como respuesta de Sklar (1959) a un problema de Fréchet, quien estudiaba la relación entre una función de probabilidad multivariada y su distribución marginal. Mediante un teorema que lleva su mismo nombre, Sklar logró demostrar la existencia de una función a la que llamó cópula la cual establece la relación que buscaba Fréchet.

Teniendo en cuenta que el objetivo del trabajo es estimar la dependencia entre las respectivas tasas de cambio, el enfoque se realizará en cópulas bivariadas.

En este capítulo se siguen de cerca las siguientes referencias para las definiciones y los teoremas: [Cherubini et al., 2004], [Nelsen, 2006] y [Sandstrõn, 2010].

1.1. Cópulas

Definición 1.1 (Cópula bidimensional)**.** Una cópula bidimensional o 2-cópula es una función C de I^2 en I con las siguientes propiedades:

1. Para todo u, v en I, $C(u, 0) = 0 = C(0, v)$, $C(u, 1) = u$ y $C(1, v) = v$;

2. Para todo u_1, u_2, v_1, v_2 en I tal que $u_1 \leq u_2$ y $v_1 \leq v_2$,

$$C(u_2, v_2) - C(u_2, v_1) - C(u_1, v_2) + C(u_1, v_1) \geq 0.$$

El siguiente teorema relaciona las cópulas con las funciones de distribución conjunta de variables aleatorias.

Teorema 1.1 (Teorema de Sklar)**.** Sea H una función de sitribución conjunta con marginales F y G. Entonces existe una cópula C tal que para todo x, y en $\overline{\mathbb{R}}$,

$$H(x, y) = C(F(x), G(y)).$$

Si F y G son continuas, entonces C es única; de otra manera, C está determinada únicamente sobre Ran$F$ $\times$ Ran$G$. Inversamente, si C es una cópula y F y G son funciones de distribución, entonces la función $H(x, y) = C(F(x), G(y))$ es una función de distribución conjunta con marginales F y G.

Una consecuencia importante del teorema de Sklar es que dada una cópula y unas funciones de distribución cualesquiera, la función $H(x, y)$ es también una función de distribución, donde la cópula separa el comportamiento marginal de F y de G.

1.2. Medidas de correlación

La medida de correlación es una de las más utilizadas para cuantificar la relación entre dos variables debido a su facilidad de cálculo. Sin embargo, es una medida de relación lineal y no captura ningún otro tipo de relación entre variables.

Definición 1.2 (Coeficiente de correlación de Pearson)**.** Sean X y Y variables aleatorias reales con $Var(X) \in (0, +\infty)$ y $Var(Y) \in (0, +\infty)$. El coeficiente de correlación de Pearson está definido como sigue:

$$\rho(X, Y) = \frac{Cov(X,Y)}{\sqrt{Var(X)}\sqrt{Var(Y)}}$$

Dentro de sus propiedades están:

1. ρ está definido para todo par de variables aleatorias X e Y.

2. $\rho(X, Y) = \rho(Y, X)$

3. $-1 \leq \rho(X, Y) \leq 1$

4. Si X y Y son independientes, entonces $\rho(X, Y) = 0$

5. Si C_1 y C_2 con cópulas tales que $C_1 \prec C_2$ entonces $\rho_{C_1} \leq \rho_{C_2}$

1.3. Medidas de concordancia

Dado que ρ mide únicamente relaciones lineales entre X y Y, se hace necesaria la introducción de nuevas medidas que permitan otro tipo de relación entre las variables aleatorias, estas son conocidas como medidas de concordancia.

Denotando con (x_i, y_i) y (x_j, y_j) dos observaciones de un vector (X, Y) de variables aleatorias continuas, decimos que (x_i, y_i) y (x_j, y_j) son concordantes si $x_i < x_j$ y $y_i < y_j$, o si $x_i > x_j$ y $y_i > y_j$. Decimos que (x_i, y_i) y (x_j, y_j) son discordantes si $x_i < x_j$ y $y_i > y_j$, o si $x_i > x_j$ y $y_i < y_j$.

Definición 1.3 (Medida de concordancia)**.** Una medida numérica κ de asociación entre dos variables aleatorias continuas X e Y cuya cópula es C es una medida de concordancia si satisface las siguientes propiedades:

1. κ está definida para todo par X, Y de variables aleatorias continuas

2. $-1 \leq \kappa_{X,Y} \leq 1$, $\kappa_{X,X} = 1$, y $\kappa_{X,-X} = -1$

3. $\kappa_{X,Y} = \kappa_{Y,X}$

4. Si X e Y son independientes, entonces $\kappa_{X,Y} = \kappa_{\Pi} = 0$

5. Si C_1 y C_2 con cópulas tales que $C_1 \prec C_2$ entonces $\kappa_{C_1} \leq \kappa_{C_2}$

6. Si $\{(X_n, Y_n)\}$ es una sucesión de variables aleatorias continuas con cópulas C_n, y si $\{C_n\}$ converge puntualmente a C, entonces $\lim\limits_{n \to +\infty} \kappa_{C_n} = \kappa_C$

Definición 1.4 (τ de Kendall)**.** La versión popular de τ de Kendall está definida como la probabilidad de concordancia menos la probabilidad de discordancia, es decir: $\tau = \tau_{X,Y} = P[(X_1 - X_2)(Y_1 - Y_2) > 0] - P[(X_1 - X_2)(Y_1 - Y_2) < 0]$ donde (X_1, Y_1) y (X_2, Y_2) son vectores independientes e idénticamente distribuidos, cada uno con función de distribución conjunta H.

Definición 1.5 (ρ de Spearman)**.** La versión popular de ρ de Spearman se define como sigue: $\rho_{X,Y} = 3(P[(X_1 - X_2)(Y_1 - Y_3) > 0] - P[(X_1 - X_2)(Y_1 - Y_3) < 0])$ donde (X_1, Y_1), (X_2, Y_2) y (X_3, Y_3) son vectores aleatorios independientes con una función de distribución conjunta común H, cuyas marginales son F y G, y una cópula C.

Incluso cuando τ y ρ son medidas de probabilidad de concordancia, sus valores son diferentes. Sin embargo, existe una desigualdad que las relaciona.

Teorema 1.2. Sean X e Y variables aleatorias continuas, τ y ρ definidos como τ de Kendall y ρ de Spearman respectivamente. Entonces: $-1 \leq 3\tau - 2\rho \leq 1$.

1.4. Medidas de dependencia

Dentro de las propiedades de las medidas de concordancia se encuentra que es igual que cero si X y Y son idependientes, pero no es posible afirmar que si $\kappa_{X,Y} = 0$ entonces X e Y son independientes. Sin embargo, existen otro tipo de medidas que permite establecer esta propiedad en ambos sentidos, estas son las medidas de dependencia.

Definición 1.6 (Medida de dependencia)**.** Una medida numérica de asociación δ entre dos variables aleatorias continuas X e Y cuya cópula es C es una medida de dependencia si satisface las siguientes propiedades:

1. δ está definida para todo par X, Y de variables aleatorias continuas

2. $\delta_{X,Y} = \delta_{Y,X}$

3. $0 \leq \delta_{X,Y} \leq 1$

4. $\delta_{X,Y} = 0$ si y solo si X e Y son independientes

5. $\delta_{X,Y} = 1$ si y solo si X e Y son funciones estrictamente monótonas casi siempre la una de la otra

6. Si α y β son casi siempre funciones estrictamente monótonas en Ran$X$ y Ran$Y$, respectivamente, entonces $\delta_{\alpha(x),\beta(Y)} = \delta_{X,Y}$

7. Si $\{(X_n, Y_n)\}$ es una sucesión de variables aleatorias continuas con cópulas C_n, y si $\{C_n\}$ converge puntualmente a C, entonces $\lim\limits_{n\to+\infty} \kappa_{C_n} = \kappa_C$

Definición 1.7 (σ de Schweizer y Wolff)**.** Esta medida de dependencia satisface las siete condiciones dadas en la definición anterior. Está dada por:

$$\sigma_{X,Y} = \sigma_C = 12 \iint |C(u,v) - uv| \, du \, dv$$

1.5. Familias de cópulas

1.5.1. Cópula producto

La cópula producto se define como sigue $\Pi(u, v) = uv$.

1.5.2. Cópulas arquimedianas

Pueden ser expresadas de la forma $C(u_1, \cdots, u_d) = \varphi^{-1}\{\varphi(u_1), \cdots, \varphi(u_d)\}$, donde φ : $(0,1] \to [0,\infty)$, tal que $\varphi(1) = 0$. La función φ se conoce como generador de la cópula. Una cópula bivariada arquimediana está definida por:

$$C(u,v) = \begin{cases} \varphi^{-1}[\varphi(u) + \varphi(v)] & \text{si } \varphi(u) + \varphi(v) \neq \varphi(0) \\ 0 & \text{en otro caso} \end{cases}$$

para $0 \leq u$, $v \leq 1$, donde el generador φ es una función convexa.

Además, el τ de Kendall puede expresarse como:

$$\tau = 1 + 4 \int_0^1 \frac{\varphi(t)}{\varphi'(t)}\, dt$$

- Familia Gumbel. Tiene como generador $\varphi(t) = (-\ln t)^\theta$ y está definida así:

$$C_\theta^{Gu}(u,v) = \exp\left\{-[(-\ln u)^\theta + (-\ln v)^\theta]^{1/\theta}\right\}, \quad 1 \leq \theta \leq \infty$$

- Familia Clayton. Tiene como generador $\varphi(t) = (1/\theta)(t^{-\theta} - 1)$ y está definida de la siguiente manera:

$$C_\theta^{Cl}(u,v) = (u^{-\theta} + v^{-\theta} - 1)^{-1/\theta}, \quad \theta \geq -1$$

1.5.3. Cópulas elípticas

Son las cópulas de las distribuciones elípticas. Dentro de esta clase de cópulas se encuentran:

- Cópula Gaussiana. Está definida en el caso bivariado así:

$$C_{v,\rho}^{Ga}(u,v) = \int_{-\infty}^{\Phi^{-1}(u)} \int_{-\infty}^{\Phi^{-1}(v)} \frac{1}{2\pi(1-\rho^2)^{1/2}} \exp\left\{-\frac{s^2 - 2\rho st + t^2}{v(1-\rho^2)}\right\} ds\, dt$$

  donde ρ es el coeficiente de correlación de Pearson de la distribución normal bivariada.

- Cópula t-student. Está definida en el caso bivariado como sigue:

$$C^t_{v,\rho}(u,v) = \int_{-\infty}^{t_v^{-1}(u)} \int_{-\infty}^{t_v^{-1}(v)} \frac{1}{2\pi(1-\rho^2)^{1/2}} \times \left\{1 + \frac{s^2 - 2\rho st + t^2}{v(1-\rho^2)}\right\}^{-(v+2)/2} ds\, dt$$

donde ρ es el coeficiente de correlación de distribución bivariada correspondiente t_v si $v > 2$, con v siendo los grados de libertad.

1.5.4. Cópulas Marshall-Olkin

La cópula bivariada se define así:

$$C^{MO}_{\alpha_1,\alpha_2}(u,v) = \text{mín}\{u^{1-\alpha_1}v, uv^{1-\alpha_2}\}$$

Se puede demostrar que $\tau = \frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2-\alpha_1\alpha_2}$ y $\rho = \frac{3\alpha_1\alpha_2}{2\alpha_1+2\alpha_2-\alpha_1\alpha_2}$.

1.5.5. Cópulas Frechet

Están definidas como sigue:

$$C^{FH}_\theta(u,v) = (1-\theta)uv + \theta\,\text{mín}(u,v)$$

donde $\theta \in [0,1]$ y τ de Kendall es $\tau = \frac{(\theta(\theta+2))}{3}$.

1.5.6. Familia de Farlie Gumbel Morgenstern

Está definida como:

$$C^{FGM}_\theta(u,v) = uv[1+\theta(1-u)(1-v)], \;\; \theta \in [-1,1]$$

donde τ de Kendall es $\tau = \frac{2}{9}\theta$ y ρ de Spearman es $\rho = \frac{1}{4} + \frac{\theta}{36}$.

2. Series de tiempo

Las series de tiempo son datos que se encuentran en función del tiempo y pueden clasificarse como estocásticas o determinísticas. Las primeras se predicen parcialmente pues cuentan con algún elemento de aleatoriedad, representado por un término de error; las segundas son aquellas que pueden predecirse totalmente. Generalmente, el estudio de series de tiempo se enfoca en las series estocásticas, las cuales vamos a tratar en este trabajo.

En este capítulo se siguen de cerca las siguientes referencias para las definiciones y los teoremas: [Montengro, 2004], [Tsay, 2002] y [Wei, 2006].

A continuación se presentan unas definiciones importantes para los temas tratados en este capítulo.

Definición 2.1 (Ruido blanco)**.** Una serie y_t es ruido blanco si

$$y_t \sim (\mu, \sigma^2).$$

Definición 2.2 (Función de Autocorrelación Parcial (PACF))**.** El coeficiente de autocorrelación parcial, denotado por $r_p(\tau)$ se calcula de la siguiente manera:

$$r_p(\tau) = \frac{Cov(y_t - \alpha_1 y_{t-1} - \alpha_2 y_{t-2} \ldots - \alpha_{\tau-1} y_{t-\tau+1}, y_{t-\tau})}{\sqrt{VAR(y_t - \alpha_1 y_{t-1} - \alpha_2 y_{t-2} \ldots - \alpha_{\tau-1} y_{t-\tau+1}) \cdot VAR(y_{t-\tau})}}$$

Definición 2.3 (Supuesto de homocedasticidad)**.** Se habla de homocedasticidad cuando en el modelo, la varianza del error es constante. Se dice que el modelo es heterocedástico si viola el supuesto de homocedasticidad, es decir, si algunos períodos presentan mayor varianza que otros.

Para modelar las series de tiempo, se pueden utilizar los modelos autorregresivos y de promedio móvil, y los modelos de heterocedasticidad condicional; la principal diferencia entre estos modelos radica en que los modelos autorregresivos y de promedio móvil asumen homocedasticidad, mientras que, los modelos de heterocedasticidad condicional permiten la violación de este supuesto.

2.1. Modelos autorregresivos y de promedio móvil

Los modelos autorregresivos y de promedio móvil son utilizados para procesos estocásticos univariados y estacionarios, es decir, las series de tiempo deben cumplir: invarianza en el tiempo para los dos primeros momentos de la función marginal de distribución y tener el mismo tipo de dependencia temporal a través de la muestra.

2.1.1. Modelos autorregresivos

Los procesos autorregresivos son aquellos que expresan una variable en función de su información pasada. El proceso autorregresivo de primer orden AR(1) tiene un solo rezago, AR(2) tiene dos rezagos y AR(p) tiene p rezagos.

Definición 2.4 (Proceso autorregresivo de primer orden AR(1))**.** [Gourieroux and Jasiak, 2001] Las series y_t, $t \in \mathbb{Z}$ siguen un proceso autorregresivo de orden 1, denotado AR(1), si y solo si pueden escribirse como

$$y_t = \alpha y_{t-1} + \varepsilon_t$$

donde ε_t es ruido blanco con varianza σ^2 y $|\alpha| < 1$.

Teorema 2.1. La autocovarianza es obtenida de la siguiente manera

$$\mathbb{E}(y_{t-k} \cdot y_t) = \mathbb{E}(\alpha y_{t-k} \cdot y_t) + \mathbb{E}(y_{t-k} \cdot \varepsilon_t)$$

$$R(k) = \alpha R(k-1),\ k \geq 1$$

la autocorrelación es

$$r(k) = \tfrac{R(k)}{R(0)}$$

$$r(k) = \alpha r(k-1) = \alpha^k,\ k \geq 1.$$

y la función de autocorrelación parcial está definida como

$$r_p(k) = \begin{cases} r(1) = r_p(1) & \text{si } k = 1 \\ 0 & \text{si } k \geq 2 \end{cases}$$

Definición 2.5 (Proceso autorregresivo de segundo orden AR(2))**.** Las series y_t, $t \in \mathbb{Z}$ siguen un proceso autorregresivo de orden 2, denotado AR(2), si y solo si pueden escribirse como

$$y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \varepsilon_t$$

donde ε_t es ruido blanco con varianza σ^2 y las raíces del polinomio deben estar por fuera del círculo unitario.

Teorema 2.2. La autocovarianza es obtenida de la siguiente manera

$$\mathbb{E}(y_{t-k} \cdot y_t) = \alpha_1 \mathbb{E}(y_{t-k} \cdot y_{t-1}) + \alpha_2 \mathbb{E}(y_{t-k} \cdot y_{t-2}) + \mathbb{E}(y_{t-k} \cdot \varepsilon_t)$$

$$R(k) = \alpha_1 R(k-1) + \alpha_2 R(k-2),\ k \geq 1$$

la autocorrelación es

$$r(k) = \tfrac{R(k)}{R(0)}$$

$$r(k) = \alpha_1 r(k-1) + \alpha_2 r(k-2),\ k \geq 1.$$

y la función de autocorrelación parcial está definida como

$$r_p(k) = \begin{cases} r(1) & \text{si } k = 1 \\ \frac{r(2)-r(1)^2}{1-r(1)^2} & \text{si } k = 2 \\ 0 & \text{si } k \geq 3 \end{cases}$$

Definición 2.6 (Proceso autorregresivo de orden general p AR(p))**.** Las series y_t, $t \in \mathbb{Z}$ siguen un proceso autorregresivo de orden p, denotado AR(p), si y solo si pueden escribirse como

$$y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \cdots + \alpha_p y_{t-p} + \varepsilon_t$$

donde ε_t es ruido blanco con varianza σ^2 y las raíces del polinomio deben estar por fuera del círculo unitario.

Teorema 2.3. La autocovarianza es obtenida de la siguiente manera

$$\mathbb{E}(y_{t-k} \cdot y_t) = \alpha_1 \mathbb{E}(y_{t-k} \cdot y_{t-1}) + \cdots + \alpha_p \mathbb{E}(y_{t-k} \cdot y_{t-p}) + \mathbb{E}(y_{t-k} \cdot \varepsilon_t)$$

$$R(k) = \alpha_1 R(k-1) + \cdots + \alpha_p R(k-p),\ k > 0$$

y la autocorrelación es

$$r(k) = \frac{R(k)}{R(0)}$$

$$r(k) = \alpha_1 r(k-1) + \cdots + \alpha_p r(k-p),\ k > 0.$$

2.1.2. Modelo de promedio móvil

Los modelos de promedio móvil expresan la variable en función de una serie de ruido blanco con media cero y varianza finita. El modelo de promedio móvil de primer orden MA(1) tiene un solo rezago de ε_t, MA(2) tiene dos rezagos y MA(q) tiene q rezagos de ε_t.

Definición 2.7 (Modelo de promedio móvil de primer orden MA(1))**.** Las series y_t, $t \in \mathbb{Z}$ siguen un modelo móvil de orden 1, denotado MA(1), si y solo si pueden escribirse como

$$y_t = \varepsilon_t - \beta_1 \varepsilon_{t-1}$$

donde $|\beta_1| < 1$

Teorema 2.4. La autocovarianza es obtenida de la siguiente manera

$$\mathbb{E}(y_{t-k} \cdot y_t) = \mathbb{E}[(\varepsilon_t - \beta_1 \cdot \varepsilon_{t-1})(\varepsilon_{t-k} - \beta_1 \cdot \varepsilon_{t-1-k})]$$

$$R(k) = \begin{cases} (1+\beta_1^2)\sigma_\varepsilon^2 & \text{si } k = 0 \\ -\beta_1 \sigma_\varepsilon^2 & \text{si } k = 1 \\ 0 & \text{si } k > 1 \end{cases}$$

y la autocorrelación es

$$r(k) = \tfrac{R(k)}{R(0)}$$

$$r(k) = \begin{cases} \frac{-\beta_1}{1+\beta_1^2} & \text{si } k = 1 \\ 0 & \text{si } k > 1 \end{cases}$$

y la función de autocorrelación parcial es

$$r_p(k) = \tfrac{-\beta_1^k(1-\beta_1^2)}{1-\beta_1^{2(k+1)}}, \text{ para } k \geq 1$$

Definición 2.8 (Modelo de promedio móvil de segundo orden MA(2))**.** Cuando $\theta(B) = (1 - \beta_1 B - \beta_2 B^2)$, se tiene el modelo de promedio móvil de segundo orden, denotado MA(2), si y solo si puede escribirse

$$y_t = (1 - \beta_1 B - \beta_2 B^2)\varepsilon_t$$

donde las raíces de $(1 - \beta_1 B - \beta_2 B^2) = 0$ deben estar por fuera del círculo unitario.

Teorema 2.5. La autocovarianza de MA(2) es

$$R(0) = (1 + \beta_1^2 + \beta_2^2)\sigma_\varepsilon^2,$$

$$R(1) = -\beta_1(1 - \beta_2)\sigma_\varepsilon^2,$$

$$R(2) = -\beta_2\sigma_\varepsilon^2,$$

$$R(k) = 0,\ k > 2$$

la función de autocorrelación es

$$r(k) = \frac{R(k)}{R(0)}$$

$$r(k) = \begin{cases} \frac{-\beta_1(1-\beta_2)}{1+\beta_1^2+\beta_2^2} & \text{si } k = 1 \\ \frac{-\beta_2}{1+\beta_1^2+\beta_2^2} & \text{si } k = 2 \\ 0 & \text{si } k > 2 \end{cases}$$

y la autocorrelación parcial es

$$r_p(k) = \begin{cases} r(1) & \text{si } k = 1 \\ \frac{r(2)-r(1)^2}{1-r(1)^2} & \text{si } k = 2 \\ \frac{r(1)^3-r(1)r(2)(2-r(2))}{1-r(2)^2-2r(1)^2(1-r(2))} & \text{si } k = 3 \\ \\ 0 & \text{si } k \geq 4 \end{cases}$$

Definición 2.9 (Modelo de promedio móvil de orden general q MA(q))**.** Cuando $\theta(B) = (1 - \beta_1 B - \beta_2 B^2 - \cdots - \beta_q B^q)$, se tiene el modelo de promedio móvil de orden general q, denotado MA(q), si y solo si puede escribirse

$$y_t = (1 - \beta_1 B - \beta_2 B^2 - \cdots - \beta_q B^q)\varepsilon_t$$

donde las raíces de $(1 - \beta_1 B - \beta_2 B^2 - \cdots - \beta_q B^q) = 0$ deben estar por fuera del círculo unitario.

Teorema 2.6. La autocovarianza de MA(q) es

$$R(k) = \begin{cases} \sigma_\varepsilon^2(-\beta_k + \beta_1\beta_{k+1} + \cdots + \beta_{q-k}\beta_q) & \text{si } k = 1, 2, \ldots, q \\ 0 & \text{si } k > q \end{cases}$$

y la función de autocorrelación es

$$r(k) = \frac{R(k)}{R(0)}$$

$$r(k) = \begin{cases} \frac{-\beta_k + \beta_1\beta_{k+1} + \cdots + \beta_{q-k}\beta_q}{1+\beta_1^2 + \cdots + \beta_q^2} & \text{si } k = 1, 2, \ldots, q \\ 0 & \text{si } k > q \end{cases}$$

2.1.3. Modelo ARMA(p, q)

El modelo ARMA(p, q) es un modelo de promedio móvil autorregresivo el cual es una combinación de los modelos AR(p) y MA(q), y su propiedad de invertibilidad, es decir, las raíces de los polinomios de los respectivos modelos están por fuera del círculo unitario.

Definición 2.10 (Modelo ARMA(p, q))**.** La expresión para el modelo ARMA(p, q) donde p y q son el último rezago de la serie está dada por

$$y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \cdots + \alpha_p y_{t-p} + \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \cdots + \beta_q \varepsilon_{t-q}$$

Teorema 2.7. La autocovarianza del modelo ARMA(p, q) es

$$R(k) = \alpha_1 R(k-1) + \cdots + \alpha_p R(k-p),\ k \geq (q+1)$$

y la función de autocorrelación está dada por

$$r(k) = \frac{R(k)}{R(0)}$$

$$r(k) = \alpha_1 r(k-1) + \cdots + \alpha_p r(k-p),\ k \geq (q+1)$$

2.1.4. Identificación del Modelo

Las tablas y figuras de este apartado son de la autoría de la profesora Ana María Díaz en Notas de Clase: Econometría Avanzada [Díaz, 2013]. La identificación del modelo a utilizar se realiza basándose en la siguiente tabla que utiliza la función de autocorrelación (ACF) y la función de autocorrelación parcial (PACF).

Modelo	ACF	PACF
AR(p)	Su gráfica presenta una disminución exponencial que combina coeficientes positivos y negativos en forma regular o sinusoidal	Coeficientes significativos a lo largo de p rezagos
MA(q)	Coeficientes significativos a lo largo de q rezagos	Su gráfica presenta una disminución exponencial
ARMA(p,q)	Su gráfica presenta una disminución exponencial	Su gráfica presenta una disminución exponencial

2.2. Modelos de heterocedasticidad condicional

Los modelos de heterocedasticidad condicional son comúnmente utilizados para modelar la volatilidad de los retornos financieros. En los modelos anteriores se asume homocedasticidad, en esta sección se viola este supuesto permitiendo modelar aquellas series que presentan períodos con una varianza mayor que otros.

El primer modelo de este tipo es el modelo ARCH, el cual asume que la media del retorno no está correlacionada y que la dependencia del error puede representarse mediante una función cuadrática de sus valores rezagados.

Definición 2.11 (Modelo ARCH)**.** El modelo ARCH(m) asume que

$$\sigma_t^2 = \beta_0 + \beta_1\varepsilon_{t-1}^2 + \beta_2\varepsilon_{t-2}^2 + \cdots + \beta_q\varepsilon_{t-q}^2$$

donde $\beta_0 > 0$ y $\beta_i \geq 0$ para $i > 0$.

El siguiente modelo también se conoce como modelo ARCH generalizado pues la varianza condicional sigue un modelo ARMA, en este modelo la volatilidad también depende de las volatilidades anteriores.

Definición 2.12 (Modelo GARCH)**.** El modelo GARCH(p, q) asume que

$$\sigma_t^2 = \alpha_0 + \alpha_1 \sigma_{t-1}^2 + \alpha_2 \sigma_{t-2}^2 + \cdots + \alpha_p \sigma_{t-p}^2 + \beta_1 \varepsilon_{t-1}^2 + \beta_2 \varepsilon_{t-2}^2 + \cdots + \beta_q \varepsilon_{t-q}^2$$

donde p es el número de rezagos de la varianza y q es el número de rezagos de los errores al cuadrado.

3. Solvencia y Riesgo de Mercado

El término solvencia hace referencia a la capacidad de las instituciones de respaldar sus deudas mediante la liquidación de sus activos, es decir, que sus activos sean mayores que sus pasivos. Se dice que una aseguradora es solvente siempre y cuando sea capaz de cumplir con sus obligaciones actuales a medida que estas vencen [Cummins and Derrig, 1989].

En Europa, Solvencia II es un marco prudencial para las compañías de seguros introducido en 2009 en las áreas de seguros de vida, seguros de no vida y reaseguradores. Este marco cuenta con tres pilares: el primero hace referencia a los requerimientos de capital basados en riesgos, donde requiere que las compañías de seguros cuenten con suficiente capital para garantizar que tengan los recursos financieros suficientes para soportar dificultades financieras; el segundo hace referencia a los requisitos de gestión del riesgo donde establece que las aseguradoras deben realizar su propia evaluación de riesgo y solvencia de forma regular; y el tercer pilar hace referencia a los informes de supervisión y divulgación pública el cual permite a los supervisores revisar y evaluar si las compañías de seguros cumplen con las reglas establecidas.

La autoridad encargada de establecer la forma en que debe medirse el requerimiento de capital de solvencia (SCR) de Solvencia II en las compañías de seguros es EIOPA (European Insurance and Occupational Pensions Authority), la cual ha realizado cinco QIS (Quantitative Impact Studies) para este fin. Teniendo en cuenta que este trabajo se centra en el riesgo de mercado, únicamente se presenta la fórmula de SRC para riesgo de mercado establecida en QIS5 [EIOPA, 2010]:

$$SCR_{mkt} = \text{máx}\left(\frac{\sqrt{\sum CorrMktUp_{r,c} \cdot Mkt_{up,r} \cdot Mkt_{up,c}}}{\sqrt{\sum CorrMktDown_{r,c} \cdot Mkt_{down,r} \cdot Mkt_{down,c}}}\right)$$

donde:

- CorrMktDown son las entradas de la siguiente tabla que muestra la matriz de correlación de riesgo de mercado ante choques negativos.

CorrMktDown	Interest	Equity	Property	Spread	Currency	Concentration	Illiquidity premium
Interest	1						
Equity	0.5	1					
Property	0.5	0.75	1				
Spread	0.5	0.75	0.5	1			
Currency	0.25	0.25	0.25	0.25	1		
Concentration	0	0	0	0	0	1	
Illiquidity premium	0	0	0	-0.5	0	0	1

- CorrMktUp son las entradas de la siguiente tabla que muestra la matriz de correlación de riesgo de mercado ante choques positivos.

CorrMktUp	Interest	Equity	Property	Spread	Currency	Concentration	Illiquidity premium
Interest	1						
Equity	0	1					
Property	0	0.75	1				
Spread	0	0.75	0.5	1			
Currency	0.25	0.25	0.25	0.25	1		
Concentration	0	0	0	0	0	1	
Illiquidity premium	0	0	0	-0.5	0	0	1

- $Mkt_{up,r}$ y $Mkt_{up,r}$ son los requerimientos de capital para los riesgos de mercado individuales bajo la tasa de interés Up de acuerdo con las filas y las columnas de la matriz CorrMktUp.

- $Mkt_{down,r}$ y $Mkt_{down,r}$ son los requerimientos de capital para los riesgos de mercado individuales bajo la tasa de interés Down de acuerdo con las filas y las columnas de la matriz CorrMktDown.

A continuación se presenta la normatividad vigente en Colombia, la cual tiene dentro de sus objetivos que las compañías cumplan algunos requisitos mínimos respecto a la medición de sus riesgos. En Colombia, el ente encargado de regular el sistema financiero es el Ministerio de Hacienda y Crédito Público. La Superintendencia Financiera de Colombia (SFC) es la encargada de que hacer cumplir lo esptipulado por el Ministerio.

Para una correcta comprensión de lo establecido por el Ministerio y la SFC, es importante dar una noción de los diferentes tipos de riesgo, a saber: riesgo de activo, riesgo de suscripción y riesgo de mercado.

Según la SFC, se entiende como riesgo de activo al relacionado con que la entidad aseguradora tenga pérdidas o disminuya el valor de sus activos por el incumplimiento de las obligaciones de alguna contraparte (reaseguradores, asegurados, intermediarios de seguros y otras compañías de seguros con las cuales realiza operaciones de coaseguro).

Se entiende como riesgo de suscripción aquel riesgo que se presenta por la la posibilidad de incurrir en pérdidas como consecuencia de políticas y prácticas inadecuadas en el diseño de productos, de tarifas o en la colocación de los mismos.

Y se define riesgo de mercado, en la Circular Básica Contable y Financiera, como la posibilidad de que las entidades incurran en pérdidas asociadas a la disminución del valor de sus portafolios, las caídas del valor de las carteras colectivas o fondos que administran, por efecto de cambios en el precio de los instrumentos financieros en los cuales se mantienen posiciones dentro o fuera del balance. Así como también a la posibilidad de incurrir en pérdidas derivadas del incremento no esperado en el monto de sus obligaciones con asegurados, reaseguradores, intermediarios y otros agentes externos a causa de variaciones en las tasas de interés, en la tasa de devaluación o en las tasas de cambio [SFC, 2012]. El interés de este trabajo es medir el riesgo de mercado asociado a las tasas de cambio, específicamente las tasas de cambio respecto al dólar y al euro.

El Ministerio de Hacienda y Crédito Público, mediante el decreto 2954 del 6 de agosto de 2010, establece el régimen de patrimonio adecuado de las entidades aseguradoras. Allí estipula que además de los riesgos de suscripción asociados con los riesgos amparados y las primas cobradas se deben tener en cuenta otro tipo de riesgos financieros, entre ellos el riesgo de mercado [MinHacienda, 2010].

Dentro de este decreto se fija el patrimonio adecuado, el cual corresponde al patrimonio técnico mínimo que deben mantener y acreditar las aseguradoras. Se calcula de la siguiente manera:

$$PA = \sqrt{\sum_{i=1}^{3}\left(\sum_{j=1}^{3}\rho_{ij}R_iR_j\right)}$$

donde PA es el patrimonio adecuado, R_1 es el riesgo de suscripción, R_2 es el riesgo de activo, R_3 es el valor de riesgo de mercado y ρ_{ij} es el coeficiente de correlación entre el riesgo R_i y el riesgo R_j. Actualmente $\rho_{ij} = 1$. Sin embargo, las aseguradoras basándose en sus modelos de medición pueden realizar sus propios cálculos de este coeficiente, previa autorización de la SFC. Así mismo, instaura que para el cálculo del riesgo de mercado en las entidades de seguro se utilizará la metodología en función del valor en riesgo, el cual es establecido por la SFC en la Circular Básica Contable y Financiera.

Las entidades vigiladas deben diseñar y adoptar el Sistema de Administración de Riesgo de Mercado (SARM) con el propósito de identificar, medir, controlar y monitorear el riesgo de mercado al que se encuentran expuestas [SFC, 2012]. En la administración de riesgo de mercado se deben desarrollar las siguientes etapas:

a) Identificación. Se identifican los diferentes tipos de riesgo de mercado, donde se encuentran los siguientes: tasa de interés en moneda legal, tasa de interés en moneda extranjera, tasa de interés en operaciones pactadas en UVR, **tipo de cambio**, precio de acciones e inversiones realizadas en carteras colectivas. Recordemos que en este trabajo el enfoque se realizará en el tipo de cambio ya que se busca estimar la dependencia de las tasas de cambio en Colombia.

b) Medición. Se cuantifican las pérdidas asociadas al riesgo de mercado. Se establece que todo modelo interno que adopte una aseguradora para la medición del riesgo debe capturar los principales factores de riesgo a los que se encuentra expuesta, el valor en riesgo debe ser calculado diariamente con un intervalo de confianza de 99 % y se pueden adoptar enfoques tanto paramétricos como no paramétricos. Para estos modelos pueden combinar la metodología estándar para medir su exposición al riesgo de mercado o sus modelos internos, los cuales se encuentran en el anexo 3 de la circular básica contable y financiera.

   La metodología en este anexo está compuesta por cuatro módulos que se calculan separadamente: riesgo de tasa de interés, **riesgo de tasa de cambio**, riesgo de precios de acciones y riesgo de inversiones en carteras colectivas. Teniendo en cuenta que este trabajo está centrado en el riesgo de la tasa de cambio, únicamente se presenta la metodología para le medición de este tipo de riesgo, los demás pueden ser consultados en el anexo 3 de la circular básica contable y financiera.

Para el cálculo de la posición neta en cada moneda se deben sumar las siguientes posiciones:

- Posición neta de las operaciones spot de la entidad, la cual se calcula como la diferencia entre los activos y los pasivos incluyendo los intereses.

- Posición neta de las operaciones forward de la entidad, la cual se calcula como la diferencia entre las posiciones largas y las posiciones cortas en forwards, futuros y operaciones a plazo.

- Posición neta de las operaciones en derivados de la entidad que tenga como subyacente un título o una tasa de interés en dicha moneda, la cual se calcula como la diferencia entre las posiciones nocionales largas y las posiciones nocionales cortas

- Adicionalmente para aquellas entidades que posean posiciones cortas en opciones, las posiciones delta ponderadas de opciones en monedas.

Cuando ya se tenga la posición neta de cada moneda, el equivalente en moneda legal se calcula así: para determinar la exposición neta en USD, se multiplica la posición neta en USD por la Tasa de Cambio Representativa del Mercado (TCRM) calculada en la fecha de la evaluación; para monedas que no sean USD, primero se debe convertir las exposiciones a USD tomando como base las tasas de conversión de divisas que publica el Banco Central Europeo (BCE).

Para calcular la exposición al riesgo de tasa de cambio, se debe calcular la sensibilidad neta en cada moneda como el producto de la posición neta y el factor de sensibilidad correspondiente definido en la siguiente tabla:

Moneda	Factor de Sensibilidad
USD	12.49 %
EUR	11 %
Otras monedas	13.02 %
Riesgo general precio de acciones	9.1 %

Así, la exposición al riesgo de tasa de cambio se calcula como la suma de:

-El mayor valor entre la suma de las sensibilidades netas positivas y el valor absoluto de la suma de las sensibilidades netas negativas.

- Para las entidades elegibles para la aproximación simplificada de tratamiento de opciones (aquellas entidades que tengan registradas solamente posiciones largas en opciones), la exposición resultante de las posiciones en opciones sobre monedas.

- Para las entidades que deban aplicar la metodología intermedia (aquellas entidades que tengan registradas posiciones cortas en opciones), los cargos correspondientes a los riesgos Gamma y Vega de dichas opciones.

c) Control. Donde se permite tomar medidas que controlen el riesgo de mercado al que se ven expuestas las aseguradoras en el desarrollo de sus operaciones.

d) Monitoreo. Donde se permite llevar a cabo un seguimiento permanente de la evolución de la exposición al riesgo de mercado de las entidades vigiladas.

4. Resultados

El presente capítulo presenta el análisis gráfico de datos, la metodología utilizada para la estimación de los distintos modelos, así como sus resultados y un caso práctico sobre la estimación del VaR de un portafolio ficticio.

4.1. Análisis Gráfico de Datos

La tasa representativa de mercado (TRM) indica el número de pesos colombianos que se necesitan para adquirir un dólar americano. Así mismo, la tasa de cambio del euro indica el número de pesos colombianos que se necesitan para adquirir un euro. Para este trabajo se tomaron datos desde 31 de enero de 1999 hasta 31 de enero de 2019. Se retiraron de la base de datos aquellos días en que el mercado estaba cerrado, y se emparejaron las bases de datos de tal forma que ambas contaran con los mismo días, lo que da un total de 4757 observaciones.

La gráfica **4-1** representa, en el lado de izquierdo el valor de la TRM en cada instante de tiempo y en el lado derecho el valor de la tasa de cambio del euro en cada instante del tiempo. A partir de las gráficas se puede tener una idea de la dependencia que existe entre estas tasas de cambio puesto que presentan, en su mayoría, el mismo comportamiento. A partir de estos datos se calculan los retornos de cada una de las tasas de cambio que se muestran en la siguiente gráfica teniendo en cuenta la siguiente fórmula $ret_t = \ln y_t - \ln y_{t-1}$, donde y_t se define como el valor de la serie del dólar o del euro en el momento t. Se evidencia que la

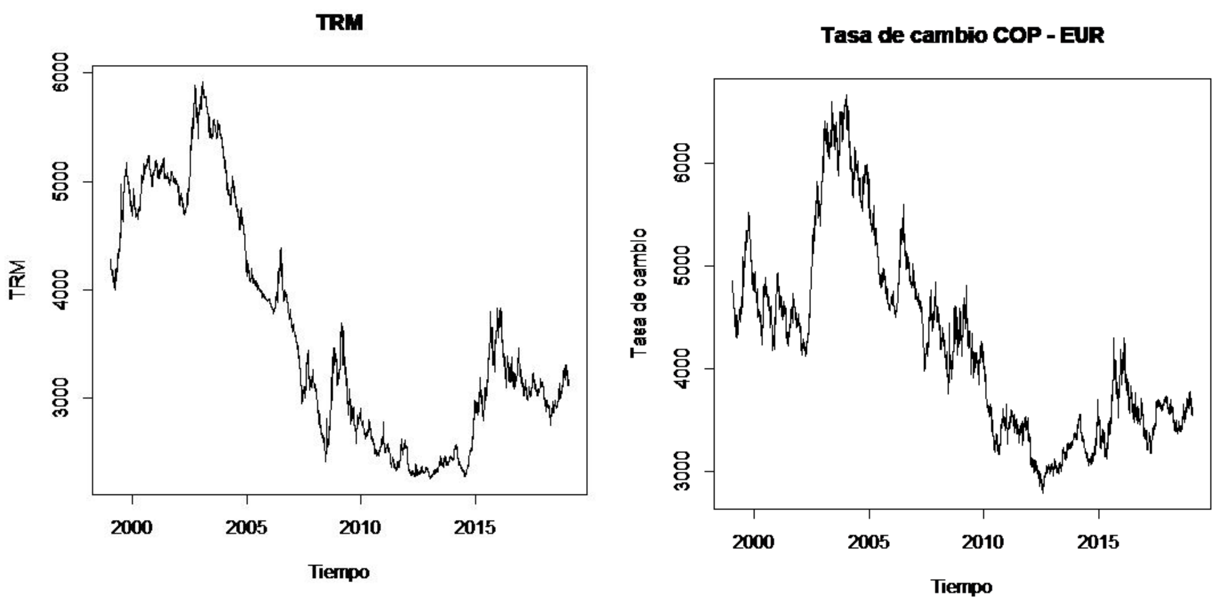


Figura 4-1.: Tasas de cambio

mayor volatilidad se encuentra entre los años 2008 y 2010 para ambas series de tiempo, la cual puede estar explicada por la crisis financiera de 2008.

Esta crisis financiera que estalló en septiembre de 2008 con la declaración en bancarrota del banco de inversión Lehman Brothers, se origina a partir de las llamadas hipotecas subrprime, las cuales eran hipotecas concedidas a clientes que tienen porbabilidades muy bajas de pago, es decir eran hipotecas de alto riesgo y bancos como Lehman Brothers se dedicaban a ofrecer este tipo de servicios. Todas estas hipotecas crearon lo que se conoce como una burbuja inmobiliaria en Estados Unidos, y su estallido fue uno de los factores principales para el origen de la crisis en el país norteamericano. Sin embargo, esta crisis se propagó a nivel mundial por la incertidumbre que generó. En Colombia hubo salida de capital, generando así unas altas devaluaciones y una mayor volatilidad de la tasa de cambio en Colombia tal y como se observa en la gráfica **4-2**.

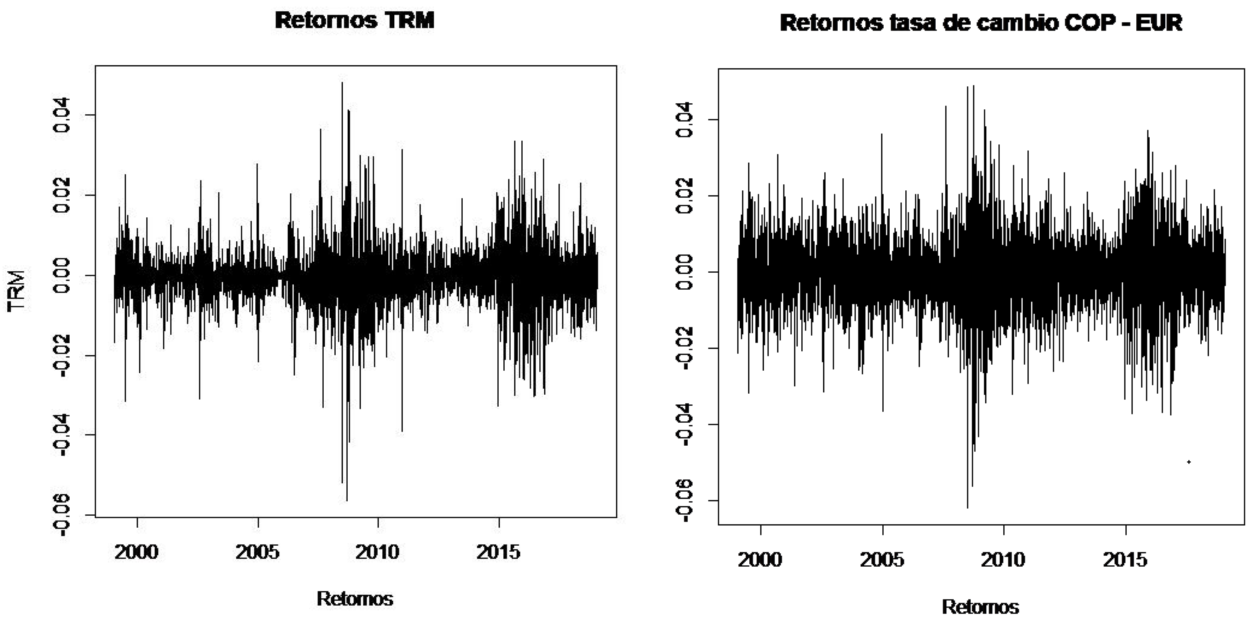


Figura 4-2.: Retornos

Para los distintos modelos explicados en la sección anterior es importante saber si los datos siguen una distribución normal. Para ello se realiza la prueba gráfica QQ-Plot de ambas series, a partir de la gráfica **4-3** se puede concluir que los datos no son los de una normal en ninguna de las dos series.

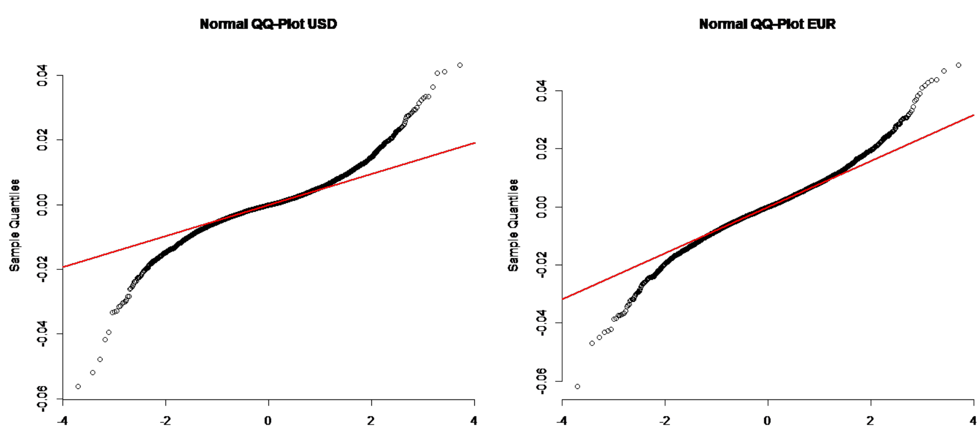
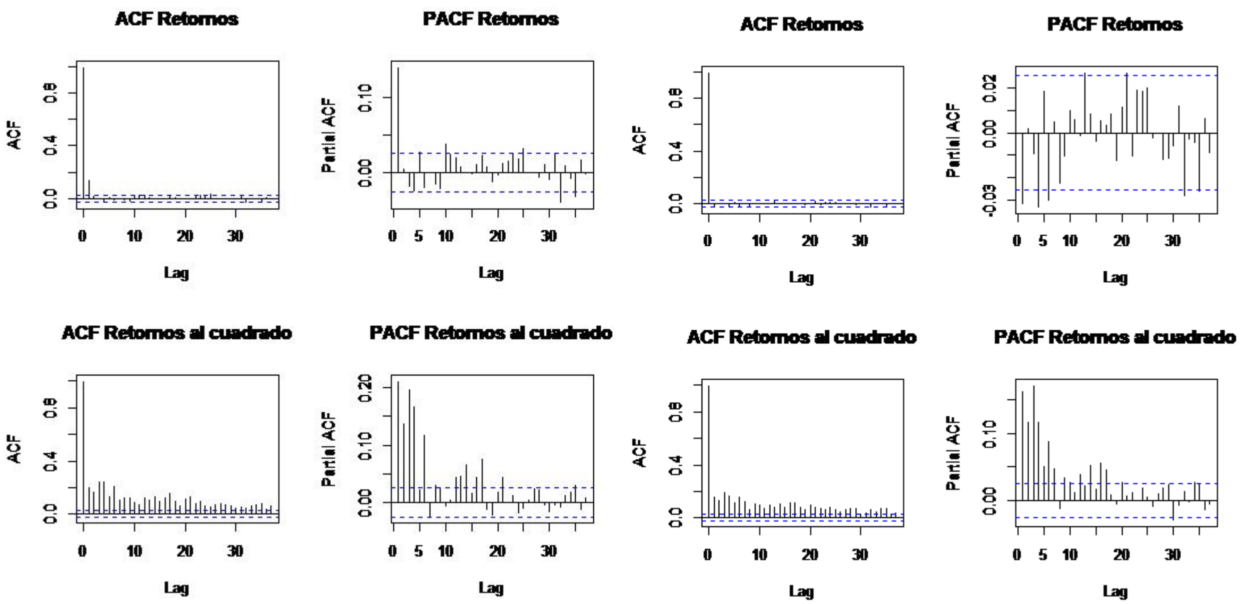


Figura 4-3.: QQ-Plot tasas de cambio

Otro aspecto importante a analizar son las correlaciones de los retornos y de los retornos al cuadrado. A partir de la gráfica **4-4** es posible concluir que los retornos al cuadrado presentan alta dependencia lo cual puede ser una explicación de los grupos de volatilidad de la TRM y del euro. Teniendo en cuenta las gráficas anteriores junto con las pruebas realizadas, se presentan claras señales de un GARCH en ambas series.



(a) ACF y PACF TRM (b) ACF y PACF EUR

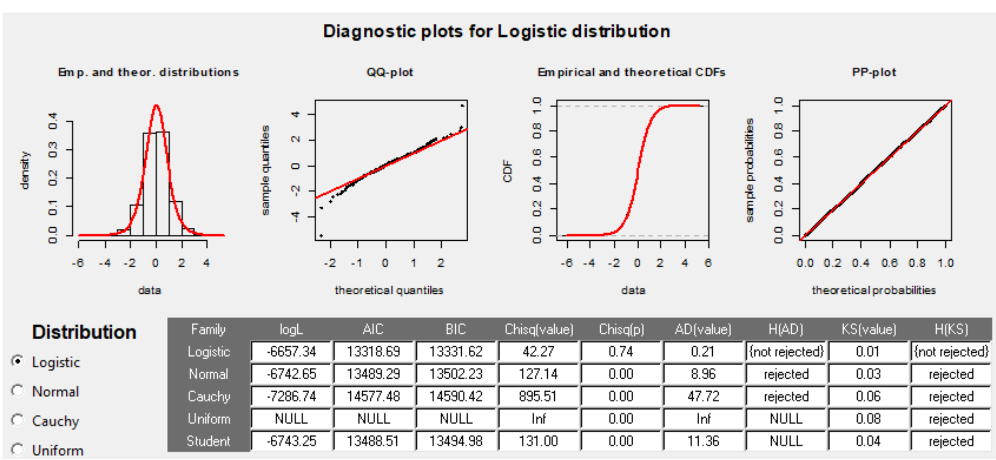
Figura 4-4.: ACF y PACF

4.2. Metodología y resultados

Para la serie de retornos del dólar y la serie se retornos del euro se realizó la estimación del modelo ARMA pertinente. Para ello se tiene en cuenta la significancia de cada coeficiente y el criterio Akaike, donde el mejor modelo será aquel que presente un menor valor. Según los resultados, la serie de los retornos del dólar sigue un modelo ARMA(3,1) y la serie de los retornos del euro sigue un modelo ARMA(1,0), los resultados de las pruebas se encuentran en el anexo A.

Seguido de esto se realizan las pruebas de estacionariedad sobre los cuadrados de los residuales de cada serie para poder estimar un modelo GARCH. Para la estimación del modelo GARCH(p,q) para cada serie, se estima este modelo con distintos parámetros, es decir, se realizan distintas estimaciones con p y q variando entre 0 y 10. Esto da como resultado, según el criterio de Akaike, un modelo GARCH(4,8) para la serie de retornos del dólar y un modelo GARCH(1,3) para la serie de retornos del euro. Los resultados de los distintos modelos GARCH(p,q) pueden verse en el anexo A.

Después de realizar la estimación de los modelos para ambas series, se procede a realizar la estimación de la cópula. Para ello se tienen en cuenta los errores estandarizados de ambas series y su distribución. Para ambas series se realiza con las pruebas pertinentes con el fin de conocer la distribución a la cual se ajustaban los datos. Para ello se comparan varias distribuciones dentro de las que se encuentran: normal, Cauchy, logística, uniforme, t de Student. Una de las pruebas realizadas es el gráfico cuantil-cuantil. La única distribución que no es rechazada es la distribución logística para ambas series como se observa en la siguiente figura.



Family	logL	AIC	BIC	Chisq(value)	Chisq(p)	AD(value)	H(AD)	KS(value)	H(KS)
Logistic	-6657.34	13318.69	13331.62	42.27	0.74	0.21	{not rejected}	0.01	{not rejected}
Normal	-6742.65	13489.29	13502.23	127.14	0.00	8.96	rejected	0.03	rejected
Cauchy	-7286.74	14577.48	14590.42	895.51	0.00	47.72	rejected	0.06	rejected
Uniform	NULL	NULL	NULL	Inf	0.00	Inf	NULL	0.08	rejected
Student	-6743.25	13488.51	13494.98	131.00	0.00	11.36	NULL	0.04	rejected

Figura 4-5.: Pruebas distribución residuales USD

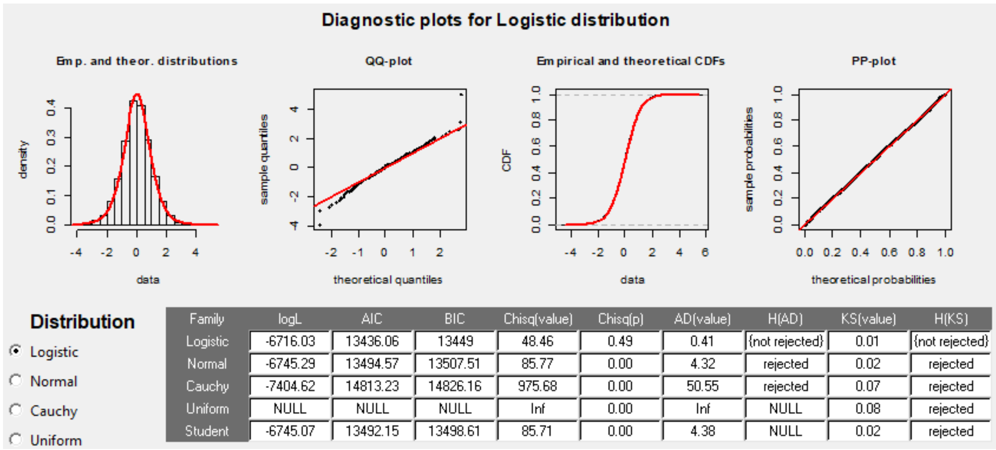


Figura 4-6.: Pruebas distribución residuales EUR

Los parámetros de la distribución son los siguientes:

Parámetros	Dólar	Euro
Localización	0.0304	0.0030
Escala	0.5481	0.5576

Tabla 4-1.: Parámetros distribución logística

Teniendo en cuenta estos parámetros, se estandarizan los residuos al cuadrado de las series con el fin de conocer la cópula que mejor se ajuste a los datos, con el comando *BiCopSelect* se concluye que la cópula para estos datos es la cópula t-Student, que a diferencia de la cópula normal o gaussiana, le da un peso a las colas de la distribución y no únicamente al centro de la misma y sus parámetros se encuentran en la tabla $5-2$.

Nombre	Valor
Parámetro 1	0.657
Parámetro 2	6.426
τ de Kendall	0.457
ρ de Spearman	0.64

Tabla 4-2.: Datos cópula t-Student

A partir de la cópula seleccionada y de las medidas de correlación se puede concluir que ambas series están correlacionadas positivamente, es decir, ambas series aumentan o disminuyen simultáneamente.

Para la construcción de la distribución marginal, a partir de la cópula definida se generan 59 datos aleatorios (01/02/2019 - 31/03/2019) y se repite este proceso 1000 veces. A partir de ello se procede a realizar el pronóstico teniendo en cuenta los modelos GARCH(p,q) especificados para cada serie, seguido del cálculo de los retornos. La figura $5-2$ compara los datos obtenidos a partir de la estimación del modelo GARCH con los datos reales tomados de la página del Banco de la República.

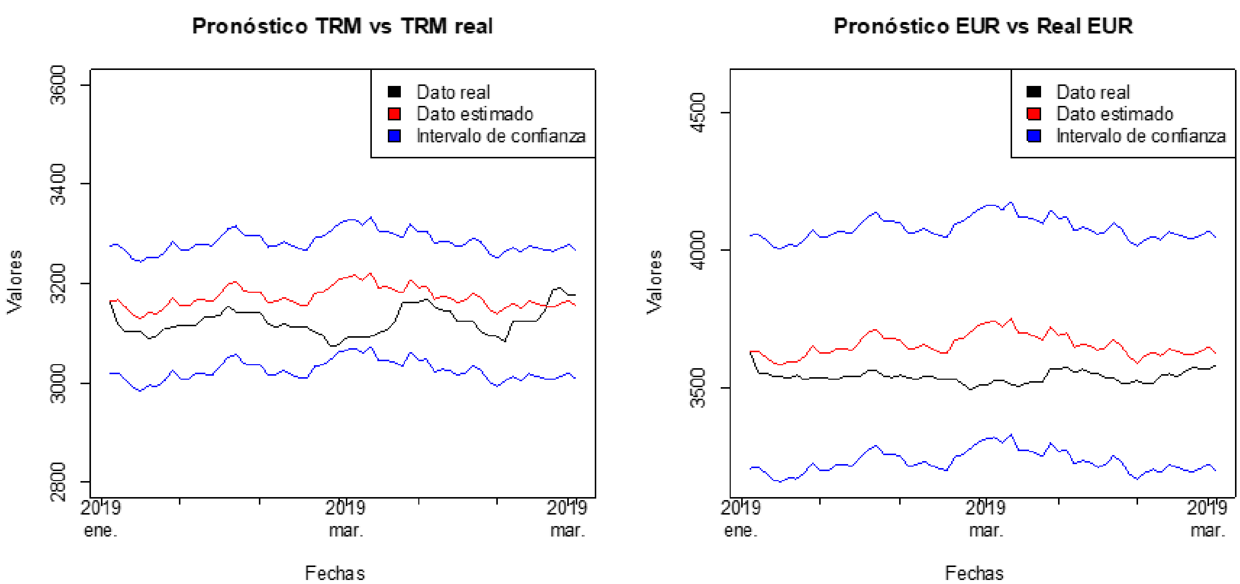


Figura 4-7.: Pronóstico vs. Real

4.3. Caso práctico

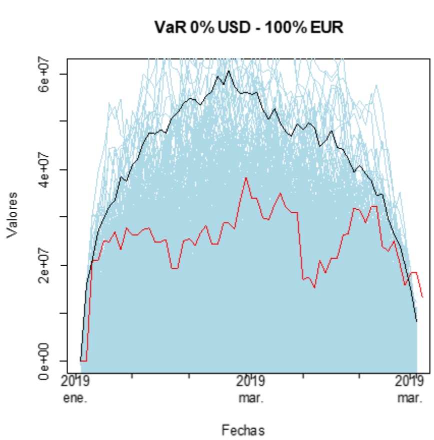
Se crea un portafolio ficticio con un valor de COP 1.000.000.000, repartido en inversiones en euro y en dólar cuyo porcentaje de participación va a variar desde el 0 % hasta el 100 % para ambas monedas. Primero se halla el valor de portafolio a partir de los datos obtenidos en la estimación y con los cuantiles se halla el VaR para los 59 datos pronosticados 1000 veces.

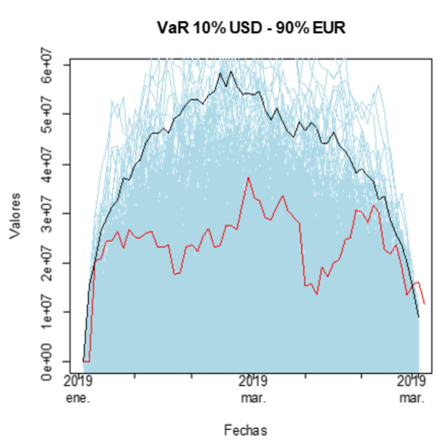
La tabla **4-3** muestra el valor nominal por cada moneda el 31 de enero de 2019, según el porcentaje de participación en el portafolio.

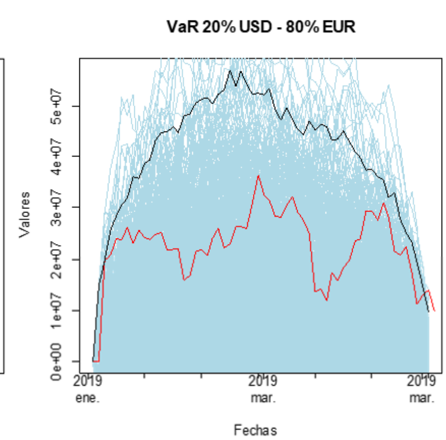
Número de caso	% USD	% EUR	Valor nominal USD	Valor nominal EUR
1	0	100	0	275.452
2	10	90	31.610	247.907
3	20	80	63.221	220.362
4	30	70	94.832	192.816
5	40	60	126.443	165.271
6	50	50	158.054	137.726
7	60	40	189.665	110.181
8	70	30	221.276	82.635
9	80	20	252.887	55.090
9	90	10	284.498	27.545
10	100	0	316.109	0

Tabla 4-3.: Valor invertido por moneda

Para el cálculo del VaR, primero se resta cada valor del portafolio en los distintos días al valor del portafolio el día 31 de enero de 2019; así, si el valor es positivo es porque hay pérdidas y si el valor es negativo hay ganancias. Las siguientes gráficas muestran las estimaciones para los distintos casos.







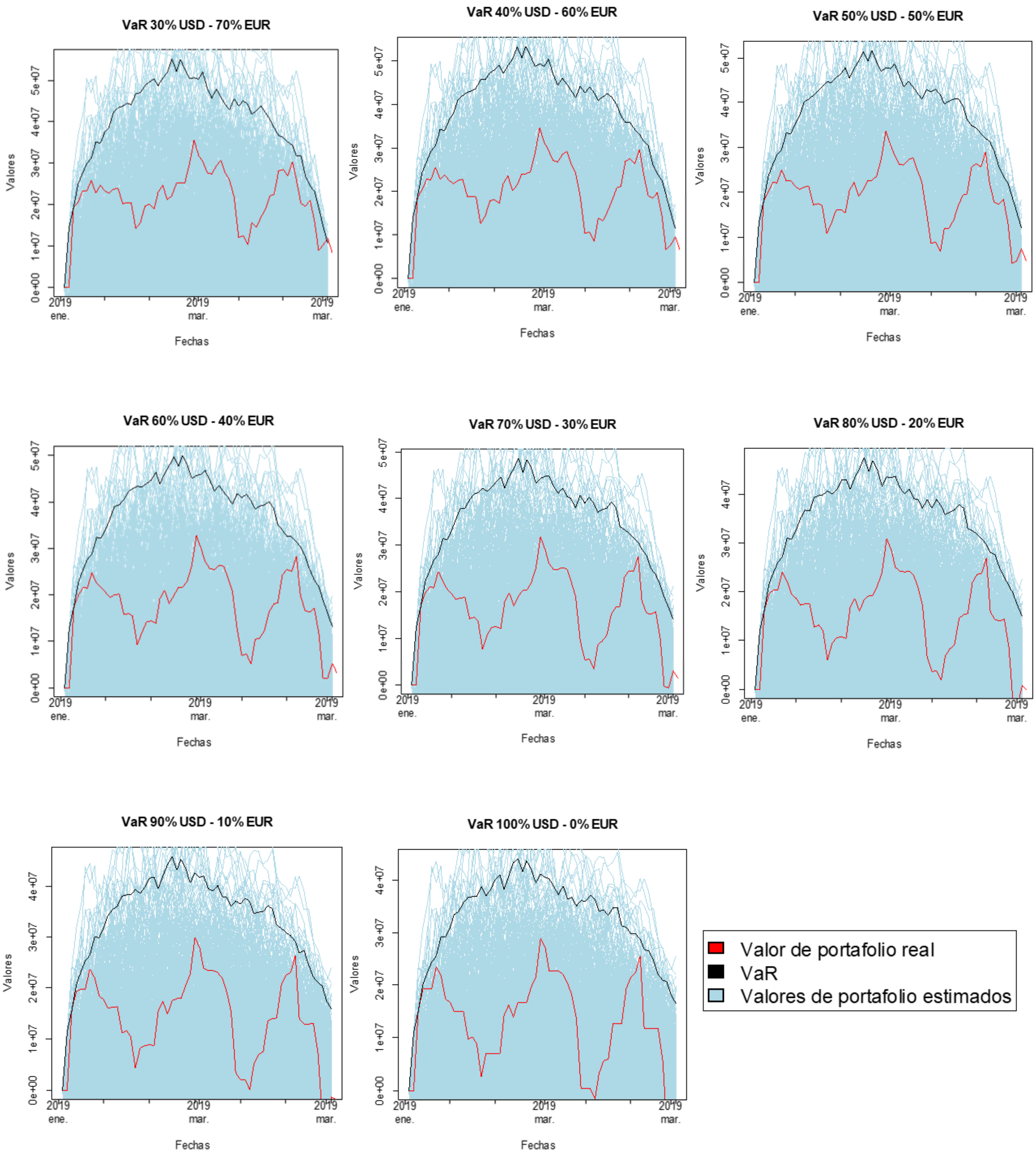


Figura 4-8.: VaR

A partir de las gráficas anteriores es posible ver que la variación del valor de portafolio real está por debajo del VaR y se encuentra dentro de los valores de portafolio estimados, como era de esperarse, puesto que el VaR estima la pérdida máxima de las inversiones en el horizonte temporal que va desde enero 31 hasta marzo 31 del 2019 con un nivel de confianza del 99 %. Teniendo en cuenta las distintas gráficas en la figura **4-8** se puede concluir que el VaR no presenta variaciones entre los distintos casos de la tabla **4-3**. Sin embargo, el valor de portafolio real varía y tiene más volatilidad a medida que aumenta la participación del dólar y por ende disminuye la del euro. Por otro lado se observa un pico inusual en el valor del portafolio real en el mes de febrero. Sin embargo, el modelo estimado captura esta caída lo que da indicios de que la estimación es correcta.

Este pico coincide con las negociaciones entre Estados Unidos y China, ya que como había anunciado el presidente Donald Trump, para el primero de marzo empezaría a aplicar aranceles de hasta 25 %, los cuales estaban en 10 %, sobre US$200,000 millones de bienes del país asiático. Sin embargo, esta aplicación fue retrasada ante unos posibles acuerdos que existieron respecto a política monetaria después de más de un año de la llamada guerra comercial. La cual, recordemos se debe principalmente a los pedidos del país norteamericano de que China aumente sus compras de productos estadounidenses para mitigar el déficit comercial que este país tiene con Pekín, el cual supera los US400,000 millones. Estados Unidos acusa a China de prácticas comerciales desleales pues asegura que las actuales políticas económicas favorecen las empresas del país asiático mediante un sistema de subsidios.

Conclusiones

El uso de cópulas es de utilidad en la asignación de distribuciones bivariadas cuando se tienen distribuciones marginales distintas. Es una función que representa de forma más general las relaciones de dependencia que existen entre variables aleatorias. Sin embargo, no existe un procedimiento óptimo que establezca la mejor cópula que debe ser utilizada.

No obstante, a diferencia del coeficiente de correlación de Pearson, las cópulas capturan dependencias que no son lineales tal y como sucede con los datos trabajados. Como resultado del análisis de dependencia de ambas series de tiempo, se concluye que los datos se ajustan a la cópula t-Student con un τ de kendall de 0,457 y un coeficiente ρ de Spearman de 0,64, es decir existe una correlación positiva entre ambas variables, esto coincide con la teoría económica respecto al arbitraje en el mercado de divisas.

A partir de esta medida de dependencia se puede decir que el riesgo de mercado de una empresa, que está definido como la posibilidad de que las entidades incurran en pérdidas asociadas a la disminución del valor en sus portafolios por efecto de cambios en el precio de los instrumentos financieros, puede medirse de manera óptima teniendo en cuenta este coeficiente de correlación.

A partir de la medición del VaR, que establece la pérdida máxima de las inversiones en el horizonte temporal con un nivel de confianza del 99 %, realizada teniendo en cuenta las distintas simulaciones de los valores de portafolio a partir de los modelos GARCH y la cópula t-student, puede decirse que la cópula elegida fue la adecuada pues el valor del portafolio real desde el 31 de enero de 2019 hasta el 31 de marzo de 2019 está por debajo del VaR, es decir, el modelo capturó adecuadamente las variaciones en las tasas de cambio.

A. Anexo: Modelos ARMA(p, q)

El presente anexo muestra los resultados del criterio Akaike para los modelos que se estimaron teniendo en cuenta la figura **4-4**.

1. Resultados para la serie del dólar

	nombres_d	aic_d
1	aic100_d	−33879.75
2	aic001_d	−33882.73
3	aic002_d	−33881.68
4	aic101_d	−33881.39
5	aic102_d	−33891.40
6	aic103_d	−33885.05
7	aic200_d	−33882.84
8	aic201_d	−33883.83
9	aic202_d	−33883.34
10	aic203_d	−33889.02
11	aic300_d	−33885.57
12	aic301_d	−33891.48
13	aic302_d	−33890.28
14	aic303_d	−33888.38

2. Resultados para la serie del euro

	nombres_e	aic_e
1	aic001_e	−30812.19
2	aic100_e	−30813.17
3	aic101_e	−30810.18

B. Anexo: Modelos GARCH(p, q)

El presente anexo muestra las salidas en R de los distintos modelos GARCH(p, q) que fueron estimados para p y q variando entre 1 y 10.

1. Resultados para la serie del dólar

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------

GARCH Model      : sGARCH(1,1)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------

         Estimate  Std. Error    t value Pr(>|t|)
mu      -0.000199   0.000064   -3.11528 0.001838
ar1     -0.978362   0.003929 -249.03301 0.000000
```

```
ar2     -0.008209   0.014535     -0.56475 0.572241
ar3     -0.022033   0.015345     -1.43586 0.151043
ma1      0.996233   0.000012  81330.45700 0.000000
omega    0.000000   0.000001      0.70528 0.480637
alpha1   0.123888   0.017353      7.13942 0.000000
beta1    0.874206   0.015185     57.56922 0.000000

Robust Standard Errors:
         Estimate  Std. Error      t value Pr(>|t|)
mu      -0.000199   0.000187    -1.064403 0.287146
ar1     -0.978362   0.070468   -13.883736 0.000000
ar2     -0.008209   0.157593    -0.052089 0.958458
ar3     -0.022033   0.075259    -0.292759 0.769706
ma1      0.996233   0.000367  2716.090281 0.000000
omega    0.000000   0.000011     0.034731 0.972294
alpha1   0.123888   0.295045     0.419894 0.674563
beta1    0.874206   0.267904     3.263134 0.001102

LogLikelihood : 17982.42

Information Criteria
------------------------------------

Akaike       -7.5602
Bayes        -7.5493
Shibata      -7.5602
```

```
Hannan-Quinn  -7.5564


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(1,2)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000213    0.000078    -2.73843 0.006173
ar1     0.971965    0.015955    60.91986 0.000000
ar2    -0.035973    0.022040    -1.63215 0.102649
ar3     0.031624    0.015339     2.06166 0.039240
ma1    -0.960487    0.000925 -1037.90031 0.000000
omega   0.000000    0.000001     0.81263 0.416428
alpha1  0.151139    0.024262     6.22946 0.000000
beta1   0.601556    0.097105     6.19492 0.000000
beta2   0.244702    0.066511     3.67911 0.000234
```

```
Robust Standard Errors:
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000213    0.000185 -1.1485e+00  0.25078
ar1     0.971965    0.020242  4.8016e+01  0.00000
ar2    -0.035973    0.027956 -1.2868e+00  0.19817
ar3     0.031624    0.018459  1.7132e+00  0.08668
ma1    -0.960487    0.000446 -2.1525e+03  0.00000
omega   0.000000    0.000010  4.8543e-02  0.96128
alpha1  0.151139    0.473607  3.1912e-01  0.74963
beta1   0.601556    2.336802  2.5743e-01  0.79685
beta2   0.244702    1.900872  1.2873e-01  0.89757

LogLikelihood : 17983.71

Information Criteria
------------------------------------

Akaike       -7.5603
Bayes        -7.5481
Shibata      -7.5603
Hannan-Quinn -7.5560


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(1,3)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000194    0.000063 -3.0724e+00 0.002124
ar1    -0.981483    0.002122 -4.6264e+02 0.000000
ar2    -0.011519    0.012348 -9.3291e-01 0.350864
ar3    -0.022142    0.014898 -1.4863e+00 0.137210
ma1     0.996223    0.000023  4.3795e+04 0.000000
omega   0.000000    0.000000  1.0268e+00 0.304519
alpha1  0.168172    0.023361  7.1988e+00 0.000000
beta1   0.613129    0.092597  6.6215e+00 0.000000
beta2   0.001284    0.124494  1.0313e-02 0.991772
beta3   0.215312    0.073692  2.9218e+00 0.003481

Robust Standard Errors:
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000194    0.000076   -2.547437 0.010852
ar1    -0.981483    0.014196  -69.135977 0.000000
ar2    -0.011519    0.030873   -0.373128 0.709053
```

```
ar3      -0.022142    0.018883    -1.172591  0.240960
ma1       0.996223    0.000109  9099.450472  0.000000
omega     0.000000    0.000006     0.081882  0.934740
alpha1    0.168172    0.366169     0.459274  0.646037
beta1     0.613129    1.919505     0.319420  0.749408
beta2     0.001284    1.069129     0.001201  0.999042
beta3     0.215312    0.529651     0.406517  0.684363

LogLikelihood : 17988.7

Information Criteria
------------------------------------

Akaike       -7.5620
Bayes        -7.5484
Shibata      -7.5620
Hannan-Quinn -7.5572



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(1,4)
```

```
Mean Model        : ARFIMA(3,0,1)
Distribution      : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000196    0.000063 -3.1053e+00 0.001901
ar1    -0.982339    0.002488 -3.9476e+02 0.000000
ar2    -0.012442    0.012605 -9.8704e-01 0.323621
ar3    -0.022297    0.014996 -1.4868e+00 0.137057
ma1     0.996232    0.000021  4.7195e+04 0.000000
omega   0.000000    0.000000  1.3049e+00 0.191934
alpha1  0.167413    0.019465  8.6008e+00 0.000000
beta1   0.642586    0.068722  9.3505e+00 0.000000
beta2   0.003186    0.134403  2.3704e-02 0.981088
beta3   0.121851    0.171660  7.0984e-01 0.477802
beta4   0.063087    0.094973  6.6426e-01 0.506522

Robust Standard Errors:
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000196    0.000073 -2.6955e+00 0.007027
ar1    -0.982339    0.007171 -1.3699e+02 0.000000
ar2    -0.012442    0.019121 -6.5070e-01 0.515241
ar3    -0.022297    0.017035 -1.3088e+00 0.190586
ma1     0.996232    0.000057  1.7526e+04 0.000000
omega   0.000000    0.000004  1.3415e-01 0.893282
```

```
alpha1   0.167413    0.264112   6.3387e-01  0.526164
beta1    0.642586    1.452807   4.4231e-01  0.658267
beta2    0.003186    0.609600   5.2260e-03  0.995830
beta3    0.121851    0.744430   1.6368e-01  0.869980
beta4    0.063087    0.151863   4.1542e-01  0.677835

LogLikelihood : 17988.67

Information Criteria
------------------------------------

Akaike         -7.5616
Bayes          -7.5466
Shibata        -7.5616
Hannan-Quinn   -7.5563


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(1,5)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm
```

```
Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000197    0.000063  -3.123667 0.001786
ar1     0.259916    2.253317   0.115348 0.908169
ar2    -0.028499    0.020674  -1.378538 0.168037
ar3     0.010225    0.050331   0.203157 0.839012
ma1    -0.248567    2.253156  -0.110320 0.912156
omega   0.000000    0.000000   1.652127 0.098509
alpha1  0.163421    0.015945  10.249319 0.000000
beta1   0.715661    0.006984 102.469592 0.000000
beta2   0.006323    0.154488   0.040931 0.967351
beta3   0.004348    0.178560   0.024353 0.980571
beta4   0.000333    0.176836   0.001883 0.998497
beta5   0.108444    0.086334   1.256096 0.209081

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000197    0.000072 -2.749259 0.005973
ar1     0.259916    1.628661  0.159589 0.873205
ar2    -0.028499    0.024761 -1.150954 0.249751
ar3     0.010225    0.043434  0.235421 0.813882
ma1    -0.248567    1.627354 -0.152743 0.878601
omega   0.000000    0.000002  0.223656 0.823025
alpha1  0.163421    0.195223  0.837101 0.402536
```

```
beta1    0.715661    1.029169    0.695377 0.486819
beta2    0.006323    0.275731    0.022933 0.981704
beta3    0.004348    0.960090    0.004529 0.996386
beta4    0.000333    0.621978    0.000535 0.999573
beta5    0.108444    0.289043    0.375182 0.707525

LogLikelihood : 17986.73

Information Criteria
------------------------------------

Akaike        -7.5603
Bayes         -7.5440
Shibata       -7.5604
Hannan-Quinn  -7.5546



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(1,6)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm
```

```
Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000196    0.000062 -3.143548 0.001669
ar1    -0.156054    1.041853 -0.149785 0.880935
ar2    -0.023332    0.009596 -2.431354 0.015043
ar3     0.001214    0.011621  0.104445 0.916816
ma1     0.167991    1.042054  0.161211 0.871927
omega   0.000000    0.000001  0.784863 0.432534
alpha1  0.160314    0.025012  6.409496 0.000000
beta1   0.749809    0.057849 12.961394 0.000000
beta2   0.000746    0.159506  0.004676 0.996269
beta3   0.000056    0.071844  0.000774 0.999383
beta4   0.000008    0.518024  0.000016 0.999987
beta5   0.000011    0.756318  0.000015 0.999988
beta6   0.087803    0.335582  0.261644 0.793596

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000196    0.000164 -1.193816 0.232550
ar1    -0.156054    2.140065 -0.072920 0.941870
ar2    -0.023332    0.062083 -0.375821 0.707050
ar3     0.001214    0.090042  0.013480 0.989245
ma1     0.167991    2.122380  0.079152 0.936912
omega   0.000000    0.000009  0.047068 0.962459
```

```
alpha1  0.160314    0.481299  0.333086 0.739069
beta1   0.749809    0.322195  2.327186 0.019955
beta2   0.000746    1.955868  0.000381 0.999696
beta3   0.000056    2.056546  0.000027 0.999978
beta4   0.000008   11.459625  0.000001 0.999999
beta5   0.000011   13.168400  0.000001 0.999999
beta6   0.087803    5.393472  0.016279 0.987011

LogLikelihood : 17988.35

Information Criteria
------------------------------------

Akaike       -7.5606
Bayes        -7.5429
Shibata      -7.5606
Hannan-Quinn -7.5544



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(1,7)
```

```
Mean Model        : ARFIMA(3,0,1)
Distribution      : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000199    0.000062 -3.1950e+00 0.001398
ar1    -0.983070    0.002771 -3.5471e+02 0.000000
ar2    -0.013898    0.012685 -1.0957e+00 0.273221
ar3    -0.022844    0.015090 -1.5139e+00 0.130062
ma1     0.996202    0.000020  4.8607e+04 0.000000
omega   0.000000    0.000001  7.5472e-01 0.450419
alpha1  0.169496    0.028499  5.9474e+00 0.000000
beta1   0.739015    0.062522  1.1820e+01 0.000000
beta2   0.000005    0.107841  4.9000e-05 0.999961
beta3   0.000002    0.134377  1.6000e-05 0.999987
beta4   0.000001    0.269050  3.0000e-06 0.999997
beta5   0.000001    0.281668  3.0000e-06 0.999998
beta6   0.000001    0.110194  1.2000e-05 0.999991
beta7   0.090391    0.085364  1.0589e+00 0.289648

Robust Standard Errors:
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000199    0.000116   -1.706828 0.087854
ar1    -0.983070    0.006376 -154.175962 0.000000
ar2    -0.013898    0.035770   -0.388542 0.697615
```

ar3	−0.022844	0.031495	−0.725322	0.468254
ma1	0.996202	0.000113	8781.402899	0.000000
omega	0.000000	0.000010	0.045898	0.963391
alpha1	0.169496	0.540163	0.313787	0.753683
beta1	0.739015	1.491011	0.495647	0.620144
beta2	0.000005	1.234138	0.000004	0.999997
beta3	0.000002	0.446110	0.000005	0.999996
beta4	0.000001	0.729817	0.000001	0.999999
beta5	0.000001	3.100476	0.000000	1.000000
beta6	0.000001	0.913326	0.000001	0.999999
beta7	0.090391	1.394342	0.064827	0.948312

LogLikelihood : 17995.28

Information Criteria

Akaike	−7.5631
Bayes	−7.5441
Shibata	−7.5631
Hannan–Quinn	−7.5564

———————————————————————————

*   GARCH Model Fit   *

———————————————————————————

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(1,8)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000192    0.000063 -3.068106 0.002154
ar1    -0.054047    1.185755 -0.045580 0.963645
ar2    -0.025555    0.010670 -2.395065 0.016617
ar3     0.006010    0.025005  0.240364 0.810048
ma1     0.063487    1.186033  0.053528 0.957311
omega   0.000000    0.000000  2.661492 0.007780
alpha1  0.184331    0.016208 11.372768 0.000000
beta1   0.706686    0.033189 21.292492 0.000000
beta2   0.000115    0.078587  0.001463 0.998833
beta3   0.000031    0.094653  0.000331 0.999736
beta4   0.000015    0.170186  0.000087 0.999930
beta5   0.000017    0.167851  0.000101 0.999919
beta6   0.000024    0.053746  0.000448 0.999642
beta7   0.000041    0.128126  0.000323 0.999743
beta8   0.107478    0.095099  1.130164 0.258407
```

```
Robust Standard Errors:
        Estimate  Std. Error   t value  Pr(>|t|)
mu     -0.000192    0.000070 -2.739508  0.006153
ar1    -0.054047    2.188170 -0.024700  0.980294
ar2    -0.025555    0.020546 -1.243833  0.213561
ar3     0.006010    0.050612  0.118751  0.905472
ma1     0.063487    2.182654  0.029087  0.976795
omega   0.000000    0.000001  0.401880  0.687772
alpha1  0.184331    0.167045  1.103481  0.269818
beta1   0.706686    1.575441  0.448564  0.653747
beta2   0.000115    0.970574  0.000118  0.999905
beta3   0.000031    0.844876  0.000037  0.999970
beta4   0.000015    0.468675  0.000032  0.999975
beta5   0.000017    1.230793  0.000014  0.999989
beta6   0.000024    0.082277  0.000293  0.999766
beta7   0.000041    1.087278  0.000038  0.999970
beta8   0.107478    0.609430  0.176358  0.860013

LogLikelihood : 17994.95

Information Criteria
------------------------------------

Akaike       -7.5625
Bayes        -7.5421
Shibata      -7.5626
```

```
Hannan–Quinn  −7.5554


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(1,9)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000193    0.000063 -3.076005 0.002098
ar1     0.096583    1.816096  0.053182 0.957587
ar2    -0.026855    0.007516 -3.572954 0.000353
ar3     0.009478    0.043696  0.216904 0.828283
ma1    -0.086868    1.816293 -0.047827 0.961854
omega   0.000000    0.000000  1.559731 0.118824
alpha1  0.184321    0.007499 24.579935 0.000000
beta1   0.707462    0.071816  9.851082 0.000000
beta2   0.000002    0.160549  0.000012 0.999991
beta3   0.000001    0.220679  0.000004 0.999997
```

beta4	0.000000	0.334464	0.000001	0.999999
beta5	0.000000	0.414687	0.000001	0.999999
beta6	0.000001	0.190965	0.000003	0.999997
beta7	0.000001	0.180696	0.000006	0.999996
beta8	0.107097	0.077340	1.384768	0.166124
beta9	0.000026	0.030786	0.000838	0.999331

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000193	0.000085	−2.280399	0.022584
ar1	0.096583	1.972079	0.048975	0.960939
ar2	−0.026855	0.026660	−1.007310	0.313786
ar3	0.009478	0.066965	0.141534	0.887448
ma1	−0.086868	1.963175	−0.044249	0.964706
omega	0.000000	0.000003	0.163132	0.870415
alpha1	0.184321	0.073254	2.516198	0.011863
beta1	0.707462	0.482944	1.464896	0.142949
beta2	0.000002	0.438869	0.000004	0.999997
beta3	0.000001	1.853312	0.000000	1.000000
beta4	0.000000	3.447074	0.000000	1.000000
beta5	0.000000	4.085895	0.000000	1.000000
beta6	0.000001	1.445050	0.000000	1.000000
beta7	0.000001	1.198427	0.000001	0.999999
beta8	0.107097	0.700121	0.152970	0.878422
beta9	0.000026	0.087017	0.000297	0.999763

```
LogLikelihood : 17994.85

Information Criteria
------------------------------------

Akaike       -7.5621
Bayes        -7.5403
Shibata      -7.5621
Hannan-Quinn -7.5544


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(1,10)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000197    0.000062 -3.1583e+00 0.001587
ar1    -0.983499    0.003257 -3.0199e+02 0.000000
```

```
ar2     -0.015015    0.012949 -1.1596e+00 0.246223
ar3     -0.023761    0.015080 -1.5756e+00 0.115111
ma1      0.996386    0.000021  4.8579e+04 0.000000
omega    0.000000    0.000000  1.3349e+00 0.181916
alpha1   0.176300    0.019764  8.9201e+00 0.000000
beta1    0.733725    0.023206  3.1618e+01 0.000000
beta2    0.000461    0.137411  3.3550e-03 0.997323
beta3    0.019490    0.122917  1.5856e-01 0.874017
beta4    0.000040    0.081839  4.9100e-04 0.999608
beta5    0.000111    0.074904  1.4810e-03 0.998818
beta6    0.000125    0.067175  1.8640e-03 0.998513
beta7    0.000055    0.063526  8.6200e-04 0.999313
beta8    0.000061    0.055461  1.0960e-03 0.999125
beta9    0.000016    0.076484  2.0300e-04 0.999838
beta10   0.067863    0.063766  1.0643e+00 0.287211

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000197    0.000071 -2.7781e+00 0.005467
ar1     -0.983499    0.007230 -1.3603e+02 0.000000
ar2     -0.015015    0.020272 -7.4067e-01 0.458893
ar3     -0.023761    0.017569 -1.3524e+00 0.176240
ma1      0.996386    0.000047  2.1316e+04 0.000000
omega    0.000000    0.000003  1.4577e-01 0.884107
alpha1   0.176300    0.260464  6.7687e-01 0.498488
beta1    0.733725    0.988838  7.4201e-01 0.458083
```

```
beta2    0.000461    0.165219   2.7900e-03  0.997774
beta3    0.019490    1.178373   1.6539e-02  0.986804
beta4    0.000040    0.611885   6.6000e-05  0.999948
beta5    0.000111    0.103981   1.0670e-03  0.999149
beta6    0.000125    0.247194   5.0700e-04  0.999596
beta7    0.000055    0.121218   4.5200e-04  0.999640
beta8    0.000061    0.185415   3.2800e-04  0.999738
beta9    0.000016    0.176521   8.8000e-05  0.999930
beta10   0.067863    0.140304   4.8369e-01  0.628607

LogLikelihood : 17998.89

Information Criteria
------------------------------------

Akaike        -7.5634
Bayes         -7.5402
Shibata       -7.5634
Hannan-Quinn  -7.5552


*---------------------------------*
*          GARCH Model Fit         *
*---------------------------------*

Conditional Variance Dynamics
```

```
---------------------------------------
GARCH Model      : sGARCH(2,1)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
----------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000198    0.000065 -3.0215e+00 0.002515
ar1    -0.978923    0.007756 -1.2622e+02 0.000000
ar2    -0.009693    0.021024 -4.6104e-01 0.644771
ar3    -0.022648    0.017041 -1.3290e+00 0.183833
ma1     0.996054    0.000031  3.1826e+04 0.000000
omega   0.000000    0.000001  3.6041e-01 0.718538
alpha1  0.123722    0.018339  6.7464e+00 0.000000
alpha2  0.000012    0.036221  3.3300e-04 0.999734
beta1   0.873949    0.032574  2.6830e+01 0.000000

Robust Standard Errors:
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000198    0.000645  -0.306126 0.759508
ar1    -0.978923    0.293380  -3.336703 0.000848
ar2    -0.009693    0.667426  -0.014523 0.988413
ar3    -0.022648    0.322323  -0.070266 0.943982
ma1     0.996054    0.001496 665.749566 0.000000
omega   0.000000    0.000043   0.009167 0.992686
```

```
alpha1   0.123722   0.183573   0.673963 0.500335
alpha2   0.000012   1.204275   0.000010 0.999992
beta1    0.873949   1.238062   0.705901 0.480250

LogLikelihood : 17982.41

Information Criteria
------------------------------------

Akaike        -7.5598
Bayes         -7.5476
Shibata       -7.5598
Hannan-Quinn  -7.5555


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(2,2)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000199	0.000063	−3.1516e+00	0.001624
ar1	−0.980165	0.002294	−4.2728e+02	0.000000
ar2	−0.009471	0.012332	−7.6799e−01	0.442491
ar3	−0.021354	0.014750	−1.4478e+00	0.147683
ma1	0.996104	0.000022	4.5357e+04	0.000000
omega	0.000000	0.000000	4.0927e+00	0.000043
alpha1	0.151023	0.020461	7.3812e+00	0.000000
alpha2	0.000062	0.009564	6.4480e−03	0.994855
beta1	0.609255	0.055863	1.0906e+01	0.000000
beta2	0.237359	0.033438	7.0984e+00	0.000000

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000199	0.000072	−2.7856e+00	0.005343
ar1	−0.980165	0.006128	−1.5994e+02	0.000000
ar2	−0.009471	0.015590	−6.0750e−01	0.543517
ar3	−0.021354	0.016402	−1.3019e+00	0.192948
ma1	0.996104	0.000019	5.3309e+04	0.000000
omega	0.000000	0.000000	1.6329e+00	0.102484
alpha1	0.151023	0.062957	2.3988e+00	0.016447
alpha2	0.000062	0.168301	3.6600e−04	0.999708
beta1	0.609255	0.861527	7.0718e−01	0.479454
beta2	0.237359	0.760053	3.1229e−01	0.754818

```
LogLikelihood : 17985.36

Information Criteria
------------------------------------

Akaike       -7.5606
Bayes        -7.5470
Shibata      -7.5606
Hannan-Quinn -7.5558


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(2,3)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000193    0.000063 -3.0674e+00 0.002159
ar1    -0.982165    0.002461 -3.9902e+02 0.000000
```

```
ar2     -0.011785    0.012524  -9.4102e-01  0.346694
ar3     -0.021604    0.014907  -1.4492e+00  0.147284
ma1      0.996149    0.000021   4.6805e+04  0.000000
omega    0.000000    0.000000   2.1841e+00  0.028953
alpha1   0.167903    0.018073   9.2904e+00  0.000000
alpha2   0.000024    0.009944   2.3710e-03  0.998108
beta1    0.613723    0.057151   1.0739e+01  0.000000
beta2    0.000059    0.041446   1.4130e-03  0.998872
beta3    0.215975    0.008105   2.6648e+01  0.000000

Robust Standard Errors:
         Estimate  Std. Error      t value  Pr(>|t|)
mu      -0.000193    0.000072  -2.6970e+00  0.006997
ar1     -0.982165    0.005981  -1.6420e+02  0.000000
ar2     -0.011785    0.016060  -7.3383e-01  0.463054
ar3     -0.021604    0.016670  -1.2959e+00  0.195003
ma1      0.996149    0.000022   4.5119e+04  0.000000
omega    0.000000    0.000001   4.1102e-01  0.681061
alpha1   0.167903    0.031987   5.2492e+00  0.000000
alpha2   0.000024    0.140113   1.6800e-04  0.999866
beta1    0.613723    0.784963   7.8185e-01  0.434303
beta2    0.000059    0.147351   3.9800e-04  0.999683
beta3    0.215975    0.490432   4.4038e-01  0.659664

LogLikelihood : 17988.7
```

```
Information Criteria
------------------------------------

Akaike       -7.5616
Bayes        -7.5466
Shibata      -7.5616
Hannan-Quinn -7.5563



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(2,4)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000196    0.000063 -3.1079e+00 0.001885
ar1    -0.982340    0.002636 -3.7271e+02 0.000000
ar2    -0.012796    0.012686 -1.0087e+00 0.313115
ar3    -0.022567    0.015004 -1.5040e+00 0.132572
```

```
ma1         0.996199    0.000020   4.9195e+04 0.000000
omega       0.000000    0.000000   3.6961e+00 0.000219
alpha1      0.167857    0.019917   8.4277e+00 0.000000
alpha2      0.000043    0.012850   3.3300e-03 0.997343
beta1       0.641894    0.014916   4.3034e+01 0.000000
beta2       0.000509    0.132347   3.8480e-03 0.996930
beta3       0.124936    0.174818   7.1466e-01 0.474818
beta4       0.062981    0.094513   6.6638e-01 0.505170

Robust Standard Errors:
            Estimate  Std. Error      t value Pr(>|t|)
mu         -0.000196    0.000073  -2.6928e+00 0.007085
ar1        -0.982340    0.007234  -1.3580e+02 0.000000
ar2        -0.012796    0.017074  -7.4945e-01 0.453589
ar3        -0.022567    0.016600  -1.3594e+00 0.174013
ma1         0.996199    0.000018   5.5057e+04 0.000000
omega       0.000000    0.000000   1.4154e+00 0.156964
alpha1      0.167857    0.026773   6.2695e+00 0.000000
alpha2      0.000043    0.123371   3.4700e-04 0.999723
beta1       0.641894    0.809491   7.9296e-01 0.427801
beta2       0.000509    0.437351   1.1640e-03 0.999071
beta3       0.124936    0.357430   3.4954e-01 0.726684
beta4       0.062981    0.116755   5.3943e-01 0.589587

LogLikelihood : 17988.67
```

```
Information Criteria
------------------------------------

Akaike       -7.5612
Bayes        -7.5448
Shibata      -7.5612
Hannan-Quinn -7.5554


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(2,5)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000198    0.000062 -3.1930e+00 0.001408
ar1    -0.982780    0.002563 -3.8344e+02 0.000000
ar2    -0.013676    0.012249 -1.1165e+00 0.264210
ar3    -0.022841    0.014876 -1.5355e+00 0.124667
```

```
ma1       0.996135    0.000021   4.8547e+04 0.000000
omega     0.000000    0.000000   3.2568e+00 0.001127
alpha1    0.164361    0.011991   1.3707e+01 0.000000
alpha2    0.000008    0.014286   5.5000e-04 0.999561
beta1     0.724072    0.005013   1.4444e+02 0.000000
beta2     0.000745    0.161048   4.6260e-03 0.996309
beta3     0.000178    0.441556   4.0400e-04 0.999678
beta4     0.000012    0.396151   3.0000e-05 0.999976
beta5     0.109244    0.112259   9.7314e-01 0.330483

Robust Standard Errors:
           Estimate  Std. Error     t value Pr(>|t|)
mu        -0.000198    0.000075 -2.6303e+00 0.008532
ar1       -0.982780    0.007571 -1.2981e+02 0.000000
ar2       -0.013676    0.019577 -6.9854e-01 0.484840
ar3       -0.022841    0.018939 -1.2061e+00 0.227798
ma1        0.996135    0.000025  3.9276e+04 0.000000
omega      0.000000    0.000000  9.4303e-01 0.345667
alpha1     0.164361    0.065557  2.5072e+00 0.012171
alpha2     0.000008    0.176935  4.4000e-05 0.999965
beta1      0.724072    0.788253  9.1858e-01 0.358316
beta2      0.000745    1.060836  7.0200e-04 0.999440
beta3      0.000178    1.617664  1.1000e-04 0.999912
beta4      0.000012    1.539220  8.0000e-06 0.999994
beta5      0.109244    0.467420  2.3372e-01 0.815205
```

```
LogLikelihood : 17990.61

Information Criteria
------------------------------------

Akaike       -7.5616
Bayes        -7.5439
Shibata      -7.5616
Hannan-Quinn -7.5553



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(2,6)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000198    0.000062 -3.1875e+00 0.001435
ar1    -0.982638    0.002703 -3.6350e+02 0.000000
```

```
ar2     -0.013333    0.012311  -1.0830e+00  0.278791
ar3     -0.022664    0.014927  -1.5184e+00  0.128917
ma1      0.996166    0.000021   4.6346e+04  0.000000
omega    0.000000    0.000001   8.0965e-01  0.418142
alpha1   0.162466    0.020171   8.0545e+00  0.000000
alpha2   0.000006    0.024899   2.5100e-04  0.999800
beta1    0.748486    0.049070   1.5254e+01  0.000000
beta2    0.000299    0.176119   1.6950e-03  0.998647
beta3    0.000024    0.057484   4.2600e-04  0.999660
beta4    0.000004    0.227981   1.9000e-05  0.999985
beta5    0.000006    0.933276   6.0000e-06  0.999995
beta6    0.087434    0.555621   1.5736e-01  0.874959

Robust Standard Errors:
         Estimate   Std. Error      t value  Pr(>|t|)
mu      -0.000198    0.000144     -1.382209  0.166908
ar1     -0.982638    0.011134    -88.254669  0.000000
ar2     -0.013333    0.065636     -0.203134  0.839030
ar3     -0.022664    0.052373     -0.432747  0.665198
ma1      0.996166    0.000149   6683.314425  0.000000
omega    0.000000    0.000010      0.046701  0.962752
alpha1   0.162466    0.111987      1.450754  0.146848
alpha2   0.000006    0.611719      0.000010  0.999992
beta1    0.748486    0.420571      1.779690  0.075127
beta2    0.000299    1.205509      0.000248  0.999802
beta3    0.000024    0.785528      0.000031  0.999975
```

```
beta4     0.000004     6.974806     0.000001  1.000000
beta5     0.000006    17.231840     0.000000  1.000000
beta6     0.087434     9.897102     0.008834  0.992951

LogLikelihood : 17992.25

Information Criteria
------------------------------------


Akaike          −7.5618
Bayes           −7.5428
Shibata         −7.5618
Hannan−Quinn    −7.5551



*−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−*
*           GARCH Model Fit          *
*−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−*

Conditional Variance Dynamics
−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−
GARCH Model      : sGARCH(2,7)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000214	0.000082	−2.596000	0.009432
ar1	0.968644	0.016195	59.810056	0.000000
ar2	−0.036760	0.022351	−1.644697	0.100032
ar3	0.035993	0.015634	2.302176	0.021325
ma1	−0.958521	0.001075	−891.697052	0.000000
omega	0.000000	0.000000	2.237013	0.025286
alpha1	0.170943	0.020954	8.157833	0.000000
alpha2	0.002179	0.011031	0.197493	0.843442
beta1	0.727921	0.028765	25.306202	0.000000
beta2	0.000001	0.129565	0.000004	0.999996
beta3	0.000000	0.153487	0.000001	0.999999
beta4	0.000000	0.301820	0.000000	1.000000
beta5	0.000000	0.271524	0.000000	1.000000
beta6	0.000000	0.139395	0.000001	0.999999
beta7	0.097566	0.058374	1.671381	0.094646

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000214	0.000090	−2.3857e+00	0.017049
ar1	0.968644	0.018200	5.3221e+01	0.000000
ar2	−0.036760	0.027375	−1.3428e+00	0.179326
ar3	0.035993	0.019315	1.8635e+00	0.062396
ma1	−0.958521	0.000885	−1.0828e+03	0.000000
omega	0.000000	0.000001	4.3988e−01	0.660027

```
alpha1   0.170943   0.036911   4.6313e+00 0.000004
alpha2   0.002179   0.168709   1.2913e-02 0.989697
beta1    0.727921   0.599700   1.2138e+00 0.224821
beta2    0.000001   0.481542   1.0000e-06 0.999999
beta3    0.000000   0.571653   0.0000e+00 1.000000
beta4    0.000000   0.788101   0.0000e+00 1.000000
beta5    0.000000   0.676645   0.0000e+00 1.000000
beta6    0.000000   0.416357   0.0000e+00 1.000000
beta7    0.097566   0.454285   2.1477e-01 0.829949

LogLikelihood : 17994.63

Information Criteria
------------------------------------

Akaike       -7.5624
Bayes        -7.5420
Shibata      -7.5624
Hannan-Quinn -7.5552


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model       : sGARCH(2,8)
Mean Model        : ARFIMA(3,0,1)
Distribution      : norm

Optimal Parameters

         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000195    0.000062 -3.1258e+00 0.001773
ar1     -0.984330    0.003642 -2.7029e+02 0.000000
ar2     -0.016147    0.013013 -1.2408e+00 0.214678
ar3     -0.024038    0.015281 -1.5730e+00 0.115713
ma1      0.996426    0.000019  5.3757e+04 0.000000
omega    0.000001    0.000000  3.0006e+00 0.002694
alpha1   0.175869    0.015220  1.1555e+01 0.000000
alpha2   0.024549    0.017311  1.4181e+00 0.156170
beta1    0.675103    0.043048  1.5682e+01 0.000000
beta2    0.000002    0.070553  2.8000e-05 0.999978
beta3    0.000000    0.164262  1.0000e-06 0.999999
beta4    0.000000    0.311388  0.0000e+00 1.000000
beta5    0.000000    0.306945  0.0000e+00 1.000000
beta6    0.000000    0.069712  2.0000e-06 0.999999
beta7    0.000000    0.159772  1.0000e-06 0.999999
beta8    0.123477    0.073241  1.6859e+00 0.091816

Robust Standard Errors:
```

```
        Estimate   Std. Error     t value  Pr(>|t|)
mu     -0.000195    0.000072  -2.7191e+00  0.006547
ar1    -0.984330    0.011842  -8.3121e+01  0.000000
ar2    -0.016147    0.023306  -6.9280e-01  0.488433
ar3    -0.024038    0.018460  -1.3021e+00  0.192872
ma1     0.996426    0.000036   2.8014e+04  0.000000
omega   0.000001    0.000001   6.6802e-01  0.504123
alpha1  0.175869    0.062450   2.8161e+00  0.004860
alpha2  0.024549    0.198965   1.2338e-01  0.901805
beta1   0.675103    1.041435   6.4824e-01  0.516828
beta2   0.000002    1.027907   2.0000e-06  0.999998
beta3   0.000000    1.073870   0.0000e+00  1.000000
beta4   0.000000    1.799210   0.0000e+00  1.000000
beta5   0.000000    1.781844   0.0000e+00  1.000000
beta6   0.000000    0.870173   0.0000e+00  1.000000
beta7   0.000000    0.284751   1.0000e-06  0.999999
beta8   0.123477    0.159563   7.7384e-01  0.439023

LogLikelihood : 17999.43

Information Criteria
------------------------------------

Akaike       -7.5640
Bayes        -7.5422
Shibata      -7.5640
```

```
Hannan-Quinn  -7.5564


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(2,9)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000190    0.000062 -3.070267 0.002139
ar1     0.129611    1.852256  0.069975 0.944214
ar2    -0.027493    0.007797 -3.526325 0.000421
ar3     0.010845    0.046605  0.232696 0.815998
ma1    -0.119789    1.852437 -0.064666 0.948440
omega   0.000001    0.000000  2.696719 0.007003
alpha1  0.175787    0.003198 54.964011 0.000000
alpha2  0.129424    0.036725  3.524144 0.000425
beta1   0.076864    0.139754  0.549999 0.582320
beta2   0.429870    0.310732  1.383408 0.166540
```

```
beta3     0.000168    0.332684  0.000505 0.999597
beta4     0.000023    0.036469  0.000629 0.999498
beta5     0.000020    0.036495  0.000561 0.999552
beta6     0.000027    0.019304  0.001424 0.998864
beta7     0.000030    0.067011  0.000446 0.999644
beta8     0.133430    0.119297  1.118469 0.263367
beta9     0.052490    0.064742  0.810752 0.417508

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000190    0.000079 -2.413146 0.015815
ar1       0.129611    2.212538  0.058580 0.953286
ar2      -0.027493    0.026169 -1.050600 0.293442
ar3       0.010845    0.056895  0.190611 0.848830
ma1      -0.119789    2.215263 -0.054075 0.956876
omega     0.000001    0.000001  0.712852 0.475937
alpha1    0.175787    0.071435  2.460785 0.013863
alpha2    0.129424    0.264532  0.489255 0.624661
beta1     0.076864    1.386344  0.055444 0.955785
beta2     0.429870    1.680159  0.255851 0.798066
beta3     0.000168    1.276234  0.000132 0.999895
beta4     0.000023    0.238779  0.000096 0.999923
beta5     0.000020    0.194802  0.000105 0.999916
beta6     0.000027    0.208043  0.000132 0.999895
beta7     0.000030    0.307545  0.000097 0.999922
beta8     0.133430    0.773282  0.172550 0.863005
```

```
beta9    0.052490     0.411920   0.127427  0.898602

LogLikelihood : 17995.26

Information Criteria
------------------------------------

Akaike        -7.5618
Bayes         -7.5387
Shibata       -7.5619
Hannan-Quinn  -7.5537



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(2,10)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
```

```
mu      -0.000187    0.000063  -2.984703 0.002839
ar1      0.033926    1.418963   0.023909 0.980925
ar2     -0.026368    0.008193  -3.218558 0.001288
ar3      0.008262    0.033326   0.247925 0.804192
ma1     -0.024353    1.418709  -0.017166 0.986304
omega    0.000001    0.000000   3.062586 0.002194
alpha1   0.176874    0.022413   7.891602 0.000000
alpha2   0.134800    0.009092  14.825856 0.000000
beta1    0.056627    0.037350   1.516102 0.129493
beta2    0.394263    0.152985   2.577144 0.009962
beta3    0.057972    0.121705   0.476334 0.633837
beta4    0.000038    0.102491   0.000373 0.999703
beta5    0.000038    0.092050   0.000412 0.999671
beta6    0.000044    0.039058   0.001130 0.999098
beta7    0.000048    0.014368   0.003372 0.997310
beta8    0.116331    0.269824   0.431137 0.666369
beta9    0.000071    0.045309   0.001567 0.998749
beta10   0.060278    0.148554   0.405762 0.684918

Robust Standard Errors:
         Estimate  Std. Error    t value Pr(>|t|)
mu      -0.000187    0.000075  -2.489649 0.012787
ar1      0.033926    1.929189   0.017586 0.985969
ar2     -0.026368    0.024218  -1.088800 0.276242
ar3      0.008262    0.043677   0.189167 0.849962
ma1     -0.024353    1.932250  -0.012604 0.989944
```

omega	0.000001	0.000001	0.789425	0.429864
alpha1	0.176874	0.051682	3.422359	0.000621
alpha2	0.134800	0.187333	0.719575	0.471787
beta1	0.056627	0.960175	0.058976	0.952971
beta2	0.394263	0.442030	0.891938	0.372426
beta3	0.057972	0.427908	0.135478	0.892234
beta4	0.000038	0.441537	0.000087	0.999931
beta5	0.000038	0.381620	0.000099	0.999921
beta6	0.000044	0.176178	0.000251	0.999800
beta7	0.000048	0.098011	0.000494	0.999606
beta8	0.116331	1.163184	0.100011	0.920336
beta9	0.000071	0.221979	0.000320	0.999745
beta10	0.060278	0.636047	0.094769	0.924498

LogLikelihood : 17995.44

Information Criteria

Akaike	−7.5615
Bayes	−7.5370
Shibata	−7.5615
Hannan–Quinn	−7.5529

————————————————————

```
*               GARCH Model Fit               *
*---------------------------------------------*

Conditional Variance Dynamics
-----------------------------------------------
GARCH Model      : sGARCH(3,1)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------------------
         Estimate   Std. Error    t value  Pr(>|t|)
mu      -0.000195    0.000063  -3.113022  0.001852
ar1      0.243500    3.230657   0.075372  0.939919
ar2     -0.029173    0.040505  -0.720237  0.471379
ar3      0.006535    0.067534   0.096764  0.922914
ma1     -0.229052    3.228507  -0.070947  0.943440
omega    0.000000    0.000000   0.790056  0.429495
alpha1   0.122151    0.017201   7.101239  0.000000
alpha2   0.000055    0.021601   0.002525  0.997985
alpha3   0.000034    0.007736   0.004391  0.996496
beta1    0.875469    0.016159  54.178654  0.000000

Robust Standard Errors:
         Estimate   Std. Error    t value  Pr(>|t|)
mu      -0.000195    0.000173  -1.127274  0.259627
```

ar1	0.243500	7.784212	0.031281	0.975045
ar2	−0.029173	0.095171	−0.306533	0.759199
ar3	0.006535	0.197071	0.033160	0.973547
ma1	−0.229052	7.802787	−0.029355	0.976581
omega	0.000000	0.000009	0.044965	0.964135
alpha1	0.122151	0.042446	2.877791	0.004005
alpha2	0.000055	0.081939	0.000666	0.999469
alpha3	0.000034	0.262351	0.000129	0.999897
beta1	0.875469	0.327987	2.669217	0.007603

```
LogLikelihood : 17978.74

Information Criteria
------------------------------------

Akaike       -7.5578
Bayes        -7.5442
Shibata      -7.5578
Hannan-Quinn -7.5530


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model      : sGARCH(3,2)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters

          Estimate   Std. Error      t value  Pr(>|t|)
mu       -0.000201     0.000063  -3.1738e+00  0.001504
ar1      -0.981549     0.003013  -3.2581e+02  0.000000
ar2      -0.011960     0.012471  -9.5901e-01  0.337556
ar3      -0.022325     0.014712  -1.5175e+00  0.129139
ma1       0.996051     0.000022   4.6298e+04  0.000000
omega     0.000000     0.000000   3.9870e+00  0.000067
alpha1    0.151532     0.020303   7.4634e+00  0.000000
alpha2    0.001201     0.019367   6.2009e-02  0.950556
alpha3    0.000233     0.020987   1.1118e-02  0.991129
beta1     0.596052     0.037972   1.5697e+01  0.000000
beta2     0.248800     0.028498   8.7303e+00  0.000000

Robust Standard Errors:
          Estimate   Std. Error      t value  Pr(>|t|)
mu       -0.000201     0.000072  -2.7891e+00  0.005285
ar1      -0.981549     0.007855  -1.2495e+02  0.000000
ar2      -0.011960     0.016281  -7.3462e-01  0.462568
ar3      -0.022325     0.016293  -1.3702e+00  0.170624
```

```
ma1      0.996051   0.000020   4.8766e+04 0.000000
omega    0.000000   0.000000   1.5474e+00 0.121762
alpha1   0.151532   0.057705   2.6260e+00 0.008640
alpha2   0.001201   0.195178   6.1530e-03 0.995091
alpha3   0.000233   0.041275   5.6530e-03 0.995489
beta1    0.596052   0.950432   6.2714e-01 0.530569
beta2    0.248800   0.847154   2.9369e-01 0.768995

LogLikelihood : 17985.27

Information Criteria
------------------------------------

Akaike       -7.5602
Bayes        -7.5452
Shibata      -7.5602
Hannan-Quinn -7.5549


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(3,3)
```

```
Mean Model        : ARFIMA(3,0,1)
Distribution      : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000194    0.000064 -3.0479e+00 0.002305
ar1      -0.981877    0.016102 -6.0980e+01 0.000000
ar2      -0.010232    0.026602 -3.8465e-01 0.700500
ar3      -0.020582    0.016476 -1.2492e+00 0.211598
ma1       0.996258    0.000031  3.2324e+04 0.000000
omega     0.000001    0.000000  4.0024e+00 0.000063
alpha1    0.169058    0.028835  5.8630e+00 0.000000
alpha2    0.004968    0.286226  1.7357e-02 0.986152
alpha3    0.000180    0.312702  5.7600e-04 0.999541
beta1     0.585630    1.562291  3.7485e-01 0.707770
beta2     0.015604    2.698997  5.7810e-03 0.995387
beta3     0.222710    1.133304  1.9651e-01 0.844208

Robust Standard Errors:
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000194    0.000083   -2.330507 0.019779
ar1      -0.981877    0.097078  -10.114323 0.000000
ar2      -0.010232    0.145278   -0.070433 0.943849
ar3      -0.020582    0.047065   -0.437306 0.661890
ma1       0.996258    0.000227 4382.643029 0.000000
```

```
omega     0.000001    0.000000   1.319963  0.186847
alpha1    0.169058    0.132217   1.278640  0.201024
alpha2    0.004968    1.726878   0.002877  0.997705
alpha3    0.000180    1.921441   0.000094  0.999925
beta1     0.585630    9.420731   0.062164  0.950432
beta2     0.015604   16.408261   0.000951  0.999241
beta3     0.222710    6.973707   0.031936  0.974523

LogLikelihood : 17988.64

Information Criteria
------------------------------------

Akaike       -7.5612
Bayes        -7.5448
Shibata      -7.5612
Hannan-Quinn -7.5554


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(3,4)
```

```
Mean Model        : ARFIMA(3,0,1)
Distribution      : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000196    0.000063 -3.1049e+00 0.001904
ar1    -0.982235    0.001768 -5.5560e+02 0.000000
ar2    -0.012597    0.012353 -1.0198e+00 0.307839
ar3    -0.022434    0.014980 -1.4976e+00 0.134246
ma1     0.996185    0.000021  4.8233e+04 0.000000
omega   0.000000    0.000000  4.3060e+00 0.000017
alpha1  0.167840    0.020637  8.1330e+00 0.000000
alpha2  0.000095    0.034568  2.7430e-03 0.997812
alpha3  0.000020    0.039397  5.1300e-04 0.999591
beta1   0.641006    0.199084  3.2198e+00 0.001283
beta2   0.001280    0.281716  4.5430e-03 0.996376
beta3   0.124878    0.154282  8.0941e-01 0.418279
beta4   0.063049    0.090140  6.9946e-01 0.484266

Robust Standard Errors:
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000196    0.000073 -2.6823e+00 0.007312
ar1    -0.982235    0.008183 -1.2003e+02 0.000000
ar2    -0.012597    0.017730 -7.1046e-01 0.477418
ar3    -0.022434    0.016604 -1.3511e+00 0.176665
```

```
ma1      0.996185   0.000020   4.9423e+04  0.000000
omega    0.000000   0.000000   1.9528e+00  0.050842
alpha1   0.167840   0.029775   5.6370e+00  0.000000
alpha2   0.000095   0.148889   6.3700e-04  0.999492
alpha3   0.000020   0.034225   5.9000e-04  0.999529
beta1    0.641006   0.887912   7.2193e-01  0.470340
beta2    0.001280   0.637881   2.0060e-03  0.998399
beta3    0.124878   0.345940   3.6098e-01  0.718114
beta4    0.063049   0.115905   5.4397e-01  0.586462

LogLikelihood : 17988.67

Information Criteria
------------------------------------

Akaike       -7.5607
Bayes        -7.5431
Shibata      -7.5608
Hannan-Quinn -7.5545


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
---------------------------------------
GARCH Model      : sGARCH(3,5)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
----------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000198    0.000063 -3.1601e+00 0.001577
ar1     -0.982743    0.004502 -2.1827e+02 0.000000
ar2     -0.013632    0.010352 -1.3168e+00 0.187891
ar3     -0.022840    0.015051 -1.5175e+00 0.129150
ma1      0.996139    0.000023  4.3623e+04 0.000000
omega    0.000000    0.000000  4.9876e+00 0.000001
alpha1   0.164364    0.024624  6.6748e+00 0.000000
alpha2   0.000007    0.098283  7.0000e-05 0.999944
alpha3   0.000003    0.106523  3.1000e-05 0.999975
beta1    0.723954    0.492578  1.4697e+00 0.141636
beta2    0.000693    0.690475  1.0030e-03 0.999200
beta3    0.000396    0.359856  1.1000e-03 0.999122
beta4    0.000010    0.250679  4.1000e-05 0.999967
beta5    0.109176    0.128985  8.4642e-01 0.397317

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000198    0.000077 -2.5812e+00 0.009845
```

ar1	−0.982743	0.019638	−5.0044e+01	0.000000
ar2	−0.013632	0.031624	−4.3106e−01	0.666428
ar3	−0.022840	0.019039	−1.1996e+00	0.230293
ma1	0.996139	0.000045	2.2036e+04	0.000000
omega	0.000000	0.000000	1.6048e+00	0.108545
alpha1	0.164364	0.054117	3.0372e+00	0.002388
alpha2	0.000007	0.373343	1.9000e−05	0.999985
alpha3	0.000003	0.329854	1.0000e−05	0.999992
beta1	0.723954	1.842719	3.9287e−01	0.694414
beta2	0.000693	2.527572	2.7400e−04	0.999781
beta3	0.000396	1.224173	3.2300e−04	0.999742
beta4	0.000010	1.143995	9.0000e−06	0.999993
beta5	0.109176	0.449522	2.4287e−01	0.808105

LogLikelihood : 17990.61

Information Criteria

Akaike	−7.5611
Bayes	−7.5421
Shibata	−7.5612
Hannan−Quinn	−7.5544

———————————————————

```
*              GARCH Model Fit           *
*----------------------------------------*

 Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(3,6)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000198    0.000063 -3.1753e+00 0.001497
ar1     -0.982591    0.002804 -3.5041e+02 0.000000
ar2     -0.013276    0.012660 -1.0487e+00 0.294321
ar3     -0.022658    0.015094 -1.5012e+00 0.133312
ma1      0.996167    0.000020  4.9820e+04 0.000000
omega    0.000000    0.000000  2.5466e+00 0.010878
alpha1   0.162487    0.020462  7.9407e+00 0.000000
alpha2   0.000001    0.022523  2.7000e-05 0.999978
alpha3   0.000000    0.017446  2.2000e-05 0.999983
beta1    0.748740    0.049168  1.5228e+01 0.000000
beta2    0.000047    0.105497  4.4100e-04 0.999648
beta3    0.000003    0.060859  5.2000e-05 0.999958
beta4    0.000001    0.040024  1.8000e-05 0.999985
beta5    0.000001    0.306089  3.0000e-06 0.999998
```

```
beta6    0.087472     0.172447   5.0724e-01 0.611984

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000198    0.000076 -2.5948e+00 0.009464
ar1     -0.982591    0.006274 -1.5661e+02 0.000000
ar2     -0.013276    0.017829 -7.4464e-01 0.456489
ar3     -0.022658    0.018645 -1.2153e+00 0.224270
ma1      0.996167    0.000024  4.1508e+04 0.000000
omega    0.000000    0.000001  5.0234e-01 0.615429
alpha1   0.162487    0.054813  2.9644e+00 0.003033
alpha2   0.000001    0.148686  4.0000e-06 0.999997
alpha3   0.000000    0.053327  7.0000e-06 0.999994
beta1    0.748740    0.514949  1.4540e+00 0.145944
beta2    0.000047    0.525563  8.9000e-05 0.999929
beta3    0.000003    1.006977  3.0000e-06 0.999997
beta4    0.000001    1.989795  0.0000e+00 1.000000
beta5    0.000001    2.229459  0.0000e+00 1.000000
beta6    0.087472    1.070631  8.1702e-02 0.934884

LogLikelihood : 17992.25

Information Criteria
------------------------------------

Akaike       -7.5614
```

```
Bayes          -7.5410
Shibata        -7.5614
Hannan-Quinn   -7.5542


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(3,7)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000196    0.000063 -3.123653 0.001786
ar1     0.161732    2.167201  0.074627 0.940511
ar2    -0.027320    0.018438 -1.481732 0.138411
ar3     0.008836    0.049694  0.177816 0.858867
ma1    -0.150542    2.167007 -0.069470 0.944615
omega   0.000000    0.000000  3.862300 0.000112
alpha1  0.167751    0.021714  7.725315 0.000000
alpha2  0.000235    0.061715  0.003816 0.996956
```

```
alpha3   0.000005    0.048641   0.000112 0.999911
beta1    0.739499    0.194821   3.795788 0.000147
beta2    0.000009    0.376624   0.000023 0.999982
beta3    0.000003    0.144201   0.000024 0.999981
beta4    0.000001    0.178721   0.000005 0.999996
beta5    0.000001    0.214141   0.000004 0.999997
beta6    0.000001    0.099109   0.000014 0.999989
beta7    0.091439    0.025643   3.565786 0.000363

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000196    0.000072 -2.724448 0.006441
ar1       0.161732    1.944370  0.083180 0.933709
ar2      -0.027320    0.027582 -0.990471 0.321944
ar3       0.008836    0.048978  0.180415 0.856827
ma1      -0.150542    1.942980 -0.077480 0.938242
omega     0.000000    0.000000  1.174592 0.240158
alpha1    0.167751    0.036257  4.626670 0.000004
alpha2    0.000235    0.223003  0.001056 0.999157
alpha3    0.000005    0.289372  0.000019 0.999985
beta1     0.739499    0.794105  0.931236 0.351731
beta2     0.000009    1.862848  0.000005 0.999996
beta3     0.000003    0.856807  0.000004 0.999997
beta4     0.000001    0.894245  0.000001 0.999999
beta5     0.000001    0.855473  0.000001 0.999999
beta6     0.000001    0.312499  0.000004 0.999997
```

```
beta7    0.091439    0.163349   0.559774  0.575634

LogLikelihood : 17991.33

Information Criteria
------------------------------------

Akaike        -7.5606
Bayes         -7.5388
Shibata       -7.5606
Hannan-Quinn  -7.5530



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(3,8)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
```

```
mu      -0.000196    0.000063  -3.1435e+00  0.001669
ar1     -0.983370    0.001843  -5.3369e+02  0.000000
ar2     -0.014660    0.010931  -1.3412e+00  0.179858
ar3     -0.023477    0.014630  -1.6047e+00  0.108554
ma1      0.996387    0.000024   4.0825e+04  0.000000
omega    0.000001    0.000001   1.1274e+00  0.259582
alpha1   0.172662    0.029873   5.7799e+00  0.000000
alpha2   0.026493    0.057305   4.6232e-01  0.643854
alpha3   0.049420    0.033265   1.4856e+00  0.137372
beta1    0.579703    0.184979   3.1339e+00  0.001725
beta2    0.000009    0.163586   5.5000e-05  0.999956
beta3    0.000008    0.231214   3.4000e-05  0.999973
beta4    0.000002    0.484048   4.0000e-06  0.999997
beta5    0.000002    0.465886   5.0000e-06  0.999996
beta6    0.000002    0.095918   2.5000e-05  0.999980
beta7    0.000003    0.250928   1.3000e-05  0.999989
beta8    0.170671    0.103339   1.6516e+00  0.098625

Robust Standard Errors:
         Estimate   Std. Error      t value  Pr(>|t|)
mu      -0.000196    0.000075    -2.610136  0.009051
ar1     -0.983370    0.033791   -29.101828  0.000000
ar2     -0.014660    0.083426    -0.175728  0.860507
ar3     -0.023477    0.050204    -0.467620  0.640057
ma1      0.996387    0.000190  5243.379577  0.000000
omega    0.000001    0.000007     0.098928  0.921196
```

```
alpha1    0.172662    0.382435    0.451482  0.651642
alpha2    0.026493    0.593746    0.044620  0.964410
alpha3    0.049420    0.320117    0.154382  0.877308
beta1     0.579703    1.359936    0.426272  0.669909
beta2     0.000009    1.233784    0.000007  0.999994
beta3     0.000008    2.708205    0.000003  0.999998
beta4     0.000002    5.648743    0.000000  1.000000
beta5     0.000002    5.447770    0.000000  1.000000
beta6     0.000002    0.419529    0.000006  0.999995
beta7     0.000003    3.017668    0.000001  0.999999
beta8     0.170671    1.087110    0.156995  0.875249

LogLikelihood : 18000.94

Information Criteria
------------------------------------

Akaike        -7.5642
Bayes         -7.5411
Shibata       -7.5642
Hannan-Quinn  -7.5561


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(3,9)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000196    0.000064 -3.0610e+00 0.002206
ar1    -0.983420    0.004112 -2.3915e+02 0.000000
ar2    -0.014786    0.015972 -9.2573e-01 0.354585
ar3    -0.023560    0.016446 -1.4326e+00 0.151980
ma1     0.996397    0.000017  5.7481e+04 0.000000
omega   0.000001    0.000001  7.0634e-01 0.479978
alpha1  0.173271    0.063625  2.7233e+00 0.006463
alpha2  0.027520    0.135386  2.0327e-01 0.838925
alpha3  0.050635    0.031395  1.6128e+00 0.106785
beta1   0.574392    0.323400  1.7761e+00 0.075716
beta2   0.000000    0.584003  1.0000e-06 0.999999
beta3   0.000000    0.429124  0.0000e+00 1.000000
beta4   0.000000    0.360298  0.0000e+00 1.000000
beta5   0.000000    0.783873  0.0000e+00 1.000000
beta6   0.000000    0.186357  0.0000e+00 1.000000
beta7   0.000000    0.443681  0.0000e+00 1.000000
```

```
beta8    0.163412    0.049172  3.3232e+00 0.000890
beta9    0.009769    0.142319  6.8643e-02 0.945274

Robust Standard Errors:
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000196    0.000366   -0.537136  0.59117
ar1      -0.983420    0.056075  -17.537475  0.00000
ar2      -0.014786    0.203476   -0.072665  0.94207
ar3      -0.023560    0.137710   -0.171086  0.86416
ma1       0.996397    0.000544 1832.422744  0.00000
omega     0.000001    0.000020    0.032349  0.97419
alpha1    0.173271    1.342037    0.129110  0.89727
alpha2    0.027520    3.053014    0.009014  0.99281
alpha3    0.050635    0.682184    0.074225  0.94083
beta1     0.574392    7.964067    0.072123  0.94250
beta2     0.000000   14.028096    0.000000  1.00000
beta3     0.000000    9.286266    0.000000  1.00000
beta4     0.000000    8.787224    0.000000  1.00000
beta5     0.000000   16.890427    0.000000  1.00000
beta6     0.000000    3.548851    0.000000  1.00000
beta7     0.000000    9.418760    0.000000  1.00000
beta8     0.163412    0.786001    0.207903  0.83530
beta9     0.009769    3.353398    0.002913  0.99768

LogLikelihood : 18000.88
```

```
Information Criteria
------------------------------------

Akaike         -7.5638
Bayes          -7.5393
Shibata        -7.5638
Hannan-Quinn   -7.5552


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(3,10)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000196    0.000062    -3.15576 0.001601
ar1    -0.983366    0.003066  -320.77600 0.000000
ar2    -0.014732    0.012475    -1.18085 0.237663
ar3    -0.023563    0.015003    -1.57058 0.116281
```

```
ma1       0.996398     0.000019  51908.69953  0.000000
omega     0.000001     0.000000      2.17549  0.029593
alpha1    0.173168     0.011484     15.07866  0.000000
alpha2    0.027798     0.053269      0.52183  0.601788
alpha3    0.050906     0.041633      1.22272  0.221435
beta1     0.573440     0.211860      2.70669  0.006796
beta2     0.000000     0.303912      0.00000  1.000000
beta3     0.000000     0.125863      0.00000  1.000000
beta4     0.000000     0.236110      0.00000  1.000000
beta5     0.000000     0.064363      0.00000  1.000000
beta6     0.000000     0.086704      0.00000  1.000000
beta7     0.000000     0.140773      0.00000  1.000000
beta8     0.163556     0.046171      3.54240  0.000397
beta9     0.010132     0.081140      0.12487  0.900623
beta10    0.000000     0.003018      0.00002  0.999984

Robust Standard Errors:
           Estimate   Std. Error      t value  Pr(>|t|)
mu        -0.000196     0.000070  -2.7936e+00  0.005212
ar1       -0.983366     0.008673  -1.1338e+02  0.000000
ar2       -0.014732     0.025664  -5.7401e-01  0.565959
ar3       -0.023563     0.021369  -1.1027e+00  0.270168
ma1        0.996398     0.000038   2.6346e+04  0.000000
omega      0.000001     0.000002   4.3344e-01  0.664696
alpha1     0.173168     0.058179   2.9765e+00  0.002916
alpha2     0.027798     0.191299   1.4531e-01  0.884467
```

```
alpha3   0.050906    0.104971   4.8495e-01  0.627711
beta1    0.573440    0.711969   8.0543e-01  0.420572
beta2    0.000000    0.745256   0.0000e+00  1.000000
beta3    0.000000    0.844279   0.0000e+00  1.000000
beta4    0.000000    0.958493   0.0000e+00  1.000000
beta5    0.000000    0.744305   0.0000e+00  1.000000
beta6    0.000000    0.221890   0.0000e+00  1.000000
beta7    0.000000    0.362685   0.0000e+00  1.000000
beta8    0.163556    0.263197   6.2142e-01  0.534324
beta9    0.010132    0.612526   1.6542e-02  0.986802
beta10   0.000000    0.280738   0.0000e+00  1.000000

LogLikelihood : 18000.81

Information Criteria
------------------------------------

Akaike       -7.5633
Bayes        -7.5375
Shibata      -7.5634
Hannan-Quinn -7.5542


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(4,1)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000197    0.000063 -3.1178e+00 0.001822
ar1     -0.979168    0.004834 -2.0258e+02 0.000000
ar2     -0.009441    0.006852 -1.3779e+00 0.168243
ar3     -0.022448    0.014296 -1.5703e+00 0.116354
ma1      0.996191    0.000032  3.1383e+04 0.000000
omega    0.000000    0.000001  7.4848e-01 0.454171
alpha1   0.123547    0.017516  7.0536e+00 0.000000
alpha2   0.000005    0.024798  2.0500e-04 0.999837
alpha3   0.000003    0.026503  1.1800e-04 0.999906
alpha4   0.000003    0.014809  1.9500e-04 0.999844
beta1    0.874431    0.018245  4.7927e+01 0.000000

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000197    0.000131   -1.506443 0.131954
ar1     -0.979168    0.101527   -9.644447 0.000000
```

```
ar2      -0.009441    0.194817     -0.048463  0.961348
ar3      -0.022448    0.081360     -0.275908  0.782618
ma1       0.996191    0.000439   2266.671421  0.000000
omega     0.000000    0.000010      0.040558  0.967648
alpha1    0.123547    0.065598      1.883398  0.059646
alpha2    0.000005    0.042061      0.000121  0.999904
alpha3    0.000003    0.087287      0.000036  0.999971
alpha4    0.000003    0.272761      0.000011  0.999992
beta1     0.874431    0.383578      2.279672  0.022627

LogLikelihood : 17982.16

Information Criteria
------------------------------------

Akaike       -7.5588
Bayes        -7.5439
Shibata      -7.5589
Hannan-Quinn -7.5536



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model     : sGARCH(4,2)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000199    0.000063 -3.1361e+00 0.001712
ar1    -0.980497    0.003333 -2.9414e+02 0.000000
ar2    -0.010062    0.012750 -7.8912e-01 0.430040
ar3    -0.021564    0.014775 -1.4594e+00 0.144442
ma1     0.996077    0.000020  4.8681e+04 0.000000
omega   0.000000    0.000000  5.5327e+00 0.000000
alpha1  0.150214    0.021289  7.0559e+00 0.000000
alpha2  0.000029    0.024469  1.2050e-03 0.999039
alpha3  0.000007    0.025140  2.6300e-04 0.999790
alpha4  0.000007    0.018354  3.6100e-04 0.999712
beta1   0.612063    0.015560  3.9336e+01 0.000000
beta2   0.235315    0.042302  5.5627e+00 0.000000

Robust Standard Errors:
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000199    0.000076 -2.6188e+00 0.008825
ar1    -0.980497    0.011078 -8.8509e+01 0.000000
ar2    -0.010062    0.019644 -5.1219e-01 0.608517
```

```
ar3       -0.021564    0.016365  -1.3176e+00  0.187622
ma1        0.996077    0.000032   3.1020e+04  0.000000
omega      0.000000    0.000000   9.9796e-01  0.318301
alpha1     0.150214    0.075638   1.9860e+00  0.047039
alpha2     0.000029    0.211763   1.3900e-04  0.999889
alpha3     0.000007    0.084059   7.9000e-05  0.999937
alpha4     0.000007    0.032823   2.0200e-04  0.999839
beta1      0.612063    0.877319   6.9765e-01  0.485395
beta2      0.235315    0.796610   2.9540e-01  0.767691

LogLikelihood : 17985.09

Information Criteria
------------------------------------

Akaike        -7.5597
Bayes         -7.5433
Shibata       -7.5597
Hannan-Quinn  -7.5539


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model      : sGARCH(4,3)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters

          Estimate  Std. Error     t value  Pr(>|t|)
mu       -0.000194    0.000063 -3.0681e+00  0.002154
ar1      -0.981767    0.002886 -3.4013e+02  0.000000
ar2      -0.011386    0.012722 -8.9498e-01  0.370798
ar3      -0.021778    0.014918 -1.4598e+00  0.144352
ma1       0.996245    0.000021  4.8380e+04  0.000000
omega     0.000000    0.000000  3.9269e+00  0.000086
alpha1    0.168038    0.021262  7.9031e+00  0.000000
alpha2    0.000119    0.011009  1.0793e-02  0.991389
alpha3    0.000023    0.025663  9.0700e-04  0.999277
alpha4    0.000010    0.015627  6.2900e-04  0.999498
beta1     0.613076    0.084869  7.2238e+00  0.000000
beta2     0.001154    0.120836  9.5480e-03  0.992382
beta3     0.215742    0.042366  5.0923e+00  0.000000

Robust Standard Errors:
          Estimate  Std. Error     t value  Pr(>|t|)
mu       -0.000194    0.000072 -2.6711e+00  0.007560
ar1      -0.981767    0.006558 -1.4970e+02  0.000000
```

```
ar2     -0.011386   0.016440  -6.9258e-01  0.488572
ar3     -0.021778   0.016445  -1.3242e+00  0.185423
ma1      0.996245   0.000018   5.5446e+04  0.000000
omega    0.000000   0.000000   1.6159e+00  0.106111
alpha1   0.168038   0.037021   4.5390e+00  0.000006
alpha2   0.000119   0.137012   8.6700e-04  0.999308
alpha3   0.000023   0.010087   2.3060e-03  0.998160
alpha4   0.000010   0.020115   4.8900e-04  0.999610
beta1    0.613076   0.783857   7.8213e-01  0.434140
beta2    0.001154   0.489818   2.3550e-03  0.998121
beta3    0.215742   0.248014   8.6988e-01  0.384367

LogLikelihood : 17988.41

Information Criteria
------------------------------------

Akaike       -7.5606
Bayes        -7.5430
Shibata      -7.5607
Hannan-Quinn -7.5544


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model       : sGARCH(4,4)
Mean Model        : ARFIMA(3,0,1)
Distribution      : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000196    0.000063 -3.0928e+00 0.001983
ar1    -0.982066    0.004485 -2.1896e+02 0.000000
ar2    -0.012343    0.014194 -8.6963e-01 0.384505
ar3    -0.022357    0.015217 -1.4692e+00 0.141779
ma1     0.996171    0.000018  5.4674e+04 0.000000
omega   0.000000    0.000000  4.5017e+00 0.000007
alpha1  0.168183    0.022981  7.3184e+00 0.000000
alpha2  0.000755    0.011101  6.8011e-02 0.945777
alpha3  0.000160    0.072899  2.1890e-03 0.998253
alpha4  0.000097    0.020533  4.7000e-03 0.996250
beta1   0.636228    0.241518  2.6343e+00 0.008432
beta2   0.006864    0.432517  1.5869e-02 0.987339
beta3   0.118539    0.267061  4.4386e-01 0.657141
beta4   0.067387    0.216509  3.1124e-01 0.755616

Robust Standard Errors:
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000196	0.000073	−2.6743e+00	0.007487
ar1	−0.982066	0.009451	−1.0392e+02	0.000000
ar2	−0.012343	0.021411	−5.7649e−01	0.564284
ar3	−0.022357	0.017741	−1.2602e+00	0.207590
ma1	0.996171	0.000023	4.2473e+04	0.000000
omega	0.000000	0.000000	2.1334e+00	0.032891
alpha1	0.168183	0.043863	3.8342e+00	0.000126
alpha2	0.000755	0.118760	6.3570e−03	0.994928
alpha3	0.000160	0.101410	1.5740e−03	0.998744
alpha4	0.000097	0.077956	1.2380e−03	0.999012
beta1	0.636228	0.811050	7.8445e−01	0.432776
beta2	0.006864	0.795874	8.6240e−03	0.993119
beta3	0.118539	0.836176	1.4176e−01	0.887267
beta4	0.067387	0.488649	1.3790e−01	0.890316

LogLikelihood : 17988.65

Information Criteria

Akaike	−7.5603
Bayes	−7.5413
Shibata	−7.5603
Hannan–Quinn	−7.5536

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model    : sGARCH(4,5)
Mean Model     : ARFIMA(3,0,1)
Distribution   : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000199    0.000063 -3.1543e+00 0.001609
ar1    -0.982616    0.003599 -2.7304e+02 0.000000
ar2    -0.013478    0.010843 -1.2431e+00 0.213837
ar3    -0.022767    0.015010 -1.5168e+00 0.129308
ma1     0.996123    0.000022  4.4890e+04 0.000000
omega   0.000000    0.000000  3.9910e+00 0.000066
alpha1  0.164301    0.029462  5.5766e+00 0.000000
alpha2  0.000006    0.040089  1.5600e-04 0.999876
alpha3  0.000002    0.056776  3.0000e-05 0.999976
alpha4  0.000005    0.043187  1.2500e-04 0.999900
beta1   0.724418    0.380181  1.9055e+00 0.056721
beta2   0.000489    0.066129  7.3910e-03 0.994103
```

```
beta3     0.000284     0.565457   5.0200e-04 0.999599
beta4     0.000006     0.175157   3.2000e-05 0.999975
beta5     0.108998     0.097216   1.1212e+00 0.262207

Robust Standard Errors:
          Estimate  Std. Error      t value Pr(>|t|)
mu       -0.000199     0.000075  -2.6323e+00 0.008482
ar1      -0.982616     0.017353  -5.6624e+01 0.000000
ar2      -0.013478     0.027306  -4.9360e-01 0.621593
ar3      -0.022767     0.017670  -1.2884e+00 0.197597
ma1       0.996123     0.000038   2.5955e+04 0.000000
omega     0.000000     0.000000   1.4559e+00 0.145409
alpha1    0.164301     0.074910   2.1933e+00 0.028285
alpha2    0.000006     0.337609   1.9000e-05 0.999985
alpha3    0.000002     0.261560   6.0000e-06 0.999995
alpha4    0.000005     0.115173   4.7000e-05 0.999963
beta1     0.724418     1.643896   4.4067e-01 0.659451
beta2     0.000489     1.982399   2.4700e-04 0.999803
beta3     0.000284     1.257945   2.2600e-04 0.999820
beta4     0.000006     0.934728   6.0000e-06 0.999995
beta5     0.108998     0.255926   4.2590e-01 0.670184

LogLikelihood : 17990.61

Information Criteria
------------------------------------
```

```
Akaike       -7.5607
Bayes        -7.5403
Shibata      -7.5607
Hannan-Quinn -7.5536


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(4,6)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000198    0.000063 -3.1389e+00 0.001696
ar1    -0.982545    0.003123 -3.1464e+02 0.000000
ar2    -0.013131    0.013198 -9.9498e-01 0.319744
ar3    -0.022539    0.015188 -1.4840e+00 0.137813
ma1     0.996154    0.000019  5.2502e+04 0.000000
omega   0.000000    0.000000  1.1712e+01 0.000000
```

```
alpha1   0.162907    0.020064   8.1193e+00 0.000000
alpha2   0.000080    0.017507   4.5760e-03 0.996349
alpha3   0.000029    0.024799   1.1680e-03 0.999068
alpha4   0.000038    0.024903   1.5380e-03 0.998773
beta1    0.745385    0.115882   6.4323e+00 0.000000
beta2    0.002882    0.144893   1.9891e-02 0.984130
beta3    0.000156    0.067185   2.3270e-03 0.998143
beta4    0.000043    0.102562   4.1800e-04 0.999666
beta5    0.000052    0.055895   9.3300e-04 0.999256
beta6    0.087098    0.075819   1.1488e+00 0.250652

Robust Standard Errors:
          Estimate  Std. Error      t value Pr(>|t|)
mu       -0.000198    0.000082  -2.4247e+00 0.015323
ar1      -0.982545    0.011303  -8.6925e+01 0.000000
ar2      -0.013131    0.022790  -5.7620e-01 0.564477
ar3      -0.022539    0.017665  -1.2759e+00 0.201999
ma1       0.996154    0.000030   3.2874e+04 0.000000
omega     0.000000    0.000000   1.1170e+00 0.264001
alpha1    0.162907    0.035658   4.5686e+00 0.000005
alpha2    0.000080    0.145110   5.5200e-04 0.999559
alpha3    0.000029    0.139276   2.0800e-04 0.999834
alpha4    0.000038    0.073113   5.2400e-04 0.999582
beta1     0.745385    0.945829   7.8808e-01 0.430652
beta2     0.002882    0.737469   3.9080e-03 0.996882
beta3     0.000156    0.404522   3.8700e-04 0.999692
```

```
beta4    0.000043    0.607468   7.1000e-05  0.999944
beta5    0.000052    0.632085   8.2000e-05  0.999934
beta6    0.087098    0.258108   3.3745e-01  0.735779

LogLikelihood : 17992.25

Information Criteria
------------------------------------


Akaike        -7.5610
Bayes         -7.5392
Shibata       -7.5610
Hannan-Quinn  -7.5533



*-----------------------------------*
*          GARCH Model Fit          *
*-----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(4,7)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000194	0.000063	−3.0758e+00	0.002099
ar1	−0.982258	0.002834	−3.4658e+02	0.000000
ar2	−0.012178	0.012786	−9.5246e−01	0.340865
ar3	−0.022018	0.015132	−1.4550e+00	0.145661
ma1	0.996295	0.000020	4.9022e+04	0.000000
omega	0.000001	0.000000	2.6328e+00	0.008469
alpha1	0.159062	0.020762	7.6613e+00	0.000000
alpha2	0.022276	0.033668	6.6165e−01	0.508197
alpha3	0.000653	0.031124	2.0992e−02	0.983252
alpha4	0.037809	0.016522	2.2883e+00	0.022119
beta1	0.639114	0.101574	6.2921e+00	0.000000
beta2	0.000472	0.198317	2.3790e−03	0.998102
beta3	0.000175	0.100504	1.7380e−03	0.998613
beta4	0.000060	0.039061	1.5280e−03	0.998781
beta5	0.000061	0.032181	1.8920e−03	0.998491
beta6	0.000094	0.045605	2.0540e−03	0.998361
beta7	0.138319	0.001640	8.4335e+01	0.000000

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000194	0.000073	−2.6357e+00	0.008396
ar1	−0.982258	0.006095	−1.6115e+02	0.000000
ar2	−0.012178	0.016777	−7.2588e−01	0.467916
ar3	−0.022018	0.016774	−1.3126e+00	0.189325

```
ma1       0.996295   0.000024   4.2257e+04  0.000000
omega     0.000001   0.000001   6.6662e-01  0.505015
alpha1    0.159062   0.038031   4.1824e+00  0.000029
alpha2    0.022276   0.094949   2.3461e-01  0.814511
alpha3    0.000653   0.045886   1.4239e-02  0.988640
alpha4    0.037809   0.090842   4.1620e-01  0.677263
beta1     0.639114   0.429150   1.4893e+00  0.136421
beta2     0.000472   0.161209   2.9260e-03  0.997665
beta3     0.000175   0.054225   3.2220e-03  0.997429
beta4     0.000060   0.014658   4.0720e-03  0.996751
beta5     0.000061   0.020132   3.0240e-03  0.997587
beta6     0.000094   0.066265   1.4140e-03  0.998872
beta7     0.138319   0.216610   6.3856e-01  0.523107

LogLikelihood : 17995.98

Information Criteria
------------------------------------

Akaike        -7.5621
Bayes         -7.5390
Shibata       -7.5622
Hannan-Quinn  -7.5540


*-----------------------------------*
```

```
*            GARCH Model Fit          *
*-------------------------------------*

Conditional Variance Dynamics
--------------------------------------
GARCH Model       : sGARCH(4,8)
Mean Model        : ARFIMA(3,0,1)
Distribution      : norm

Optimal Parameters
----------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000179    0.000062 -2.8891e+00 0.003863
ar1     -0.981013    0.002782 -3.5266e+02 0.000000
ar2     -0.010735    0.012692 -8.4577e-01 0.397679
ar3     -0.022034    0.015020 -1.4670e+00 0.142376
ma1      0.996590    0.000019  5.1642e+04 0.000000
omega    0.000001    0.000000  3.0186e+00 0.002540
alpha1   0.156834    0.020759  7.5549e+00 0.000000
alpha2   0.062366    0.021208  2.9407e+00 0.003275
alpha3   0.044602    0.010714  4.1631e+00 0.000031
alpha4   0.093708    0.015622  5.9986e+00 0.000000
beta1    0.373475    0.017047  2.1909e+01 0.000000
beta2    0.000001    0.149919  4.0000e-06 0.999997
beta3    0.000000    0.295153  0.0000e+00 1.000000
beta4    0.000000    0.266697  0.0000e+00 1.000000
```

```
beta5     0.000000    0.132730   0.0000e+00 1.000000
beta6     0.000000    0.152265   0.0000e+00 1.000000
beta7     0.000000    0.092229   1.0000e-06 0.999999
beta8     0.268013    0.053141   5.0434e+00 0.000000

Robust Standard Errors:
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000179    0.000080 -2.2514e+00 0.024360
ar1      -0.981013    0.006653 -1.4745e+02 0.000000
ar2      -0.010735    0.019546 -5.4921e-01 0.582864
ar3      -0.022034    0.017903 -1.2308e+00 0.218412
ma1       0.996590    0.000030  3.3765e+04 0.000000
omega     0.000001    0.000002  6.0086e-01 0.547935
alpha1    0.156834    0.045173  3.4719e+00 0.000517
alpha2    0.062366    0.059737  1.0440e+00 0.296483
alpha3    0.044602    0.081700  5.4593e-01 0.585115
alpha4    0.093708    0.067920  1.3797e+00 0.167684
beta1     0.373475    0.393284  9.4963e-01 0.342300
beta2     0.000001    0.580626  1.0000e-06 0.999999
beta3     0.000000    0.720810  0.0000e+00 1.000000
beta4     0.000000    1.053838  0.0000e+00 1.000000
beta5     0.000000    0.723882  0.0000e+00 1.000000
beta6     0.000000    0.319478  0.0000e+00 1.000000
beta7     0.000000    0.430413  0.0000e+00 1.000000
beta8     0.268013    0.447297  5.9918e-01 0.549052
```

```
LogLikelihood : 18007.16

Information Criteria
------------------------------------

Akaike        -7.5664
Bayes         -7.5419
Shibata       -7.5664
Hannan-Quinn  -7.5578


*-----------------------------------*
*          GARCH Model Fit          *
*-----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(4,9)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000176    0.000062 -2.8575e+00 0.004270
ar1    -0.981696    0.003047 -3.2222e+02 0.000000
```

```
ar2     -0.011753    0.012339  -9.5249e-01 0.340851
ar3     -0.022347    0.014866  -1.5032e+00 0.132794
ma1      0.996600    0.000020   5.0449e+04 0.000000
omega    0.000001    0.000000   2.2478e+00 0.024588
alpha1   0.161078    0.012625   1.2759e+01 0.000000
alpha2   0.069470    0.023888   2.9082e+00 0.003635
alpha3   0.051365    0.016063   3.1978e+00 0.001385
alpha4   0.094214    0.021659   4.3499e+00 0.000014
beta1    0.337242    0.182736   1.8455e+00 0.064962
beta2    0.000019    0.018027   1.0800e-03 0.999138
beta3    0.000002    0.244856   9.0000e-06 0.999992
beta4    0.000001    0.117204   9.0000e-06 0.999993
beta5    0.000001    0.184792   6.0000e-06 0.999995
beta6    0.000001    0.068474   1.4000e-05 0.999989
beta7    0.000001    0.202876   7.0000e-06 0.999995
beta8    0.224563    0.134052   1.6752e+00 0.093895
beta9    0.061028    0.068639   8.8913e-01 0.373934

Robust Standard Errors:
         Estimate  Std. Error      t value Pr(>|t|)
mu      -0.000176    0.000087  -2.0194e+00 0.043441
ar1     -0.981696    0.010194  -9.6305e+01 0.000000
ar2     -0.011753    0.032231  -3.6465e-01 0.715372
ar3     -0.022347    0.023751  -9.4087e-01 0.346773
ma1      0.996600    0.000053   1.8766e+04 0.000000
omega    0.000001    0.000003   3.4929e-01 0.726872
```

```
alpha1   0.161078   0.115785   1.3912e+00 0.164171
alpha2   0.069470   0.143957   4.8257e-01 0.629397
alpha3   0.051365   0.091234   5.6300e-01 0.573436
alpha4   0.094214   0.220580   4.2712e-01 0.669291
beta1    0.337242   0.778645   4.3311e-01 0.664932
beta2    0.000019   0.008101   2.4040e-03 0.998082
beta3    0.000002   1.087373   2.0000e-06 0.999998
beta4    0.000001   0.950526   1.0000e-06 0.999999
beta5    0.000001   1.221713   1.0000e-06 0.999999
beta6    0.000001   0.544064   2.0000e-06 0.999999
beta7    0.000001   1.506048   1.0000e-06 0.999999
beta8    0.224563   0.811077   2.7687e-01 0.781879
beta9    0.061028   0.303477   2.0110e-01 0.840622

LogLikelihood : 18007.4

Information Criteria
------------------------------------

Akaike       -7.5661
Bayes        -7.5403
Shibata      -7.5661
Hannan-Quinn -7.5570

*----------------------------------*
```

```
*            GARCH Model Fit           *
*--------------------------------------*

Conditional Variance Dynamics
--------------------------------------
GARCH Model     : sGARCH(4,10)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
--------------------------------------
         Estimate  Std. Error     t value  Pr(>|t|)
mu      -0.000176    0.000062 -2.8336e+00  0.004602
ar1     -0.981673    0.002846 -3.4493e+02  0.000000
ar2     -0.011738    0.012464 -9.4175e-01  0.346321
ar3     -0.022358    0.014909 -1.4996e+00  0.133712
ma1      0.996602    0.000020  5.1100e+04  0.000000
omega    0.000001    0.000000  2.8490e+00  0.004386
alpha1   0.161091    0.017424  9.2456e+00  0.000000
alpha2   0.069548    0.013809  5.0363e+00  0.000000
alpha3   0.051356    0.022924  2.2402e+00  0.025075
alpha4   0.094088    0.007479  1.2580e+01  0.000000
beta1    0.337445    0.191457  1.7625e+00  0.077983
beta2    0.000001    0.114404  7.0000e-06  0.999995
beta3    0.000000    0.208897  1.0000e-06  1.000000
beta4    0.000000    0.158851  0.0000e+00  1.000000
```

```
beta5    0.000000    0.276978   0.0000e+00 1.000000
beta6    0.000000    0.104882   0.0000e+00 1.000000
beta7    0.000000    0.148078   0.0000e+00 1.000000
beta8    0.223249    0.045382   4.9194e+00 0.000001
beta9    0.062220    0.084234   7.3866e-01 0.460111
beta10   0.000001    0.048189   2.6000e-05 0.999979

Robust Standard Errors:
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000176    0.000075 -2.3486e+00 0.018843
ar1      -0.981673    0.007582 -1.2947e+02 0.000000
ar2      -0.011738    0.024868 -4.7202e-01 0.636914
ar3      -0.022358    0.021091 -1.0601e+00 0.289116
ma1       0.996602    0.000031  3.2289e+04 0.000000
omega     0.000001    0.000002  5.5357e-01 0.579871
alpha1    0.161091    0.074760  2.1548e+00 0.031180
alpha2    0.069548    0.091321  7.6158e-01 0.446312
alpha3    0.051356    0.053837  9.5391e-01 0.340129
alpha4    0.094088    0.142001  6.6259e-01 0.507595
beta1     0.337445    0.617871  5.4614e-01 0.584969
beta2     0.000001    0.441798  2.0000e-06 0.999999
beta3     0.000000    0.602631  0.0000e+00 1.000000
beta4     0.000000    0.708766  0.0000e+00 1.000000
beta5     0.000000    1.337198  0.0000e+00 1.000000
beta6     0.000000    0.190408  0.0000e+00 1.000000
beta7     0.000000    0.854155  0.0000e+00 1.000000
```

```
beta8    0.223249    0.175917  1.2691e+00 0.204421
beta9    0.062220    0.734991  8.4655e-02 0.932536
beta10   0.000001    0.211052  6.0000e-06 0.999995

LogLikelihood : 18007.37

Information Criteria
------------------------------------

Akaike        -7.5657
Bayes         -7.5385
Shibata       -7.5657
Hannan-Quinn  -7.5561



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(5,1)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000197	0.000063	−3.1202e+00	0.001807
ar1	−0.979060	0.004132	−2.3696e+02	0.000000
ar2	−0.009301	0.008269	−1.1248e+00	0.260685
ar3	−0.022431	0.014388	−1.5590e+00	0.119007
ma1	0.996213	0.000029	3.3994e+04	0.000000
omega	0.000000	0.000000	9.7930e−01	0.327430
alpha1	0.123381	0.017579	7.0184e+00	0.000000
alpha2	0.000015	0.024835	6.0300e−04	0.999519
alpha3	0.000009	0.026622	3.3600e−04	0.999732
alpha4	0.000008	0.026234	3.1400e−04	0.999749
alpha5	0.000006	0.014688	4.0200e−04	0.999679
beta1	0.874589	0.015048	5.8118e+01	0.000000

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000197	0.000107	−1.845587	0.064952
ar1	−0.979060	0.070550	−13.877508	0.000000
ar2	−0.009301	0.137775	−0.067510	0.946176
ar3	−0.022431	0.061122	−0.366989	0.713627
ma1	0.996213	0.000290	3431.883055	0.000000
omega	0.000000	0.000006	0.070318	0.943940
alpha1	0.123381	0.049483	2.493396	0.012653
alpha2	0.000015	0.035804	0.000418	0.999666
alpha3	0.000009	0.062975	0.000142	0.999887

```
alpha4   0.000008   0.030234   0.000273  0.999782
alpha5   0.000006   0.184828   0.000032  0.999975
beta1    0.874589   0.258686   3.380888  0.000723

LogLikelihood : 17981.93

Information Criteria
------------------------------------

Akaike        -7.5583
Bayes         -7.5420
Shibata       -7.5583
Hannan-Quinn  -7.5526



*-----------------------------------*
*          GARCH Model Fit          *
*-----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(5,2)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000199	0.000063	−3.1317e+00	0.001738
ar1	−0.980194	0.002892	−3.3890e+02	0.000000
ar2	−0.009427	0.012588	−7.4891e−01	0.453911
ar3	−0.021228	0.014795	−1.4348e+00	0.151355
ma1	0.996078	0.000022	4.6005e+04	0.000000
omega	0.000000	0.000000	3.1975e+00	0.001386
alpha1	0.150278	0.019084	7.8747e+00	0.000000
alpha2	0.000049	0.019748	2.4840e−03	0.998018
alpha3	0.000015	0.024134	6.2100e−04	0.999505
alpha4	0.000015	0.021540	7.1200e−04	0.999432
alpha5	0.000010	0.018495	5.3900e−04	0.999570
beta1	0.611893	0.034993	1.7486e+01	0.000000
beta2	0.235532	0.054915	4.2890e+00	0.000018

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000199	0.000073	−2.7272e+00	0.006387
ar1	−0.980194	0.006106	−1.6054e+02	0.000000
ar2	−0.009427	0.017114	−5.5086e−01	0.581731
ar3	−0.021228	0.016874	−1.2580e+00	0.208383
ma1	0.996078	0.000025	4.0221e+04	0.000000
omega	0.000000	0.000000	9.6498e−01	0.334555
alpha1	0.150278	0.030918	4.8605e+00	0.000001
alpha2	0.000049	0.118233	4.1500e−04	0.999669

```
alpha3    0.000015     0.051722   2.9000e-04  0.999769
alpha4    0.000015     0.039171   3.9200e-04  0.999687
alpha5    0.000010     0.040049   2.4900e-04  0.999801
beta1     0.611893     0.792272   7.7233e-01  0.439921
beta2     0.235532     0.682293   3.4521e-01  0.729939

LogLikelihood : 17984.85

Information Criteria
------------------------------------

Akaike        -7.5591
Bayes         -7.5415
Shibata       -7.5592
Hannan-Quinn  -7.5529


*---------------------------------*
*          GARCH Model Fit         *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model    : sGARCH(5,3)
Mean Model     : ARFIMA(3,0,1)
Distribution   : norm
```

Optimal Parameters

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000192	0.000064	−3.0255e+00	0.002483
ar1	−0.981909	0.004694	−2.0917e+02	0.000000
ar2	−0.011497	0.013774	−8.3472e−01	0.403873
ar3	−0.021718	0.015005	−1.4474e+00	0.147787
ma1	0.996234	0.000019	5.1887e+04	0.000000
omega	0.000000	0.000000	4.6463e+00	0.000003
alpha1	0.167611	0.021539	7.7817e+00	0.000000
alpha2	0.000074	0.103378	7.1900e−04	0.999427
alpha3	0.000010	0.141038	6.8000e−05	0.999945
alpha4	0.000006	0.032257	1.7800e−04	0.999858
alpha5	0.000003	0.022468	1.2800e−04	0.999898
beta1	0.615534	0.527851	1.1661e+00	0.243568
beta2	0.000349	1.004982	3.4700e−04	0.999723
beta3	0.214434	0.474984	4.5145e−01	0.651662

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000192	0.000077	−2.5074e+00	0.012161
ar1	−0.981909	0.009480	−1.0358e+02	0.000000
ar2	−0.011497	0.019826	−5.7992e−01	0.561970
ar3	−0.021718	0.016991	−1.2782e+00	0.201168
ma1	0.996234	0.000023	4.4234e+04	0.000000

```
omega     0.000000     0.000000   2.1399e+00  0.032359
alpha1    0.167611     0.037609   4.4567e+00  0.000008
alpha2    0.000074     0.243493   3.0500e-04  0.999757
alpha3    0.000010     0.278857   3.5000e-05  0.999972
alpha4    0.000006     0.061292   9.4000e-05  0.999925
alpha5    0.000003     0.042967   6.7000e-05  0.999947
beta1     0.615534     1.251241   4.9194e-01  0.622763
beta2     0.000349     1.916407   1.8200e-04  0.999855
beta3     0.214434     0.869996   2.4648e-01  0.805313

LogLikelihood : 17988.18

Information Criteria
------------------------------------

Akaike        -7.5601
Bayes         -7.5411
Shibata       -7.5601
Hannan-Quinn  -7.5534


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model     : sGARCH(5,4)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters

        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000184    0.000063 -2.925001 0.003445
ar1    -0.766109    0.466793 -1.641220 0.100752
ar2    -0.016593    0.020775 -0.798687 0.424472
ar3    -0.007525    0.022998 -0.327202 0.743515
ma1     0.779229    0.462630  1.684344 0.092115
omega   0.000000    0.000000  4.150291 0.000033
alpha1  0.167082    0.021299  7.844698 0.000000
alpha2  0.000368    0.192834  0.001906 0.998479
alpha3  0.000060    0.233202  0.000256 0.999795
alpha4  0.000023    0.033984  0.000668 0.999467
alpha5  0.000008    0.039111  0.000206 0.999836
beta1   0.624618    1.093104  0.571417 0.567717
beta2   0.004308    1.860685  0.002315 0.998153
beta3   0.169749    0.539214  0.314809 0.752907
beta4   0.031412    0.070158  0.447739 0.654342

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
```

mu	−0.000184	0.000073	−2.515935	0.011872
ar1	−0.766109	0.785106	−0.975804	0.329162
ar2	−0.016593	0.024041	−0.690190	0.490075
ar3	−0.007525	0.029683	−0.253512	0.799873
ma1	0.779229	0.775564	1.004725	0.315029
omega	0.000000	0.000000	1.790729	0.073337
alpha1	0.167082	0.038491	4.340856	0.000014
alpha2	0.000368	0.477930	0.000769	0.999386
alpha3	0.000060	0.610362	0.000098	0.999922
alpha4	0.000023	0.034858	0.000651	0.999480
alpha5	0.000008	0.111119	0.000072	0.999942
beta1	0.624618	2.729704	0.228823	0.819007
beta2	0.004308	4.878022	0.000883	0.999295
beta3	0.169749	1.782931	0.095208	0.924150
beta4	0.031412	0.421266	0.074567	0.940559

LogLikelihood : 17985.02

Information Criteria

Akaike	−7.5584
Bayes	−7.5380
Shibata	−7.5584
Hannan–Quinn	−7.5512

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(5,5)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000198    0.000063 -3.1476e+00 0.001646
ar1      -0.982789    0.003181 -3.0900e+02 0.000000
ar2      -0.013624    0.013058 -1.0433e+00 0.296790
ar3      -0.022796    0.015136 -1.5060e+00 0.132060
ma1       0.996148    0.000020  5.0808e+04 0.000000
omega     0.000000    0.000000  5.1973e+00 0.000000
alpha1    0.164380    0.009802  1.6769e+01 0.000000
alpha2    0.000009    0.054322  1.7100e-04 0.999864
alpha3    0.000004    0.068273  6.4000e-05 0.999949
alpha4    0.000009    0.035057  2.4400e-04 0.999805
alpha5    0.000001    0.018218  5.2000e-05 0.999959
beta1     0.723613    0.209119  3.4603e+00 0.000540
```

```
beta2    0.000952    0.472027   2.0170e-03 0.998391
beta3    0.000554    0.461983   1.2000e-03 0.999043
beta4    0.000014    0.336297   4.1000e-05 0.999968
beta5    0.109061    0.037406   2.9156e+00 0.003550

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000198    0.000073 -2.7202e+00 0.006525
ar1     -0.982789    0.006574 -1.4949e+02 0.000000
ar2     -0.013624    0.016986 -8.0207e-01 0.422514
ar3     -0.022796    0.016731 -1.3625e+00 0.173032
ma1      0.996148    0.000018  5.4657e+04 0.000000
omega    0.000000    0.000000  2.4392e+00 0.014721
alpha1   0.164380    0.020874  7.8749e+00 0.000000
alpha2   0.000009    0.099826  9.3000e-05 0.999926
alpha3   0.000004    0.091229  4.8000e-05 0.999962
alpha4   0.000009    0.071983  1.1900e-04 0.999905
alpha5   0.000001    0.048107  2.0000e-05 0.999984
beta1    0.723613    0.543345  1.3318e+00 0.182934
beta2    0.000952    0.753746  1.2630e-03 0.998992
beta3    0.000554    0.732522  7.5700e-04 0.999396
beta4    0.000014    0.540480  2.5000e-05 0.999980
beta5    0.109061    0.308084  3.5400e-01 0.723341

LogLikelihood : 17990.61
```

```
Information Criteria
------------------------------------

Akaike       -7.5603
Bayes        -7.5385
Shibata      -7.5603
Hannan-Quinn -7.5527


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(5,6)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000192    0.000063 -3.0445e+00 0.002331
ar1    -0.983482    0.002832 -3.4733e+02 0.000000
ar2    -0.013458    0.012710 -1.0588e+00 0.289671
ar3    -0.022066    0.015055 -1.4657e+00 0.142727
```

```
ma1       0.996313    0.000021  4.8491e+04 0.000000
omega     0.000001    0.000000  1.5993e+01 0.000000
alpha1    0.169421    0.020959  8.0834e+00 0.000000
alpha2    0.118002    0.052900  2.2307e+00 0.025702
alpha3    0.000060    0.039723  1.5150e-03 0.998792
alpha4    0.007626    0.022609  3.3729e-01 0.735901
alpha5    0.000026    0.026483  9.7000e-04 0.999226
beta1     0.002093    0.232005  9.0230e-03 0.992801
beta2     0.434242    0.353794  1.2274e+00 0.219677
beta3     0.106667    0.105384  1.0122e+00 0.311455
beta4     0.000211    0.031903  6.6230e-03 0.994715
beta5     0.000644    0.168271  3.8280e-03 0.996945
beta6     0.157881    0.081832  1.9293e+00 0.053690

Robust Standard Errors:
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000192    0.000072 -2.6479e+00 0.008098
ar1      -0.983482    0.006379 -1.5419e+02 0.000000
ar2      -0.013458    0.016685 -8.0663e-01 0.419880
ar3      -0.022066    0.016656 -1.3248e+00 0.185231
ma1       0.996313    0.000019  5.1758e+04 0.000000
omega     0.000001    0.000000  2.3407e+00 0.019245
alpha1    0.169421    0.029123  5.8175e+00 0.000000
alpha2    0.118002    0.086256  1.3680e+00 0.171299
alpha3    0.000060    0.101421  5.9300e-04 0.999527
alpha4    0.007626    0.051841  1.4710e-01 0.883052
```

```
alpha5   0.000026    0.057065  4.5000e-04 0.999641
beta1    0.002093    0.320612  6.5290e-03 0.994791
beta2    0.434242    0.697503  6.2257e-01 0.533570
beta3    0.106667    0.340242  3.1350e-01 0.753898
beta4    0.000211    0.265771  7.9500e-04 0.999366
beta5    0.000644    0.411890  1.5640e-03 0.998752
beta6    0.157881    0.085658  1.8432e+00 0.065304

LogLikelihood : 17992.2

Information Criteria
------------------------------------

Akaike        -7.5605
Bayes         -7.5374
Shibata       -7.5606
Hannan-Quinn  -7.5524


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model       : sGARCH(5,7)
```

```
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000192    0.000063 -3.0583e+00 0.002226
ar1     -0.982149    0.003014 -3.2588e+02 0.000000
ar2     -0.012269    0.012785 -9.5967e-01 0.337222
ar3     -0.022256    0.015104 -1.4735e+00 0.140615
ma1      0.996326    0.000020  4.9221e+04 0.000000
omega    0.000001    0.000000  3.7113e+00 0.000206
alpha1   0.159237    0.020861  7.6331e+00 0.000000
alpha2   0.021841    0.028469  7.6718e-01 0.442973
alpha3   0.000078    0.029147  2.6700e-03 0.997870
alpha4   0.037468    0.029278  1.2797e+00 0.200639
alpha5   0.000004    0.018229  2.3800e-04 0.999810
beta1    0.641915    0.050880  1.2616e+01 0.000000
beta2    0.000046    0.106155  4.3100e-04 0.999656
beta3    0.000016    0.061843  2.6400e-04 0.999789
beta4    0.000008    0.202574  4.0000e-05 0.999968
beta5    0.000008    0.148099  5.2000e-05 0.999959
beta6    0.000010    0.042640  2.3700e-04 0.999811
beta7    0.137549    0.053899  2.5520e+00 0.010712

Robust Standard Errors:
```

```
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000192    0.000072 -2.6807e+00 0.007347
ar1     -0.982149    0.006920 -1.4194e+02 0.000000
ar2     -0.012269    0.017811 -6.8884e-01 0.490926
ar3     -0.022256    0.017071 -1.3038e+00 0.192312
ma1      0.996326    0.000023  4.4266e+04 0.000000
omega    0.000001    0.000000  1.4380e+00 0.150422
alpha1   0.159237    0.038091  4.1804e+00 0.000029
alpha2   0.021841    0.069943  3.1227e-01 0.754837
alpha3   0.000078    0.051244  1.5190e-03 0.998788
alpha4   0.037468    0.058068  6.4524e-01 0.518769
alpha5   0.000004    0.055117  7.9000e-05 0.999937
beta1    0.641915    0.328741  1.9526e+00 0.050862
beta2    0.000046    0.141378  3.2300e-04 0.999742
beta3    0.000016    0.392543  4.2000e-05 0.999967
beta4    0.000008    0.323432  2.5000e-05 0.999980
beta5    0.000008    0.229630  3.3000e-05 0.999973
beta6    0.000010    0.145090  7.0000e-05 0.999945
beta7    0.137549    0.174563  7.8796e-01 0.430720

LogLikelihood : 17996

Information Criteria
------------------------------------

Akaike       -7.5617
```

```
Bayes          -7.5372
Shibata        -7.5618
Hannan-Quinn   -7.5531


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(5,8)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000179    0.000063 -2.8550e+00 0.004304
ar1     -0.980896    0.002834 -3.4609e+02 0.000000
ar2     -0.010569    0.012740 -8.2957e-01 0.406784
ar3     -0.021983    0.015039 -1.4617e+00 0.143822
ma1      0.996587    0.000019  5.2196e+04 0.000000
omega    0.000001    0.000000  6.0368e+00 0.000000
alpha1   0.156684    0.023682  6.6162e+00 0.000000
alpha2   0.062635    0.033793  1.8535e+00 0.063815
```

```
alpha3   0.044809    0.028532   1.5705e+00 0.116303
alpha4   0.093951    0.023124   4.0629e+00 0.000048
alpha5   0.000314    0.020606   1.5251e-02 0.987832
beta1    0.372041    0.202267   1.8394e+00 0.065864
beta2    0.000099    0.250835   3.9600e-04 0.999684
beta3    0.000020    0.030653   6.6100e-04 0.999472
beta4    0.000010    0.055962   1.7900e-04 0.999857
beta5    0.000010    0.176460   5.7000e-05 0.999955
beta6    0.000011    0.103643   1.0200e-04 0.999919
beta7    0.000015    0.216740   6.9000e-05 0.999945
beta8    0.268274    0.112565   2.3833e+00 0.017160

Robust Standard Errors:
         Estimate  Std. Error      t value Pr(>|t|)
mu      -0.000179    0.000077  -2.3296e+00 0.019828
ar1     -0.980896    0.007194  -1.3634e+02 0.000000
ar2     -0.010569    0.018939  -5.5805e-01 0.576812
ar3     -0.021983    0.017399  -1.2635e+00 0.206420
ma1      0.996587    0.000025   4.0194e+04 0.000000
omega    0.000001    0.000000   1.8957e+00 0.057996
alpha1   0.156684    0.044780   3.4989e+00 0.000467
alpha2   0.062635    0.130961   4.7827e-01 0.632458
alpha3   0.044809    0.054999   8.1474e-01 0.415223
alpha4   0.093951    0.028009   3.3543e+00 0.000796
alpha5   0.000314    0.090942   3.4560e-03 0.997243
beta1    0.372041    0.925097   4.0216e-01 0.687563
```

```
beta2    0.000099    0.835995   1.1900e-04  0.999905
beta3    0.000020    0.050480   4.0200e-04  0.999680
beta4    0.000010    0.310087   3.2000e-05  0.999974
beta5    0.000010    0.502125   2.0000e-05  0.999984
beta6    0.000011    0.317347   3.3000e-05  0.999973
beta7    0.000015    0.544267   2.8000e-05  0.999978
beta8    0.268274    0.302272   8.8752e-01  0.374797

LogLikelihood : 18007.16

Information Criteria
------------------------------------

Akaike       -7.5660
Bayes        -7.5402
Shibata      -7.5660
Hannan-Quinn -7.5569


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(5,9)
```

```
Mean Model        : ARFIMA(3,0,1)
Distribution      : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000177    0.000062 -2.8465e+00 0.004420
ar1    -0.981393    0.002757 -3.5594e+02 0.000000
ar2    -0.011543    0.012618 -9.1484e-01 0.360274
ar3    -0.022461    0.014986 -1.4988e+00 0.133925
ma1     0.996601    0.000019  5.2175e+04 0.000000
omega   0.000001    0.000000  5.5463e+00 0.000000
alpha1  0.160118    0.020914  7.6560e+00 0.000000
alpha2  0.075804    0.019259  3.9360e+00 0.000083
alpha3  0.056712    0.014359  3.9495e+00 0.000078
alpha4  0.095592    0.020941  4.5648e+00 0.000005
alpha5  0.009590    0.010703  8.9605e-01 0.370227
beta1   0.299190    0.104520  2.8625e+00 0.004203
beta2   0.000010    0.142961  7.1000e-05 0.999943
beta3   0.000001    0.213876  6.0000e-06 0.999996
beta4   0.000001    0.200879  3.0000e-06 0.999998
beta5   0.000001    0.215158  3.0000e-06 0.999998
beta6   0.000001    0.136117  4.0000e-06 0.999997
beta7   0.000001    0.042499  1.6000e-05 0.999987
beta8   0.223072    0.093507  2.3856e+00 0.017050
beta9   0.078900    0.102071  7.7299e-01 0.439529
```

```
Robust Standard Errors:
          Estimate  Std. Error      t value Pr(>|t|)
mu       -0.000177    0.000070  -2.5292e+00 0.011433
ar1      -0.981393    0.006941  -1.4138e+02 0.000000
ar2      -0.011543    0.018159  -6.3569e-01 0.524981
ar3      -0.022461    0.017205  -1.3055e+00 0.191719
ma1       0.996601    0.000022   4.5231e+04 0.000000
omega     0.000001    0.000000   2.2666e+00 0.023413
alpha1    0.160118    0.041420   3.8657e+00 0.000111
alpha2    0.075804    0.074558   1.0167e+00 0.309291
alpha3    0.056712    0.058176   9.7484e-01 0.329637
alpha4    0.095592    0.046754   2.0446e+00 0.040897
alpha5    0.009590    0.066365   1.4450e-01 0.885103
beta1     0.299190    0.459434   6.5121e-01 0.514909
beta2     0.000010    0.512502   2.0000e-05 0.999984
beta3     0.000001    0.378922   3.0000e-06 0.999997
beta4     0.000001    0.327488   2.0000e-06 0.999999
beta5     0.000001    0.404779   1.0000e-06 0.999999
beta6     0.000001    0.237258   2.0000e-06 0.999998
beta7     0.000001    0.342946   2.0000e-06 0.999998
beta8     0.223072    0.264663   8.4285e-01 0.399310
beta9     0.078900    0.303526   2.5994e-01 0.794907

LogLikelihood : 18007.49
```

```
Information Criteria
------------------------------------

Akaike       -7.5657
Bayes        -7.5385
Shibata      -7.5658
Hannan-Quinn -7.5562


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(5,10)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000177    0.000062 -2.8395e+00 0.004518
ar1     -0.981406    0.002808 -3.4952e+02 0.000000
ar2     -0.011581    0.012751 -9.0819e-01 0.363776
ar3     -0.022487    0.015041 -1.4951e+00 0.134901
```

```
ma1      0.996602    0.000019   5.2512e+04 0.000000
omega    0.000001    0.000000   7.0938e+00 0.000000
alpha1   0.160214    0.021117   7.5868e+00 0.000000
alpha2   0.075856    0.019334   3.9234e+00 0.000087
alpha3   0.056657    0.023239   2.4380e+00 0.014767
alpha4   0.095377    0.021045   4.5321e+00 0.000006
alpha5   0.009538    0.012961   7.3584e-01 0.461826
beta1    0.299737    0.094025   3.1878e+00 0.001433
beta2    0.000008    0.109157   7.1000e-05 0.999944
beta3    0.000001    0.204288   3.0000e-06 0.999998
beta4    0.000000    0.192917   1.0000e-06 0.999999
beta5    0.000000    0.194210   1.0000e-06 0.999999
beta6    0.000000    0.121809   2.0000e-06 0.999998
beta7    0.000000    0.040098   8.0000e-06 0.999993
beta8    0.221274    0.064413   3.4353e+00 0.000592
beta9    0.080234    0.109590   7.3213e-01 0.464089
beta10   0.000102    0.066499   1.5290e-03 0.998780

Robust Standard Errors:
          Estimate  Std. Error      t value  Pr(>|t|)
mu       -0.000177    0.000071  -2.4807e+00 0.013114
ar1      -0.981406    0.007119  -1.3786e+02 0.000000
ar2      -0.011581    0.018525  -6.2514e-01 0.531880
ar3      -0.022487    0.017263  -1.3026e+00 0.192718
ma1       0.996602    0.000023   4.3691e+04 0.000000
omega     0.000001    0.000000   2.4296e+00 0.015118
```

alpha1	0.160214	0.043427	3.6892e+00	0.000225
alpha2	0.075856	0.074548	1.0175e+00	0.308898
alpha3	0.056657	0.063884	8.8688e−01	0.375146
alpha4	0.095377	0.044832	2.1274e+00	0.033385
alpha5	0.009538	0.073264	1.3018e−01	0.896424
beta1	0.299737	0.474572	6.3159e−01	0.527652
beta2	0.000008	0.527649	1.5000e−05	0.999988
beta3	0.000001	0.340162	2.0000e−06	0.999999
beta4	0.000000	0.355111	1.0000e−06	0.999999
beta5	0.000000	0.301181	1.0000e−06	0.999999
beta6	0.000000	0.266507	1.0000e−06	0.999999
beta7	0.000000	0.317212	1.0000e−06	0.999999
beta8	0.221274	0.217658	1.0166e+00	0.309337
beta9	0.080234	0.171214	4.6862e−01	0.639341
beta10	0.000102	0.128543	7.9100e−04	0.999369

LogLikelihood : 18007.46

Information Criteria

Akaike	−7.5653
Bayes	−7.5367
Shibata	−7.5653
Hannan−Quinn	−7.5552

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(6,1)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000200    0.000063 -3.1655e+00 0.001548
ar1    -0.979435    0.003617 -2.7081e+02 0.000000
ar2    -0.010113    0.009146 -1.1058e+00 0.268828
ar3    -0.022884    0.014487 -1.5796e+00 0.114190
ma1     0.996205    0.000028  3.5776e+04 0.000000
omega   0.000000    0.000000  1.1370e+00 0.255540
alpha1  0.123830    0.017523  7.0668e+00 0.000000
alpha2  0.000122    0.023982  5.0870e-03 0.995941
alpha3  0.000100    0.025868  3.8800e-03 0.996904
alpha4  0.000103    0.026334  3.9230e-03 0.996870
alpha5  0.000081    0.026957  2.9900e-03 0.997614
alpha6  0.000085    0.017765  4.7600e-03 0.996202
```

```
beta1     0.874058     0.013785   6.3405e+01 0.000000

Robust Standard Errors:
          Estimate  Std. Error      t value Pr(>|t|)
mu       -0.000200    0.000092    -2.169645 0.030034
ar1      -0.979435    0.055955   -17.503961 0.000000
ar2      -0.010113    0.108156    -0.093502 0.925504
ar3      -0.022884    0.048100    -0.475762 0.634244
ma1       0.996205    0.000223  4475.153197 0.000000
omega     0.000000    0.000004     0.096134 0.923414
alpha1    0.123830    0.043241     2.863718 0.004187
alpha2    0.000122    0.033936     0.003595 0.997132
alpha3    0.000100    0.061254     0.001638 0.998693
alpha4    0.000103    0.029875     0.003458 0.997241
alpha5    0.000081    0.047345     0.001703 0.998642
alpha6    0.000085    0.122658     0.000689 0.999450
beta1     0.874058    0.214053     4.083375 0.000044

LogLikelihood : 17981.63

Information Criteria
------------------------------------

Akaike       -7.5578
Bayes        -7.5401
Shibata      -7.5578
```

```
Hannan-Quinn  -7.5516


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(6,2)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000198    0.000063 -3.1143e+00 0.001844
ar1    -0.980444    0.003519 -2.7864e+02 0.000000
ar2    -0.010482    0.012913 -8.1176e-01 0.416931
ar3    -0.021981    0.014808 -1.4843e+00 0.137725
ma1     0.996036    0.000021  4.8326e+04 0.000000
omega   0.000000    0.000000  6.3286e+00 0.000000
alpha1  0.150604    0.020732  7.2642e+00 0.000000
alpha2  0.000005    0.024779  1.9700e-04 0.999843
alpha3  0.000001    0.025542  5.3000e-05 0.999958
alpha4  0.000002    0.022423  7.0000e-05 0.999944
```

```
alpha5    0.000001    0.023906   3.4000e-05 0.999973
alpha6    0.000001    0.020961   3.7000e-05 0.999970
beta1     0.611232    0.052141   1.1723e+01 0.000000
beta2     0.236047    0.068499   3.4460e+00 0.000569

Robust Standard Errors:
          Estimate  Std. Error      t value Pr(>|t|)
mu       -0.000198    0.000075  -2.6510e+00 0.008025
ar1      -0.980444    0.007604  -1.2894e+02 0.000000
ar2      -0.010482    0.016855  -6.2187e-01 0.534028
ar3      -0.021981    0.016465  -1.3350e+00 0.181893
ma1       0.996036    0.000020   4.9423e+04 0.000000
omega     0.000000    0.000000   2.0702e+00 0.038429
alpha1    0.150604    0.053743   2.8023e+00 0.005074
alpha2    0.000005    0.170380   2.9000e-05 0.999977
alpha3    0.000001    0.073599   1.8000e-05 0.999985
alpha4    0.000002    0.038758   4.0000e-05 0.999968
alpha5    0.000001    0.048511   1.7000e-05 0.999987
alpha6    0.000001    0.036205   2.2000e-05 0.999983
beta1     0.611232    0.855316   7.1463e-01 0.474839
beta2     0.236047    0.761963   3.0979e-01 0.756723

LogLikelihood : 17984.68

Information Criteria
```

```
Akaike        -7.5586
Bayes         -7.5396
Shibata       -7.5587
Hannan-Quinn  -7.5520


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model       : sGARCH(6,3)
Mean Model        : ARFIMA(3,0,1)
Distribution      : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000194    0.000063 -3.0628e+00 0.002193
ar1      -0.981904    0.003293 -2.9821e+02 0.000000
ar2      -0.011944    0.012882 -9.2718e-01 0.353835
ar3      -0.022214    0.014922 -1.4886e+00 0.136580
ma1       0.996286    0.000021  4.8556e+04 0.000000
omega     0.000000    0.000000  4.7404e+00 0.000002
```

```
alpha1   0.167702    0.021525    7.7909e+00 0.000000
alpha2   0.000029    0.035269    8.3500e-04 0.999333
alpha3   0.000003    0.037066    8.1000e-05 0.999936
alpha4   0.000002    0.022533    7.3000e-05 0.999942
alpha5   0.000001    0.023164    3.7000e-05 0.999971
alpha6   0.000001    0.018322    4.4000e-05 0.999965
beta1    0.616127    0.099864    6.1697e+00 0.000000
beta2    0.000112    0.191664    5.8400e-04 0.999534
beta3    0.214018    0.093964    2.2777e+00 0.022746

Robust Standard Errors:
          Estimate  Std. Error      t value Pr(>|t|)
mu       -0.000194    0.000073  -2.6438e+00 0.008197
ar1      -0.981904    0.006079  -1.6152e+02 0.000000
ar2      -0.011944    0.016468  -7.2527e-01 0.468286
ar3      -0.022214    0.016573  -1.3404e+00 0.180129
ma1       0.996286    0.000019   5.3327e+04 0.000000
omega     0.000000    0.000000   2.2217e+00 0.026307
alpha1    0.167702    0.035411   4.7359e+00 0.000002
alpha2    0.000029    0.110145   2.6700e-04 0.999787
alpha3    0.000003    0.049288   6.1000e-05 0.999952
alpha4    0.000002    0.030245   5.4000e-05 0.999957
alpha5    0.000001    0.033851   2.5000e-05 0.999980
alpha6    0.000001    0.031514   2.6000e-05 0.999980
beta1     0.616127    0.614482   1.0027e+00 0.316017
beta2     0.000112    0.277079   4.0400e-04 0.999678
```

```
beta3    0.214018     0.275443   7.7699e-01 0.437161

LogLikelihood : 17988

Information Criteria
------------------------------------

Akaike        -7.5596
Bayes         -7.5392
Shibata       -7.5596
Hannan-Quinn  -7.5525



*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(6,4)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
```

```
mu      -0.000209   0.000080  -2.6189e+00 0.008821
ar1      0.971000   0.016183   6.0002e+01 0.000000
ar2     -0.036948   0.022272  -1.6590e+00 0.097123
ar3      0.033722   0.015537   2.1705e+00 0.029972
ma1     -0.959983   0.000908  -1.0577e+03 0.000000
omega    0.000000   0.000000   4.7614e+00 0.000002
alpha1   0.168167   0.017822   9.4362e+00 0.000000
alpha2   0.000124   0.032348   3.8330e-03 0.996941
alpha3   0.000021   0.043739   4.8700e-04 0.999612
alpha4   0.000012   0.045195   2.5500e-04 0.999797
alpha5   0.000004   0.021965   1.7600e-04 0.999860
alpha6   0.000003   0.012628   2.7300e-04 0.999782
beta1    0.641602   0.228958   2.8023e+00 0.005074
beta2    0.001839   0.292925   6.2790e-03 0.994990
beta3    0.108254   0.359378   3.0123e-01 0.763242
beta4    0.078125   0.225965   3.4574e-01 0.729539

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000209   0.000087  -2.3994e+00 0.016424
ar1      0.971000   0.017362   5.5926e+01 0.000000
ar2     -0.036948   0.025008  -1.4774e+00 0.139560
ar3      0.033722   0.017357   1.9428e+00 0.052037
ma1     -0.959983   0.000712  -1.3483e+03 0.000000
omega    0.000000   0.000000   2.1977e+00 0.027971
alpha1   0.168167   0.039561   4.2508e+00 0.000021
```

```
alpha2   0.000124   0.072899   1.7010e-03 0.998643
alpha3   0.000021   0.044568   4.7800e-04 0.999619
alpha4   0.000012   0.084605   1.3600e-04 0.999891
alpha5   0.000004   0.033516   1.1500e-04 0.999908
alpha6   0.000003   0.026956   1.2800e-04 0.999898
beta1    0.641602   0.412916   1.5538e+00 0.120225
beta2    0.001839   0.339243   5.4220e-03 0.995674
beta3    0.108254   0.413700   2.6167e-01 0.793573
beta4    0.078125   0.429167   1.8204e-01 0.855553

LogLikelihood : 17986.91

Information Criteria
------------------------------------

Akaike       -7.5587
Bayes        -7.5370
Shibata      -7.5588
Hannan-Quinn -7.5511


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model      : sGARCH(6,5)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000195	0.000063	−3.086979	0.002022
ar1	0.228874	2.460640	0.093014	0.925892
ar2	−0.027863	0.023459	−1.187758	0.234929
ar3	0.009207	0.054143	0.170054	0.864967
ma1	−0.217349	2.461142	−0.088312	0.929629
omega	0.000000	0.000000	5.064819	0.000000
alpha1	0.162864	0.023341	6.977623	0.000000
alpha2	0.000007	0.062194	0.000118	0.999906
alpha3	0.000011	0.069963	0.000154	0.999877
alpha4	0.000030	0.033991	0.000897	0.999285
alpha5	0.000004	0.030895	0.000117	0.999907
alpha6	0.000002	0.020760	0.000113	0.999910
beta1	0.719036	0.239072	3.007615	0.002633
beta2	0.005031	0.526637	0.009552	0.992379
beta3	0.002321	0.076873	0.030199	0.975909
beta4	0.000057	0.063317	0.000893	0.999287
beta5	0.109163	0.102333	1.066738	0.286090

```
Robust Standard Errors:
        Estimate  Std. Error  t value Pr(>|t|)
mu     -0.000195    0.000072 -2.691298 0.007117
ar1     0.228874    1.806495  0.126695 0.899182
ar2    -0.027863    0.026546 -1.049608 0.293898
ar3     0.009207    0.047354  0.194436 0.845835
ma1    -0.217349    1.806449 -0.120318 0.904231
omega   0.000000    0.000000  2.309029 0.020942
alpha1  0.162864    0.045149  3.607262 0.000309
alpha2  0.000007    0.129871  0.000057 0.999955
alpha3  0.000011    0.102581  0.000105 0.999916
alpha4  0.000030    0.067705  0.000450 0.999641
alpha5  0.000004    0.058573  0.000062 0.999951
alpha6  0.000002    0.030779  0.000076 0.999939
beta1   0.719036    0.665835  1.079901 0.280186
beta2   0.005031    0.933015  0.005392 0.995698
beta3   0.002321    0.609056  0.003812 0.996959
beta4   0.000057    0.047473  0.001191 0.999049
beta5   0.109163    0.256527  0.425541 0.670443

LogLikelihood : 17986.54

Information Criteria
------------------------------------

Akaike       -7.5582
```

```
Bayes          -7.5350
Shibata        -7.5582
Hannan-Quinn   -7.5500


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(6,6)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000198    0.000063 -3.1571e+00 0.001594
ar1    -0.982248    0.003063 -3.2067e+02 0.000000
ar2    -0.013280    0.012800 -1.0375e+00 0.299500
ar3    -0.023065    0.015122 -1.5253e+00 0.127191
ma1     0.996194    0.000020  5.0743e+04 0.000000
omega   0.000000    0.000000  3.4096e+00 0.000651
alpha1  0.162207    0.019702  8.2329e+00 0.000000
alpha2  0.000002    0.027097  8.2000e-05 0.999934
```

```
alpha3   0.000001    0.010899    1.1500e-04 0.999908
alpha4   0.000003    0.008206    3.1700e-04 0.999747
alpha5   0.000000    0.031734    9.0000e-06 0.999993
alpha6   0.000000    0.022319    9.0000e-06 0.999992
beta1    0.748871    0.090891    8.2393e+00 0.000000
beta2    0.000103    0.146506    7.0500e-04 0.999438
beta3    0.000011    0.254846    4.3000e-05 0.999966
beta4    0.000002    0.410251    6.0000e-06 0.999995
beta5    0.000003    0.132385    2.2000e-05 0.999982
beta6    0.087430    0.091153    9.5916e-01 0.337480

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000198    0.000072 -2.7509e+00 0.005943
ar1     -0.982248    0.007390 -1.3291e+02 0.000000
ar2     -0.013280    0.018035 -7.3636e-01 0.461511
ar3     -0.023065    0.016978 -1.3585e+00 0.174295
ma1      0.996194    0.000022  4.5392e+04 0.000000
omega    0.000000    0.000000  1.2811e+00 0.200170
alpha1   0.162207    0.031073  5.2203e+00 0.000000
alpha2   0.000002    0.066468  3.3000e-05 0.999973
alpha3   0.000001    0.066845  1.9000e-05 0.999985
alpha4   0.000003    0.104825  2.5000e-05 0.999980
alpha5   0.000000    0.059858  5.0000e-06 0.999996
alpha6   0.000000    0.077977  3.0000e-06 0.999998
beta1    0.748871    0.469360  1.5955e+00 0.110597
```

```
beta2    0.000103    0.102532  1.0070e-03 0.999196
beta3    0.000011    0.729897  1.5000e-05 0.999988
beta4    0.000002    0.742552  3.0000e-06 0.999997
beta5    0.000003    0.606853  5.0000e-06 0.999996
beta6    0.087430    0.415881  2.1023e-01 0.833490

LogLikelihood : 17992.26

Information Criteria
------------------------------------

Akaike       -7.5601
Bayes        -7.5357
Shibata      -7.5602
Hannan-Quinn -7.5515


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(6,7)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm
```

```
Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000193    0.000063 -3.0673e+00 0.002160
ar1    -0.982096    0.002606 -3.7680e+02 0.000000
ar2    -0.012171    0.012666 -9.6089e-01 0.336607
ar3    -0.022257    0.015118 -1.4722e+00 0.140968
ma1     0.996354    0.000021  4.8420e+04 0.000000
omega   0.000001    0.000000  3.7985e+00 0.000146
alpha1  0.159474    0.020748  7.6862e+00 0.000000
alpha2  0.021742    0.024316  8.9415e-01 0.371244
alpha3  0.000264    0.023202  1.1362e-02 0.990935
alpha4  0.037341    0.021070  1.7722e+00 0.076357
alpha5  0.000016    0.021138  7.5400e-04 0.999399
alpha6  0.000010    0.016307  5.8500e-04 0.999533
beta1   0.641935    0.070258  9.1369e+00 0.000000
beta2   0.000093    0.043779  2.1260e-03 0.998304
beta3   0.000025    0.004155  6.1260e-03 0.995113
beta4   0.000018    0.021034  8.7400e-04 0.999303
beta5   0.000019    0.044330  4.3600e-04 0.999652
beta6   0.000027    0.020825  1.2760e-03 0.998982
beta7   0.137300    0.027741  4.9494e+00 0.000001

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
```

mu	−0.000193	0.000072	−2.6659e+00	0.007679
ar1	−0.982096	0.007055	−1.3920e+02	0.000000
ar2	−0.012171	0.018119	−6.7170e−01	0.501775
ar3	−0.022257	0.017085	−1.3027e+00	0.192675
ma1	0.996354	0.000023	4.3392e+04	0.000000
omega	0.000001	0.000000	1.5350e+00	0.124794
alpha1	0.159474	0.036370	4.3848e+00	0.000012
alpha2	0.021742	0.064526	3.3696e−01	0.736150
alpha3	0.000264	0.038688	6.8140e−03	0.994563
alpha4	0.037341	0.043513	8.5816e−01	0.390803
alpha5	0.000016	0.053748	2.9600e−04	0.999763
alpha6	0.000010	0.028761	3.3200e−04	0.999735
beta1	0.641935	0.310392	2.0681e+00	0.038627
beta2	0.000093	0.086330	1.0780e−03	0.999140
beta3	0.000025	0.006381	3.9880e−03	0.996818
beta4	0.000018	0.018932	9.7100e−04	0.999225
beta5	0.000019	0.029360	6.5800e−04	0.999475
beta6	0.000027	0.013520	1.9650e−03	0.998432
beta7	0.137300	0.127646	1.0756e+00	0.282090

LogLikelihood : 17995.99

Information Criteria

Akaike −7.5613

```
Bayes          −7.5355
Shibata        −7.5613
Hannan−Quinn   −7.5522


*−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−*
*          GARCH Model Fit         *
*−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−*

Conditional Variance Dynamics
−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−
GARCH Model       : sGARCH(6,8)
Mean Model        : ARFIMA(3,0,1)
Distribution      : norm

Optimal Parameters
−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−−
        Estimate   Std. Error     t value  Pr(>|t|)
mu     −0.000181    0.000063  −2.8847e+00  0.003918
ar1    −0.981053    0.002754  −3.5626e+02  0.000000
ar2    −0.010773    0.012619  −8.5369e−01  0.393275
ar3    −0.022037    0.014992  −1.4699e+00  0.141580
ma1     0.996590    0.000020   5.1023e+04  0.000000
omega   0.000001    0.000000   4.7652e+00  0.000002
alpha1  0.155798    0.020956   7.4346e+00  0.000000
alpha2  0.064409    0.038355   1.6793e+00  0.093095
```

```
alpha3   0.047450    0.039216   1.2100e+00 0.226286
alpha4   0.096334    0.022320   4.3160e+00 0.000016
alpha5   0.000007    0.047759   1.4800e-04 0.999882
alpha6   0.005773    0.031236   1.8483e-01 0.853363
beta1    0.354353    0.198100   1.7888e+00 0.073654
beta2    0.000002    0.233255   8.0000e-06 0.999994
beta3    0.000000    0.226203   2.0000e-06 0.999999
beta4    0.000000    0.164687   1.0000e-06 0.999999
beta5    0.000000    0.177909   1.0000e-06 0.999999
beta6    0.000000    0.118790   2.0000e-06 0.999998
beta7    0.000000    0.048036   7.0000e-06 0.999994
beta8    0.274868    0.069386   3.9614e+00 0.000075

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000181    0.000073 -2.4634e+00 0.013764
ar1     -0.981053    0.007552 -1.2990e+02 0.000000
ar2     -0.010773    0.019509 -5.5219e-01 0.580816
ar3     -0.022037    0.017551 -1.2556e+00 0.209252
ma1      0.996590    0.000027  3.7468e+04 0.000000
omega    0.000001    0.000001  1.7861e+00 0.074081
alpha1   0.155798    0.033354  4.6710e+00 0.000003
alpha2   0.064409    0.084357  7.6353e-01 0.445149
alpha3   0.047450    0.122456  3.8749e-01 0.698395
alpha4   0.096334    0.035119  2.7431e+00 0.006087
alpha5   0.000007    0.100067  7.0000e-05 0.999944
```

```
alpha6   0.005773   0.079021   7.3061e-02  0.941758
beta1    0.354353   0.531126   6.6717e-01  0.504662
beta2    0.000002   0.643908   3.0000e-06  0.999998
beta3    0.000000   0.390824   1.0000e-06  0.999999
beta4    0.000000   0.460820   0.0000e+00  1.000000
beta5    0.000000   0.418997   1.0000e-06  1.000000
beta6    0.000000   0.194126   1.0000e-06  0.999999
beta7    0.000000   0.332376   1.0000e-06  0.999999
beta8    0.274868   0.307418   8.9412e-01  0.371257

LogLikelihood : 18007.25

Information Criteria
------------------------------------

Akaike        -7.5656
Bayes         -7.5384
Shibata       -7.5656
Hannan-Quinn  -7.5561


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model      : sGARCH(6,9)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters

         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000180    0.000062 -2.8986e+00 0.003749
ar1     -0.981634    0.001804 -5.4404e+02 0.000000
ar2     -0.012088    0.011503 -1.0508e+00 0.293337
ar3     -0.022785    0.014672 -1.5529e+00 0.120441
ma1      0.996611    0.000023  4.4108e+04 0.000000
omega    0.000001    0.000001  2.3363e+00 0.019474
alpha1   0.158837    0.019074  8.3275e+00 0.000000
alpha2   0.089854    0.011802  7.6134e+00 0.000000
alpha3   0.073192    0.048922  1.4961e+00 0.134629
alpha4   0.104122    0.018829  5.5300e+00 0.000000
alpha5   0.015160    0.012385  1.2241e+00 0.220928
alpha6   0.017083    0.031601  5.4060e-01 0.588787
beta1    0.198771    0.129125  1.5394e+00 0.123715
beta2    0.000012    0.293139  4.3000e-05 0.999966
beta3    0.000004    0.161013  2.4000e-05 0.999981
beta4    0.000002    0.195584  8.0000e-06 0.999993
beta5    0.000002    0.167906  1.0000e-05 0.999992
beta6    0.000002    0.071673  2.5000e-05 0.999980
```

```
beta7    0.000002    0.053815   3.9000e-05 0.999969
beta8    0.209275    0.041982   4.9849e+00 0.000001
beta9    0.132630    0.096362   1.3764e+00 0.168708


Robust Standard Errors:
          Estimate  Std. Error      t value Pr(>|t|)
mu       -0.000180    0.000070  -2.5745e+00 0.010037
ar1      -0.981634    0.010850  -9.0472e+01 0.000000
ar2      -0.012088    0.029074  -4.1576e-01 0.677583
ar3      -0.022785    0.021758  -1.0472e+00 0.295011
ma1       0.996611    0.000053   1.8877e+04 0.000000
omega     0.000001    0.000002   5.5058e-01 0.581922
alpha1    0.158837    0.028359   5.6009e+00 0.000000
alpha2    0.089854    0.072294   1.2429e+00 0.213910
alpha3    0.073192    0.228118   3.2085e-01 0.748322
alpha4    0.104122    0.085588   1.2165e+00 0.223776
alpha5    0.015160    0.062357   2.4311e-01 0.807918
alpha6    0.017083    0.141820   1.2046e-01 0.904120
beta1     0.198771    0.386450   5.1435e-01 0.607008
beta2     0.000012    1.123935   1.1000e-05 0.999991
beta3     0.000004    0.242493   1.6000e-05 0.999987
beta4     0.000002    0.484915   3.0000e-06 0.999997
beta5     0.000002    0.300747   5.0000e-06 0.999996
beta6     0.000002    0.122619   1.4000e-05 0.999989
beta7     0.000002    0.189373   1.1000e-05 0.999991
beta8     0.209275    0.163041   1.2836e+00 0.199290
```

```
beta9    0.132630     0.435431   3.0459e-01 0.760675

LogLikelihood : 18008.11

Information Criteria
------------------------------------


Akaike        -7.5656
Bayes         -7.5370
Shibata       -7.5656
Hannan-Quinn  -7.5555



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(6,10)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
```

```
mu      -0.000178    0.000062  -2.8635e+00 0.004190
ar1     -0.981932    0.002602  -3.7741e+02 0.000000
ar2     -0.012484    0.012337  -1.0119e+00 0.311573
ar3     -0.022868    0.014906  -1.5341e+00 0.124998
ma1      0.996620    0.000020   4.8686e+04 0.000000
omega    0.000001    0.000000   4.2465e+00 0.000022
alpha1   0.163680    0.020261   8.0787e+00 0.000000
alpha2   0.110089    0.017001   6.4753e+00 0.000000
alpha3   0.080298    0.019173   4.1882e+00 0.000028
alpha4   0.110719    0.021056   5.2583e+00 0.000000
alpha5   0.028055    0.015574   1.8014e+00 0.071647
alpha6   0.021052    0.027559   7.6389e-01 0.444936
beta1    0.096183    0.148979   6.4561e-01 0.518529
beta2    0.000007    0.219782   3.2000e-05 0.999974
beta3    0.000004    0.158517   2.4000e-05 0.999981
beta4    0.000001    0.119611   1.1000e-05 0.999991
beta5    0.000001    0.148494   1.0000e-05 0.999992
beta6    0.000002    0.055541   3.1000e-05 0.999975
beta7    0.000002    0.030669   5.1000e-05 0.999959
beta8    0.214580    0.041603   5.1578e+00 0.000000
beta9    0.095166    0.058051   1.6394e+00 0.101139
beta10   0.078013    0.007980   9.7766e+00 0.000000

Robust Standard Errors:
         Estimate  Std. Error      t value Pr(>|t|)
mu      -0.000178    0.000072  -2.4826e+00 0.013042
```

ar1	−0.981932	0.007255	−1.3534e+02	0.000000
ar2	−0.012484	0.019695	−6.3386e−01	0.526173
ar3	−0.022868	0.017697	−1.2922e+00	0.196297
ma1	0.996620	0.000026	3.8185e+04	0.000000
omega	0.000001	0.000001	1.8256e+00	0.067903
alpha1	0.163680	0.031959	5.1216e+00	0.000000
alpha2	0.110089	0.055952	1.9676e+00	0.049119
alpha3	0.080298	0.091872	8.7403e−01	0.382104
alpha4	0.110719	0.049109	2.2546e+00	0.024162
alpha5	0.028055	0.059161	4.7421e−01	0.635351
alpha6	0.021052	0.063277	3.3270e−01	0.739362
beta1	0.096183	0.290017	3.3165e−01	0.740156
beta2	0.000007	0.447827	1.6000e−05	0.999987
beta3	0.000004	0.227034	1.7000e−05	0.999987
beta4	0.000001	0.212711	6.0000e−06	0.999995
beta5	0.000001	0.181920	8.0000e−06	0.999994
beta6	0.000002	0.174164	1.0000e−05	0.999992
beta7	0.000002	0.193911	8.0000e−06	0.999994
beta8	0.214580	0.103584	2.0716e+00	0.038306
beta9	0.095166	0.182980	5.2009e−01	0.603001
beta10	0.078013	0.145334	5.3678e−01	0.591417

```
LogLikelihood : 18008.35

Information Criteria
------------------------------------
```

```
Akaike        -7.5652
Bayes         -7.5353
Shibata       -7.5653
Hannan-Quinn  -7.5547


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(7,1)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000194    0.000064 -3.048465  0.00230
ar1     0.222625    2.523036  0.088237  0.92969
ar2    -0.028043    0.036262 -0.773333  0.43933
ar3     0.007251    0.047193  0.153640  0.87789
ma1    -0.207228    2.524270 -0.082094  0.93457
omega   0.000000    0.000000  1.596869  0.11030
```

```
alpha1   0.121208    0.016027   7.562657   0.00000
alpha2   0.000020    0.019663   0.001006   0.99920
alpha3   0.000014    0.025162   0.000537   0.99957
alpha4   0.000013    0.026066   0.000486   0.99961
alpha5   0.000009    0.026468   0.000354   0.99972
alpha6   0.000010    0.027568   0.000349   0.99972
alpha7   0.000011    0.018146   0.000611   0.99951
beta1    0.876424    0.010545  83.110361   0.00000

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000194    0.000077 -2.533254 0.011301
ar1       0.222625    2.393586  0.093009 0.925896
ar2      -0.028043    0.037767 -0.742516 0.457775
ar3       0.007251    0.062004  0.116940 0.906908
ma1      -0.207228    2.395751 -0.086498 0.931070
omega     0.000000    0.000002  0.195898 0.844690
alpha1    0.121208    0.026756  4.530199 0.000006
alpha2    0.000020    0.022547  0.000877 0.999300
alpha3    0.000014    0.046886  0.000288 0.999770
alpha4    0.000013    0.028868  0.000439 0.999650
alpha5    0.000009    0.044616  0.000210 0.999833
alpha6    0.000010    0.041508  0.000232 0.999815
alpha7    0.000011    0.085357  0.000130 0.999896
beta1     0.876424    0.138458  6.329868 0.000000
```

```
LogLikelihood : 17977.98

Information Criteria
------------------------------------

Akaike       -7.5558
Bayes        -7.5368
Shibata      -7.5558
Hannan-Quinn -7.5491



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model   : sGARCH(7,2)
Mean Model    : ARFIMA(3,0,1)
Distribution  : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000198    0.000064 -3.1171e+00 0.001826
ar1    -0.980394    0.003681 -2.6634e+02 0.000000
```

```
ar2    -0.010020    0.013028 -7.6909e-01 0.441843
ar3    -0.021479    0.014835 -1.4478e+00 0.147662
ma1     0.995978    0.000020  4.8957e+04 0.000000
omega   0.000000    0.000000  1.5660e+01 0.000000
alpha1  0.150146    0.021222  7.0751e+00 0.000000
alpha2  0.000033    0.026772  1.2420e-03 0.999009
alpha3  0.000008    0.025994  3.2000e-04 0.999745
alpha4  0.000008    0.022485  3.6700e-04 0.999707
alpha5  0.000005    0.024559  2.1700e-04 0.999827
alpha6  0.000005    0.024080  2.1200e-04 0.999831
alpha7  0.000006    0.019137  3.0900e-04 0.999754
beta1   0.614415    0.066196  9.2818e+00 0.000000
beta2   0.233268    0.079532  2.9330e+00 0.003357

Robust Standard Errors:
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000198    0.000075 -2.6277e+00 0.008595
ar1    -0.980394    0.008228 -1.1915e+02 0.000000
ar2    -0.010020    0.017303 -5.7907e-01 0.562544
ar3    -0.021479    0.016465 -1.3045e+00 0.192049
ma1     0.995978    0.000022  4.5259e+04 0.000000
omega   0.000000    0.000000  1.6804e+00 0.092878
alpha1  0.150146    0.059135  2.5390e+00 0.011116
alpha2  0.000033    0.177615  1.8700e-04 0.999851
alpha3  0.000008    0.075489  1.1000e-04 0.999912
alpha4  0.000008    0.037378  2.2100e-04 0.999824
```

```
alpha5   0.000005     0.044641   1.1900e-04  0.999905
alpha6   0.000005     0.048055   1.0600e-04  0.999915
alpha7   0.000006     0.030052   1.9700e-04  0.999843
beta1    0.614415     0.837094   7.3399e-01  0.462957
beta2    0.233268     0.748474   3.1166e-01  0.755300

LogLikelihood : 17984.56

Information Criteria
------------------------------------

Akaike        -7.5582
Bayes         -7.5378
Shibata       -7.5582
Hannan-Quinn  -7.5510


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model    : sGARCH(7,3)
Mean Model     : ARFIMA(3,0,1)
Distribution   : norm
```

Optimal Parameters

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000193	0.000063	−3.0515e+00	0.002277
ar1	−0.981957	0.003549	−2.7668e+02	0.000000
ar2	−0.011528	0.013098	−8.8011e−01	0.378797
ar3	−0.021740	0.014953	−1.4539e+00	0.145980
ma1	0.996257	0.000020	4.9647e+04	0.000000
omega	0.000000	0.000000	4.9211e+00	0.000001
alpha1	0.167673	0.021418	7.8285e+00	0.000000
alpha2	0.000007	0.023413	2.8800e−04	0.999770
alpha3	0.000001	0.021933	3.9000e−05	0.999969
alpha4	0.000000	0.021818	2.0000e−05	0.999984
alpha5	0.000000	0.023254	9.0000e−06	0.999993
alpha6	0.000000	0.022746	9.0000e−06	0.999993
alpha7	0.000000	0.020259	1.0000e−05	0.999992
beta1	0.615283	0.031001	1.9847e+01	0.000000
beta2	0.000030	0.047776	6.3400e−04	0.999494
beta3	0.215141	0.048136	4.4694e+00	0.000008

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000193	0.000073	−2.6509e+00	0.008028
ar1	−0.981957	0.006105	−1.6085e+02	0.000000
ar2	−0.011528	0.016617	−6.9373e−01	0.487849

```
ar3      -0.021740   0.016619  -1.3081e+00  0.190835
ma1       0.996257   0.000018   5.3971e+04  0.000000
omega     0.000000   0.000000   2.3059e+00  0.021115
alpha1    0.167673   0.035147   4.7706e+00  0.000002
alpha2    0.000007   0.081811   8.2000e-05  0.999934
alpha3    0.000001   0.058243   1.5000e-05  0.999988
alpha4    0.000000   0.031141   1.4000e-05  0.999989
alpha5    0.000000   0.032664   7.0000e-06  0.999995
alpha6    0.000000   0.042918   5.0000e-06  0.999996
alpha7    0.000000   0.029079   7.0000e-06  0.999994
beta1     0.615283   0.494759   1.2436e+00  0.213646
beta2     0.000030   0.006164   4.9150e-03  0.996079
beta3     0.215141   0.392952   5.4750e-01  0.584036

LogLikelihood : 17987.87

Information Criteria
------------------------------------

Akaike       -7.5591
Bayes        -7.5374
Shibata      -7.5592
Hannan-Quinn -7.5515

*---------------------------------*
```

```
*          GARCH Model Fit          *
*-----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(7,4)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000196    0.000063 -3.1137e+00 0.001848
ar1     -0.982544    0.002802 -3.5064e+02 0.000000
ar2     -0.013014    0.012667 -1.0274e+00 0.304220
ar3     -0.022590    0.014974 -1.5086e+00 0.131393
ma1      0.996213    0.000020  4.8962e+04 0.000000
omega    0.000000    0.000000  4.7014e+00 0.000003
alpha1   0.166872    0.020286  8.2258e+00 0.000000
alpha2   0.000048    0.052906  8.9800e-04 0.999283
alpha3   0.000012    0.066691  1.7400e-04 0.999861
alpha4   0.000007    0.031662  2.1600e-04 0.999828
alpha5   0.000003    0.019594  1.2900e-04 0.999897
alpha6   0.000002    0.010308  2.2500e-04 0.999820
alpha7   0.000003    0.014268  1.7800e-04 0.999858
beta1    0.644216    0.293156  2.1975e+00 0.027983
```

```
beta2    0.000713    0.465985   1.5300e-03 0.998779
beta3    0.123377    0.333930   3.6947e-01 0.711778
beta4    0.062604    0.186308   3.3602e-01 0.736855

Robust Standard Errors:
         Estimate  Std. Error      t value Pr(>|t|)
mu      -0.000196    0.000072  -2.7241e+00 0.006447
ar1     -0.982544    0.006718  -1.4626e+02 0.000000
ar2     -0.013014    0.016953  -7.6768e-01 0.442679
ar3     -0.022590    0.016647  -1.3570e+00 0.174784
ma1      0.996213    0.000020   5.0039e+04 0.000000
omega    0.000000    0.000000   2.2612e+00 0.023747
alpha1   0.166872    0.039647   4.2089e+00 0.000026
alpha2   0.000048    0.062731   7.5800e-04 0.999396
alpha3   0.000012    0.124548   9.3000e-05 0.999926
alpha4   0.000007    0.059545   1.1500e-04 0.999908
alpha5   0.000003    0.035560   7.1000e-05 0.999943
alpha6   0.000002    0.024395   9.5000e-05 0.999924
alpha7   0.000003    0.021529   1.1800e-04 0.999906
beta1    0.644216    0.370317   1.7396e+00 0.081923
beta2    0.000713    0.786213   9.0700e-04 0.999277
beta3    0.123377    0.473494   2.6057e-01 0.794427
beta4    0.062604    0.325954   1.9206e-01 0.847693

LogLikelihood : 17988.12
```

```
Information Criteria
------------------------------------

Akaike       -7.5588
Bayes        -7.5357
Shibata      -7.5589
Hannan-Quinn -7.5507


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model    : sGARCH(7,5)
Mean Model     : ARFIMA(3,0,1)
Distribution   : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000198    0.000063 -3.1367e+00 0.001709
ar1    -0.982769    0.003779 -2.6004e+02 0.000000
ar2    -0.013584    0.013445 -1.0103e+00 0.312335
ar3    -0.022789    0.015201 -1.4991e+00 0.133839
```

```
ma1      0.996150    0.000019   5.2262e+04  0.000000
omega    0.000000    0.000000   5.7676e+00  0.000000
alpha1   0.164110    0.033788   4.8571e+00  0.000001
alpha2   0.000018    0.030381   5.8100e-04  0.999536
alpha3   0.000009    0.026381   3.5100e-04  0.999720
alpha4   0.000011    0.064086   1.7300e-04  0.999862
alpha5   0.000002    0.050244   4.0000e-05  0.999968
alpha6   0.000001    0.022045   6.7000e-05  0.999947
alpha7   0.000001    0.028322   4.9000e-05  0.999961
beta1    0.724044    0.112036   6.4626e+00  0.000000
beta2    0.000831    0.273842   3.0340e-03  0.997580
beta3    0.000531    0.565965   9.3800e-04  0.999252
beta4    0.000029    0.109178   2.6900e-04  0.999785
beta5    0.108861    0.198387   5.4873e-01  0.583189

Robust Standard Errors:
          Estimate  Std. Error      t value  Pr(>|t|)
mu       -0.000198    0.000073  -2.7076e+00  0.006778
ar1      -0.982769    0.006776  -1.4505e+02  0.000000
ar2      -0.013584    0.018461  -7.3578e-01  0.461863
ar3      -0.022789    0.017415  -1.3086e+00  0.190686
ma1       0.996150    0.000019   5.2205e+04  0.000000
omega     0.000000    0.000000   2.4344e+00  0.014915
alpha1    0.164110    0.087546   1.8746e+00  0.060854
alpha2    0.000018    0.066701   2.6500e-04  0.999789
alpha3    0.000009    0.114880   8.1000e-05  0.999936
```

```
alpha4   0.000011    0.153083   7.2000e-05  0.999942
alpha5   0.000002    0.123804   1.6000e-05  0.999987
alpha6   0.000001    0.035762   4.1000e-05  0.999967
alpha7   0.000001    0.068453   2.0000e-05  0.999984
beta1    0.724044    0.563338   1.2853e+00  0.198696
beta2    0.000831    0.468698   1.7720e-03  0.998586
beta3    0.000531    1.377839   3.8500e-04  0.999693
beta4    0.000029    0.132166   2.2300e-04  0.999822
beta5    0.108861    0.514496   2.1159e-01  0.832428

LogLikelihood : 17990.3

Information Criteria
------------------------------------

Akaike       -7.5593
Bayes        -7.5348
Shibata      -7.5594
Hannan-Quinn -7.5507


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model      : sGARCH(7,6)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000197	0.000063	−3.117245	0.001825
ar1	0.145073	2.271457	0.063868	0.949075
ar2	−0.027486	0.022167	−1.239980	0.214983
ar3	0.007638	0.049834	0.153274	0.878182
ma1	−0.133359	2.270336	−0.058740	0.953159
omega	0.000000	0.000000	3.887951	0.000101
alpha1	0.160955	0.022376	7.193269	0.000000
alpha2	0.000000	0.031565	0.000006	0.999996
alpha3	0.000000	0.031421	0.000004	0.999997
alpha4	0.000000	0.047556	0.000004	0.999997
alpha5	0.000000	0.034752	0.000000	1.000000
alpha6	0.000000	0.027582	0.000000	1.000000
alpha7	0.000000	0.016438	0.000000	1.000000
beta1	0.750102	0.131362	5.710172	0.000000
beta2	0.000027	0.034369	0.000777	0.999380
beta3	0.000001	0.176581	0.000006	0.999995
beta4	0.000000	0.363425	0.000001	1.000000
beta5	0.000000	0.087335	0.000003	0.999998

```
beta6     0.087564     0.041504   2.109745 0.034880

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000197    0.000072 -2.719333 0.006541
ar1       0.145073    1.702860  0.085194 0.932107
ar2      -0.027486    0.024875 -1.104959 0.269177
ar3       0.007638    0.046898  0.162871 0.870620
ma1      -0.133359    1.704332 -0.078247 0.937631
omega     0.000000    0.000000  1.744831 0.081014
alpha1    0.160955    0.037330  4.311701 0.000016
alpha2    0.000000    0.061243  0.000003 0.999998
alpha3    0.000000    0.069633  0.000002 0.999999
alpha4    0.000000    0.090679  0.000002 0.999998
alpha5    0.000000    0.068908  0.000000 1.000000
alpha6    0.000000    0.075787  0.000000 1.000000
alpha7    0.000000    0.034385  0.000000 1.000000
beta1     0.750102    0.404705  1.853452 0.063818
beta2     0.000027    0.007806  0.003422 0.997269
beta3     0.000001    0.568621  0.000002 0.999999
beta4     0.000000    0.531147  0.000000 1.000000
beta5     0.000000    0.660079  0.000000 1.000000
beta6     0.087564    0.364620  0.240151 0.810213

LogLikelihood : 17988.2
```

```
Information Criteria
------------------------------------

Akaike       -7.5580
Bayes        -7.5322
Shibata      -7.5581
Hannan-Quinn -7.5489


*---------------------------------*
*          GARCH Model Fit         *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(7,7)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000193    0.000063 -3.0833e+00 0.002047
ar1    -0.982126    0.003115 -3.1532e+02 0.000000
ar2    -0.012373    0.012880 -9.6064e-01 0.336733
ar3    -0.022394    0.015121 -1.4810e+00 0.138608
```

```
ma1      0.996335    0.000020  4.9849e+04 0.000000
omega    0.000001    0.000000  3.8577e+00 0.000114
alpha1   0.159452    0.021525  7.4079e+00 0.000000
alpha2   0.021691    0.022071  9.8276e-01 0.325725
alpha3   0.000054    0.020965  2.5730e-03 0.997947
alpha4   0.037108    0.039377  9.4239e-01 0.345994
alpha5   0.000003    0.020950  1.4000e-04 0.999888
alpha6   0.000002    0.005800  3.0200e-04 0.999759
alpha7   0.000001    0.034056  3.6000e-05 0.999971
beta1    0.642788    0.045309  1.4187e+01 0.000000
beta2    0.000033    0.028498  1.1740e-03 0.999063
beta3    0.000012    0.177230  7.0000e-05 0.999945
beta4    0.000006    0.207713  2.9000e-05 0.999977
beta5    0.000005    0.158811  3.4000e-05 0.999973
beta6    0.000007    0.231858  3.0000e-05 0.999976
beta7    0.137134    0.120218  1.1407e+00 0.253988

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000193    0.000072 -2.6803e+00 0.007357
ar1     -0.982126    0.006504 -1.5100e+02 0.000000
ar2     -0.012373    0.017109 -7.2320e-01 0.469557
ar3     -0.022394    0.016840 -1.3298e+00 0.183568
ma1      0.996335    0.000020  4.9008e+04 0.000000
omega    0.000001    0.000000  1.6054e+00 0.108400
alpha1   0.159452    0.035489  4.4929e+00 0.000007
```

```
alpha2   0.021691   0.058805   3.6886e-01  0.712231
alpha3   0.000054   0.073201   7.3700e-04  0.999412
alpha4   0.037108   0.065750   5.6438e-01  0.572495
alpha5   0.000003   0.060299   4.9000e-05  0.999961
alpha6   0.000002   0.097217   1.8000e-05  0.999986
alpha7   0.000001   0.072639   1.7000e-05  0.999987
beta1    0.642788   0.443681   1.4488e+00  0.147404
beta2    0.000033   0.030321   1.1040e-03  0.999119
beta3    0.000012   0.483628   2.5000e-05  0.999980
beta4    0.000006   0.378599   1.6000e-05  0.999987
beta5    0.000005   0.400100   1.4000e-05  0.999989
beta6    0.000007   0.548702   1.3000e-05  0.999990
beta7    0.137134   0.210047   6.5288e-01  0.513836

LogLikelihood : 17996

Information Criteria
------------------------------------

Akaike        -7.5609
Bayes         -7.5337
Shibata       -7.5609
Hannan-Quinn  -7.5513

*----------------------------------*
```

```
*               GARCH Model Fit            *
*------------------------------------------*

Conditional Variance Dynamics
-------------------------------------------
GARCH Model     : sGARCH(7,8)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
--------------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000181    0.000062 -2.9346e+00 0.003340
ar1     -0.980990    0.001882 -5.2111e+02 0.000000
ar2     -0.010691    0.012134 -8.8102e-01 0.378304
ar3     -0.022013    0.014923 -1.4751e+00 0.140193
ma1      0.996588    0.000021  4.6419e+04 0.000000
omega    0.000001    0.000000  3.5761e+00 0.000349
alpha1   0.155784    0.015293  1.0187e+01 0.000000
alpha2   0.064360    0.012594  5.1105e+00 0.000000
alpha3   0.047483    0.018216  2.6066e+00 0.009144
alpha4   0.096238    0.010586  9.0914e+00 0.000000
alpha5   0.000051    0.018771  2.7010e-03 0.997845
alpha6   0.005733    0.014887  3.8512e-01 0.700148
alpha7   0.000008    0.022772  3.3700e-04 0.999731
beta1    0.354499    0.113384  3.1265e+00 0.001769
```

```
beta2    0.000020    0.031019  6.3100e-04 0.999497
beta3    0.000006    0.269447  2.1000e-05 0.999983
beta4    0.000003    0.314911  9.0000e-06 0.999993
beta5    0.000003    0.094070  2.7000e-05 0.999979
beta6    0.000003    0.174315  1.6000e-05 0.999987
beta7    0.000004    0.215729  1.8000e-05 0.999985
beta8    0.274780    0.092320  2.9764e+00 0.002917

Robust Standard Errors:
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000181    0.000071 -2.5314e+00 0.011360
ar1      -0.980990    0.008821 -1.1121e+02 0.000000
ar2      -0.010691    0.020648 -5.1777e-01 0.604620
ar3      -0.022013    0.017597 -1.2509e+00 0.210959
ma1       0.996588    0.000033  3.0099e+04 0.000000
omega     0.000001    0.000001  1.2999e+00 0.193646
alpha1    0.155784    0.036452  4.2736e+00 0.000019
alpha2    0.064360    0.080698  7.9754e-01 0.425135
alpha3    0.047483    0.075233  6.3114e-01 0.527948
alpha4    0.096238    0.059008  1.6309e+00 0.102908
alpha5    0.000051    0.057213  8.8600e-04 0.999293
alpha6    0.005733    0.048811  1.1746e-01 0.906499
alpha7    0.000008    0.057890  1.3300e-04 0.999894
beta1     0.354499    0.468887  7.5604e-01 0.449624
beta2     0.000020    0.024837  7.8800e-04 0.999372
beta3     0.000006    0.481065  1.2000e-05 0.999991
```

```
beta4    0.000003    0.454180   6.0000e-06 0.999995
beta5    0.000003    0.373948   7.0000e-06 0.999995
beta6    0.000003    0.405330   7.0000e-06 0.999995
beta7    0.000004    0.466017   8.0000e-06 0.999993
beta8    0.274780    0.241717   1.1368e+00 0.255629

LogLikelihood : 18007.25

Information Criteria
------------------------------------

Akaike       -7.5652
Bayes        -7.5366
Shibata      -7.5652
Hannan-Quinn -7.5552


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(7,9)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm
```

```
Optimal Parameters
------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000194    0.000084 -2.3041e+00 0.021217
ar1      0.970712    0.015962  6.0814e+01 0.000000
ar2     -0.037481    0.022276 -1.6825e+00 0.092464
ar3      0.036959    0.015615  2.3669e+00 0.017938
ma1     -0.960298    0.000926 -1.0374e+03 0.000000
omega    0.000001    0.000000  3.4283e+00 0.000607
alpha1   0.162828    0.019015  8.5630e+00 0.000000
alpha2   0.096681    0.023381  4.1351e+00 0.000035
alpha3   0.077271    0.015059  5.1311e+00 0.000000
alpha4   0.100792    0.014833  6.7951e+00 0.000000
alpha5   0.016330    0.003104  5.2617e+00 0.000000
alpha6   0.016767    0.019349  8.6651e-01 0.386208
alpha7   0.002976    0.019060  1.5613e-01 0.875933
beta1    0.173249    0.018619  9.3051e+00 0.000000
beta2    0.000025    0.160799  1.5700e-04 0.999875
beta3    0.000007    0.157646  4.6000e-05 0.999963
beta4    0.000004    0.244072  1.5000e-05 0.999988
beta5    0.000004    0.193786  1.8000e-05 0.999986
beta6    0.000004    0.104262  3.4000e-05 0.999973
beta7    0.000005    0.115546  4.3000e-05 0.999966
beta8    0.190729    0.053393  3.5722e+00 0.000354
beta9    0.161267    0.050380  3.2010e+00 0.001369
```

```
Robust Standard Errors:
          Estimate  Std. Error      t value Pr(>|t|)
mu       -0.000194    0.000095  -2.0345e+00 0.041898
ar1       0.970712    0.017548   5.5316e+01 0.000000
ar2      -0.037481    0.024963  -1.5015e+00 0.133229
ar3       0.036959    0.017527   2.1087e+00 0.034973
ma1      -0.960298    0.000505  -1.9006e+03 0.000000
omega     0.000001    0.000001   1.2522e+00 0.210484
alpha1    0.162828    0.032031   5.0834e+00 0.000000
alpha2    0.096681    0.089531   1.0799e+00 0.280205
alpha3    0.077271    0.096404   8.0154e-01 0.422819
alpha4    0.100792    0.104811   9.6165e-01 0.336225
alpha5    0.016330    0.072494   2.2526e-01 0.821777
alpha6    0.016767    0.072327   2.3182e-01 0.816680
alpha7    0.002976    0.085901   3.4641e-02 0.972366
beta1     0.173249    0.447458   3.8719e-01 0.698619
beta2     0.000025    0.590845   4.3000e-05 0.999966
beta3     0.000007    0.488652   1.5000e-05 0.999988
beta4     0.000004    0.508624   7.0000e-06 0.999994
beta5     0.000004    0.326302   1.1000e-05 0.999991
beta6     0.000004    0.345263   1.0000e-05 0.999992
beta7     0.000005    0.218539   2.3000e-05 0.999982
beta8     0.190729    0.206833   9.2214e-01 0.356457
beta9     0.161267    0.172237   9.3631e-01 0.349114
```

```
LogLikelihood : 18007.31

Information Criteria
------------------------------------

Akaike        -7.5648
Bayes         -7.5349
Shibata       -7.5648
Hannan-Quinn  -7.5543



*-----------------------------------*
*          GARCH Model Fit          *
*-----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(7,10)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000176    0.000062 -2.8530e+00 0.004331
ar1    -0.982616    0.001714 -5.7343e+02 0.000000
```

```
ar2     -0.012989    0.011649  -1.1150e+00  0.264845
ar3     -0.022718    0.014759  -1.5392e+00  0.123745
ma1      0.996657    0.000024   4.1916e+04  0.000000
omega    0.000001    0.000001   2.9056e+00  0.003666
alpha1   0.163915    0.018500   8.8602e+00  0.000000
alpha2   0.127557    0.061002   2.0910e+00  0.036524
alpha3   0.091963    0.041548   2.2134e+00  0.026868
alpha4   0.118282    0.033833   3.4961e+00  0.000472
alpha5   0.039342    0.008077   4.8711e+00  0.000001
alpha6   0.022609    0.039970   5.6566e-01  0.571624
alpha7   0.013676    0.038093   3.5902e-01  0.719582
beta1    0.000003    0.383335   7.0000e-06  0.999995
beta2    0.000001    0.509862   1.0000e-06  0.999999
beta3    0.000000    0.422520   1.0000e-06  1.000000
beta4    0.000000    0.418813   0.0000e+00  1.000000
beta5    0.000000    0.302579   0.0000e+00  1.000000
beta6    0.000000    0.162238   1.0000e-06  0.999999
beta7    0.000000    0.118443   1.0000e-06  0.999999
beta8    0.201458    0.182385   1.1046e+00  0.269343
beta9    0.115762    0.046135   2.5092e+00  0.012100
beta10   0.103648    0.070860   1.4627e+00  0.143547

Robust Standard Errors:
         Estimate  Std. Error      t value  Pr(>|t|)
mu      -0.000176    0.000075  -2.3620e+00  0.018179
ar1     -0.982616    0.009856  -9.9695e+01  0.000000
```

```
ar2     -0.012989   0.024223  -5.3623e-01  0.591800
ar3     -0.022718   0.019072  -1.1912e+00  0.233594
ma1      0.996657   0.000046   2.1791e+04  0.000000
omega    0.000001   0.000002   9.8540e-01  0.324430
alpha1   0.163915   0.032797   4.9979e+00  0.000001
alpha2   0.127557   0.151325   8.4294e-01  0.399264
alpha3   0.091963   0.131265   7.0059e-01  0.483559
alpha4   0.118282   0.120765   9.7944e-01  0.327362
alpha5   0.039342   0.058775   6.6937e-01  0.503262
alpha6   0.022609   0.088067   2.5673e-01  0.797389
alpha7   0.013676   0.101933   1.3417e-01  0.893272
beta1    0.000003   0.851916   3.0000e-06  0.999998
beta2    0.000001   1.051775   1.0000e-06  1.000000
beta3    0.000000   0.737518   0.0000e+00  1.000000
beta4    0.000000   0.896739   0.0000e+00  1.000000
beta5    0.000000   0.633499   0.0000e+00  1.000000
beta6    0.000000   0.299783   0.0000e+00  1.000000
beta7    0.000000   0.172618   1.0000e-06  0.999999
beta8    0.201458   0.441720   4.5608e-01  0.648335
beta9    0.115762   0.103676   1.1166e+00  0.264177
beta10   0.103648   0.228021   4.5456e-01  0.649429

LogLikelihood : 18009.11

Information Criteria
------------------------------------
```

```
Akaike       -7.5651
Bayes        -7.5339
Shibata      -7.5652
Hannan-Quinn -7.5541


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(8,1)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000193    0.000064 -3.027363 0.002467
ar1     0.300883    2.536417  0.118625 0.905572
ar2    -0.029177    0.038114 -0.765520 0.443962
ar3     0.008676    0.048595  0.178540 0.858299
ma1    -0.284666    2.538346 -0.112146 0.910707
omega   0.000000    0.000000  1.704079 0.088366
```

```
alpha1    0.121880   0.017838   6.832423 0.000000
alpha2    0.000014   0.024956   0.000546 0.999564
alpha3    0.000012   0.026661   0.000447 0.999643
alpha4    0.000009   0.026218   0.000329 0.999738
alpha5    0.000006   0.026621   0.000236 0.999812
alpha6    0.000006   0.027748   0.000210 0.999832
alpha7    0.000006   0.026000   0.000247 0.999803
alpha8    0.000007   0.017255   0.000433 0.999655
beta1     0.875778   0.010511  83.316369 0.000000

Robust Standard Errors:
           Estimate  Std. Error    t value Pr(>|t|)
mu        -0.000193    0.000076  -2.526394 0.011524
ar1        0.300883    2.101558   0.143171 0.886155
ar2       -0.029177    0.035665  -0.818089 0.413306
ar3        0.008676    0.056523   0.153497 0.878006
ma1       -0.284666    2.102838  -0.135372 0.892317
omega      0.000000    0.000002   0.223069 0.823482
alpha1     0.121880    0.028050   4.345114 0.000014
alpha2     0.000014    0.035497   0.000384 0.999694
alpha3     0.000012    0.047025   0.000254 0.999798
alpha4     0.000009    0.028911   0.000298 0.999762
alpha5     0.000006    0.043287   0.000145 0.999884
alpha6     0.000006    0.041477   0.000141 0.999888
alpha7     0.000006    0.046092   0.000139 0.999889
alpha8     0.000007    0.053843   0.000139 0.999889
```

```
beta1    0.875778     0.133642   6.553175  0.000000

LogLikelihood : 17977.83

Information Criteria
------------------------------------

Akaike        -7.5553
Bayes         -7.5349
Shibata       -7.5554
Hannan-Quinn  -7.5482


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(8,2)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
```

```
mu     -0.000211   0.000082    -2.576519 0.009980
ar1     0.973398   0.016034    60.707100 0.000000
ar2    -0.037816   0.022100    -1.711135 0.087056
ar3     0.032016   0.015393     2.079824 0.037542
ma1    -0.960517   0.001219  -787.933544 0.000000
omega   0.000000   0.000000     1.328182 0.184118
alpha1  0.150155   0.022946     6.543789 0.000000
alpha2  0.000077   0.066870     0.001148 0.999084
alpha3  0.000019   0.092144     0.000211 0.999832
alpha4  0.000019   0.047497     0.000407 0.999675
alpha5  0.000013   0.027801     0.000451 0.999640
alpha6  0.000012   0.026471     0.000465 0.999629
alpha7  0.000014   0.022298     0.000632 0.999496
alpha8  0.000015   0.033686     0.000446 0.999644
beta1   0.604233   0.265182     2.278561 0.022693
beta2   0.243056   0.277518     0.875822 0.381127

Robust Standard Errors:
        Estimate  Std. Error      t value Pr(>|t|)
mu     -0.000211   0.000288    -0.730265 0.465228
ar1     0.973398   0.018892    51.523792 0.000000
ar2    -0.037816   0.027982    -1.351412 0.176564
ar3     0.032016   0.018739     1.708488 0.087546
ma1    -0.960517   0.009315  -103.112477 0.000000
omega   0.000000   0.000004     0.114137 0.909129
alpha1  0.150155   0.145707     1.030524 0.302764
```

```
alpha2   0.000077   0.838344   0.000092 0.999927
alpha3   0.000019   1.051595   0.000018 0.999985
alpha4   0.000019   0.527525   0.000037 0.999971
alpha5   0.000013   0.181598   0.000069 0.999945
alpha6   0.000012   0.143206   0.000086 0.999931
alpha7   0.000014   0.067012   0.000210 0.999832
alpha8   0.000015   0.331462   0.000045 0.999964
beta1    0.604233   3.562828   0.169594 0.865330
beta2    0.243056   3.586437   0.067771 0.945968

LogLikelihood : 17982.7

Information Criteria
------------------------------------

Akaike       -7.5570
Bayes        -7.5352
Shibata      -7.5570
Hannan-Quinn -7.5493


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model     : sGARCH(8,3)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters

         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000192    0.000063 -3.0327e+00 0.002424
ar1     -0.982458    0.003908 -2.5139e+02 0.000000
ar2     -0.012076    0.013252 -9.1124e-01 0.362167
ar3     -0.021823    0.014946 -1.4601e+00 0.144253
ma1      0.996287    0.000020  5.0305e+04 0.000000
omega    0.000000    0.000000  6.9696e+00 0.000000
alpha1   0.167883    0.022808  7.3606e+00 0.000000
alpha2   0.000037    0.036744  9.9500e-04 0.999206
alpha3   0.000004    0.048778  8.5000e-05 0.999932
alpha4   0.000002    0.022519  8.9000e-05 0.999929
alpha5   0.000001    0.025575  4.0000e-05 0.999968
alpha6   0.000001    0.023178  4.3000e-05 0.999966
alpha7   0.000001    0.026577  3.7000e-05 0.999970
alpha8   0.000001    0.021131  5.0000e-05 0.999960
beta1    0.614936    0.182479  3.3699e+00 0.000752
beta2    0.000155    0.341294  4.5300e-04 0.999638
beta3    0.214751    0.168159  1.2771e+00 0.201577
```

```
Robust Standard Errors:
        Estimate  Std. Error      t value Pr(>|t|)
mu     -0.000192    0.000074 -2.6085e+00 0.009094
ar1    -0.982458    0.006125 -1.6040e+02 0.000000
ar2    -0.012076    0.016905 -7.1434e-01 0.475017
ar3    -0.021823    0.016667 -1.3094e+00 0.190410
ma1     0.996287    0.000018  5.4580e+04 0.000000
omega   0.000000    0.000000  2.2954e+00 0.021711
alpha1  0.167883    0.047892  3.5054e+00 0.000456
alpha2  0.000037    0.069318  5.2700e-04 0.999579
alpha3  0.000004    0.123858  3.3000e-05 0.999973
alpha4  0.000002    0.036475  5.5000e-05 0.999956
alpha5  0.000001    0.035057  2.9000e-05 0.999977
alpha6  0.000001    0.048459  2.0000e-05 0.999984
alpha7  0.000001    0.054827  1.8000e-05 0.999986
alpha8  0.000001    0.036259  2.9000e-05 0.999977
beta1   0.614936    0.329882  1.8641e+00 0.062306
beta2   0.000155    0.621173  2.4900e-04 0.999801
beta3   0.214751    0.649279  3.3075e-01 0.740831

LogLikelihood : 17987.69

Information Criteria
------------------------------------

Akaike       -7.5586
```

```
Bayes          -7.5355
Shibata        -7.5587
Hannan-Quinn   -7.5505


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(8,4)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000195    0.000063 -3.0965e+00 0.001958
ar1    -0.982056    0.002678 -3.6678e+02 0.000000
ar2    -0.012173    0.012648 -9.6242e-01 0.335837
ar3    -0.022240    0.014986 -1.4841e+00 0.137796
ma1     0.996205    0.000020  4.9151e+04 0.000000
omega   0.000000    0.000000  4.7030e+00 0.000003
alpha1  0.167269    0.018773  8.9099e+00 0.000000
alpha2  0.000000    0.051124  8.0000e-06 0.999994
```

```
alpha3   0.000000    0.059491   0.0000e+00 1.000000
alpha4   0.000000    0.032572   1.0000e-06 0.999999
alpha5   0.000000    0.018426   0.0000e+00 1.000000
alpha6   0.000000    0.011363   0.0000e+00 1.000000
alpha7   0.000000    0.014472   0.0000e+00 1.000000
alpha8   0.000000    0.013391   0.0000e+00 1.000000
beta1    0.644269    0.330304   1.9505e+00 0.051112
beta2    0.000006    0.460966   1.3000e-05 0.999990
beta3    0.123714    0.278580   4.4409e-01 0.656978
beta4    0.062952    0.200161   3.1451e-01 0.753136

Robust Standard Errors:
         Estimate  Std. Error      t value Pr(>|t|)
mu      -0.000195    0.000072  -2.7130e+00 0.006669
ar1     -0.982056    0.006895  -1.4242e+02 0.000000
ar2     -0.012173    0.017066  -7.1329e-01 0.475666
ar3     -0.022240    0.016657  -1.3352e+00 0.181819
ma1      0.996205    0.000020   4.9744e+04 0.000000
omega    0.000000    0.000000   2.2576e+00 0.023972
alpha1   0.167269    0.034774   4.8102e+00 0.000002
alpha2   0.000000    0.086837   5.0000e-06 0.999996
alpha3   0.000000    0.091105   0.0000e+00 1.000000
alpha4   0.000000    0.063630   0.0000e+00 1.000000
alpha5   0.000000    0.035420   0.0000e+00 1.000000
alpha6   0.000000    0.027940   0.0000e+00 1.000000
alpha7   0.000000    0.021094   0.0000e+00 1.000000
```

```
alpha8   0.000000    0.017183   0.0000e+00  1.000000
beta1    0.644269    0.516808   1.2466e+00  0.212532
beta2    0.000006    0.654094   9.0000e-06  0.999993
beta3    0.123714    0.389744   3.1743e-01  0.750921
beta4    0.062952    0.331547   1.8987e-01  0.849408

LogLikelihood : 17987.93

Information Criteria
------------------------------------

Akaike        -7.5583
Bayes         -7.5339
Shibata       -7.5584
Hannan-Quinn  -7.5497


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model    : sGARCH(8,5)
Mean Model     : ARFIMA(3,0,1)
Distribution   : norm
```

```
Optimal Parameters
------------------------------------
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000197    0.000063 -3.1286e+00 0.001756
ar1      -0.982702    0.003744 -2.6249e+02 0.000000
ar2      -0.013466    0.013279 -1.0141e+00 0.310527
ar3      -0.022750    0.015156 -1.5010e+00 0.133349
ma1       0.996161    0.000019  5.1978e+04 0.000000
omega     0.000000    0.000000  7.1109e+00 0.000000
alpha1    0.163931    0.023123  7.0895e+00 0.000000
alpha2    0.000002    0.040709  3.8000e-05 0.999970
alpha3    0.000001    0.039341  1.7000e-05 0.999986
alpha4    0.000001    0.033493  3.7000e-05 0.999970
alpha5    0.000000    0.013394  1.2000e-05 0.999991
alpha6    0.000000    0.021376  5.0000e-06 0.999996
alpha7    0.000000    0.022029  5.0000e-06 0.999996
alpha8    0.000000    0.007385  1.2000e-05 0.999991
beta1     0.725229    0.170666  4.2494e+00 0.000021
beta2     0.000141    0.224236  6.2800e-04 0.999499
beta3     0.000099    0.176398  5.6000e-04 0.999553
beta4     0.000003    0.024399  1.0200e-04 0.999918
beta5     0.109116    0.160441  6.8010e-01 0.496443

Robust Standard Errors:
          Estimate  Std. Error     t value Pr(>|t|)
```

```
mu      -0.000197   0.000074  -2.6652e+00  0.007693
ar1     -0.982702   0.006451  -1.5233e+02  0.000000
ar2     -0.013466   0.016899  -7.9688e-01  0.425522
ar3     -0.022750   0.016760  -1.3574e+00  0.174652
ma1      0.996161   0.000018   5.6446e+04  0.000000
omega    0.000000   0.000000   2.1913e+00  0.028433
alpha1   0.163931   0.043647   3.7558e+00  0.000173
alpha2   0.000002   0.058765   2.6000e-05  0.999979
alpha3   0.000001   0.075641   9.0000e-06  0.999993
alpha4   0.000001   0.070974   1.8000e-05  0.999986
alpha5   0.000000   0.053593   3.0000e-06  0.999998
alpha6   0.000000   0.037251   3.0000e-06  0.999998
alpha7   0.000000   0.039895   3.0000e-06  0.999998
alpha8   0.000000   0.033218   3.0000e-06  0.999998
beta1    0.725229   0.245724   2.9514e+00  0.003163
beta2    0.000141   0.279649   5.0300e-04  0.999598
beta3    0.000099   0.254878   3.8800e-04  0.999691
beta4    0.000003   0.523622   5.0000e-06  0.999996
beta5    0.109116   0.266135   4.1000e-01  0.681805

LogLikelihood : 17990.11

Information Criteria
------------------------------------

Akaike       -7.5588
```

```
Bayes          -7.5330
Shibata        -7.5589
Hannan-Quinn   -7.5497


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(8,6)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000198    0.000063 -3.1577e+00 0.001590
ar1    -0.982548    0.003611 -2.7209e+02 0.000000
ar2    -0.013087    0.013154 -9.9496e-01 0.319755
ar3    -0.022520    0.015155 -1.4859e+00 0.137296
ma1     0.996169    0.000019  5.2023e+04 0.000000
omega   0.000000    0.000000  3.9078e+00 0.000093
alpha1  0.162267    0.015177  1.0692e+01 0.000000
alpha2  0.000003    0.032869  8.3000e-05 0.999934
```

```
alpha3   0.000003    0.026876   1.0900e-04 0.999913
alpha4   0.000003    0.041527   7.7000e-05 0.999939
alpha5   0.000001    0.010540   6.8000e-05 0.999946
alpha6   0.000001    0.005892   8.8000e-05 0.999930
alpha7   0.000000    0.016095   2.4000e-05 0.999981
alpha8   0.000000    0.014081   2.3000e-05 0.999982
beta1    0.749085    0.040004   1.8725e+01 0.000000
beta2    0.000195    0.166918   1.1670e-03 0.999069
beta3    0.000013    0.335611   3.8000e-05 0.999969
beta4    0.000006    0.365256   1.6000e-05 0.999988
beta5    0.000007    0.282987   2.5000e-05 0.999980
beta6    0.087098    0.106644   8.1672e-01 0.414090

Robust Standard Errors:
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000198    0.000071 -2.7972e+00 0.005155
ar1      -0.982548    0.006263 -1.5688e+02 0.000000
ar2      -0.013087    0.016557 -7.9045e-01 0.429265
ar3      -0.022520    0.016731 -1.3460e+00 0.178301
ma1       0.996169    0.000018  5.5485e+04 0.000000
omega     0.000000    0.000000  1.7078e+00 0.087679
alpha1    0.162267    0.028957  5.6038e+00 0.000000
alpha2    0.000003    0.056119  4.8000e-05 0.999961
alpha3    0.000003    0.077265  3.8000e-05 0.999970
alpha4    0.000003    0.091244  3.5000e-05 0.999972
alpha5    0.000001    0.054056  1.3000e-05 0.999989
```

```
alpha6   0.000001    0.068921   8.0000e-06 0.999994
alpha7   0.000000    0.037732   1.0000e-05 0.999992
alpha8   0.000000    0.026206   1.2000e-05 0.999990
beta1    0.749085    0.363852   2.0588e+00 0.039517
beta2    0.000195    0.126198   1.5430e-03 0.998769
beta3    0.000013    0.710494   1.8000e-05 0.999986
beta4    0.000006    0.561295   1.0000e-05 0.999992
beta5    0.000007    0.459039   1.5000e-05 0.999988
beta6    0.087098    0.310641   2.8038e-01 0.779184

LogLikelihood : 17991.93

Information Criteria
------------------------------------

Akaike       -7.5592
Bayes        -7.5320
Shibata      -7.5592
Hannan-Quinn -7.5496


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model     : sGARCH(8,7)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters

         Estimate  Std. Error    t value Pr(>|t|)
mu      -0.000210    0.000085  -2.483871 0.012996
ar1      0.970280    0.016166  60.020076 0.000000
ar2     -0.036561    0.022400  -1.632162 0.102645
ar3      0.035067    0.015748   2.226718 0.025966
ma1     -0.959696    0.000977 -982.042352 0.000000
omega    0.000001    0.000000   4.386533 0.000012
alpha1   0.164337    0.026436   6.216397 0.000000
alpha2   0.016863    0.026790   0.629464 0.529045
alpha3   0.000055    0.034456   0.001607 0.998718
alpha4   0.027446    0.092963   0.295238 0.767812
alpha5   0.000003    0.015155   0.000198 0.999842
alpha6   0.000002    0.067937   0.000029 0.999977
alpha7   0.000001    0.044154   0.000029 0.999977
alpha8   0.000001    0.031375   0.000027 0.999979
beta1    0.658306    0.161992   4.063803 0.000048
beta2    0.000058    0.029117   0.001994 0.998409
beta3    0.000015    0.450710   0.000034 0.999973
beta4    0.000007    0.210471   0.000031 0.999975
```

```
beta5     0.000005     0.033610     0.000158  0.999874
beta6     0.000012     0.204702     0.000061  0.999951
beta7     0.131185     0.042659     3.075187  0.002104

Robust Standard Errors:
          Estimate   Std. Error      t value  Pr(>|t|)
mu       -0.000210     0.000121  -1.7322e+00  0.083245
ar1       0.970280     0.017350   5.5924e+01  0.000000
ar2      -0.036561     0.025178  -1.4521e+00  0.146466
ar3       0.035067     0.018264   1.9201e+00  0.054851
ma1      -0.959696     0.000648  -1.4814e+03  0.000000
omega     0.000001     0.000000   1.7127e+00  0.086777
alpha1    0.164337     0.070946   2.3164e+00  0.020539
alpha2    0.016863     0.063533   2.6543e-01  0.790680
alpha3    0.000055     0.105182   5.2600e-04  0.999580
alpha4    0.027446     0.297399   9.2287e-02  0.926470
alpha5    0.000003     0.075205   4.0000e-05  0.999968
alpha6    0.000002     0.238216   8.0000e-06  0.999993
alpha7    0.000001     0.183658   7.0000e-06  0.999994
alpha8    0.000001     0.105404   8.0000e-06  0.999994
beta1     0.658306     0.569644   1.1556e+00  0.247827
beta2     0.000058     0.213317   2.7200e-04  0.999783
beta3     0.000015     1.412582   1.1000e-05  0.999991
beta4     0.000007     1.059732   6.0000e-06  0.999995
beta5     0.000005     0.885094   6.0000e-06  0.999995
beta6     0.000012     1.091557   1.1000e-05  0.999991
```

```
beta7    0.131185     0.407201   3.2216e-01 0.747329

LogLikelihood : 17994.87

Information Criteria
------------------------------------

Akaike       -7.5600
Bayes        -7.5314
Shibata      -7.5600
Hannan-Quinn -7.5500


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(8,8)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
```

```
mu      -0.000196    0.000084     -2.330123 0.019800
 ar1     0.972427    0.016242     59.872344 0.000000
 ar2    -0.037386    0.022717     -1.645721 0.099821
 ar3     0.035729    0.015617      2.287832 0.022147
ma1     -0.961200    0.001071   -897.512084 0.000000
omega    0.000001    0.000000      3.669979 0.000243
 alpha1  0.159721    0.020348      7.849533 0.000000
 alpha2  0.063947    0.100250      0.637871 0.523558
 alpha3  0.045508    0.099163      0.458918 0.646293
 alpha4  0.089309    0.010985      8.130455 0.000000
 alpha5  0.000001    0.130797      0.000005 0.999996
 alpha6  0.003226    0.023953      0.134698 0.892851
 alpha7  0.000000    0.061308      0.000001 0.999999
 alpha8  0.000000    0.069809      0.000000 1.000000
 beta1   0.365904    0.742487      0.492809 0.622148
 beta2   0.000000    0.910704      0.000001 1.000000
 beta3   0.000000    0.401492      0.000000 1.000000
 beta4   0.000000    0.261634      0.000000 1.000000
 beta5   0.000000    0.153529      0.000000 1.000000
 beta6   0.000000    0.502721      0.000000 1.000000
 beta7   0.000000    0.108151      0.000001 0.999999
 beta8   0.271383    0.292087      0.929116 0.352829

 Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000196    0.000106     -1.851504 0.064097
```

ar1	0.972427	0.029201	33.301011	0.000000
ar2	−0.037386	0.043405	−0.861334	0.389054
ar3	0.035729	0.017477	2.044379	0.040916
ma1	−0.961200	0.005334	−180.199125	0.000000
omega	0.000001	0.000003	0.318116	0.750397
alpha1	0.159721	0.064212	2.487386	0.012869
alpha2	0.063947	0.798646	0.080069	0.936182
alpha3	0.045508	0.888223	0.051234	0.959139
alpha4	0.089309	0.179084	0.498701	0.617990
alpha5	0.000001	1.106675	0.000001	0.999999
alpha6	0.003226	0.073893	0.043663	0.965173
alpha7	0.000000	0.558962	0.000000	1.000000
alpha8	0.000000	0.594334	0.000000	1.000000
beta1	0.365904	6.103032	0.059954	0.952192
beta2	0.000000	7.928280	0.000000	1.000000
beta3	0.000000	0.608505	0.000000	1.000000
beta4	0.000000	3.529116	0.000000	1.000000
beta5	0.000000	0.811615	0.000000	1.000000
beta6	0.000000	4.447869	0.000000	1.000000
beta7	0.000000	1.327008	0.000000	1.000000
beta8	0.271383	2.692571	0.100789	0.919718

LogLikelihood : 18006.21

Information Criteria

```
Akaike        -7.5643
Bayes         -7.5344
Shibata       -7.5644
Hannan-Quinn  -7.5538


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(8,9)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000179    0.000062 -2.8941e+00 0.003802
ar1    -0.981693    0.001968 -4.9888e+02 0.000000
ar2    -0.012076    0.010623 -1.1367e+00 0.255650
ar3    -0.022730    0.014633 -1.5533e+00 0.120352
ma1     0.996625    0.000023  4.2588e+04 0.000000
omega   0.000001    0.000000  2.8820e+00 0.003951
```

```
 alpha1   0.157209     0.017710   8.8771e+00 0.000000
 alpha2   0.101224     0.043480   2.3281e+00 0.019909
 alpha3   0.083378     0.056997   1.4628e+00 0.143510
 alpha4   0.111079     0.001816   6.1167e+01 0.000000
 alpha5   0.024480     0.035649   6.8670e-01 0.492275
 alpha6   0.018098     0.012836   1.4099e+00 0.158558
 alpha7   0.007978     0.017763   4.4912e-01 0.653344
 alpha8   0.000000     0.037852   1.0000e-06 1.000000
 beta1    0.126981     0.293792   4.3222e-01 0.665585
 beta2    0.000001     0.444935   2.0000e-06 0.999998
 beta3    0.000000     0.180316   1.0000e-06 0.999999
 beta4    0.000000     0.219957   0.0000e+00 1.000000
 beta5    0.000000     0.223179   0.0000e+00 1.000000
 beta6    0.000000     0.097854   1.0000e-06 0.999999
 beta7    0.000000     0.242260   1.0000e-06 0.999999
 beta8    0.200344     0.154341   1.2981e+00 0.194265
 beta9    0.168224     0.091580   1.8369e+00 0.066225

 Robust Standard Errors:
          Estimate  Std. Error      t value Pr(>|t|)
 mu      -0.000179     0.000072 -2.4809e+00 0.013105
 ar1     -0.981693     0.013957 -7.0338e+01 0.000000
 ar2     -0.012076     0.029978 -4.0282e-01 0.687080
 ar3     -0.022730     0.020216 -1.1243e+00 0.260866
 ma1      0.996625     0.000051  1.9727e+04 0.000000
 omega    0.000001     0.000001  8.8564e-01 0.375812
```

alpha1	0.157209	0.032299	4.8672e+00	0.000001
alpha2	0.101224	0.132831	7.6205e−01	0.446029
alpha3	0.083378	0.187576	4.4450e−01	0.656678
alpha4	0.111079	0.126237	8.7993e−01	0.378897
alpha5	0.024480	0.090018	2.7194e−01	0.785666
alpha6	0.018098	0.079181	2.2856e−01	0.819210
alpha7	0.007978	0.085524	9.3278e−02	0.925682
alpha8	0.000000	0.110399	0.0000e+00	1.000000
beta1	0.126981	0.786903	1.6137e−01	0.871803
beta2	0.000001	1.277401	1.0000e−06	0.999999
beta3	0.000000	0.358332	1.0000e−06	1.000000
beta4	0.000000	0.642487	0.0000e+00	1.000000
beta5	0.000000	0.395146	0.0000e+00	1.000000
beta6	0.000000	0.513513	0.0000e+00	1.000000
beta7	0.000000	0.573335	0.0000e+00	1.000000
beta8	0.200344	0.497012	4.0310e−01	0.686876
beta9	0.168224	0.278275	6.0452e−01	0.545495

LogLikelihood : 18008.3

Information Criteria

Akaike	−7.5648
Bayes	−7.5335
Shibata	−7.5648

```
Hannan-Quinn  -7.5538


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(8,10)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error      t value  Pr(>|t|)
mu       -0.000176    0.000062  -2.8346e+00  0.004588
ar1      -0.982628    0.002742  -3.5832e+02  0.000000
ar2      -0.012949    0.012079  -1.0720e+00  0.283712
ar3      -0.022666    0.014785  -1.5331e+00  0.125253
ma1       0.996656    0.000022   4.4382e+04  0.000000
omega     0.000001    0.000000   3.0185e+00  0.002540
alpha1    0.163885    0.019484   8.4112e+00  0.000000
alpha2    0.127497    0.016868   7.5583e+00  0.000000
alpha3    0.091921    0.034412   2.6712e+00  0.007557
alpha4    0.118302    0.021622   5.4714e+00  0.000000
```

```
alpha5   0.039381    0.010998   3.5807e+00 0.000343
alpha6   0.022609    0.007940   2.8477e+00 0.004404
alpha7   0.013706    0.015830   8.6584e-01 0.386578
alpha8   0.000000    0.026610   1.7000e-05 0.999987
beta1    0.000022    0.029433   7.5000e-04 0.999402
beta2    0.000006    0.244970   2.3000e-05 0.999982
beta3    0.000002    0.350625   6.0000e-06 0.999995
beta4    0.000001    0.250319   5.0000e-06 0.999996
beta5    0.000001    0.215198   6.0000e-06 0.999995
beta6    0.000001    0.144209   8.0000e-06 0.999993
beta7    0.000002    0.134477   1.2000e-05 0.999991
beta8    0.201551    0.094404   2.1350e+00 0.032763
beta9    0.115257    0.044549   2.5872e+00 0.009676
beta10   0.103916    0.052640   1.9741e+00 0.048374

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000176    0.000073 -2.4141e+00 0.015773
ar1     -0.982628    0.008395 -1.1705e+02 0.000000
ar2     -0.012949    0.022589 -5.7325e-01 0.566472
ar3     -0.022666    0.018825 -1.2041e+00 0.228559
ma1      0.996656    0.000040  2.4865e+04 0.000000
omega    0.000001    0.000001  1.0318e+00 0.302175
alpha1   0.163885    0.027802  5.8947e+00 0.000000
alpha2   0.127497    0.026155  4.8746e+00 0.000001
alpha3   0.091921    0.168843  5.4442e-01 0.586153
```

```
alpha4   0.118302   0.091315   1.2955e+00 0.195136
alpha5   0.039381   0.059678   6.5989e−01 0.509323
alpha6   0.022609   0.114499   1.9746e−01 0.843466
alpha7   0.013706   0.053817   2.5468e−01 0.798968
alpha8   0.000000   0.049454   9.0000e−06 0.999993
beta1    0.000022   0.018910   1.1670e−03 0.999069
beta2    0.000006   0.950858   6.0000e−06 0.999995
beta3    0.000002   0.643114   4.0000e−06 0.999997
beta4    0.000001   0.463260   3.0000e−06 0.999998
beta5    0.000001   0.361730   3.0000e−06 0.999997
beta6    0.000001   0.433760   3.0000e−06 0.999998
beta7    0.000002   0.212970   7.0000e−06 0.999994
beta8    0.201551   0.323319   6.2338e−01 0.533036
beta9    0.115257   0.159205   7.2396e−01 0.469093
beta10   0.103916   0.263458   3.9443e−01 0.693264

LogLikelihood : 18009.11

Information Criteria
------------------------------------

Akaike        −7.5647
Bayes         −7.5321
Shibata       −7.5648
Hannan−Quinn  −7.5532
```

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(9,1)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000197    0.000064 -3.0958e+00 0.001963
ar1     -0.979151    0.003150 -3.1083e+02 0.000000
ar2     -0.009269    0.009958 -9.3084e-01 0.351934
ar3     -0.022336    0.014614 -1.5283e+00 0.126431
ma1      0.996229    0.000026  3.7860e+04 0.000000
omega    0.000000    0.000000  1.4701e+00 0.141529
alpha1   0.123123    0.017688  6.9610e+00 0.000000
alpha2   0.000005    0.024858  1.9300e-04 0.999846
alpha3   0.000003    0.026727  1.1000e-04 0.999912
alpha4   0.000003    0.026228  1.0400e-04 0.999917
alpha5   0.000002    0.026908  7.3000e-05 0.999942
alpha6   0.000002    0.027859  7.2000e-05 0.999942
```

```
alpha7   0.000002    0.025982   9.2000e-05 0.999927
alpha8   0.000003    0.027101   1.0300e-04 0.999918
alpha9   0.000007    0.019584   3.5800e-04 0.999714
beta1    0.874724    0.012192   7.1746e+01 0.000000

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000197    0.000075   -2.623060 0.008714
ar1     -0.979151    0.041995  -23.316016 0.000000
ar2     -0.009269    0.078900   -0.117483 0.906477
ar3     -0.022336    0.035385   -0.631208 0.527904
ma1      0.996229    0.000153 6509.963719 0.000000
omega    0.000000    0.000002    0.164580 0.869275
alpha1   0.123123    0.035119    3.505906 0.000455
alpha2   0.000005    0.038419    0.000125 0.999900
alpha3   0.000003    0.049328    0.000060 0.999952
alpha4   0.000003    0.029284    0.000093 0.999926
alpha5   0.000002    0.038639    0.000051 0.999960
alpha6   0.000002    0.041418    0.000049 0.999961
alpha7   0.000002    0.052109    0.000046 0.999963
alpha8   0.000003    0.040819    0.000069 0.999945
alpha9   0.000007    0.081933    0.000086 0.999932
beta1    0.874724    0.164577    5.314989 0.000000

LogLikelihood : 17981.39
```

```
Information Criteria
------------------------------------

Akaike        -7.5564
Bayes         -7.5347
Shibata       -7.5564
Hannan-Quinn  -7.5488


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(9,2)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000198    0.000060 -3.2868e+00 0.001013
ar1    -0.980343    0.018016 -5.4414e+01 0.000000
ar2    -0.009609    0.025015 -3.8412e-01 0.700890
ar3    -0.021265    0.012388 -1.7166e+00 0.086046
```

```
ma1       0.996059     0.000064  1.5564e+04 0.000000
omega     0.000000     0.000001  4.5002e-01 0.652697
alpha1    0.149655     0.065270  2.2929e+00 0.021856
alpha2    0.000028     0.128354  2.1400e-04 0.999829
alpha3    0.000007     0.059336  1.1200e-04 0.999911
alpha4    0.000007     0.022455  2.9900e-04 0.999761
alpha5    0.000004     0.023600  1.7600e-04 0.999859
alpha6    0.000004     0.020997  1.9300e-04 0.999846
alpha7    0.000005     0.022203  2.1500e-04 0.999828
alpha8    0.000005     0.010105  4.7800e-04 0.999619
alpha9    0.000012     0.006732  1.7510e-03 0.998603
beta1     0.615143     0.258815  2.3768e+00 0.017465
beta2     0.232764     0.295373  7.8803e-01 0.430677

Robust Standard Errors:
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000198    0.000605   -0.327887 0.742997
ar1      -0.980343    0.563273   -1.740442 0.081781
ar2      -0.009609    0.867092   -0.011081 0.991159
ar3      -0.021265    0.253171   -0.083996 0.933060
ma1       0.996059    0.001863  534.562293 0.000000
omega     0.000000    0.000031    0.014677 0.988290
alpha1    0.149655    2.063807    0.072514 0.942193
alpha2    0.000028    3.867735    0.000007 0.999994
alpha3    0.000007    1.929742    0.000003 0.999997
alpha4    0.000007    0.030445    0.000221 0.999824
```

```
alpha5   0.000004    0.199563   0.000021  0.999983
alpha6   0.000004    0.352440   0.000011  0.999991
alpha7   0.000005    0.086625   0.000055  0.999956
alpha8   0.000005    0.646612   0.000007  0.999994
alpha9   0.000012    0.660737   0.000018  0.999986
beta1    0.615143    7.527171   0.081723  0.934867
beta2    0.232764    8.796926   0.026460  0.978891

LogLikelihood : 17984.27

Information Criteria
------------------------------------

Akaike       -7.5572
Bayes        -7.5341
Shibata      -7.5572
Hannan-Quinn -7.5491


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(9,3)
```

```
Mean Model          : ARFIMA(3,0,1)
Distribution        : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000193    0.000063 -3.0568e+00 0.002237
ar1    -0.981831    0.003784 -2.5950e+02 0.000000
ar2    -0.011405    0.013294 -8.5793e-01 0.390932
ar3    -0.021729    0.014973 -1.4512e+00 0.146732
ma1     0.996249    0.000020  4.9998e+04 0.000000
omega   0.000000    0.000000  4.4678e+00 0.000008
alpha1  0.168099    0.021068  7.9788e+00 0.000000
alpha2  0.000373    0.016162  2.3094e-02 0.981575
alpha3  0.000033    0.032988  1.0120e-03 0.999193
alpha4  0.000022    0.019707  1.1340e-03 0.999095
alpha5  0.000011    0.020306  5.4900e-04 0.999562
alpha6  0.000011    0.020221  5.4400e-04 0.999566
alpha7  0.000011    0.014405  7.8000e-04 0.999378
alpha8  0.000012    0.012140  9.7300e-04 0.999224
alpha9  0.000020    0.006903  2.8800e-03 0.997702
beta1   0.611647    0.159278  3.8401e+00 0.000123
beta2   0.001855    0.336653  5.5110e-03 0.995603
beta3   0.216046    0.164288  1.3150e+00 0.188495

Robust Standard Errors:
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000193	0.000073	−2.6576e+00	0.007870
ar1	−0.981831	0.006515	−1.5071e+02	0.000000
ar2	−0.011405	0.017169	−6.6427e−01	0.506517
ar3	−0.021729	0.016721	−1.2995e+00	0.193771
ma1	0.996249	0.000020	5.0063e+04	0.000000
omega	0.000000	0.000000	1.8696e+00	0.061533
alpha1	0.168099	0.038158	4.4053e+00	0.000011
alpha2	0.000373	0.084286	4.4280e−03	0.996467
alpha3	0.000033	0.105285	3.1700e−04	0.999747
alpha4	0.000022	0.023430	9.5400e−04	0.999239
alpha5	0.000011	0.036141	3.0900e−04	0.999754
alpha6	0.000011	0.048671	2.2600e−04	0.999820
alpha7	0.000011	0.038214	2.9400e−04	0.999765
alpha8	0.000012	0.033613	3.5100e−04	0.999720
alpha9	0.000020	0.024363	8.1600e−04	0.999349
beta1	0.611647	0.464097	1.3179e+00	0.187527
beta2	0.001855	0.685193	2.7080e−03	0.997840
beta3	0.216046	0.613055	3.5241e−01	0.724532

LogLikelihood : 17987.55

Information Criteria

Akaike −7.5582

```
Bayes          -7.5337
Shibata        -7.5582
Hannan-Quinn   -7.5496


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(9,4)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000195    0.000063 -3.0901e+00 0.002001
ar1    -0.981827    0.003963 -2.4772e+02 0.000000
ar2    -0.011753    0.013431 -8.7511e-01 0.381513
ar3    -0.022064    0.015055 -1.4656e+00 0.142761
ma1     0.996212    0.000019  5.2056e+04 0.000000
omega   0.000000    0.000000  4.8813e+00 0.000001
alpha1  0.167310    0.019385  8.6310e+00 0.000000
alpha2  0.000074    0.008493  8.7680e-03 0.993004
```

```
alpha3    0.000026      0.029019   9.0200e-04 0.999281
alpha4    0.000016      0.021590   7.2300e-04 0.999423
alpha5    0.000006      0.022881   2.4900e-04 0.999801
alpha6    0.000005      0.017898   2.8900e-04 0.999770
alpha7    0.000006      0.016822   3.3500e-04 0.999733
alpha8    0.000006      0.018457   3.0800e-04 0.999754
alpha9    0.000010      0.012673   7.7400e-04 0.999382
beta1     0.642818      0.115002   5.5896e+00 0.000000
beta2     0.001003      0.196626   5.1010e-03 0.995930
beta3     0.124032      0.232897   5.3256e-01 0.594337
beta4     0.062849      0.140744   4.4655e-01 0.655202

Robust Standard Errors:
           Estimate  Std. Error      t value Pr(>|t|)
mu        -0.000195    0.000073  -2.6853e+00 0.007247
ar1       -0.981827    0.005989  -1.6395e+02 0.000000
ar2       -0.011753    0.016770  -7.0087e-01 0.483385
ar3       -0.022064    0.016708  -1.3206e+00 0.186645
ma1        0.996212    0.000017   5.7849e+04 0.000000
omega      0.000000    0.000000   2.3017e+00 0.021352
alpha1     0.167310    0.031830   5.2563e+00 0.000000
alpha2     0.000074    0.087889   8.4700e-04 0.999324
alpha3     0.000026    0.038591   6.7800e-04 0.999459
alpha4     0.000016    0.044948   3.4700e-04 0.999723
alpha5     0.000006    0.032730   1.7400e-04 0.999861
alpha6     0.000005    0.030707   1.6800e-04 0.999866
```

```
alpha7   0.000006    0.024797   2.2700e-04  0.999819
alpha8   0.000006    0.022488   2.5300e-04  0.999798
alpha9   0.000010    0.016901   5.8000e-04  0.999537
beta1    0.642818    0.536276   1.1987e+00  0.230656
beta2    0.001003    0.284886   3.5210e-03  0.997191
beta3    0.124032    0.338192   3.6675e-01  0.713805
beta4    0.062849    0.214645   2.9280e-01  0.769673

LogLikelihood : 17987.81

Information Criteria
------------------------------------

Akaike        -7.5579
Bayes         -7.5320
Shibata       -7.5579
Hannan-Quinn  -7.5488


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(9,5)
```

```
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000197    0.000063 -3.1257e+00 0.001774
ar1    -0.983013    0.004038 -2.4344e+02 0.000000
ar2    -0.013885    0.013563 -1.0238e+00 0.305953
ar3    -0.022696    0.015198 -1.4934e+00 0.135338
ma1     0.996086    0.000019  5.2736e+04 0.000000
omega   0.000000    0.000000  6.0211e+00 0.000000
alpha1  0.165290    0.018722  8.8287e+00 0.000000
alpha2  0.000011    0.013824  8.2400e-04 0.999343
alpha3  0.000005    0.027135  2.0100e-04 0.999840
alpha4  0.000009    0.006965  1.2450e-03 0.999006
alpha5  0.000001    0.011703  1.1000e-04 0.999912
alpha6  0.000001    0.021661  4.3000e-05 0.999966
alpha7  0.000001    0.019187  4.5000e-05 0.999964
alpha8  0.000001    0.010748  7.1000e-05 0.999943
alpha9  0.000001    0.014665  8.5000e-05 0.999932
beta1   0.720677    0.116624  6.1795e+00 0.000000
beta2   0.000778    0.229373  3.3910e-03 0.997294
beta3   0.000676    0.206646  3.2700e-03 0.997391
beta4   0.000020    0.033742  5.8000e-04 0.999537
beta5   0.111015    0.087712  1.2657e+00 0.205629
```

```
Robust Standard Errors:
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000197    0.000074 -2.6790e+00 0.007384
ar1    -0.983013    0.006673 -1.4731e+02 0.000000
ar2    -0.013885    0.017102 -8.1189e-01 0.416854
ar3    -0.022696    0.016774 -1.3530e+00 0.176052
ma1     0.996086    0.000018  5.5126e+04 0.000000
omega   0.000000    0.000000  2.2972e+00 0.021605
alpha1  0.165290    0.026080  6.3378e+00 0.000000
alpha2  0.000011    0.097908  1.1600e-04 0.999907
alpha3  0.000005    0.043750  1.2500e-04 0.999901
alpha4  0.000009    0.038584  2.2500e-04 0.999821
alpha5  0.000001    0.036202  3.5000e-05 0.999972
alpha6  0.000001    0.035674  2.6000e-05 0.999979
alpha7  0.000001    0.038497  2.2000e-05 0.999982
alpha8  0.000001    0.028357  2.7000e-05 0.999979
alpha9  0.000001    0.021999  5.7000e-05 0.999955
beta1   0.720677    0.575970  1.2512e+00 0.210847
beta2   0.000778    0.370197  2.1010e-03 0.998324
beta3   0.000676    0.325503  2.0760e-03 0.998344
beta4   0.000020    0.013219  1.4800e-03 0.998819
beta5   0.111015    0.140098  7.9241e-01 0.428121

LogLikelihood : 17989.99
```

```
Information Criteria
------------------------------------

Akaike       -7.5584
Bayes        -7.5312
Shibata      -7.5584
Hannan-Quinn -7.5488


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(9,6)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error    t value Pr(>|t|)
mu      -0.000215    0.000081  -2.642878 0.008220
ar1      0.970391    0.016183  59.965160 0.000000
ar2     -0.037000    0.022415  -1.650679 0.098804
ar3      0.034604    0.015681   2.206792 0.027329
```

```
ma1     -0.959632   0.001020 -940.905088 0.000000
omega    0.000000   0.000000    4.567469 0.000005
alpha1   0.163739   0.022491    7.280212 0.000000
alpha2   0.000008   0.014829    0.000541 0.999568
alpha3   0.000008   0.008522    0.000965 0.999230
alpha4   0.000011   0.029761    0.000371 0.999704
alpha5   0.000002   0.016783    0.000130 0.999896
alpha6   0.000002   0.020009    0.000080 0.999936
alpha7   0.000001   0.017861    0.000065 0.999948
alpha8   0.000001   0.021881    0.000049 0.999961
alpha9   0.000001   0.012634    0.000119 0.999905
beta1    0.743415   0.148349    5.011245 0.000001
beta2    0.000665   0.223275    0.002978 0.997624
beta3    0.000080   0.154218    0.000522 0.999584
beta4    0.000018   0.074498    0.000237 0.999811
beta5    0.000021   0.033956    0.000628 0.999499
beta6    0.090653   0.030299    2.991992 0.002772

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000215   0.000090   -2.385844 0.017040
ar1      0.970391   0.017527   55.364784 0.000000
ar2     -0.037000   0.025537   -1.448903 0.147365
ar3      0.034604   0.017483    1.979308 0.047781
ma1     -0.959632   0.001087 -882.724512 0.000000
omega    0.000000   0.000000    2.031016 0.042253
```

alpha1	0.163739	0.040445	4.048467	0.000052
alpha2	0.000008	0.097217	0.000083	0.999934
alpha3	0.000008	0.054860	0.000150	0.999880
alpha4	0.000011	0.049975	0.000221	0.999824
alpha5	0.000002	0.052959	0.000041	0.999967
alpha6	0.000002	0.050186	0.000032	0.999975
alpha7	0.000001	0.030078	0.000039	0.999969
alpha8	0.000001	0.050249	0.000021	0.999983
alpha9	0.000001	0.013495	0.000111	0.999911
beta1	0.743415	0.458760	1.620488	0.105127
beta2	0.000665	0.463676	0.001434	0.998856
beta3	0.000080	0.206320	0.000390	0.999689
beta4	0.000018	0.142600	0.000124	0.999901
beta5	0.000021	0.054499	0.000391	0.999688
beta6	0.090653	0.242360	0.374043	0.708372

LogLikelihood : 17990.68

Information Criteria

Akaike	−7.5582
Bayes	−7.5297
Shibata	−7.5583
Hannan–Quinn	−7.5482

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(9,7)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000211    0.000082   -2.555442 0.010605
ar1       0.970266    0.016185   59.947876 0.000000
ar2      -0.036437    0.022440   -1.623719 0.104436
ar3       0.034986    0.015700    2.228367 0.025856
ma1      -0.959712    0.000975 -984.486394 0.000000
omega     0.000001    0.000000    4.346655 0.000014
alpha1    0.164421    0.021597    7.613296 0.000000
alpha2    0.017041    0.023638    0.720919 0.470959
alpha3    0.000056    0.011510    0.004902 0.996089
alpha4    0.027670    0.009145    3.025806 0.002480
alpha5    0.000005    0.002732    0.001727 0.998622
alpha6    0.000003    0.025048    0.000118 0.999906
```

```
alpha7   0.000002    0.026512     0.000076  0.999939
alpha8   0.000001    0.017357     0.000082  0.999934
alpha9   0.000003    0.016950     0.000151  0.999879
beta1    0.657617    0.021886    30.047854  0.000000
beta2    0.000056    0.055805     0.000998  0.999204
beta3    0.000020    0.016970     0.001172  0.999065
beta4    0.000010    0.159213     0.000061  0.999951
beta5    0.000009    0.292140     0.000031  0.999976
beta6    0.000012    0.273589     0.000043  0.999966
beta7    0.131476    0.109860     1.196765  0.231398

Robust Standard Errors:
         Estimate   Std. Error       t value  Pr(>|t|)
mu      -0.000211    0.000088  -2.3849e+00  0.017082
ar1      0.970266    0.017581   5.5187e+01  0.000000
ar2     -0.036437    0.025700  -1.4178e+00  0.156259
ar3      0.034986    0.017414   2.0091e+00  0.044529
ma1     -0.959712    0.000658  -1.4583e+03  0.000000
omega    0.000001    0.000000   1.9730e+00  0.048495
alpha1   0.164421    0.037543   4.3795e+00  0.000012
alpha2   0.017041    0.066527   2.5615e-01  0.797836
alpha3   0.000056    0.041330   1.3650e-03  0.998911
alpha4   0.027670    0.039204   7.0580e-01  0.480314
alpha5   0.000005    0.062136   7.6000e-05  0.999939
alpha6   0.000003    0.062340   4.7000e-05  0.999962
alpha7   0.000002    0.051772   3.9000e-05  0.999969
```

```
alpha8   0.000001    0.034174   4.2000e-05  0.999967
alpha9   0.000003    0.030384   8.4000e-05  0.999933
beta1    0.657617    0.332740   1.9764e+00  0.048113
beta2    0.000056    0.051811   1.0750e-03  0.999142
beta3    0.000020    0.016181   1.2290e-03  0.999019
beta4    0.000010    0.303420   3.2000e-05  0.999974
beta5    0.000009    0.477755   1.9000e-05  0.999985
beta6    0.000012    0.443683   2.6000e-05  0.999979
beta7    0.131476    0.237616   5.5331e-01  0.580050

LogLikelihood : 17994.76

Information Criteria
------------------------------------

Akaike       -7.5595
Bayes        -7.5296
Shibata      -7.5596
Hannan-Quinn -7.5490


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

GARCH Model : sGARCH(9,8)

Mean Model : ARFIMA(3,0,1)

Distribution : norm

Optimal Parameters

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000195	0.000084	−2.3368e+00	0.019450
ar1	0.972687	0.015943	6.1008e+01	0.000000
ar2	−0.037593	0.022252	−1.6894e+00	0.091141
ar3	0.035710	0.015616	2.2867e+00	0.022213
ma1	−0.961273	0.000888	−1.0826e+03	0.000000
omega	0.000001	0.000000	5.6312e+00	0.000000
alpha1	0.159613	0.019666	8.1160e+00	0.000000
alpha2	0.063741	0.034150	1.8665e+00	0.061974
alpha3	0.045483	0.049597	9.1706e−01	0.359112
alpha4	0.088863	0.021893	4.0589e+00	0.000049
alpha5	0.000073	0.021776	3.3430e−03	0.997333
alpha6	0.003390	0.024054	1.4094e−01	0.887914
alpha7	0.000006	0.027510	2.0400e−04	0.999837
alpha8	0.000001	0.016613	5.2000e−05	0.999959
alpha9	0.000001	0.006294	1.2000e−04	0.999904
beta1	0.367418	0.282594	1.3002e+00	0.193546
beta2	0.000017	0.496636	3.3000e−05	0.999973
beta3	0.000004	0.323721	1.2000e−05	0.999991

```
beta4     0.000002     0.170902   9.0000e-06 0.999993
beta5     0.000001     0.084284   1.6000e-05 0.999988
beta6     0.000002     0.300719   5.0000e-06 0.999996
beta7     0.000002     0.151493   1.5000e-05 0.999988
beta8     0.270339     0.132938   2.0336e+00 0.041995

Robust Standard Errors:
          Estimate   Std. Error      t value Pr(>|t|)
mu       -0.000195     0.000093  -2.1040e+00 0.035376
ar1       0.972687     0.017214   5.6504e+01 0.000000
ar2      -0.037593     0.024655  -1.5248e+00 0.127317
ar3       0.035710     0.017485   2.0423e+00 0.041122
ma1      -0.961273     0.000818  -1.1755e+03 0.000000
omega     0.000001     0.000001   1.4412e+00 0.149525
alpha1    0.159613     0.031257   5.1065e+00 0.000000
alpha2    0.063741     0.106596   5.9797e-01 0.549859
alpha3    0.045483     0.132049   3.4444e-01 0.730513
alpha4    0.088863     0.073345   1.2116e+00 0.225676
alpha5    0.000073     0.096884   7.5100e-04 0.999400
alpha6    0.003390     0.047019   7.2105e-02 0.942518
alpha7    0.000006     0.080295   7.0000e-05 0.999944
alpha8    0.000001     0.062258   1.4000e-05 0.999989
alpha9    0.000001     0.095752   8.0000e-06 0.999994
beta1     0.367418     0.633110   5.8034e-01 0.561687
beta2     0.000017     1.123195   1.5000e-05 0.999988
beta3     0.000004     0.601062   6.0000e-06 0.999995
```

```
beta4     0.000002     0.760008   2.0000e-06 0.999998
beta5     0.000001     0.911424   1.0000e-06 0.999999
beta6     0.000002     0.684123   2.0000e-06 0.999998
beta7     0.000002     0.255338   9.0000e-06 0.999993
beta8     0.270339     0.418948   6.4528e-01 0.518745

LogLikelihood : 18006.08

Information Criteria
------------------------------------

Akaike       -7.5639
Bayes        -7.5326
Shibata      -7.5639
Hannan-Quinn -7.5529


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(9,9)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm
```

```
Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000179   0.000062 -2.8870e+00 0.003890
ar1    -0.981693   0.001037 -9.4706e+02 0.000000
ar2    -0.012075   0.010869 -1.1109e+00 0.266605
ar3    -0.022729   0.014645 -1.5519e+00 0.120675
ma1     0.996625   0.000024  4.2113e+04 0.000000
omega   0.000001   0.000000  3.0092e+00 0.002619
alpha1  0.157209   0.018906  8.3154e+00 0.000000
alpha2  0.101253   0.042840  2.3635e+00 0.018103
alpha3  0.083413   0.062932  1.3254e+00 0.185026
alpha4  0.111081   0.016301  6.8146e+00 0.000000
alpha5  0.024502   0.036394  6.7324e-01 0.500795
alpha6  0.018106   0.010807  1.6754e+00 0.093858
alpha7  0.007987   0.024541  3.2545e-01 0.744841
alpha8  0.000000   0.031471  0.0000e+00 1.000000
alpha9  0.000000   0.020532  2.0000e-06 0.999998
beta1   0.126820   0.293505  4.3209e-01 0.665677
beta2   0.000001   0.488718  1.0000e-06 0.999999
beta3   0.000000   0.159131  1.0000e-06 0.999999
beta4   0.000000   0.213238  0.0000e+00 1.000000
beta5   0.000000   0.211887  0.0000e+00 1.000000
beta6   0.000000   0.106608  1.0000e-06 1.000000
beta7   0.000000   0.195384  0.0000e+00 1.000000
```

```
beta8    0.200266    0.167459   1.1959e+00 0.231733
beta9    0.168361    0.087651   1.9208e+00 0.054756

Robust Standard Errors:
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000179    0.000072 -2.4836e+00 0.013006
ar1     -0.981693    0.015794 -6.2156e+01 0.000000
ar2     -0.012075    0.033141 -3.6434e-01 0.715601
ar3     -0.022729    0.021109 -1.0767e+00 0.281612
ma1      0.996625    0.000055  1.8033e+04 0.000000
omega    0.000001    0.000002  8.3565e-01 0.403352
alpha1   0.157209    0.029281  5.3690e+00 0.000000
alpha2   0.101253    0.131634  7.6920e-01 0.441772
alpha3   0.083413    0.224911  3.7087e-01 0.710736
alpha4   0.111081    0.142651  7.7869e-01 0.436164
alpha5   0.024502    0.098016  2.4998e-01 0.802601
alpha6   0.018106    0.090995  1.9898e-01 0.842280
alpha7   0.007987    0.083457  9.5700e-02 0.923759
alpha8   0.000000    0.115778  0.0000e+00 1.000000
alpha9   0.000000    0.056638  1.0000e-06 0.999999
beta1    0.126820    0.786153  1.6132e-01 0.871843
beta2    0.000001    1.521499  0.0000e+00 1.000000
beta3    0.000000    0.317208  1.0000e-06 1.000000
beta4    0.000000    0.783448  0.0000e+00 1.000000
beta5    0.000000    0.326584  0.0000e+00 1.000000
beta6    0.000000    0.645683  0.0000e+00 1.000000
```

```
beta7    0.000000     0.527961   0.0000e+00  1.000000
beta8    0.200266     0.567453   3.5292e-01  0.724148
beta9    0.168361     0.316469   5.3200e-01  0.594728

LogLikelihood : 18008.3

Information Criteria
------------------------------------

Akaike        -7.5644
Bayes         -7.5317
Shibata       -7.5644
Hannan-Quinn  -7.5529



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model       : sGARCH(9,10)
Mean Model        : ARFIMA(3,0,1)
Distribution      : norm

Optimal Parameters
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000176	0.000062	−2.8408e+00	0.004501
ar1	−0.982610	0.002789	−3.5229e+02	0.000000
ar2	−0.012985	0.012047	−1.0779e+00	0.281081
ar3	−0.022720	0.014776	−1.5376e+00	0.124149
ma1	0.996657	0.000023	4.3468e+04	0.000000
omega	0.000001	0.000001	2.8607e+00	0.004227
alpha1	0.163906	0.019933	8.2227e+00	0.000000
alpha2	0.127565	0.025458	5.0109e+00	0.000001
alpha3	0.091960	0.005393	1.7051e+01	0.000000
alpha4	0.118275	0.025490	4.6401e+00	0.000003
alpha5	0.039343	0.011789	3.3373e+00	0.000846
alpha6	0.022613	0.019055	1.1867e+00	0.235336
alpha7	0.013675	0.016054	8.5184e−01	0.394305
alpha8	0.000000	0.028246	0.0000e+00	1.000000
alpha9	0.000000	0.013398	5.0000e−06	0.999996
beta1	0.000002	0.195629	9.0000e−06	0.999993
beta2	0.000000	0.086374	5.0000e−06	0.999996
beta3	0.000000	0.194530	1.0000e−06	0.999999
beta4	0.000000	0.245449	0.0000e+00	1.000000
beta5	0.000000	0.086225	1.0000e−06	0.999999
beta6	0.000000	0.189937	0.0000e+00	1.000000
beta7	0.000000	0.129414	1.0000e−06	1.000000
beta8	0.201466	0.044511	4.5262e+00	0.000006
beta9	0.115697	0.046450	2.4908e+00	0.012747

```
beta10   0.103714    0.019397   5.3469e+00 0.000000


Robust Standard Errors:
         Estimate   Std. Error      t value  Pr(>|t|)
mu      -0.000176     0.000074  -2.3818e+00  0.01723
ar1     -0.982610     0.008939  -1.0993e+02  0.00000
ar2     -0.012985     0.023623  -5.4970e-01  0.58252
ar3     -0.022720     0.019086  -1.1904e+00  0.23389
ma1      0.996657     0.000044   2.2453e+04  0.00000
omega    0.000001     0.000002   9.5241e-01  0.34089
alpha1   0.163906     0.030012   5.4613e+00  0.00000
alpha2   0.127565     0.111551   1.1436e+00  0.25281
alpha3   0.091960     0.109487   8.3991e-01  0.40096
alpha4   0.118275     0.121816   9.7093e-01  0.33158
alpha5   0.039343     0.057401   6.8541e-01  0.49308
alpha6   0.022613     0.083906   2.6951e-01  0.78754
alpha7   0.013675     0.079329   1.7238e-01  0.86314
alpha8   0.000000     0.054872   0.0000e+00  1.00000
alpha9   0.000000     0.025767   3.0000e-06  1.00000
beta1    0.000002     0.611931   3.0000e-06  1.00000
beta2    0.000000     0.587603   1.0000e-06  1.00000
beta3    0.000000     0.507940   0.0000e+00  1.00000
beta4    0.000000     0.713354   0.0000e+00  1.00000
beta5    0.000000     0.644747   0.0000e+00  1.00000
beta6    0.000000     0.470244   0.0000e+00  1.00000
beta7    0.000000     0.198388   0.0000e+00  1.00000
```

```
beta8    0.201466    0.420163   4.7950e-01   0.63159
beta9    0.115697    0.166317   6.9564e-01   0.48665
beta10   0.103714    0.208029   4.9855e-01   0.61809

LogLikelihood : 18009.11

Information Criteria
------------------------------------

Akaike        -7.5643
Bayes         -7.5303
Shibata       -7.5643
Hannan-Quinn  -7.5523



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(10,1)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000210	0.000078	−2.6903e+00	0.007139
ar1	0.974942	0.015733	6.1966e+01	0.000000
ar2	−0.040066	0.022071	−1.8153e+00	0.069478
ar3	0.031853	0.015578	2.0448e+00	0.040877
ma1	−0.959903	0.000943	−1.0182e+03	0.000000
omega	0.000000	0.000000	1.9454e+00	0.051725
alpha1	0.123268	0.015548	7.9281e+00	0.000000
alpha2	0.000027	0.018165	1.4700e−03	0.998827
alpha3	0.000017	0.025101	6.7100e−04	0.999464
alpha4	0.000015	0.026326	5.8700e−04	0.999531
alpha5	0.000012	0.026987	4.2700e−04	0.999659
alpha6	0.000012	0.028099	4.2000e−04	0.999665
alpha7	0.000014	0.026499	5.2200e−04	0.999583
alpha8	0.000017	0.026891	6.3500e−04	0.999493
alpha9	0.000041	0.023191	1.7640e−03	0.998592
alpha10	0.000089	0.015871	5.6230e−03	0.995514
beta1	0.874331	0.010155	8.6095e+01	0.000000

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000210	0.000086	−2.453713	0.014139
ar1	0.974942	0.017391	56.061562	0.000000
ar2	−0.040066	0.025264	−1.585920	0.112757
ar3	0.031853	0.017622	1.807591	0.070670

ma1	−0.959903	0.001363	−704.068359	0.000000
omega	0.000000	0.000001	0.299463	0.764587
alpha1	0.123268	0.025152	4.900878	0.000001
alpha2	0.000027	0.026072	0.001024	0.999183
alpha3	0.000017	0.041622	0.000405	0.999677
alpha4	0.000015	0.028956	0.000534	0.999574
alpha5	0.000012	0.040186	0.000287	0.999771
alpha6	0.000012	0.041846	0.000282	0.999775
alpha7	0.000014	0.043352	0.000319	0.999745
alpha8	0.000017	0.038579	0.000443	0.999647
alpha9	0.000041	0.036597	0.001118	0.999108
alpha10	0.000089	0.038458	0.002320	0.998149
beta1	0.874331	0.122641	7.129188	0.000000

LogLikelihood : 17979.41

Information Criteria

Akaike	−7.5552
Bayes	−7.5320
Shibata	−7.5552
Hannan−Quinn	−7.5470

——————————————————

```
*               GARCH Model Fit           *
*-----------------------------------------*

Conditional Variance Dynamics
-----------------------------------------
GARCH Model     : sGARCH(10,2)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
-----------------------------------------
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000199    0.000064 -3.1247e+00 0.001780
ar1      -0.979947    0.005568 -1.7598e+02 0.000000
ar2      -0.009514    0.014902 -6.3845e-01 0.523182
ar3      -0.021542    0.015073 -1.4291e+00 0.152966
ma1       0.996054    0.000017  5.8959e+04 0.000000
omega     0.000000    0.000000  3.8652e+00 0.000111
alpha1    0.149695    0.022455  6.6665e+00 0.000000
alpha2    0.000013    0.032737  4.1200e-04 0.999672
alpha3    0.000003    0.028607  9.9000e-05 0.999921
alpha4    0.000003    0.022623  1.3000e-04 0.999896
alpha5    0.000002    0.024845  7.1000e-05 0.999943
alpha6    0.000002    0.024417  7.1000e-05 0.999943
alpha7    0.000002    0.022722  9.2000e-05 0.999926
alpha8    0.000002    0.024742  8.5000e-05 0.999932
```

alpha9	0.000006	0.022539	2.4500e−04	0.999805
alpha10	0.000006	0.022457	2.6600e−04	0.999788
beta1	0.614480	0.120734	5.0895e+00	0.000000
beta2	0.233411	0.132880	1.7566e+00	0.078993

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000199	0.000082	−2.4364e+00	0.014833
ar1	−0.979947	0.021820	−4.4911e+01	0.000000
ar2	−0.009514	0.037654	−2.5268e−01	0.800516
ar3	−0.021542	0.019940	−1.0803e+00	0.280002
ma1	0.996054	0.000055	1.7993e+04	0.000000
omega	0.000000	0.000001	6.8855e−01	0.491108
alpha1	0.149695	0.083949	1.7832e+00	0.074560
alpha2	0.000013	0.244045	5.5000e−05	0.999956
alpha3	0.000003	0.116371	2.4000e−05	0.999981
alpha4	0.000003	0.046932	6.3000e−05	0.999950
alpha5	0.000002	0.053608	3.3000e−05	0.999974
alpha6	0.000002	0.049996	3.5000e−05	0.999972
alpha7	0.000002	0.059924	3.5000e−05	0.999972
alpha8	0.000002	0.039829	5.3000e−05	0.999958
alpha9	0.000006	0.037208	1.4800e−04	0.999882
alpha10	0.000006	0.080823	7.4000e−05	0.999941
beta1	0.614480	1.210030	5.0782e−01	0.611578
beta2	0.233411	1.141712	2.0444e−01	0.838010

```
LogLikelihood : 17984.19

Information Criteria
------------------------------------

Akaike       -7.5568
Bayes        -7.5323
Shibata      -7.5568
Hannan-Quinn -7.5482



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(10,3)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000205    0.000080 -2.572706 0.010091
ar1     0.971890    0.016258 59.780365 0.000000
```

```
ar2      -0.036380   0.022313    -1.630433 0.103010
ar3       0.032672   0.015516     2.105699 0.035230
ma1      -0.960594   0.001112  -864.218396 0.000000
omega     0.000000   0.000000     3.091323 0.001993
alpha1    0.167445   0.023261     7.198383 0.000000
alpha2    0.000000   0.026985     0.000016 0.999988
alpha3    0.000000   0.026725     0.000002 0.999998
alpha4    0.000000   0.021842     0.000001 0.999999
alpha5    0.000000   0.023641     0.000000 1.000000
alpha6    0.000000   0.023743     0.000000 1.000000
alpha7    0.000000   0.020889     0.000000 1.000000
alpha8    0.000000   0.015887     0.000000 1.000000
alpha9    0.000000   0.022080     0.000001 0.999999
alpha10   0.000000   0.030039     0.000000 1.000000
beta1     0.612497   0.115460     5.304824 0.000000
beta2     0.000002   0.229965     0.000010 0.999992
beta3     0.218144   0.087278     2.499406 0.012440

Robust Standard Errors:
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000205   0.000088    -2.340555 0.019255
ar1       0.971890   0.019611    49.559400 0.000000
ar2      -0.036380   0.026851    -1.354867 0.175460
ar3       0.032672   0.018419     1.773873 0.076084
ma1      -0.960594   0.003728  -257.662183 0.000000
omega     0.000000   0.000001     0.530281 0.595917
```

```
alpha1    0.167445   0.073229   2.286602  0.022219
alpha2    0.000000   0.218502   0.000002  0.999998
alpha3    0.000000   0.048932   0.000001  0.999999
alpha4    0.000000   0.046141   0.000000  1.000000
alpha5    0.000000   0.036946   0.000000  1.000000
alpha6    0.000000   0.062420   0.000000  1.000000
alpha7    0.000000   0.027817   0.000000  1.000000
alpha8    0.000000   0.037530   0.000000  1.000000
alpha9    0.000000   0.076491   0.000000  1.000000
alpha10   0.000000   0.152585   0.000000  1.000000
beta1     0.612497   1.307961   0.468283  0.639582
beta2     0.000002   0.660069   0.000004  0.999997
beta3     0.218144   0.672916   0.324177  0.745804

LogLikelihood : 17985.97

Information Criteria
------------------------------------

Akaike        -7.5571
Bayes         -7.5312
Shibata       -7.5571
Hannan-Quinn  -7.5480


*---------------------------------*
```

```
*              GARCH Model Fit          *
*---------------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(10,4)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000195    0.000063 -3.0810e+00 0.002063
ar1     -0.981840    0.005764 -1.7034e+02 0.000000
ar2     -0.011767    0.015199 -7.7424e-01 0.438791
ar3     -0.022054    0.015285 -1.4429e+00 0.149051
ma1      0.996206    0.000016  6.0989e+04 0.000000
omega    0.000000    0.000000  5.2047e+00 0.000000
alpha1   0.167157    0.020784  8.0424e+00 0.000000
alpha2   0.000003    0.023229  1.1600e-04 0.999907
alpha3   0.000000    0.018695  2.2000e-05 0.999982
alpha4   0.000000    0.017485  1.3000e-05 0.999989
alpha5   0.000000    0.023318  4.0000e-06 0.999997
alpha6   0.000000    0.018879  4.0000e-06 0.999997
alpha7   0.000000    0.019283  4.0000e-06 0.999997
alpha8   0.000000    0.023382  3.0000e-06 0.999997
```

```
alpha9    0.000000    0.017353  9.0000e-06 0.999993
alpha10   0.000000    0.023091  6.0000e-06 0.999995
beta1     0.644739    0.069146  9.3243e+00 0.000000
beta2     0.000026    0.060339  4.3100e-04 0.999656
beta3     0.123442    0.210681  5.8592e-01 0.557929
beta4     0.062853    0.127785  4.9186e-01 0.622818

Robust Standard Errors:
           Estimate  Std. Error    t value Pr(>|t|)
mu        -0.000195    0.000075 -2.6089e+00 0.009084
ar1       -0.981840    0.016982 -5.7817e+01 0.000000
ar2       -0.011767    0.031789 -3.7017e-01 0.711254
ar3       -0.022054    0.019279 -1.1439e+00 0.252646
ma1        0.996206    0.000039  2.5849e+04 0.000000
omega      0.000000    0.000000  9.8228e-01 0.325959
alpha1     0.167157    0.052470  3.1858e+00 0.001444
alpha2     0.000003    0.093445  2.9000e-05 0.999977
alpha3     0.000000    0.047055  9.0000e-06 0.999993
alpha4     0.000000    0.062045  4.0000e-06 0.999997
alpha5     0.000000    0.030994  3.0000e-06 0.999998
alpha6     0.000000    0.032477  2.0000e-06 0.999998
alpha7     0.000000    0.034033  2.0000e-06 0.999998
alpha8     0.000000    0.040814  2.0000e-06 0.999998
alpha9     0.000000    0.021152  7.0000e-06 0.999994
alpha10    0.000000    0.086975  2.0000e-06 0.999999
beta1      0.644739    0.517404  1.2461e+00 0.212727
```

```
beta2     0.000026     0.039472   6.5900e-04  0.999474
beta3     0.123442     0.296962   4.1568e-01  0.677641
beta4     0.062853     0.364192   1.7258e-01  0.862981

LogLikelihood : 17987.72

Information Criteria
------------------------------------

Akaike       -7.5574
Bayes        -7.5302
Shibata      -7.5574
Hannan-Quinn -7.5478



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(10,5)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
```

```
           Estimate   Std. Error     t value  Pr(>|t|)
mu        -0.000212    0.000081    -2.626945  0.008616
ar1        0.970536    0.016160    60.058954  0.000000
ar2       -0.036566    0.022312    -1.638867  0.101241
ar3        0.034303    0.015658     2.190842  0.028463
ma1       -0.960046    0.001056  -909.365800  0.000000
omega      0.000000    0.000000     4.342423  0.000014
alpha1     0.166083    0.016136    10.292864  0.000000
alpha2     0.000006    0.024848     0.000238  0.999810
alpha3     0.000003    0.043024     0.000073  0.999942
alpha4     0.000005    0.031589     0.000143  0.999886
alpha5     0.000001    0.017232     0.000040  0.999968
alpha6     0.000000    0.010099     0.000049  0.999961
alpha7     0.000000    0.010139     0.000044  0.999965
alpha8     0.000000    0.011605     0.000036  0.999971
alpha9     0.000001    0.016444     0.000041  0.999967
alpha10    0.000001    0.018726     0.000035  0.999972
beta1      0.714663    0.108639     6.578331  0.000000
beta2      0.002562    0.311264     0.008231  0.993433
beta3      0.000380    0.379593     0.001001  0.999201
beta4      0.000011    0.265060     0.000040  0.999968
beta5      0.114844    0.061882     1.855841  0.063476

Robust Standard Errors:
           Estimate   Std. Error     t value  Pr(>|t|)
```

mu	−0.000212	0.000090	−2.365345	0.018013
ar1	0.970536	0.017268	56.203481	0.000000
ar2	−0.036566	0.025208	−1.450546	0.146906
ar3	0.034303	0.017784	1.928845	0.053750
ma1	−0.960046	0.002496	−384.644520	0.000000
omega	0.000000	0.000001	0.792618	0.428000
alpha1	0.166083	0.040024	4.149554	0.000033
alpha2	0.000006	0.153690	0.000038	0.999969
alpha3	0.000003	0.099133	0.000032	0.999975
alpha4	0.000005	0.079350	0.000057	0.999954
alpha5	0.000001	0.108872	0.000006	0.999995
alpha6	0.000000	0.034962	0.000014	0.999989
alpha7	0.000000	0.032928	0.000014	0.999989
alpha8	0.000000	0.064364	0.000007	0.999995
alpha9	0.000001	0.029588	0.000023	0.999982
alpha10	0.000001	0.079482	0.000008	0.999993
beta1	0.714663	0.803599	0.889328	0.373827
beta2	0.002562	0.738229	0.003470	0.997231
beta3	0.000380	0.897588	0.000423	0.999662
beta4	0.000011	1.104236	0.000010	0.999992
beta5	0.114844	0.802664	0.143079	0.886228

LogLikelihood : 17988.71

Information Criteria

```
Akaike        -7.5574
Bayes         -7.5288
Shibata       -7.5574
Hannan-Quinn  -7.5474


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(10,6)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000213    0.000081   -2.623029 0.008715
ar1      0.969936    0.016191   59.906759 0.000000
ar2     -0.036451    0.022405   -1.626926 0.103753
ar3      0.034340    0.015692    2.188358 0.028644
ma1     -0.959368    0.001029 -932.218288 0.000000
omega    0.000000    0.000000    4.284707 0.000018
```

```
alpha1    0.164430    0.020199      8.140347  0.000000
alpha2    0.000009    0.009252      0.000999  0.999203
alpha3    0.000005    0.015802      0.000297  0.999763
alpha4    0.000008    0.016901      0.000496  0.999604
alpha5    0.000001    0.013262      0.000064  0.999949
alpha6    0.000001    0.017272      0.000036  0.999971
alpha7    0.000000    0.018572      0.000024  0.999981
alpha8    0.000000    0.018377      0.000023  0.999981
alpha9    0.000001    0.015087      0.000049  0.999961
alpha10   0.000001    0.013250      0.000058  0.999954
beta1     0.742910    0.108822      6.826803  0.000000
beta2     0.000223    0.191885      0.001164  0.999072
beta3     0.000010    0.222560      0.000046  0.999964
beta4     0.000006    0.247506      0.000025  0.999980
beta5     0.000011    0.238657      0.000046  0.999964
beta6     0.091344    0.071736      1.273335  0.202899

Robust Standard Errors:
          Estimate  Std. Error       t value  Pr(>|t|)
mu       -0.000213    0.000088   -2.4268e+00  0.015232
ar1       0.969936    0.017456    5.5564e+01  0.000000
ar2      -0.036451    0.025224   -1.4451e+00  0.148434
ar3       0.034340    0.017457    1.9671e+00  0.049172
ma1      -0.959368    0.000840   -1.1427e+03  0.000000
omega     0.000000    0.000000    1.9431e+00  0.052004
alpha1    0.164430    0.033347    4.9308e+00  0.000001
```

```
alpha2   0.000009   0.065005  1.4200e-04  0.999887
alpha3   0.000005   0.051600  9.1000e-05  0.999928
alpha4   0.000008   0.042477  1.9700e-04  0.999842
alpha5   0.000001   0.053468  1.6000e-05  0.999987
alpha6   0.000001   0.068200  9.0000e-06  0.999993
alpha7   0.000000   0.035507  1.3000e-05  0.999990
alpha8   0.000000   0.029911  1.4000e-05  0.999989
alpha9   0.000001   0.022876  3.2000e-05  0.999974
alpha10  0.000001   0.024813  3.1000e-05  0.999975
beta1    0.742910   0.344061  2.1592e+00  0.030832
beta2    0.000223   0.176532  1.2650e-03  0.998991
beta3    0.000010   0.307268  3.3000e-05  0.999974
beta4    0.000006   0.287158  2.2000e-05  0.999983
beta5    0.000011   0.377223  2.9000e-05  0.999977
beta6    0.091344   0.346661  2.6349e-01  0.792169

LogLikelihood : 17990.58

Information Criteria
------------------------------------

Akaike        -7.5578
Bayes         -7.5278
Shibata       -7.5578
Hannan-Quinn  -7.5473
```

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(10,7)
Mean Model      : ARFIMA(3,0,1)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error     t value Pr(>|t|)
mu     -0.000193    0.000063 -3.0731e+00 0.002118
ar1    -0.981619    0.004364 -2.2492e+02 0.000000
ar2    -0.011365    0.013800 -8.2359e-01 0.410172
ar3    -0.021929    0.015223 -1.4406e+00 0.149699
ma1     0.996347    0.000019  5.3470e+04 0.000000
omega   0.000001    0.000000  4.0021e+00 0.000063
alpha1  0.158700    0.019548  8.1185e+00 0.000000
alpha2  0.022207    0.018700  1.1875e+00 0.235020
alpha3  0.000034    0.033008  1.0180e-03 0.999188
alpha4  0.037515    0.023322  1.6086e+00 0.107709
alpha5  0.000002    0.011674  1.4500e-04 0.999885
alpha6  0.000001    0.038448  2.6000e-05 0.999979
```

```
alpha7    0.000001    0.034993   1.9000e-05 0.999985
alpha8    0.000000    0.010868   3.5000e-05 0.999972
alpha9    0.000001    0.019562   3.9000e-05 0.999969
alpha10   0.000001    0.015950   5.2000e-05 0.999959
beta1     0.641538    0.186687   3.4364e+00 0.000589
beta2     0.000015    0.362020   4.2000e-05 0.999966
beta3     0.000006    0.314510   1.8000e-05 0.999986
beta4     0.000003    0.246180   1.1000e-05 0.999991
beta5     0.000003    0.244521   1.0000e-05 0.999992
beta6     0.000004    0.265728   1.4000e-05 0.999989
beta7     0.137722    0.129854   1.0606e+00 0.288876

Robust Standard Errors:
          Estimate  Std. Error      t value Pr(>|t|)
mu       -0.000193    0.000072  -2.6863e+00 0.007226
ar1      -0.981619    0.007344  -1.3366e+02 0.000000
ar2      -0.011365    0.018151  -6.2615e-01 0.531217
ar3      -0.021929    0.017029  -1.2877e+00 0.197835
ma1       0.996347    0.000018   5.4935e+04 0.000000
omega     0.000001    0.000000   1.6709e+00 0.094745
alpha1    0.158700    0.032030   4.9547e+00 0.000001
alpha2    0.022207    0.081071   2.7392e-01 0.784148
alpha3    0.000034    0.082275   4.0800e-04 0.999674
alpha4    0.037515    0.049208   7.6237e-01 0.445841
alpha5    0.000002    0.063073   2.7000e-05 0.999979
alpha6    0.000001    0.079918   1.2000e-05 0.999990
```

```
alpha7    0.000001    0.063902  1.1000e-05  0.999992
alpha8    0.000000    0.032611  1.2000e-05  0.999991
alpha9    0.000001    0.030436  2.5000e-05  0.999980
alpha10   0.000001    0.027667  3.0000e-05  0.999976
beta1     0.641538    0.474927  1.3508e+00  0.176754
beta2     0.000015    0.568019  2.7000e-05  0.999979
beta3     0.000006    0.616440  9.0000e-06  0.999993
beta4     0.000003    0.425354  6.0000e-06  0.999995
beta5     0.000003    0.335137  8.0000e-06  0.999994
beta6     0.000004    0.469585  8.0000e-06  0.999994
beta7     0.137722    0.211180  6.5215e-01  0.514302

LogLikelihood : 17995.62

Information Criteria
------------------------------------

Akaike       -7.5595
Bayes        -7.5282
Shibata      -7.5595
Hannan-Quinn -7.5485


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(10,8)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error     t value Pr(>|t|)
mu      -0.000180    0.000062 -2.9074e+00 0.003645
ar1     -0.980908    0.006961 -1.4092e+02 0.000000
ar2     -0.010600    0.015523 -6.8286e-01 0.494696
ar3     -0.022009    0.015175 -1.4504e+00 0.146956
ma1      0.996591    0.000018  5.4057e+04 0.000000
omega    0.000001    0.000000  5.7783e+00 0.000000
alpha1   0.155955    0.018575  8.3959e+00 0.000000
alpha2   0.063845    0.016606  3.8448e+00 0.000121
alpha3   0.046933    0.033241  1.4119e+00 0.157980
alpha4   0.095503    0.025803  3.7013e+00 0.000215
alpha5   0.000001    0.040033  2.5000e-05 0.999980
alpha6   0.005407    0.040071  1.3494e-01 0.892658
alpha7   0.000000    0.010442  1.3000e-05 0.999990
alpha8   0.000000    0.016805  0.0000e+00 1.000000
alpha9   0.000000    0.018078  0.0000e+00 1.000000
alpha10  0.000000    0.036206  0.0000e+00 1.000000
```

```
beta1      0.358564    0.208665   1.7184e+00 0.085729
beta2      0.000000    0.400165   1.0000e-06 0.999999
beta3      0.000000    0.184390   1.0000e-06 1.000000
beta4      0.000000    0.077847   1.0000e-06 1.000000
beta5      0.000000    0.213772   0.0000e+00 1.000000
beta6      0.000000    0.069072   1.0000e-06 1.000000
beta7      0.000000    0.131511   0.0000e+00 1.000000
beta8      0.272789    0.123956   2.2007e+00 0.027757

Robust Standard Errors:
           Estimate  Std. Error      t value Pr(>|t|)
mu        -0.000180    0.000073  -2.4584e+00 0.013957
ar1       -0.980908    0.034646  -2.8312e+01 0.000000
ar2       -0.010600    0.054259  -1.9536e-01 0.845114
ar3       -0.022009    0.023387  -9.4111e-01 0.346649
ma1        0.996591    0.000062   1.6058e+04 0.000000
omega      0.000001    0.000002   5.9106e-01 0.554482
alpha1     0.155955    0.045790   3.4059e+00 0.000660
alpha2     0.063845    0.076958   8.2961e-01 0.406761
alpha3     0.046933    0.158291   2.9650e-01 0.766848
alpha4     0.095503    0.123171   7.7537e-01 0.438123
alpha5     0.000001    0.228554   4.0000e-06 0.999996
alpha6     0.005407    0.100824   5.3630e-02 0.957230
alpha7     0.000000    0.151920   1.0000e-06 0.999999
alpha8     0.000000    0.119881   0.0000e+00 1.000000
alpha9     0.000000    0.136592   0.0000e+00 1.000000
```

```
alpha10   0.000000    0.150357   0.0000e+00  1.000000
beta1     0.358564    0.695051   5.1588e-01  0.605937
beta2     0.000000    1.070696   0.0000e+00  1.000000
beta3     0.000000    0.615796   0.0000e+00  1.000000
beta4     0.000000    0.512059   0.0000e+00  1.000000
beta5     0.000000    0.681976   0.0000e+00  1.000000
beta6     0.000000    1.241920   0.0000e+00  1.000000
beta7     0.000000    0.271330   0.0000e+00  1.000000
beta8     0.272789    0.432498   6.3073e-01  0.528218

LogLikelihood : 18007.08

Information Criteria
------------------------------------

Akaike        -7.5639
Bayes         -7.5312
Shibata       -7.5639
Hannan-Quinn  -7.5524


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model      : sGARCH(10,9)
Mean Model       : ARFIMA(3,0,1)
Distribution     : norm

Optimal Parameters

           Estimate  Std. Error     t value Pr(>|t|)
mu        -0.000179    0.000062 -2.8831e+00 0.003938
ar1       -0.981789    0.005391 -1.8211e+02 0.000000
ar2       -0.012230    0.014101 -8.6730e-01 0.385777
ar3       -0.022789    0.015000 -1.5192e+00 0.128705
ma1        0.996627    0.000020  5.0205e+04 0.000000
omega      0.000001    0.000000  3.0796e+00 0.002073
alpha1     0.157755    0.019572  8.0603e+00 0.000000
alpha2     0.099678    0.017852  5.5835e+00 0.000000
alpha3     0.081736    0.044769  1.8257e+00 0.067892
alpha4     0.109197    0.031056  3.5161e+00 0.000438
alpha5     0.022770    0.034167  6.6642e-01 0.505142
alpha6     0.017590    0.020107  8.7483e-01 0.381668
alpha7     0.007599    0.029261  2.5970e-01 0.795094
alpha8     0.000000    0.021091  1.0000e-06 0.999999
alpha9     0.000000    0.022624  4.0000e-06 0.999997
alpha10    0.000000    0.025769  1.0000e-06 0.999999
beta1      0.139545    0.126803  1.1005e+00 0.271119
beta2      0.000001    0.282725  3.0000e-06 0.999997
```

```
beta3     0.000000    0.129914   2.0000e-06 0.999999
beta4     0.000000    0.062643   2.0000e-06 0.999999
beta5     0.000000    0.188704   1.0000e-06 1.000000
beta6     0.000000    0.202708   0.0000e+00 1.000000
beta7     0.000000    0.144107   1.0000e-06 0.999999
beta8     0.196107    0.097765   2.0059e+00 0.044868
beta9     0.167018    0.064902   2.5734e+00 0.010071

Robust Standard Errors:
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000179    0.000072 -2.4818e+00 0.013074
ar1      -0.981789    0.016679 -5.8865e+01 0.000000
ar2      -0.012230    0.032964 -3.7101e-01 0.710630
ar3      -0.022789    0.020648 -1.1037e+00 0.269720
ma1       0.996627    0.000046  2.1739e+04 0.000000
omega     0.000001    0.000001  9.6596e-01 0.334062
alpha1    0.157755    0.030430  5.1842e+00 0.000000
alpha2    0.099678    0.058712  1.6977e+00 0.089556
alpha3    0.081736    0.188142  4.3444e-01 0.663971
alpha4    0.109197    0.097537  1.1195e+00 0.262906
alpha5    0.022770    0.117713  1.9344e-01 0.846618
alpha6    0.017590    0.090230  1.9494e-01 0.845436
alpha7    0.007599    0.063258  1.2013e-01 0.904381
alpha8    0.000000    0.106530  0.0000e+00 1.000000
alpha9    0.000000    0.072923  1.0000e-06 0.999999
alpha10   0.000000    0.084137  0.0000e+00 1.000000
```

```
beta1     0.139545    0.358483   3.8927e-01  0.697079
beta2     0.000001    0.980314   1.0000e-06  0.999999
beta3     0.000000    0.418049   1.0000e-06  1.000000
beta4     0.000000    0.515654   0.0000e+00  1.000000
beta5     0.000000    0.329952   0.0000e+00  1.000000
beta6     0.000000    0.545931   0.0000e+00  1.000000
beta7     0.000000    0.328239   0.0000e+00  1.000000
beta8     0.196107    0.458272   4.2793e-01  0.668704
beta9     0.167018    0.245079   6.8149e-01  0.495564

LogLikelihood : 18008.25

Information Criteria
------------------------------------

Akaike       -7.5639
Bayes        -7.5299
Shibata      -7.5640
Hannan-Quinn -7.5520


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
```

```
GARCH Model    : sGARCH(10,10)
Mean Model     : ARFIMA(3,0,1)
Distribution   : norm

Optimal Parameters

          Estimate  Std. Error     t value  Pr(>|t|)
mu       -0.000176    0.000062 -2.8577e+00  0.004268
ar1      -0.982617    0.003877 -2.5348e+02  0.000000
ar2      -0.012999    0.010453 -1.2436e+00  0.213643
ar3      -0.022727    0.014699 -1.5462e+00  0.122066
ma1       0.996657    0.000023  4.3493e+04  0.000000
omega     0.000001    0.000001  1.4507e+00  0.146858
alpha1    0.163907    0.016133  1.0159e+01  0.000000
alpha2    0.127567    0.027204  4.6893e+00  0.000003
alpha3    0.091957    0.069103  1.3307e+00  0.183282
alpha4    0.118278    0.107574  1.0995e+00  0.271550
alpha5    0.039345    0.007656  5.1394e+00  0.000000
alpha6    0.022614    0.061216  3.6941e-01  0.711819
alpha7    0.013674    0.021220  6.4438e-01  0.519328
alpha8    0.000000    0.008137  0.0000e+00  1.000000
alpha9    0.000000    0.076718  1.0000e-06  1.000000
alpha10   0.000000    0.060472  0.0000e+00  1.000000
beta1     0.000001    0.213424  4.0000e-06  0.999997
beta2     0.000000    0.398304  0.0000e+00  1.000000
```

```
beta3     0.000000    0.188496   0.0000e+00 1.000000
beta4     0.000000    0.339285   0.0000e+00 1.000000
beta5     0.000000    0.441015   0.0000e+00 1.000000
beta6     0.000000    0.334988   0.0000e+00 1.000000
beta7     0.000000    0.286268   0.0000e+00 1.000000
beta8     0.201477    0.450233   4.4750e-01 0.654517
beta9     0.115659    0.137220   8.4288e-01 0.399298
beta10    0.103740    0.197833   5.2438e-01 0.600013

Robust Standard Errors:
          Estimate   Std. Error      t value Pr(>|t|)
mu       -0.000176    0.000093  -1.8988e+00 0.057593
ar1      -0.982617    0.034557  -2.8435e+01 0.000000
ar2      -0.012999    0.041818  -3.1086e-01 0.755910
ar3      -0.022727    0.018524  -1.2269e+00 0.219858
ma1       0.996657    0.000048   2.0685e+04 0.000000
omega     0.000001    0.000008   1.9172e-01 0.847963
alpha1    0.163907    0.083379   1.9658e+00 0.049321
alpha2    0.127567    0.117479   1.0859e+00 0.277538
alpha3    0.091957    0.569659   1.6142e-01 0.871759
alpha4    0.118278    0.869807   1.3598e-01 0.891836
alpha5    0.039345    0.115426   3.4087e-01 0.733201
alpha6    0.022614    0.394041   5.7390e-02 0.954234
alpha7    0.013674    0.159714   8.5615e-02 0.931773
alpha8    0.000000    0.208587   0.0000e+00 1.000000
alpha9    0.000000    0.584029   0.0000e+00 1.000000
```

```
alpha10   0.000000    0.456743   0.0000e+00  1.000000
beta1     0.000001    1.071846   1.0000e-06  0.999999
beta2     0.000000    2.708268   0.0000e+00  1.000000
beta3     0.000000    0.577291   0.0000e+00  1.000000
beta4     0.000000    2.332926   0.0000e+00  1.000000
beta5     0.000000    2.815911   0.0000e+00  1.000000
beta6     0.000000    2.879287   0.0000e+00  1.000000
beta7     0.000000    1.903102   0.0000e+00  1.000000
beta8     0.201477    3.598056   5.5996e-02  0.955345
beta9     0.115659    0.980651   1.1794e-01  0.906115
beta10    0.103740    1.376278   7.5377e-02  0.939915

LogLikelihood : 18009.11

Information Criteria
------------------------------------

Akaike        -7.5639
Bayes         -7.5285
Shibata       -7.5639
Hannan-Quinn  -7.5514
```

2. Resultados para la serie del euro

```
*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*
```

```
Conditional Variance Dynamics
----------------------------------------------------
GARCH Model     : sGARCH(1,1)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
----------------------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu      0.000000    0.000118  -0.000174 0.999861
ar1     0.005246    0.015156   0.346152 0.729229
omega   0.000001    0.000000   3.051846 0.002274
alpha1  0.058318    0.005703  10.226284 0.000000
beta1   0.930505    0.006368 146.121200 0.000000

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu      0.000000    0.000129 -0.000159 0.999873
ar1     0.005246    0.016564  0.316723 0.751454
omega   0.000001    0.000001  0.773931 0.438971
alpha1  0.058318    0.031860  1.830438 0.067184
beta1   0.930505    0.033232 28.000046 0.000000

LogLikelihood : 15789.54

Information Criteria
```

```
--------------------------------------------------

Akaike        -6.6391
Bayes         -6.6323
Shibata       -6.6391
Hannan-Quinn  -6.6367


*------------------------------------------------*
*             GARCH Model Fit                    *
*------------------------------------------------*

Conditional Variance Dynamics
--------------------------------------------------
GARCH Model       : sGARCH(1,2)
Mean Model        : ARFIMA(1,0,0)
Distribution      : norm

Optimal Parameters
--------------------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu      0.000000    0.000118  -0.00052 0.999585
ar1     0.004761    0.015281   0.31158 0.755362
omega   0.000001    0.000000   2.90077 0.003723
alpha1  0.067796    0.006997   9.68943 0.000000
beta1   0.707386    0.008545  82.78726 0.000000
```

```
beta2    0.212097    0.008982  23.61269  0.000000

Robust Standard Errors:
         Estimate  Std. Error   t value  Pr(>|t|)
mu       0.000000    0.000129 -0.000475  0.999621
ar1      0.004761    0.016669  0.285634  0.775158
omega    0.000001    0.000002  0.723425  0.469419
alpha1   0.067796    0.037797  1.793694  0.072862
beta1    0.707386    0.022918 30.865530  0.000000
beta2    0.212097    0.017093 12.408144  0.000000

LogLikelihood : 15790.18

Information Criteria
------------------------------------

Akaike       -6.6390
Bayes        -6.6308
Shibata      -6.6390
Hannan-Quinn -6.6361


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(1,3)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000118 -0.008589 0.993147
ar1       0.003379    0.015397  0.219452 0.826298
omega     0.000001    0.000001  2.372969 0.017646
alpha1    0.076797    0.009392  8.176886 0.000000
beta1     0.695080    0.045392 15.312822 0.000000
beta2     0.000035    0.117619  0.000295 0.999764
beta3     0.213743    0.053707  3.979787 0.000069

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000128 -0.007880  0.99371
ar1       0.003379    0.017211  0.196322  0.84436
omega     0.000001    0.000002  0.510926  0.60940
alpha1    0.076797    0.054019  1.421661  0.15513
beta1     0.695080    0.031979 21.735242  0.00000
beta2     0.000035    0.218015  0.000159  0.99987
beta3     0.213743    0.138611  1.542035  0.12306
```

```
LogLikelihood : 15791.79

Information Criteria
------------------------------------

Akaike       -6.6392
Bayes        -6.6297
Shibata      -6.6392
Hannan-Quinn -6.6359


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(1,4)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008672 0.993081
```

```
ar1        0.003220    0.015454   0.208380  0.834932
omega      0.000001    0.000000   2.926963  0.003423
alpha1     0.082482    0.008725   9.453988  0.000000
beta1      0.689039    0.149885   4.597126  0.000004
beta2      0.000010    0.289312   0.000033  0.999974
beta3      0.000019    0.057295   0.000328  0.999739
beta4      0.214027    0.110129   1.943427  0.051965

Robust Standard Errors:
            Estimate  Std. Error    t value  Pr(>|t|)
mu        −0.000001    0.000124  −0.008217  0.993444
ar1        0.003220    0.017010   0.189318  0.849844
omega      0.000001    0.000002   0.805243  0.420680
alpha1     0.082482    0.043000   1.918189  0.055087
beta1      0.689039    0.283547   2.430068  0.015096
beta2      0.000010    0.552152   0.000017  0.999986
beta3      0.000019    0.031901   0.000588  0.999531
beta4      0.214027    0.286523   0.746980  0.455076

LogLikelihood : 15793.06

Information Criteria
------------------------------------

Akaike        −6.6394
Bayes         −6.6285
```

```
Shibata       -6.6394
Hannan-Quinn  -6.6355


*---------------------------------*
*          GARCH Model Fit         *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(1,5)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu      0.000000    0.000118 -0.001059 0.999155
ar1     0.003465    0.015547  0.222862 0.823643
omega   0.000001    0.000000  3.949169 0.000078
alpha1  0.087059    0.008102 10.745835 0.000000
beta1   0.663366    0.125156  5.300291 0.000000
beta2   0.004573    0.265784  0.017207 0.986272
beta3   0.027948    0.371123  0.075308 0.939970
beta4   0.058194    0.380773  0.152832 0.878531
beta5   0.143651    0.166784  0.861300 0.389073
```

```
Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu      0.000000    0.000124 -0.001011 0.999193
ar1     0.003465    0.016778  0.206510 0.836393
omega   0.000001    0.000001  1.516556 0.129379
alpha1  0.087059    0.033909  2.567404 0.010246
beta1   0.663366    0.281418  2.357225 0.018412
beta2   0.004573    0.314281  0.014552 0.988390
beta3   0.027948    0.623854  0.044800 0.964267
beta4   0.058194    0.678487  0.085771 0.931649
beta5   0.143651    0.323132  0.444559 0.656639

LogLikelihood : 15793.43

Information Criteria
------------------------------------

Akaike       -6.6391
Bayes        -6.6268
Shibata      -6.6391
Hannan-Quinn -6.6348


*---------------------------------*
*          GARCH Model Fit        *
```

```
*------------------------------------*

Conditional Variance Dynamics
--------------------------------------
GARCH Model     : sGARCH(1,6)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
---------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008557 0.993172
ar1     0.003004    0.015520  0.193573 0.846510
omega   0.000001    0.000000  3.976072 0.000070
alpha1  0.086658    0.007892 10.980317 0.000000
beta1   0.671752    0.070845  9.481938 0.000000
beta2   0.000032    0.046651  0.000685 0.999453
beta3   0.001091    0.280627  0.003886 0.996899
beta4   0.085057    0.332956  0.255460 0.798368
beta5   0.140606    0.032052  4.386730 0.000012
beta6   0.000050    0.074482  0.000672 0.999464

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000124 -0.008174 0.993479
ar1     0.003004    0.016748  0.179390 0.857631
```

```
omega     0.000001     0.000001   1.577246  0.114739
alpha1    0.086658     0.032832   2.639470  0.008304
beta1     0.671752     0.274135   2.450442  0.014268
beta2     0.000032     0.018545   0.001723  0.998625
beta3     0.001091     0.584062   0.001867  0.998510
beta4     0.085057     0.690145   0.123245  0.901913
beta5     0.140606     0.370513   0.379489  0.704325
beta6     0.000050     0.052339   0.000957  0.999237

LogLikelihood : 15793.4

Information Criteria
------------------------------------

Akaike        -6.6387
Bayes         -6.6251
Shibata       -6.6387
Hannan-Quinn  -6.6339


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
```

```
GARCH Model      : sGARCH(1,7)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008685 0.993070
ar1     0.002752    0.015480  0.177748 0.858921
omega   0.000001    0.000001  2.276904 0.022792
alpha1  0.083401    0.010233  8.150221 0.000000
beta1   0.716040    0.121438  5.896333 0.000000
beta2   0.000022    0.056000  0.000397 0.999683
beta3   0.000141    0.262608  0.000538 0.999571
beta4   0.129572    0.206901  0.626250 0.531151
beta5   0.000075    0.208085  0.000359 0.999714
beta6   0.000016    0.509019  0.000032 0.999975
beta7   0.056400    0.400795  0.140720 0.888091

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000134 -0.007636  0.99391
ar1     0.002752    0.017596  0.156372  0.87574
omega   0.000001    0.000003  0.434524  0.66391
alpha1  0.083401    0.061202  1.362706  0.17297
beta1   0.716040    0.530942  1.348621  0.17746
```

```
beta2    0.000022    0.171542   0.000130   0.99990
beta3    0.000141    0.822275   0.000172   0.99986
beta4    0.129572    1.092856   0.118563   0.90562
beta5    0.000075    0.518674   0.000144   0.99989
beta6    0.000016    2.284879   0.000007   0.99999
beta7    0.056400    2.007734   0.028091   0.97759

LogLikelihood : 15793.38

Information Criteria
------------------------------------


Akaike        -6.6382
Bayes         -6.6233
Shibata       -6.6382
Hannan-Quinn  -6.6330



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(1,8)
Mean Model       : ARFIMA(1,0,0)
```

Distribution : norm

Optimal Parameters

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000118	−0.008673	0.993080
ar1	0.002208	0.015480	0.142644	0.886571
omega	0.000001	0.000000	4.406215	0.000011
alpha1	0.081304	0.006859	11.853651	0.000000
beta1	0.770369	0.045379	16.976218	0.000000
beta2	0.000047	0.098541	0.000474	0.999622
beta3	0.036825	0.169064	0.217818	0.827571
beta4	0.000028	0.036453	0.000760	0.999394
beta5	0.000011	0.192200	0.000059	0.999953
beta6	0.000006	0.399119	0.000015	0.999988
beta7	0.000006	0.557905	0.000011	0.999991
beta8	0.097715	0.245945	0.397306	0.691142

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000124	−0.008218	0.993443
ar1	0.002208	0.016389	0.134736	0.892821
omega	0.000001	0.000001	1.842944	0.065337
alpha1	0.081304	0.028217	2.881402	0.003959
beta1	0.770369	0.247605	3.111279	0.001863
beta2	0.000047	0.135964	0.000343	0.999726

```
beta3    0.036825    0.379253   0.097099  0.922648
beta4    0.000028    0.023123   0.001197  0.999045
beta5    0.000011    0.265257   0.000043  0.999966
beta6    0.000006    0.858199   0.000007  0.999995
beta7    0.000006    1.354092   0.000005  0.999996
beta8    0.097715    0.593515   0.164638  0.869229

LogLikelihood : 15794.71

Information Criteria
------------------------------------


Akaike        -6.6384
Bayes         -6.6220
Shibata       -6.6384
Hannan-Quinn  -6.6326



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(1,9)
Mean Model      : ARFIMA(1,0,0)
```

```
Distribution       : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000118 -0.007561 0.993967
ar1       0.002121    0.015463  0.137196 0.890876
omega     0.000001    0.000000  4.377798 0.000012
alpha1    0.081833    0.006981 11.722809 0.000000
beta1     0.768501    0.077773  9.881314 0.000000
beta2     0.000015    0.270844  0.000057 0.999955
beta3     0.045261    0.396743  0.114081 0.909174
beta4     0.000717    0.739474  0.000969 0.999227
beta5     0.000147    0.291625  0.000504 0.999598
beta6     0.000056    0.026868  0.002083 0.998338
beta7     0.000047    0.041556  0.001125 0.999102
beta8     0.000115    0.164172  0.000698 0.999443
beta9     0.089563    0.155979  0.574200 0.565832

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000126 -0.007088 0.994345
ar1       0.002121    0.016651  0.127411 0.898615
omega     0.000001    0.000001  1.904364 0.056863
alpha1    0.081833    0.028343  2.887285 0.003886
beta1     0.768501    0.249066  3.085530 0.002032
```

```
beta2     0.000015      0.300018   0.000051  0.999959
beta3     0.045261      1.461990   0.030958  0.975303
beta4     0.000717      2.213732   0.000324  0.999742
beta5     0.000147      0.786737   0.000187  0.999851
beta6     0.000056      0.086154   0.000650  0.999482
beta7     0.000047      0.062044   0.000754  0.999399
beta8     0.000115      0.554212   0.000207  0.999835
beta9     0.089563      0.492151   0.181982  0.855597

LogLikelihood : 15795.37

Information Criteria
------------------------------------

Akaike        -6.6382
Bayes         -6.6205
Shibata       -6.6382
Hannan-Quinn  -6.6320


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
```

```
GARCH Model     : sGARCH(1,10)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000118  -0.008486 0.993229
ar1     0.001940    0.015511   0.125076 0.900463
omega   0.000001    0.000000   4.386020 0.000012
alpha1  0.082863    0.007007  11.826505 0.000000
beta1   0.770285    0.005746 134.064215 0.000000
beta2   0.000052    0.135997   0.000382 0.999695
beta3   0.024002    0.132224   0.181525 0.855956
beta4   0.022487    0.118668   0.189496 0.849704
beta5   0.000040    0.133035   0.000301 0.999760
beta6   0.000011    0.355996   0.000031 0.999976
beta7   0.000008    0.431275   0.000018 0.999985
beta8   0.000011    0.026503   0.000431 0.999656
beta9   0.000019    0.033503   0.000563 0.999551
beta10  0.086466    0.142953   0.604856 0.545275

Robust Standard Errors:
        Estimate  Std. Error  t value Pr(>|t|)
mu     -0.000001    0.000125 -0.007980 0.993633
ar1     0.001940    0.016592  0.116928 0.906917
```

```
omega    0.000001   0.000001  1.759229  0.078539
alpha1   0.082863   0.028611  2.896156  0.003778
beta1    0.770285   0.172676  4.460871  0.000008
beta2    0.000052   0.520558  0.000100  0.999920
beta3    0.024002   0.634042  0.037855  0.969803
beta4    0.022487   0.489442  0.045944  0.963354
beta5    0.000040   0.509556  0.000078  0.999937
beta6    0.000011   1.254752  0.000009  0.999993
beta7    0.000008   1.443791  0.000006  0.999996
beta8    0.000011   0.421451  0.000027  0.999978
beta9    0.000019   0.115958  0.000163  0.999870
beta10   0.086466   0.473939  0.182441  0.855237

LogLikelihood : 15796.19

Information Criteria
------------------------------------

Akaike       -6.6381
Bayes        -6.6191
Shibata      -6.6382
Hannan-Quinn -6.6315


*---------------------------------*
*          GARCH Model Fit         *
```

```
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model        : sGARCH(2,1)
Mean Model         : ARFIMA(1,0,0)
Distribution       : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000118  -0.008591 0.993145
ar1     0.005243    0.015179   0.345417 0.729781
omega   0.000001    0.000000   3.662982 0.000249
alpha1  0.057073    0.015111   3.776916 0.000159
alpha2  0.000001    0.013926   0.000079 0.999937
beta1   0.932046    0.005665 164.521199 0.000000

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000130 -0.007780 0.993792
ar1     0.005243    0.016163  0.324394 0.745640
omega   0.000001    0.000001  1.106617 0.268460
alpha1  0.057073    0.018283  3.121714 0.001798
alpha2  0.000001    0.034400  0.000032 0.999975
beta1   0.932046    0.027225 34.234537 0.000000
```

```
LogLikelihood : 15789.43

Information Criteria
------------------------------------

Akaike       -6.6387
Bayes        -6.6305
Shibata      -6.6387
Hannan-Quinn -6.6358


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(2,2)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008658 0.993092
```

```
ar1       0.004742    0.015295   0.310025 0.756542
omega     0.000001    0.000000   3.381630 0.000721
alpha1    0.067034    0.015374   4.360186 0.000013
alpha2    0.000001    0.014297   0.000096 0.999924
beta1     0.718873    0.008086  88.906632 0.000000
beta2     0.201517    0.008528  23.628665 0.000000

Robust Standard Errors:
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000130  -0.007835 0.993748
ar1       0.004742    0.016327   0.290440 0.771480
omega     0.000001    0.000001   0.964016 0.335038
alpha1    0.067034    0.018766   3.572138 0.000354
alpha2    0.000001    0.031391   0.000044 0.999965
beta1     0.718873    0.019697  36.496046 0.000000
beta2     0.201517    0.014086  14.306359 0.000000

LogLikelihood : 15790.18

Information Criteria
------------------------------------

Akaike       -6.6386
Bayes        -6.6290
Shibata      -6.6386
Hannan-Quinn -6.6352
```

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(2,3)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008301 0.993377
ar1     0.003533    0.015428  0.229027 0.818848
omega   0.000001    0.000000  2.911064 0.003602
alpha1  0.076590    0.015792  4.849785 0.000001
alpha2  0.000303    0.014462  0.020964 0.983275
beta1   0.689678    0.014770 46.696051 0.000000
beta2   0.000136    0.066728  0.002035 0.998376
beta3   0.219289    0.018852 11.632057 0.000000

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
```

```
mu      -0.000001   0.000130  -0.007518  0.994001
ar1      0.003533   0.016520   0.213883  0.830638
omega    0.000001   0.000002   0.770139  0.441217
alpha1   0.076590   0.021255   3.603336  0.000314
alpha2   0.000303   0.035157   0.008623  0.993120
beta1    0.689678   0.041658  16.555595  0.000000
beta2    0.000136   0.066702   0.002036  0.998376
beta3    0.219289   0.061990   3.537508  0.000404

LogLikelihood : 15791.79

Information Criteria
------------------------------------

Akaike        -6.6388
Bayes         -6.6279
Shibata       -6.6388
Hannan-Quinn  -6.6350


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
```

```
GARCH Model        : sGARCH(2,4)
Mean Model         : ARFIMA(1,0,0)
Distribution       : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000118 -0.008604 0.993135
ar1      0.003404    0.015408  0.220923 0.825152
omega    0.000001    0.000000  4.918610 0.000001
alpha1   0.076327    0.016078  4.747256 0.000002
alpha2   0.017477    0.013067  1.337482 0.181065
beta1    0.610142    0.063949  9.541026 0.000000
beta2    0.000032    0.044272  0.000728 0.999419
beta3    0.000054    0.064078  0.000838 0.999332
beta4    0.279441    0.079634  3.509058 0.000450

Robust Standard Errors:
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000124 -0.008191 0.993464
ar1      0.003404    0.016373  0.207890 0.835315
omega    0.000001    0.000001  2.389100 0.016890
alpha1   0.076327    0.020110  3.795519 0.000147
alpha2   0.017477    0.038442  0.454642 0.649367
beta1    0.610142    0.251684  2.424240 0.015340
beta2    0.000032    0.041463  0.000778 0.999380
```

```
beta3    0.000054     0.061241   0.000876  0.999301
beta4    0.279441     0.145283   1.923427  0.054426

LogLikelihood : 15793.31

Information Criteria
------------------------------------

Akaike        -6.6390
Bayes         -6.6268
Shibata       -6.6390
Hannan-Quinn  -6.6347



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(2,5)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
```

```
          Estimate  Std. Error   t value  Pr(>|t|)
mu       -0.000001    0.000118 -0.006582  0.994748
ar1       0.002744    0.015710  0.174666  0.861342
omega     0.000002    0.000000  7.798595  0.000000
alpha1    0.080419    0.016978  4.736537  0.000002
alpha2    0.034995    0.012797  2.734649  0.006245
beta1     0.431475    0.152019  2.838298  0.004535
beta2     0.010623    0.440805  0.024100  0.980773
beta3     0.147990    0.670255  0.220796  0.825251
beta4     0.000401    0.688691  0.000583  0.999535
beta5     0.274466    0.349144  0.786109  0.431803

Robust Standard Errors:
          Estimate  Std. Error   t value  Pr(>|t|)
mu       -0.000001    0.000127 -0.006144  0.995098
ar1       0.002744    0.018595  0.147565  0.882686
omega     0.000002    0.000000  3.588900  0.000332
alpha1    0.080419    0.024287  3.311222  0.000929
alpha2    0.034995    0.039563  0.884534  0.376408
beta1     0.431475    0.453166  0.952135  0.341029
beta2     0.010623    1.140759  0.009313  0.992570
beta3     0.147990    1.970190  0.075114  0.940124
beta4     0.000401    2.065361  0.000194  0.999845
beta5     0.274466    1.048546  0.261758  0.793508

LogLikelihood : 15794.1
```

```
Information Criteria
------------------------------------

Akaike       -6.6389
Bayes        -6.6253
Shibata      -6.6390
Hannan-Quinn -6.6342


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(2,6)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.006315 0.994961
ar1     0.002859    0.015207  0.187993 0.850882
omega   0.000002    0.000000  7.682600 0.000000
```

```
alpha1   0.080525    0.016208   4.968118 0.000001
alpha2   0.036380    0.012228   2.975228 0.002928
beta1    0.415914    0.040281  10.325270 0.000000
beta2    0.022367    0.437579   0.051116 0.959233
beta3    0.148291    0.819653   0.180920 0.856431
beta4    0.000751    0.881957   0.000851 0.999321
beta5    0.273115    0.555168   0.491950 0.622754
beta6    0.002643    0.115041   0.022971 0.981674

Robust Standard Errors:
         Estimate  Std. Error    t value Pr(>|t|)
mu      -0.000001    0.000125  -0.005978 0.995231
ar1      0.002859    0.019364   0.147630 0.882635
omega    0.000002    0.000000   4.176292 0.000030
alpha1   0.080525    0.021409   3.761241 0.000169
alpha2   0.036380    0.036176   1.005650 0.314584
beta1    0.415914    0.564248   0.737112 0.461054
beta2    0.022367    1.645819   0.013590 0.989157
beta3    0.148291    2.818323   0.052617 0.958037
beta4    0.000751    3.004740   0.000250 0.999801
beta5    0.273115    1.982311   0.137776 0.890417
beta6    0.002643    0.553772   0.004772 0.996193

LogLikelihood : 15794.05

Information Criteria
```

```
--------------------------------------------

Akaike        -6.6385
Bayes         -6.6235
Shibata       -6.6385
Hannan-Quinn  -6.6332


*-----------------------------------------*
*           GARCH Model Fit               *
*-----------------------------------------*

Conditional Variance Dynamics
-----------------------------------------
GARCH Model     : sGARCH(2,7)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
--------------------------------------------
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000118 -0.005283 0.995784
ar1      0.002747    0.015630  0.175751 0.860490
omega    0.000002    0.000000 11.727721 0.000000
alpha1   0.080411    0.016249  4.948620 0.000001
alpha2   0.036595    0.012663  2.889945 0.003853
```

```
beta1    0.412863    0.171371   2.409186 0.015988
beta2    0.024671    0.416798   0.059192 0.952799
beta3    0.146792    0.579010   0.253522 0.799865
beta4    0.000725    0.396009   0.001831 0.998539
beta5    0.273034    0.274891   0.993243 0.320591
beta6    0.003559    0.340824   0.010443 0.991668
beta7    0.001381    0.131380   0.010515 0.991611

Robust Standard Errors:
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000124 -0.005035 0.995983
ar1      0.002747    0.017369  0.158148 0.874340
omega    0.000002    0.000000  4.200257 0.000027
alpha1   0.080411    0.020086  4.003409 0.000062
alpha2   0.036595    0.035985  1.016940 0.309182
beta1    0.412863    0.626403  0.659102 0.509830
beta2    0.024671    1.179376  0.020919 0.983310
beta3    0.146792    1.744544  0.084144 0.932942
beta4    0.000725    1.460488  0.000496 0.999604
beta5    0.273034    0.846379  0.322591 0.747005
beta6    0.003559    0.975256  0.003650 0.997088
beta7    0.001381    0.549296  0.002515 0.997993

LogLikelihood : 15793.97

Information Criteria
```

```
----------------------------------------

Akaike       -6.6381
Bayes        -6.6217
Shibata      -6.6381
Hannan-Quinn -6.6323


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(2,8)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.007070 0.994359
ar1     0.002298    0.015481  0.148469 0.881972
omega   0.000001    0.000000  7.053291 0.000000
alpha1  0.081110    0.016665  4.866972 0.000001
alpha2  0.006237    0.014893  0.418812 0.675354
```

```
beta1     0.718400    0.061006 11.775938 0.000000
beta2     0.000036    0.046372  0.000783 0.999375
beta3     0.076016    0.208180  0.365144 0.715004
beta4     0.000282    0.196066  0.001437 0.998853
beta5     0.000117    0.074435  0.001569 0.998748
beta6     0.000073    0.080071  0.000907 0.999277
beta7     0.000080    0.032632  0.002450 0.998046
beta8     0.102869    0.074868  1.374005 0.169440

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000124 -0.006720 0.994638
ar1       0.002298    0.016373  0.140378 0.888362
omega     0.000001    0.000000  4.192623 0.000028
alpha1    0.081110    0.019322  4.197756 0.000027
alpha2    0.006237    0.030836  0.202275 0.839702
beta1     0.718400    0.224706  3.197062 0.001388
beta2     0.000036    0.040216  0.000903 0.999280
beta3     0.076016    0.255967  0.296974 0.766486
beta4     0.000282    0.337729  0.000834 0.999334
beta5     0.000117    0.060576  0.001927 0.998462
beta6     0.000073    0.030221  0.002402 0.998083
beta7     0.000080    0.101295  0.000789 0.999370
beta8     0.102869    0.065332  1.574555 0.115359

LogLikelihood : 15794.74
```

```
Information Criteria
------------------------------------

Akaike       -6.6380
Bayes        -6.6203
Shibata      -6.6380
Hannan-Quinn -6.6317


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(2,9)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008630 0.993114
ar1     0.002166    0.015599  0.138848 0.889570
omega   0.000001    0.000000 11.537586 0.000000
```

```
alpha1   0.080745    0.022082   3.656658 0.000256
alpha2   0.000015    0.023736   0.000651 0.999481
beta1    0.779211    0.029956  26.011592 0.000000
beta2    0.000055    0.055257   0.000998 0.999204
beta3    0.037107    0.096378   0.385014 0.700227
beta4    0.000065    0.072196   0.000898 0.999284
beta5    0.000014    0.149829   0.000096 0.999923
beta6    0.000004    0.603610   0.000007 0.999995
beta7    0.000003    0.877130   0.000004 0.999997
beta8    0.000008    0.521298   0.000016 0.999987
beta9    0.089229    0.049208   1.813307 0.069784

Robust Standard Errors:
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000130  -0.007866  0.99372
ar1       0.002166    0.018014   0.120236  0.90430
omega     0.000001    0.000001   1.298077  0.19426
alpha1    0.080745    0.063827   1.265059  0.20585
alpha2    0.000015    0.065563   0.000236  0.99981
beta1     0.779211    0.149323   5.218305  0.00000
beta2     0.000055    0.072554   0.000760  0.99939
beta3     0.037107    0.328564   0.112936  0.91008
beta4     0.000065    0.204670   0.000317  0.99975
beta5     0.000014    0.424743   0.000034  0.99997
beta6     0.000004    2.034603   0.000002  1.00000
beta7     0.000003    3.151508   0.000001  1.00000
```

```
beta8     0.000008     1.962970   0.000004   1.00000
beta9     0.089229     0.539233   0.165475   0.86857

LogLikelihood : 15795.37

Information Criteria
------------------------------------

Akaike        -6.6378
Bayes         -6.6188
Shibata       -6.6378
Hannan-Quinn  -6.6311


*-----------------------------------*
*          GARCH Model Fit          *
*-----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(2,10)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
```

```
          Estimate  Std. Error    t value  Pr(>|t|)
mu       -0.000001    0.000119  -0.008618  0.993124
ar1       0.002064    0.015893   0.129864  0.896674
omega     0.000001    0.000000  14.512249  0.000000
alpha1    0.081390    0.028684   2.837525  0.004546
alpha2    0.017080    0.024044   0.710345  0.477490
beta1     0.665702    0.160816   4.139541  0.000035
beta2     0.000035    0.296774   0.000118  0.999906
beta3     0.003503    0.152405   0.022983  0.981664
beta4     0.117921    0.246590   0.478207  0.632503
beta5     0.000022    0.204681   0.000105  0.999916
beta6     0.000004    1.340097   0.000003  0.999998
beta7     0.000003    1.450204   0.000002  0.999998
beta8     0.000005    0.494591   0.000010  0.999992
beta9     0.000007    0.436933   0.000016  0.999987
beta10    0.097999    0.314703   0.311400  0.755496

Robust Standard Errors:
          Estimate  Std. Error    t value  Pr(>|t|)
mu       -0.000001    0.000146  -0.006993   0.99442
ar1       0.002064    0.029127   0.070859   0.94351
omega     0.000001    0.000001   1.098928   0.27180
alpha1    0.081390    0.161147   0.505068   0.61351
alpha2    0.017080    0.145899   0.117066   0.90681
beta1     0.665702    0.973796   0.683616   0.49422
beta2     0.000035    1.830609   0.000019   0.99999
```

```
beta3    0.003503    1.250173   0.002802   0.99776
beta4    0.117921    1.444355   0.081643   0.93493
beta5    0.000022    1.241716   0.000017   0.99999
beta6    0.000004    8.807712   0.000000   1.00000
beta7    0.000003    9.678125   0.000000   1.00000
beta8    0.000005    3.412643   0.000001   1.00000
beta9    0.000007    2.046217   0.000003   1.00000
beta10   0.097999    1.797605   0.054516   0.95652

LogLikelihood : 15796.32

Information Criteria
------------------------------------

Akaike        -6.6378
Bayes         -6.6174
Shibata       -6.6378
Hannan-Quinn  -6.6306


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
```

```
GARCH Model      : sGARCH(3,1)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000118  -0.008647 0.993101
ar1     0.005253    0.015192   0.345813 0.729483
omega   0.000001    0.000000   4.351857 0.000013
alpha1  0.056989    0.015103   3.773308 0.000161
alpha2  0.000001    0.019975   0.000034 0.999973
alpha3  0.000000    0.012644   0.000025 0.999980
beta1   0.932152    0.005340 174.545273 0.000000

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000127 -0.008028  0.99359
ar1     0.005253    0.016058  0.327150  0.74355
omega   0.000001    0.000001  1.577596  0.11466
alpha1  0.056989    0.018267  3.119814  0.00181
alpha2  0.000001    0.023539  0.000029  0.99998
alpha3  0.000000    0.028345  0.000011  0.99999
beta1   0.932152    0.023818 39.135949  0.00000

LogLikelihood : 15789.33
```

```
Information Criteria
------------------------------------

Akaike       -6.6382
Bayes        -6.6287
Shibata      -6.6382
Hannan-Quinn -6.6349


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(3,2)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008643 0.993104
ar1     0.004749    0.015323  0.309923 0.756619
omega   0.000001    0.000000  4.177015 0.000030
```

```
alpha1   0.066962    0.015981   4.190142 0.000028
alpha2   0.000002    0.017621   0.000121 0.999903
alpha3   0.000000    0.012244   0.000035 0.999972
beta1    0.718514    0.008282  86.751015 0.000000
beta2    0.201966    0.008554  23.610122 0.000000

Robust Standard Errors:
         Estimate   Std. Error   t value  Pr(>|t|)
mu      -0.000001    0.000128  -0.007966 0.993644
ar1      0.004749    0.016095   0.295049 0.767957
omega    0.000001    0.000001   1.497902 0.134159
alpha1   0.066962    0.019258   3.477030 0.000507
alpha2   0.000002    0.021206   0.000101 0.999920
alpha3   0.000000    0.030415   0.000014 0.999989
beta1    0.718514    0.015641  45.937867 0.000000
beta2    0.201966    0.012198  16.557712 0.000000

LogLikelihood : 15790.09

Information Criteria
------------------------------------

Akaike       -6.6381
Bayes        -6.6272
Shibata      -6.6381
Hannan-Quinn -6.6343
```

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(3,3)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu      0.000000    0.000118 -0.002526 0.997984
ar1     0.003281    0.015450  0.212398 0.831797
omega   0.000001    0.000000  3.744189 0.000181
alpha1  0.076137    0.016465  4.624232 0.000004
alpha2  0.002238    0.017694  0.126478 0.899353
alpha3  0.000044    0.011586  0.003837 0.996939
beta1   0.678804    0.030872 21.987471 0.000000
beta2   0.001036    0.096668  0.010721 0.991446
beta3   0.227262    0.029994  7.576912 0.000000

Robust Standard Errors:
```

```
         Estimate  Std. Error    t value  Pr(>|t|)
mu       0.000000    0.000127  -0.002341  0.998132
ar1      0.003281    0.016227   0.202219  0.839746
omega    0.000001    0.000001   1.341517  0.179753
alpha1   0.076137    0.019662   3.872306  0.000108
alpha2   0.002238    0.022391   0.099946  0.920387
alpha3   0.000044    0.029549   0.001504  0.998800
beta1    0.678804    0.076338   8.892090  0.000000
beta2    0.001036    0.025342   0.040894  0.967380
beta3    0.227262    0.065110   3.490410  0.000482

LogLikelihood : 15791.79

Information Criteria
------------------------------------

Akaike        -6.6384
Bayes         -6.6262
Shibata       -6.6384
Hannan-Quinn  -6.6341


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(3,4)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.006178 0.995071
ar1     0.003461    0.015425  0.224353 0.822483
omega   0.000001    0.000000  7.666118 0.000000
alpha1  0.076239    0.016432  4.639666 0.000003
alpha2  0.017765    0.024818  0.715823 0.474100
alpha3  0.000029    0.021077  0.001356 0.998918
beta1   0.608129    0.222652  2.731302 0.006308
beta2   0.000523    0.357886  0.001463 0.998833
beta3   0.001062    0.286442  0.003709 0.997041
beta4   0.279635    0.175963  1.589172 0.112022

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000124 -0.005894 0.995297
ar1     0.003461    0.016346  0.211702 0.832339
omega   0.000001    0.000000  5.105612 0.000000
alpha1  0.076239    0.022572  3.377608 0.000731
```

```
alpha2   0.017765    0.036915   0.481253  0.630337
alpha3   0.000029    0.020309   0.001407  0.998877
beta1    0.608129    0.405187   1.500860  0.133392
beta2    0.000523    0.255975   0.002045  0.998368
beta3    0.001062    0.356806   0.002978  0.997624
beta4    0.279635    0.244162   1.145283  0.252092

LogLikelihood : 15793.3

Information Criteria
------------------------------------

Akaike         -6.6386
Bayes          -6.6250
Shibata        -6.6386
Hannan-Quinn   -6.6338


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(3,5)
Mean Model       : ARFIMA(1,0,0)
```

```
Distribution      : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value  Pr(>|t|)
mu      0.000000    0.000118 -0.001000  0.999202
ar1     0.002651    0.015492  0.171124  0.864126
omega   0.000002    0.000000  6.221407  0.000000
alpha1  0.079974    0.015670  5.103573  0.000000
alpha2  0.037256    0.022301  1.670586  0.094804
alpha3  0.001368    0.017187  0.079566  0.936582
beta1   0.404192    0.253909  1.591875  0.111413
beta2   0.028147    0.604423  0.046568  0.962858
beta3   0.138026    0.532159  0.259369  0.795351
beta4   0.013058    0.420439  0.031058  0.975223
beta5   0.277671    0.199126  1.394450  0.163182

Robust Standard Errors:
        Estimate  Std. Error   t value  Pr(>|t|)
mu      0.000000    0.000124 -0.000950  0.999242
ar1     0.002651    0.016488  0.160788  0.872260
omega   0.000002    0.000000  4.127927  0.000037
alpha1  0.079974    0.022492  3.555606  0.000377
alpha2  0.037256    0.081971  0.454499  0.649470
alpha3  0.001368    0.054357  0.025158  0.979929
beta1   0.404192    0.891333  0.453469  0.650211
```

```
beta2    0.028147    1.340095    0.021003  0.983243
beta3    0.138026    0.919551    0.150101  0.880685
beta4    0.013058    0.641333    0.020361  0.983756
beta5    0.277671    0.277868    0.999291  0.317654

LogLikelihood : 15794.09

Information Criteria
------------------------------------

Akaike        -6.6385
Bayes         -6.6236
Shibata       -6.6385
Hannan-Quinn  -6.6333


*---------------------------------*
*          GARCH Model Fit         *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(3,6)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm
```

```
Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008647 0.993101
ar1     0.002307    0.015545  0.148429 0.882004
omega   0.000003    0.000000  9.503998 0.000000
alpha1  0.084580    0.014712  5.749244 0.000000
alpha2  0.065967    0.011280  5.847962 0.000000
alpha3  0.029514    0.008486  3.478092 0.000505
beta1   0.000141    0.043337  0.003263 0.997397
beta2   0.000023    0.046405  0.000504 0.999598
beta3   0.335409    0.193206  1.736018 0.082561
beta4   0.000026    0.065871  0.000402 0.999680
beta5   0.284998    0.120636  2.362465 0.018154
beta6   0.168437    0.150648  1.118079 0.263533

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000125 -0.008181 0.993472
ar1     0.002307    0.016757  0.137690 0.890485
omega   0.000003    0.000001  2.409448 0.015977
alpha1  0.084580    0.016369  5.167161 0.000000
alpha2  0.065967    0.024263  2.718784 0.006552
alpha3  0.029514    0.025784  1.144680 0.252342
beta1   0.000141    0.411558  0.000344 0.999726
beta2   0.000023    0.113816  0.000206 0.999836
```

```
beta3     0.335409     0.510080   0.657562  0.510820
beta4     0.000026     0.139509   0.000190  0.999849
beta5     0.284998     0.120177   2.371480  0.017717
beta6     0.168437     0.283705   0.593704  0.552710

LogLikelihood : 15794.48

Information Criteria
------------------------------------

Akaike        −6.6383
Bayes         −6.6219
Shibata       −6.6383
Hannan−Quinn  −6.6325



*------------------------------------*
*          GARCH Model Fit           *
*------------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(3,7)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm
```

```
Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008633 0.993112
ar1     0.002308    0.015526  0.148686 0.881801
omega   0.000003    0.000001  1.989537 0.046642
alpha1  0.084251    0.010029  8.400943 0.000000
alpha2  0.066223    0.012762  5.188920 0.000000
alpha3  0.029253    0.007751  3.774071 0.000161
beta1   0.000039    0.033833  0.001158 0.999076
beta2   0.000091    0.072621  0.001250 0.999003
beta3   0.335254    0.166814  2.009751 0.044458
beta4   0.000013    0.068131  0.000197 0.999843
beta5   0.289737    0.136261  2.126330 0.033476
beta6   0.164273    0.176903  0.928604 0.353094
beta7   0.000014    0.071058  0.000196 0.999844

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000130 -0.007858 0.993730
ar1     0.002308    0.016625  0.138855 0.889565
omega   0.000003    0.000005  0.497196 0.619051
alpha1  0.084251    0.045876  1.836475 0.066287
alpha2  0.066223    0.037726  1.755368 0.079196
alpha3  0.029253    0.077675  0.376606 0.706466
beta1   0.000039    0.106887  0.000366 0.999708
```

```
beta2    0.000091    0.379770   0.000239  0.999809
beta3    0.335254    0.335062   1.000573  0.317033
beta4    0.000013    0.224465   0.000060  0.999952
beta5    0.289737    0.153799   1.883862  0.059584
beta6    0.164273    0.324962   0.505514  0.613198
beta7    0.000014    0.216975   0.000064  0.999949

LogLikelihood : 15794.37

Information Criteria
------------------------------------


Akaike        -6.6378
Bayes         -6.6201
Shibata       -6.6378
Hannan-Quinn  -6.6316



*---------------------------------*
*         GARCH Model Fit         *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(3,8)
Mean Model       : ARFIMA(1,0,0)
```

```
Distribution      :  norm

Optimal  Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000118  -0.006562 0.994764
ar1     0.001759    0.015530   0.113238 0.909842
omega   0.000001    0.000000  11.481247 0.000000
alpha1  0.081267    0.018144   4.478986 0.000007
alpha2  0.015518    0.062303   0.249076 0.803302
alpha3  0.000039    0.055333   0.000712 0.999432
beta1   0.639365    0.689494   0.927296 0.353773
beta2   0.002458    1.278662   0.001922 0.998466
beta3   0.131804    0.601557   0.219105 0.826568
beta4   0.000539    0.569394   0.000947 0.999244
beta5   0.000191    0.218102   0.000875 0.999302
beta6   0.000060    0.074138   0.000804 0.999358
beta7   0.000059    0.095645   0.000615 0.999510
beta8   0.112166    0.125486   0.893852 0.371401

Robust Standard Errors:
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000124  -0.006238 0.995023
ar1     0.001759    0.016475   0.106744 0.914992
omega   0.000001    0.000000   4.921198 0.000001
alpha1  0.081267    0.027229   2.984573 0.002840
```

```
alpha2   0.015518   0.107210   0.144745  0.884912
alpha3   0.000039   0.085511   0.000461  0.999633
beta1    0.639365   1.362697   0.469191  0.638933
beta2    0.002458   2.522281   0.000974  0.999222
beta3    0.131804   0.417417   0.315761  0.752184
beta4    0.000539   1.666519   0.000324  0.999742
beta5    0.000191   0.386793   0.000493  0.999607
beta6    0.000060   0.050362   0.001184  0.999056
beta7    0.000059   0.077825   0.000755  0.999397
beta8    0.112166   0.229999   0.487682  0.625775

LogLikelihood : 15794.76

Information Criteria
------------------------------------

Akaike        -6.6375
Bayes         -6.6185
Shibata       -6.6376
Hannan-Quinn  -6.6309


*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(3,9)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000118 -0.008663 0.993088
ar1      0.002184    0.015523  0.140699 0.888108
omega    0.000001    0.000000  7.080339 0.000000
alpha1   0.080741    0.018325  4.406119 0.000011
alpha2   0.000014    0.022638  0.000617 0.999507
alpha3   0.000001    0.014487  0.000096 0.999923
beta1    0.778979    0.025614 30.412749 0.000000
beta2    0.000051    0.070157  0.000721 0.999425
beta3    0.037174    0.096947  0.383451 0.701385
beta4    0.000095    0.106320  0.000895 0.999286
beta5    0.000017    0.158408  0.000106 0.999916
beta6    0.000006    0.381092  0.000016 0.999987
beta7    0.000005    0.477835  0.000010 0.999992
beta8    0.000012    0.217354  0.000055 0.999956
beta9    0.089363    0.126875  0.704342 0.481220

Robust Standard Errors:
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000126	−0.008134	0.993510
ar1	0.002184	0.016416	0.133042	0.894160
omega	0.000001	0.000000	2.848487	0.004393
alpha1	0.080741	0.027460	2.940297	0.003279
alpha2	0.000014	0.034511	0.000405	0.999677
alpha3	0.000001	0.031282	0.000044	0.999965
beta1	0.778979	0.114327	6.813599	0.000000
beta2	0.000051	0.052705	0.000960	0.999234
beta3	0.037174	0.323693	0.114845	0.908568
beta4	0.000095	0.168239	0.000566	0.999549
beta5	0.000017	0.288618	0.000058	0.999954
beta6	0.000006	0.682598	0.000009	0.999993
beta7	0.000005	0.946154	0.000005	0.999996
beta8	0.000012	0.626871	0.000019	0.999985
beta9	0.089363	0.277071	0.322528	0.747053

LogLikelihood : 15795.37

Information Criteria

Akaike	−6.6374
Bayes	−6.6170
Shibata	−6.6374
Hannan–Quinn	−6.6302

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(3,10)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008510 0.993210
ar1     0.002057    0.015380  0.133741 0.893607
omega   0.000001    0.000000 11.158959 0.000000
alpha1  0.081414    0.014405  5.651913 0.000000
alpha2  0.017158    0.009686  1.771468 0.076483
alpha3  0.000004    0.006872  0.000550 0.999561
beta1   0.665263    0.077423  8.592559 0.000000
beta2   0.000076    0.199519  0.000383 0.999695
beta3   0.003411    0.246146  0.013858 0.988943
beta4   0.118160    0.154867  0.762979 0.445476
beta5   0.000026    0.117884  0.000220 0.999825
```

```
beta6    0.000011    0.552953   0.000020  0.999984
beta7    0.000008    0.587913   0.000014  0.999989
beta8    0.000009    0.219203   0.000043  0.999966
beta9    0.000015    0.297862   0.000049  0.999961
beta10   0.098072    0.111506   0.879524  0.379117


Robust Standard Errors:
          Estimate   Std. Error    t value  Pr(>|t|)
mu       -0.000001    0.000125  -0.008048  0.993579
ar1       0.002057    0.016597   0.123934  0.901368
omega     0.000001    0.000000   6.424563  0.000000
alpha1    0.081414    0.024914   3.267744  0.001084
alpha2    0.017158    0.046205   0.371346  0.710380
alpha3    0.000004    0.036599   0.000103  0.999918
beta1     0.665263    0.364622   1.824528  0.068072
beta2     0.000076    0.614433   0.000124  0.999901
beta3     0.003411    0.564625   0.006041  0.995180
beta4     0.118160    0.419084   0.281948  0.777983
beta5     0.000026    0.355976   0.000073  0.999942
beta6     0.000011    1.030502   0.000011  0.999991
beta7     0.000008    1.137478   0.000007  0.999994
beta8     0.000009    0.771236   0.000012  0.999990
beta9     0.000015    0.429294   0.000034  0.999973
beta10    0.098072    0.222347   0.441077  0.659157


LogLikelihood : 15796.32
```

```
Information Criteria
------------------------------------

Akaike       -6.6374
Bayes        -6.6156
Shibata      -6.6374
Hannan-Quinn -6.6297


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(4,1)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008626 0.993117
ar1     0.005242    0.015193  0.345003 0.730092
omega   0.000001    0.000000  5.000565 0.000001
```

```
alpha1   0.056938    0.015102    3.770243 0.000163
alpha2   0.000000    0.019970    0.000023 0.999982
alpha3   0.000000    0.021342    0.000010 0.999992
alpha4   0.000000    0.015738    0.000013 0.999990
beta1    0.932219    0.005156  180.789752 0.000000

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000125 -0.008161 0.993489
ar1       0.005242    0.016081  0.325949 0.744463
omega     0.000001    0.000000  1.974646 0.048308
alpha1    0.056938    0.018230  3.123318 0.001788
alpha2    0.000000    0.023524  0.000020 0.999984
alpha3    0.000000    0.024445  0.000008 0.999993
alpha4    0.000000    0.026007  0.000008 0.999994
beta1     0.932219    0.022168 42.052544 0.000000

LogLikelihood : 15789.27

Information Criteria
------------------------------------

Akaike       -6.6378
Bayes        -6.6269
Shibata      -6.6378
Hannan-Quinn -6.6339
```

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(4,2)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008639 0.993107
ar1     0.004740    0.015323  0.309346 0.757058
omega   0.000001    0.000000  4.806206 0.000002
alpha1  0.066899    0.015979  4.186722 0.000028
alpha2  0.000001    0.017777  0.000069 0.999945
alpha3  0.000000    0.019430  0.000014 0.999989
alpha4  0.000000    0.015538  0.000021 0.999983
beta1   0.718699    0.008335 86.222409 0.000000
beta2   0.201862    0.008550 23.610844 0.000000

Robust Standard Errors:
```

```
          Estimate   Std. Error    t value  Pr(>|t|)
mu       -0.000001    0.000126  -0.008134  0.993510
ar1       0.004740    0.016116   0.294127  0.768661
omega     0.000001    0.000001   1.916424  0.055311
alpha1    0.066899    0.019213   3.481960  0.000498
alpha2    0.000001    0.021047   0.000058  0.999953
alpha3    0.000000    0.023378   0.000012  0.999991
alpha4    0.000000    0.026772   0.000012  0.999990
beta1     0.718699    0.014112  50.928222  0.000000
beta2     0.201862    0.011362  17.766096  0.000000

LogLikelihood : 15790.03

Information Criteria
------------------------------------

Akaike        -6.6377
Bayes         -6.6254
Shibata       -6.6377
Hannan-Quinn  -6.6334


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(4,3)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.005532 0.995586
ar1     0.003286    0.015459  0.212569 0.831663
omega   0.000001    0.000000  4.107496 0.000040
alpha1  0.076930    0.016852  4.564907 0.000005
alpha2  0.000936    0.017932  0.052193 0.958375
alpha3  0.000016    0.017251  0.000949 0.999243
alpha4  0.000010    0.015137  0.000691 0.999449
beta1   0.683052    0.015486 44.107163 0.000000
beta2   0.000510    0.082746  0.006158 0.995087
beta3   0.224314    0.022544  9.950046 0.000000

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000126 -0.005190 0.995859
ar1     0.003286    0.016233  0.202437 0.839575
omega   0.000001    0.000001  1.589111 0.112035
alpha1  0.076930    0.020549  3.743684 0.000181
```

```
alpha2   0.000936    0.021674   0.043182  0.965557
alpha3   0.000016    0.023350   0.000701  0.999441
alpha4   0.000010    0.025207   0.000415  0.999669
beta1    0.683052    0.043063  15.861656  0.000000
beta2    0.000510    0.034317   0.014848  0.988154
beta3    0.224314    0.043736   5.128837  0.000000

LogLikelihood : 15791.73

Information Criteria
------------------------------------


Akaike       -6.6380
Bayes        -6.6243
Shibata      -6.6380
Hannan-Quinn -6.6332



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(4,4)
Mean Model       : ARFIMA(1,0,0)
```

```
Distribution      :  norm

Optimal  Parameters
------------------------------------
           Estimate  Std. Error   t value  Pr(>|t|)
mu        -0.000001    0.000118 -0.008653  0.993096
ar1        0.003404    0.015419  0.220800  0.825248
omega      0.000001    0.000000  6.667962  0.000000
alpha1     0.076328    0.016424  4.647226  0.000003
alpha2     0.017477    0.010218  1.710424  0.087187
alpha3     0.000001    0.016459  0.000081  0.999935
alpha4     0.000001    0.008492  0.000141  0.999887
beta1      0.610133    0.190519  3.202480  0.001362
beta2      0.000036    0.185460  0.000194  0.999845
beta3      0.000071    0.200157  0.000355  0.999717
beta4      0.279428    0.133673  2.090392  0.036583

Robust  Standard  Errors:
           Estimate  Std. Error   t value  Pr(>|t|)
mu        -0.000001    0.000124 -0.008243  0.993423
ar1        0.003404    0.016251  0.209486  0.834069
omega      0.000001    0.000000  4.543651  0.000006
alpha1     0.076328    0.022613  3.375422  0.000737
alpha2     0.017477    0.026097  0.669690  0.503055
alpha3     0.000001    0.024048  0.000056  0.999956
alpha4     0.000001    0.025931  0.000046  0.999963
```

```
beta1    0.610133    0.176296   3.460854  0.000538
beta2    0.000036    0.121557   0.000296  0.999764
beta3    0.000071    0.135126   0.000526  0.999581
beta4    0.279428    0.226119   1.235756  0.216549

LogLikelihood : 15793.31

Information Criteria
------------------------------------

Akaike        -6.6382
Bayes         -6.6232
Shibata       -6.6382
Hannan-Quinn  -6.6329


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model       : sGARCH(4,5)
Mean Model        : ARFIMA(1,0,0)
Distribution      : norm
```

```
Optimal Parameters
------------------------------------
           Estimate  Std. Error   t value Pr(>|t|)
mu        -0.000001    0.000118 -0.008324 0.993358
ar1        0.002782    0.015447  0.180090 0.857082
omega      0.000002    0.000000  6.788874 0.000000
alpha1     0.080456    0.015041  5.348969 0.000000
alpha2     0.034921    0.041128  0.849064 0.395846
alpha3     0.000731    0.018045  0.040536 0.967666
alpha4     0.000057    0.034019  0.001688 0.998653
beta1      0.430255    0.513056  0.838611 0.401687
beta2      0.003882    0.545234  0.007120 0.994319
beta3      0.152097    0.035419  4.294161 0.000018
beta4      0.000116    0.160354  0.000725 0.999421
beta5      0.277621    0.166571  1.666676 0.095579

Robust Standard Errors:
           Estimate  Std. Error   t value Pr(>|t|)
mu        -0.000001    0.000124 -0.007925 0.993677
ar1        0.002782    0.016530  0.168287 0.866358
omega      0.000002    0.000000  5.085463 0.000000
alpha1     0.080456    0.021689  3.709566 0.000208
alpha2     0.034921    0.100448  0.347648 0.728104
alpha3     0.000731    0.039379  0.018575 0.985180
alpha4     0.000057    0.069236  0.000829 0.999338
beta1      0.430255    1.159874  0.370950 0.710675
```

```
beta2    0.003882    1.296508   0.002994  0.997611
beta3    0.152097    0.249749   0.608998  0.542526
beta4    0.000116    0.078433   0.001483  0.998817
beta5    0.277621    0.279832   0.992099  0.321149

LogLikelihood : 15794.11

Information Criteria
------------------------------------

Akaike       -6.6381
Bayes        -6.6218
Shibata      -6.6381
Hannan-Quinn -6.6324


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(4,6)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm
```

Optimal Parameters

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000118	−0.008665	0.993086
ar1	0.002435	0.015525	0.156832	0.875378
omega	0.000003	0.000001	2.201876	0.027674
alpha1	0.082350	0.015861	5.191807	0.000000
alpha2	0.066532	0.013071	5.089978	0.000000
alpha3	0.029825	0.011628	2.564824	0.010323
alpha4	0.010101	0.013885	0.727432	0.466961
beta1	0.000034	0.064766	0.000527	0.999579
beta2	0.000036	0.047638	0.000765	0.999389
beta3	0.249251	0.132711	1.878147	0.060361
beta4	0.000023	0.044968	0.000510	0.999593
beta5	0.305737	0.117714	2.597299	0.009396
beta6	0.223751	0.124287	1.800279	0.071817

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000130	−0.007879	0.993714
ar1	0.002435	0.016356	0.148857	0.881666
omega	0.000003	0.000005	0.596696	0.550710
alpha1	0.082350	0.022942	3.589419	0.000331
alpha2	0.066532	0.024425	2.723976	0.006450
alpha3	0.029825	0.027423	1.087591	0.276776
alpha4	0.010101	0.098707	0.102329	0.918495

```
beta1   0.000034   0.102877  0.000332 0.999735
beta2   0.000036   0.028091  0.001298 0.998964
beta3   0.249251   1.046573  0.238159 0.811757
beta4   0.000023   0.019282  0.001188 0.999052
beta5   0.305737   0.194503  1.571888 0.115977
beta6   0.223751   0.693682  0.322556 0.747032

LogLikelihood : 15794.57

Information Criteria
------------------------------------

Akaike       -6.6379
Bayes        -6.6202
Shibata      -6.6379
Hannan-Quinn -6.6317


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(4,7)
Mean Model      : ARFIMA(1,0,0)
```

Distribution : norm

Optimal Parameters

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000118	−0.008630	0.993115
ar1	0.002415	0.015514	0.155644	0.876313
omega	0.000003	0.000001	3.578613	0.000345
alpha1	0.082132	0.015692	5.234168	0.000000
alpha2	0.066724	0.017424	3.829545	0.000128
alpha3	0.029587	0.011689	2.531228	0.011366
alpha4	0.010145	0.014409	0.704108	0.481366
beta1	0.000047	0.060444	0.000776	0.999381
beta2	0.000054	0.043879	0.001239	0.999012
beta3	0.249369	0.202381	1.232178	0.217883
beta4	0.000017	0.078452	0.000216	0.999828
beta5	0.309523	0.126287	2.450952	0.014248
beta6	0.220044	0.209696	1.049347	0.294018
beta7	0.000013	0.094762	0.000132	0.999894

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000125	−0.008142	0.993504
ar1	0.002415	0.016557	0.145845	0.884044
omega	0.000003	0.000002	1.344761	0.178702
alpha1	0.082132	0.020657	3.976055	0.000070

```
alpha2   0.066724    0.034841   1.915132  0.055476
alpha3   0.029587    0.028969   1.021311  0.307107
alpha4   0.010145    0.060918   0.166541  0.867731
beta1    0.000047    0.169106   0.000277  0.999779
beta2    0.000054    0.067489   0.000805  0.999357
beta3    0.249369    0.763933   0.326428  0.744101
beta4    0.000017    0.228062   0.000074  0.999941
beta5    0.309523    0.127498   2.427664  0.015196
beta6    0.220044    0.766445   0.287096  0.774039
beta7    0.000013    0.198863   0.000063  0.999950

LogLikelihood : 15794.47

Information Criteria
------------------------------------

Akaike        -6.6374
Bayes         -6.6184
Shibata       -6.6374
Hannan-Quinn  -6.6307


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(4,8)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000118 -0.006115 0.995121
ar1      0.002254    0.015479  0.145602 0.884236
omega    0.000001    0.000000  9.878046 0.000000
alpha1   0.080755    0.015490  5.213458 0.000000
alpha2   0.009956    0.029055  0.342646 0.731865
alpha3   0.000069    0.036212  0.001894 0.998489
alpha4   0.000130    0.014302  0.009078 0.992757
beta1    0.688502    0.262136  2.626506 0.008627
beta2    0.002544    0.484510  0.005250 0.995811
beta3    0.094894    0.482852  0.196528 0.844197
beta4    0.001095    0.182809  0.005990 0.995221
beta5    0.000440    0.123681  0.003558 0.997161
beta6    0.000141    0.126832  0.001115 0.999110
beta7    0.000127    0.043908  0.002882 0.997701
beta8    0.105991    0.090347  1.173150 0.240736

Robust Standard Errors:
```

```
          Estimate   Std. Error    t value  Pr(>|t|)
mu       -0.000001    0.000124  -0.005837  0.995343
ar1       0.002254    0.016353   0.137815  0.890387
omega     0.000001    0.000000   6.661223  0.000000
alpha1    0.080755    0.018715   4.314894  0.000016
alpha2    0.009956    0.043560   0.228550  0.819219
alpha3    0.000069    0.049916   0.001374  0.998904
alpha4    0.000130    0.025509   0.005089  0.995939
beta1     0.688502    0.454054   1.516344  0.129432
beta2     0.002544    0.777281   0.003272  0.997389
beta3     0.094894    0.619599   0.153154  0.878277
beta4     0.001095    0.492900   0.002222  0.998227
beta5     0.000440    0.252541   0.001742  0.998610
beta6     0.000141    0.110851   0.001276  0.998982
beta7     0.000127    0.263385   0.000480  0.999617
beta8     0.105991    0.149930   0.706936  0.479606

LogLikelihood : 15794.74

Information Criteria
------------------------------------

Akaike       -6.6371
Bayes        -6.6167
Shibata      -6.6371
Hannan-Quinn -6.6299
```

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(4,9)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000085 -0.012037 0.990396
ar1     0.002184    0.010590  0.206221 0.836618
omega   0.000001    0.000003  0.444997 0.656322
alpha1  0.080736    0.103501  0.780054 0.435359
alpha2  0.000017    0.089757  0.000187 0.999851
alpha3  0.000001    0.029183  0.000051 0.999959
alpha4  0.000003    0.083506  0.000030 0.999976
beta1   0.779017    0.410580  1.897358 0.057781
beta2   0.000053    0.512359  0.000103 0.999918
beta3   0.037100    0.525084  0.070655 0.943672
beta4   0.000100    0.375108  0.000267 0.999787
```

```
beta5    0.000023    0.055220  0.000409 0.999674
beta6    0.000006    2.513177  0.000002 0.999998
beta7    0.000005    5.719013  0.000001 0.999999
beta8    0.000012    5.086850  0.000002 0.999998
beta9    0.089387    1.886758  0.047376 0.962213

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.002620 -0.000390  0.99969
ar1       0.002184    0.357942  0.006101  0.99513
omega     0.000001    0.000084  0.014034  0.98880
alpha1    0.080736    3.326047  0.024274  0.98063
alpha2    0.000017    2.905684  0.000006  0.99999
alpha3    0.000001    1.175336  0.000001  1.00000
alpha4    0.000003    2.738495  0.000001  1.00000
beta1     0.779017   13.073581  0.059587  0.95249
beta2     0.000053   16.276845  0.000003  1.00000
beta3     0.037100   16.917506  0.002193  0.99825
beta4     0.000100   12.132741  0.000008  0.99999
beta5     0.000023    1.797111  0.000013  0.99999
beta6     0.000006   79.459085  0.000000  1.00000
beta7     0.000005  181.405444  0.000000  1.00000
beta8     0.000012  161.426644  0.000000  1.00000
beta9     0.089387   59.746007  0.001496  0.99881

LogLikelihood : 15795.37
```

```
Information Criteria
------------------------------------

Akaike       -6.6370
Bayes        -6.6152
Shibata      -6.6370
Hannan-Quinn -6.6293


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(4,10)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008291 0.993385
ar1     0.002206    0.015515  0.142183 0.886936
omega   0.000001    0.000000 11.088118 0.000000
```

```
alpha1  0.081946   0.016972  4.828271 0.000001
alpha2  0.016813   0.019485  0.862849 0.388220
alpha3  0.000022   0.012398  0.001739 0.998613
alpha4  0.000799   0.004407  0.181378 0.856071
beta1   0.660993   0.127238  5.194935 0.000000
beta2   0.000319   0.234775  0.001359 0.998916
beta3   0.001219   0.361807  0.003369 0.997312
beta4   0.123228   0.271210  0.454365 0.649566
beta5   0.000050   0.030597  0.001634 0.998696
beta6   0.000040   0.025698  0.001539 0.998772
beta7   0.000028   0.017240  0.001600 0.998723
beta8   0.000035   0.077292  0.000451 0.999640
beta9   0.000048   0.084957  0.000568 0.999547
beta10  0.097868   0.027558  3.551290 0.000383

Robust Standard Errors:
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001   0.000124 -0.007905 0.993693
ar1      0.002206   0.016301  0.135330 0.892351
omega    0.000001   0.000000  6.293126 0.000000
alpha1   0.081946   0.021593  3.794937 0.000148
alpha2   0.016813   0.030736  0.546995 0.584382
alpha3   0.000022   0.009749  0.002211 0.998236
alpha4   0.000799   0.029449  0.027141 0.978348
beta1    0.660993   0.215772  3.063384 0.002188
beta2    0.000319   0.181796  0.001755 0.998600
```

```
beta3   0.001219   0.607201   0.002008 0.998398
beta4   0.123228   0.460481   0.267608 0.789001
beta5   0.000050   0.017472   0.002861 0.997717
beta6   0.000040   0.023582   0.001677 0.998662
beta7   0.000028   0.006843   0.004032 0.996783
beta8   0.000035   0.048259   0.000722 0.999424
beta9   0.000048   0.046658   0.001034 0.999175
beta10  0.097868   0.065402   1.496412 0.134546

LogLikelihood : 15796.32

Information Criteria
------------------------------------

Akaike       -6.6369
Bayes        -6.6138
Shibata      -6.6370
Hannan-Quinn -6.6288


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
```

```
GARCH Model      : sGARCH(5,1)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error    t value Pr(>|t|)
mu      -0.000001    0.000118  -0.008634 0.993111
ar1      0.005244    0.015197   0.345088 0.730028
omega    0.000001    0.000000   5.486179 0.000000
alpha1   0.056862    0.015095   3.766887 0.000165
alpha2   0.000000    0.019971   0.000024 0.999981
alpha3   0.000000    0.021336   0.000010 0.999992
alpha4   0.000000    0.023801   0.000008 0.999993
alpha5   0.000000    0.016090   0.000011 0.999991
beta1    0.932311    0.005052 184.532567 0.000000

Robust Standard Errors:
         Estimate  Std. Error  t value Pr(>|t|)
mu      -0.000001    0.000125 -0.008173 0.993479
ar1      0.005244    0.016080  0.326129 0.744327
omega    0.000001    0.000000  2.231037 0.025679
alpha1   0.056862    0.018253  3.115225 0.001838
alpha2   0.000000    0.023547  0.000020 0.999984
alpha3   0.000000    0.024500  0.000009 0.999993
alpha4   0.000000    0.028087  0.000007 0.999994
```

```
alpha5    0.000000     0.022899   0.000008  0.999994
beta1     0.932311     0.021381  43.604142  0.000000

LogLikelihood : 15789.18

Information Criteria
------------------------------------

Akaike        -6.6373
Bayes         -6.6251
Shibata       -6.6373
Hannan-Quinn  -6.6330


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(5,2)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
```

```
        Estimate  Std. Error   t value  Pr(>|t|)
mu     -0.000001    0.000118 -0.008625  0.993119
ar1     0.004744    0.015324  0.309597  0.756867
omega   0.000001    0.000000  5.303190  0.000000
alpha1  0.066836    0.015971  4.184814  0.000029
alpha2  0.000001    0.017773  0.000080  0.999936
alpha3  0.000000    0.019693  0.000014  0.999989
alpha4  0.000000    0.020903  0.000013  0.999990
alpha5  0.000000    0.015507  0.000015  0.999988
beta1   0.718389    0.008368 85.852616  0.000000
beta2   0.202248    0.008542 23.676767  0.000000

Robust Standard Errors:
        Estimate  Std. Error   t value  Pr(>|t|)
mu     -0.000001    0.000125 -0.008161  0.993489
ar1     0.004744    0.016111  0.294470  0.768399
omega   0.000001    0.000001  2.182300  0.029087
alpha1  0.066836    0.019211  3.479013  0.000503
alpha2  0.000001    0.021003  0.000068  0.999946
alpha3  0.000000    0.022897  0.000012  0.999990
alpha4  0.000000    0.025640  0.000010  0.999992
alpha5  0.000000    0.021764  0.000011  0.999992
beta1   0.718389    0.013377 53.702722  0.000000
beta2   0.202248    0.011025 18.343821  0.000000

LogLikelihood : 15789.94
```

```
Information Criteria
------------------------------------

Akaike       -6.6372
Bayes        -6.6236
Shibata      -6.6372
Hannan-Quinn -6.6324


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(5,3)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu      0.000000    0.000118 -0.001358 0.998917
ar1     0.004182    0.015451  0.270655 0.786656
omega   0.000001    0.000000  4.634746 0.000004
```

```
alpha1  0.075616    0.016777   4.507108 0.000007
alpha2  0.004274    0.017740   0.240948 0.809596
alpha3  0.000123    0.016330   0.007554 0.993973
alpha4  0.000068    0.019621   0.003473 0.997229
alpha5  0.000057    0.014957   0.003797 0.996971
beta1   0.660276    0.032532  20.296491 0.000000
beta2   0.002584    0.128438   0.020119 0.983948
beta3   0.242004    0.038579   6.272956 0.000000

Robust Standard Errors:
        Estimate  Std. Error    t value Pr(>|t|)
mu      0.000000    0.000125  -0.001287 0.998973
ar1     0.004182    0.016223   0.257767 0.796587
omega   0.000001    0.000001   2.005173 0.044945
alpha1  0.075616    0.020970   3.605927 0.000311
alpha2  0.004274    0.022372   0.191053 0.848484
alpha3  0.000123    0.024222   0.005093 0.995937
alpha4  0.000068    0.023449   0.002906 0.997681
alpha5  0.000057    0.019616   0.002895 0.997690
beta1   0.660276    0.078407   8.421184 0.000000
beta2   0.002584    0.043796   0.059002 0.952951
beta3   0.242004    0.078771   3.072227 0.002125

LogLikelihood : 15791.61


Information Criteria
```

```
Akaike        -6.6375
Bayes         -6.6225
Shibata       -6.6375
Hannan-Quinn  -6.6322


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(5,4)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008633 0.993112
ar1     0.003406    0.015431  0.220753 0.825285
omega   0.000001    0.000000  6.793929 0.000000
alpha1  0.076171    0.016881  4.512200 0.000006
alpha2  0.017825    0.019244  0.926221 0.354331
```

```
alpha3   0.000001    0.017678   0.000082  0.999935
alpha4   0.000001    0.017491   0.000079  0.999937
alpha5   0.000001    0.016952   0.000034  0.999973
beta1    0.608062    0.106648   5.701585  0.000000
beta2    0.000041    0.083305   0.000496  0.999604
beta3    0.000058    0.037569   0.001536  0.998774
beta4    0.281282    0.083644   3.362839  0.000771

Robust Standard Errors:
          Estimate  Std. Error    t value  Pr(>|t|)
mu       -0.000001    0.000124  -0.008222  0.993439
ar1       0.003406    0.016273   0.209337  0.834185
omega     0.000001    0.000000   4.834488  0.000001
alpha1    0.076171    0.021807   3.492990  0.000478
alpha2    0.017825    0.026633   0.669262  0.503328
alpha3    0.000001    0.024728   0.000058  0.999953
alpha4    0.000001    0.022093   0.000063  0.999950
alpha5    0.000001    0.019307   0.000030  0.999976
beta1     0.608062    0.206617   2.942948  0.003251
beta2     0.000041    0.026014   0.001588  0.998733
beta3     0.000058    0.007575   0.007620  0.993920
beta4     0.281282    0.170492   1.649825  0.098979

LogLikelihood : 15793.24


Information Criteria
```

```
Akaike        -6.6377
Bayes         -6.6214
Shibata       -6.6378
Hannan-Quinn  -6.6320


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(5,5)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008249  0.99342
ar1     0.002770    0.015481  0.178940  0.85798
omega   0.000002    0.000000  9.446406  0.00000
alpha1  0.080315    0.015893  5.053358  0.00000
alpha2  0.035213    0.051557  0.682995  0.49461
```

```
alpha3   0.000986    0.061137  0.016126   0.98713
alpha4   0.000163    0.011354  0.014374   0.98853
alpha5   0.000011    0.018552  0.000584   0.99953
beta1    0.427618    0.463543  0.922498   0.35627
beta2    0.004653    1.176780  0.003954   0.99684
beta3    0.150634    0.819252  0.183868   0.85412
beta4    0.000282    0.509810  0.000554   0.99956
beta5    0.280232    0.238687  1.174053   0.24037

Robust Standard Errors:
         Estimate   Std. Error   t value  Pr(>|t|)
mu      -0.000001    0.000125  -0.007800   0.99378
ar1      0.002770    0.016778   0.165104   0.86886
omega    0.000002    0.000000   5.078110   0.00000
alpha1   0.080315    0.022645   3.546678   0.00039
alpha2   0.035213    0.092539   0.380522   0.70356
alpha3   0.000986    0.124494   0.007919   0.99368
alpha4   0.000163    0.033069   0.004935   0.99606
alpha5   0.000011    0.040671   0.000266   0.99979
beta1    0.427618    0.808691   0.528778   0.59696
beta2    0.004653    2.139450   0.002175   0.99826
beta3    0.150634    1.890914   0.079662   0.93651
beta4    0.000282    1.001793   0.000282   0.99977
beta5    0.280232    0.585481   0.478635   0.63220

LogLikelihood : 15794.11
```

```
Information Criteria
------------------------------------

Akaike       -6.6377
Bayes        -6.6200
Shibata      -6.6377
Hannan-Quinn -6.6315


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(5,6)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008614 0.993127
ar1     0.002462    0.015486  0.158947 0.873711
omega   0.000003    0.000001  4.199632 0.000027
```

```
alpha1   0.082498     0.016907   4.879622  0.000001
alpha2   0.066323     0.017172   3.862202  0.000112
alpha3   0.030239     0.015793   1.914766  0.055522
alpha4   0.010411     0.005838   1.783360  0.074528
alpha5   0.000005     0.005902   0.000764  0.999390
beta1    0.000018     0.066084   0.000274  0.999781
beta2    0.000025     0.093946   0.000271  0.999784
beta3    0.244788     0.149119   1.641559  0.100681
beta4    0.000013     0.294824   0.000043  0.999966
beta5    0.307912     0.064466   4.776332  0.000002
beta6    0.225207     0.144885   1.554388  0.120092

Robust Standard Errors:
          Estimate   Std. Error    t value  Pr(>|t|)
mu       -0.000001     0.000125  -0.008194  0.993463
ar1       0.002462     0.016409   0.150008  0.880758
omega     0.000003     0.000002   1.369117  0.170963
alpha1    0.082498     0.026555   3.106740  0.001892
alpha2    0.066323     0.035161   1.886280  0.059257
alpha3    0.030239     0.022820   1.325133  0.185127
alpha4    0.010411     0.043963   0.236804  0.812809
alpha5    0.000005     0.037228   0.000121  0.999903
beta1     0.000018     0.017921   0.001010  0.999194
beta2     0.000025     0.051736   0.000492  0.999608
beta3     0.244788     0.726668   0.336863  0.736220
beta4     0.000013     0.351540   0.000036  0.999971
```

```
beta5     0.307912      0.286600   1.074362  0.282661
beta6     0.225207      0.464194   0.485156  0.627565

LogLikelihood : 15794.57

Information Criteria
------------------------------------

Akaike        -6.6375
Bayes         -6.6184
Shibata       -6.6375
Hannan-Quinn  -6.6308


*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(5,7)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
```

```
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000119 -0.008590 0.993146
ar1      0.002409    0.015525  0.155188 0.876673
omega    0.000003    0.000001  5.053753 0.000000
alpha1   0.082106    0.017513  4.688415 0.000003
alpha2   0.066699    0.020271  3.290359 0.001001
alpha3   0.029710    0.011802  2.517413 0.011822
alpha4   0.010142    0.015880  0.638655 0.523047
alpha5   0.000003    0.007405  0.000463 0.999631
beta1    0.000023    0.029913  0.000760 0.999393
beta2    0.000032    0.068666  0.000471 0.999624
beta3    0.248529    0.071266  3.487350 0.000488
beta4    0.000018    0.022159  0.000825 0.999342
beta5    0.309101    0.128308  2.409054 0.015994
beta6    0.221304    0.456468  0.484819 0.627805
beta7    0.000010    0.293154  0.000034 0.999973

Robust Standard Errors:
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000133 -0.007685 0.993868
ar1      0.002409    0.016330  0.147539 0.882707
omega    0.000003    0.000002  1.777876 0.075424
alpha1   0.082106    0.028210  2.910591 0.003607
alpha2   0.066699    0.058641  1.137404 0.255369
alpha3   0.029710    0.018458  1.609608 0.107483
alpha4   0.010142    0.055273  0.183487 0.854416
```

```
alpha5   0.000003    0.029515   0.000116 0.999907
beta1    0.000023    0.026343   0.000864 0.999311
beta2    0.000032    0.127296   0.000254 0.999797
beta3    0.248529    0.700580   0.354748 0.722778
beta4    0.000018    0.032939   0.000555 0.999557
beta5    0.309101    0.265192   1.165573 0.243787
beta6    0.221304    1.484008   0.149126 0.881454
beta7    0.000010    0.876416   0.000011 0.999991

LogLikelihood : 15794.47

Information Criteria
------------------------------------

Akaike       -6.6370
Bayes        -6.6166
Shibata      -6.6370
Hannan-Quinn -6.6298


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
```

```
GARCH Model      : sGARCH(5,8)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000118 -0.007300 0.994176
ar1      0.002286    0.015433  0.148129 0.882241
omega    0.000001    0.000000  4.927712 0.000001
alpha1   0.081514    0.015572  5.234809 0.000000
alpha2   0.006167    0.021450  0.287520 0.773714
alpha3   0.000022    0.015952  0.001398 0.998884
alpha4   0.000038    0.016634  0.002301 0.998164
alpha5   0.000036    0.007730  0.004694 0.996255
beta1    0.715288    0.233927  3.057737 0.002230
beta2    0.000479    0.315364  0.001519 0.998788
beta3    0.077874    0.210372  0.370174 0.711253
beta4    0.000308    0.265183  0.001161 0.999074
beta5    0.000115    0.094249  0.001218 0.999028
beta6    0.000040    0.019239  0.002080 0.998341
beta7    0.000042    0.032176  0.001319 0.998948
beta8    0.103361    0.100839  1.025012 0.305357

Robust Standard Errors:
         Estimate  Std. Error   t value Pr(>|t|)
```

mu	−0.000001	0.000124	−0.006947	0.994457
ar1	0.002286	0.017088	0.133776	0.893579
omega	0.000001	0.000001	2.051174	0.040250
alpha1	0.081514	0.021999	3.705382	0.000211
alpha2	0.006167	0.065436	0.094250	0.924911
alpha3	0.000022	0.015369	0.001451	0.998842
alpha4	0.000038	0.025113	0.001524	0.998784
alpha5	0.000036	0.042020	0.000864	0.999311
beta1	0.715288	0.495864	1.442509	0.149159
beta2	0.000479	0.408884	0.001171	0.999065
beta3	0.077874	0.844817	0.092179	0.926556
beta4	0.000308	0.365384	0.000843	0.999328
beta5	0.000115	0.090707	0.001265	0.998991
beta6	0.000040	0.087260	0.000459	0.999634
beta7	0.000042	0.114135	0.000372	0.999703
beta8	0.103361	0.175653	0.588437	0.556239

LogLikelihood : 15794.73

Information Criteria

Akaike	−6.6367
Bayes	−6.6149
Shibata	−6.6367
Hannan−Quinn	−6.6290

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(5,9)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000118  -0.008545  0.99318
ar1     0.002138    0.015484   0.138057  0.89019
omega   0.000001    0.000000  21.159593  0.00000
alpha1  0.080668    0.015018   5.371528  0.00000
alpha2  0.000024    0.014107   0.001726  0.99862
alpha3  0.000003    0.017609   0.000156  0.99987
alpha4  0.000005    0.019189   0.000244  0.99981
alpha5  0.000005    0.016911   0.000319  0.99975
beta1   0.780345    0.063053  12.375977  0.00000
beta2   0.000096    0.102940   0.000933  0.99926
beta3   0.036226    0.090390   0.400778  0.68858
```

```
beta4    0.000167    0.046268   0.003601   0.99713
beta5    0.000037    0.020009   0.001851   0.99852
beta6    0.000011    0.164260   0.000069   0.99994
beta7    0.000009    0.265061   0.000035   0.99997
beta8    0.000023    0.023876   0.000947   0.99924
beta9    0.088853    0.061740   1.439138   0.15011

Robust Standard Errors:
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000124  -0.008120 0.993522
ar1       0.002138    0.016340   0.130818 0.895919
omega     0.000001    0.000000   5.099597 0.000000
alpha1    0.080668    0.020904   3.858980 0.000114
alpha2    0.000024    0.038019   0.000641 0.999489
alpha3    0.000003    0.021788   0.000126 0.999899
alpha4    0.000005    0.034563   0.000135 0.999892
alpha5    0.000005    0.025527   0.000211 0.999831
beta1     0.780345    0.086971   8.972435 0.000000
beta2     0.000096    0.159979   0.000600 0.999521
beta3     0.036226    0.267274   0.135540 0.892185
beta4     0.000167    0.100323   0.001661 0.998675
beta5     0.000037    0.091735   0.000404 0.999678
beta6     0.000011    0.369036   0.000031 0.999975
beta7     0.000009    0.431560   0.000022 0.999983
beta8     0.000023    0.026697   0.000847 0.999324
beta9     0.088853    0.141994   0.625750 0.531479
```

```
LogLikelihood : 15795.37

Information Criteria
------------------------------------

Akaike        -6.6365
Bayes         -6.6134
Shibata       -6.6366
Hannan-Quinn  -6.6284


*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(5,10)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008654 0.993095
```

```
ar1       0.002069    0.015537   0.133176 0.894054
omega     0.000001    0.000000  12.718602 0.000000
alpha1    0.081212    0.018820   4.315276 0.000016
alpha2    0.017982    0.029171   0.616452 0.537596
alpha3    0.000003    0.028098   0.000119 0.999905
alpha4    0.000977    0.033931   0.028793 0.977029
alpha5    0.000033    0.020872   0.001558 0.998757
beta1     0.658314    0.173649   3.791072 0.000150
beta2     0.000045    0.058039   0.000782 0.999376
beta3     0.000325    0.212476   0.001528 0.998781
beta4     0.124400    0.202905   0.613096 0.539813
beta5     0.000023    0.030566   0.000767 0.999388
beta6     0.000005    0.560522   0.000010 0.999992
beta7     0.000004    0.502065   0.000008 0.999994
beta8     0.000005    0.375496   0.000013 0.999990
beta9     0.000007    0.276075   0.000024 0.999981
beta10    0.100029    0.169269   0.590946 0.554556

Robust Standard Errors:
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000125  -0.008204 0.993454
ar1       0.002069    0.016500   0.125402 0.900205
omega     0.000001    0.000000   6.363176 0.000000
alpha1    0.081212    0.031208   2.602285 0.009260
alpha2    0.017982    0.045340   0.396608 0.691656
alpha3    0.000003    0.063311   0.000053 0.999958
```

```
alpha4   0.000977   0.089005   0.010977  0.991242
alpha5   0.000033   0.027185   0.001197  0.999045
beta1    0.658314   0.320105   2.056559  0.039729
beta2    0.000045   0.171100   0.000265  0.999788
beta3    0.000325   0.533265   0.000609  0.999514
beta4    0.124400   0.886311   0.140357  0.888378
beta5    0.000023   0.091631   0.000256  0.999796
beta6    0.000005   1.832720   0.000003  0.999998
beta7    0.000004   1.432959   0.000003  0.999998
beta8    0.000005   0.896133   0.000005  0.999996
beta9    0.000007   0.542540   0.000012  0.999990
beta10   0.100029   0.343356   0.291327  0.770801

LogLikelihood : 15796.32

Information Criteria
------------------------------------

Akaike        -6.6365
Bayes         -6.6120
Shibata       -6.6365
Hannan-Quinn  -6.6279


*----------------------------------*
*          GARCH Model Fit         *
```

```
*------------------------------------*

Conditional Variance Dynamics
--------------------------------------
GARCH Model     : sGARCH(6,1)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
---------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000118  -0.008628 0.993116
ar1     0.005245    0.015197   0.345136 0.729992
omega   0.000001    0.000000   6.188449 0.000000
alpha1  0.056827    0.015123   3.757692 0.000171
alpha2  0.000001    0.019984   0.000030 0.999976
alpha3  0.000000    0.021341   0.000011 0.999991
alpha4  0.000000    0.023811   0.000009 0.999993
alpha5  0.000000    0.022286   0.000009 0.999993
alpha6  0.000000    0.015132   0.000012 0.999990
beta1   0.932355    0.004948 188.430987 0.000000

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000125 -0.008162 0.993487
ar1     0.005245    0.016079  0.326214 0.744263
```

```
omega     0.000001    0.000000   2.762610  0.005734
alpha1    0.056827    0.018629   3.050398  0.002285
alpha2    0.000001    0.023771   0.000025  0.999980
alpha3    0.000000    0.024545   0.000010  0.999992
alpha4    0.000000    0.028014   0.000007  0.999994
alpha5    0.000000    0.025313   0.000008  0.999994
alpha6    0.000000    0.023453   0.000008  0.999994
beta1     0.932355    0.020294  45.942467  0.000000

LogLikelihood : 15789.14

Information Criteria
------------------------------------

Akaike        -6.6369
Bayes         -6.6233
Shibata       -6.6369
Hannan-Quinn  -6.6321


*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*

Conditional Variance Dynamics
-----------------------------------
```

```
GARCH Model      : sGARCH(6,2)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000118  -0.008614  0.99313
ar1       0.004746    0.015329   0.309605  0.75686
omega     0.000001    0.000000   5.889776  0.00000
alpha1    0.066785    0.016003   4.173233  0.00003
alpha2    0.000002    0.017786   0.000101  0.99992
alpha3    0.000000    0.019696   0.000015  0.99999
alpha4    0.000000    0.021406   0.000013  0.99999
alpha5    0.000000    0.019524   0.000013  0.99999
alpha6    0.000000    0.015036   0.000017  0.99999
beta1     0.718699    0.008376  85.807958  0.00000
beta2     0.202001    0.008530  23.681745  0.00000

Robust Standard Errors:
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000125  -0.008155 0.993493
ar1       0.004746    0.016114   0.294523 0.768358
omega     0.000001    0.000000   2.616663 0.008879
alpha1    0.066785    0.019554   3.415431 0.000637
alpha2    0.000002    0.021164   0.000085 0.999932
```

```
alpha3   0.000000    0.023007   0.000013 0.999990
alpha4   0.000000    0.025356   0.000011 0.999991
alpha5   0.000000    0.021046   0.000012 0.999991
alpha6   0.000000    0.021813   0.000011 0.999991
beta1    0.718699    0.012628  56.912586 0.000000
beta2    0.202001    0.010567  19.115905 0.000000

LogLikelihood : 15789.9

Information Criteria
------------------------------------

Akaike       -6.6368
Bayes        -6.6218
Shibata      -6.6368
Hannan-Quinn -6.6315


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(6,3)
Mean Model       : ARFIMA(1,0,0)
```

```
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu      0.000000    0.000118 -0.002567 0.997952
ar1     0.003367    0.015466  0.217724 0.827644
omega   0.000001    0.000000  5.080480 0.000000
alpha1  0.076519    0.016981  4.506099 0.000007
alpha2  0.003684    0.017950  0.205212 0.837406
alpha3  0.000054    0.018499  0.002913 0.997675
alpha4  0.000034    0.023091  0.001463 0.998833
alpha5  0.000029    0.022263  0.001288 0.998972
alpha6  0.000037    0.015132  0.002464 0.998034
beta1   0.663351    0.028057 23.642895 0.000000
beta2   0.001714    0.127403  0.013454 0.989266
beta3   0.239632    0.038354  6.247870 0.000000

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu      0.000000    0.000124 -0.002438 0.998054
ar1     0.003367    0.016227  0.207509 0.835613
omega   0.000001    0.000001  2.382120 0.017213
alpha1  0.076519    0.021805  3.509230 0.000449
alpha2  0.003684    0.023530  0.156549 0.875600
alpha3  0.000054    0.025754  0.002093 0.998330
```

```
alpha4   0.000034   0.032116   0.001052  0.999161
alpha5   0.000029   0.029234   0.000981  0.999217
alpha6   0.000037   0.022027   0.001693  0.998649
beta1    0.663351   0.085984   7.714829  0.000000
beta2    0.001714   0.044508   0.038511  0.969280
beta3    0.239632   0.074000   3.238257  0.001203

LogLikelihood : 15791.58

Information Criteria
------------------------------------

Akaike       -6.6370
Bayes        -6.6207
Shibata      -6.6371
Hannan-Quinn -6.6313


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(6,4)
Mean Model       : ARFIMA(1,0,0)
```

```
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008556 0.993173
ar1     0.003408    0.015450  0.220570 0.825428
omega   0.000001    0.000000  7.213649 0.000000
alpha1  0.076235    0.016930  4.502890 0.000007
alpha2  0.017603    0.020457  0.860487 0.389521
alpha3  0.000002    0.015993  0.000143 0.999886
alpha4  0.000002    0.022922  0.000090 0.999928
alpha5  0.000001    0.019436  0.000045 0.999964
alpha6  0.000001    0.016694  0.000053 0.999958
beta1   0.608708    0.167095  3.642878 0.000270
beta2   0.000039    0.050622  0.000768 0.999388
beta3   0.000120    0.172535  0.000695 0.999446
beta4   0.280762    0.168014  1.671063 0.094709

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000124 -0.008141 0.993504
ar1     0.003408    0.016263  0.209543 0.834024
omega   0.000001    0.000000  5.319301 0.000000
alpha1  0.076235    0.021647  3.521759 0.000429
alpha2  0.017603    0.028026  0.628105 0.529935
```

alpha3	0.000002	0.024319	0.000094	0.999925
alpha4	0.000002	0.018602	0.000110	0.999912
alpha5	0.000001	0.023340	0.000037	0.999970
alpha6	0.000001	0.018103	0.000049	0.999961
beta1	0.608708	0.278822	2.183140	0.029026
beta2	0.000039	0.075153	0.000517	0.999587
beta3	0.000120	0.121736	0.000985	0.999214
beta4	0.280762	0.102400	2.741828	0.006110

LogLikelihood : 15793.18

Information Criteria

Akaike	−6.6373
Bayes	−6.6196
Shibata	−6.6373
Hannan–Quinn	−6.6311

———————————————————

*   GARCH Model Fit   *

———————————————————

Conditional Variance Dynamics

```
GARCH Model      : sGARCH(6,5)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008545 0.993182
ar1     0.002759    0.015535  0.177594 0.859042
omega   0.000002    0.000000  7.451313 0.000000
alpha1  0.080358    0.016868  4.763977 0.000002
alpha2  0.034756    0.032763  1.060826 0.288769
alpha3  0.000909    0.041922  0.021686 0.982699
alpha4  0.000025    0.008011  0.003182 0.997461
alpha5  0.000003    0.029904  0.000086 0.999931
alpha6  0.000001    0.018426  0.000064 0.999949
beta1   0.432110    0.319060  1.354325 0.175633
beta2   0.001751    0.718006  0.002439 0.998054
beta3   0.152584    0.187279  0.814745 0.415218
beta4   0.000070    0.096156  0.000727 0.999420
beta5   0.277697    0.081546  3.405387 0.000661

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000125 -0.008106 0.993532
ar1     0.002759    0.016544  0.166762 0.867557
```

```
omega     0.000002    0.000000   5.871096 0.000000
alpha1    0.080358    0.020325   3.953565 0.000077
alpha2    0.034756    0.063145   0.550413 0.582036
alpha3    0.000909    0.052133   0.017438 0.986087
alpha4    0.000025    0.028634   0.000890 0.999290
alpha5    0.000003    0.041469   0.000062 0.999950
alpha6    0.000001    0.028323   0.000042 0.999967
beta1     0.432110    0.687789   0.628260 0.529834
beta2     0.001751    0.917149   0.001909 0.998476
beta3     0.152584    0.416268   0.366553 0.713952
beta4     0.000070    0.179404   0.000390 0.999689
beta5     0.277697    0.235147   1.180953 0.237621

LogLikelihood : 15794.05

Information Criteria
------------------------------------

Akaike        -6.6372
Bayes         -6.6182
Shibata       -6.6373
Hannan-Quinn  -6.6306


*---------------------------------*
*          GARCH Model Fit        *
```

```
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(6,6)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008594 0.993143
ar1     0.002432    0.015575  0.156150 0.875915
omega   0.000003    0.000001  4.515400 0.000006
alpha1  0.082353    0.017081  4.821323 0.000001
alpha2  0.066531    0.016571  4.014990 0.000059
alpha3  0.029828    0.014130  2.110928 0.034779
alpha4  0.010084    0.015319  0.658230 0.510391
alpha5  0.000007    0.020847  0.000327 0.999739
alpha6  0.000004    0.037659  0.000115 0.999908
beta1   0.000030    0.025654  0.001165 0.999070
beta2   0.000034    0.012299  0.002804 0.997763
beta3   0.249478    0.194433  1.283103 0.199456
beta4   0.000023    0.015811  0.001450 0.998843
beta5   0.305551    0.350331  0.872179 0.383111
beta6   0.223709    0.192335  1.163118 0.244782
```

```
Robust Standard Errors:
          Estimate  Std. Error   t value  Pr(>|t|)
mu       -0.000001   0.000125  -0.008162  0.993487
ar1       0.002432   0.016371   0.148553  0.881906
omega     0.000003   0.000002   1.484539  0.137666
alpha1    0.082353   0.024563   3.352700  0.000800
alpha2    0.066531   0.033385   1.992851  0.046278
alpha3    0.029828   0.020022   1.489773  0.136284
alpha4    0.010084   0.045349   0.222355  0.824037
alpha5    0.000007   0.047656   0.000143  0.999886
alpha6    0.000004   0.060006   0.000072  0.999942
beta1     0.000030   0.009308   0.003212  0.997437
beta2     0.000034   0.022857   0.001509  0.998796
beta3     0.249478   0.732011   0.340812  0.733245
beta4     0.000023   0.023331   0.000983  0.999216
beta5     0.305551   0.601142   0.508285  0.611254
beta6     0.223709   0.439902   0.508542  0.611074

LogLikelihood : 15794.57

Information Criteria
------------------------------------

Akaike       -6.6370
Bayes        -6.6166
```

```
Shibata          -6.6371
Hannan-Quinn  -6.6299


*---------------------------------*
*           GARCH Model Fit       *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(6,7)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000120  -0.008482 0.993232
ar1     0.002401    0.015580   0.154101 0.877530
omega   0.000003    0.000001   4.786614 0.000002
alpha1  0.082193    0.017519   4.691569 0.000003
alpha2  0.066753    0.030191   2.211005 0.027035
alpha3  0.029702    0.013909   2.135536 0.032717
alpha4  0.010283    0.017398   0.591040 0.554494
alpha5  0.000004    0.023707   0.000186 0.999852
alpha6  0.000003    0.045441   0.000061 0.999951
```

```
beta1     0.000038     0.029035   0.001320  0.998947
beta2     0.000049     0.055741   0.000873  0.999303
beta3     0.248252     0.167350   1.483429  0.137960
beta4     0.000026     0.061508   0.000421  0.999664
beta5     0.309262     0.410605   0.753187  0.451338
beta6     0.221041     0.707502   0.312425  0.754718
beta7     0.000004     0.396142   0.000011  0.999991

Robust Standard Errors:
          Estimate   Std. Error    t value  Pr(>|t|)
mu       -0.000001     0.000159  -0.006401  0.994892
ar1       0.002401     0.016710   0.143681  0.885753
omega     0.000003     0.000002   1.709056  0.087441
alpha1    0.082193     0.030497   2.695098  0.007037
alpha2    0.066753     0.129437   0.515717  0.606052
alpha3    0.029702     0.022052   1.346908  0.178010
alpha4    0.010283     0.061313   0.167714  0.866808
alpha5    0.000004     0.082769   0.000053  0.999957
alpha6    0.000003     0.146569   0.000019  0.999985
beta1     0.000038     0.235105   0.000163  0.999870
beta2     0.000049     0.013938   0.003492  0.997214
beta3     0.248252     0.667176   0.372094  0.709823
beta4     0.000026     0.168008   0.000154  0.999877
beta5     0.309262     1.339778   0.230831  0.817446
beta6     0.221041     3.166859   0.069798  0.944354
beta7     0.000004     1.732606   0.000002  0.999998
```

```
LogLikelihood : 15794.47

Information Criteria
------------------------------------

Akaike       -6.6366
Bayes        -6.6148
Shibata      -6.6366
Hannan-Quinn -6.6289


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(6,8)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008675 0.993079
```

```
ar1       0.002320   0.015276   0.151885  0.879278
omega     0.000004   0.000002   2.067937  0.038646
alpha1    0.068349   0.013657   5.004591  0.000001
alpha2    0.045539   0.021729   2.095707  0.036108
alpha3    0.009462   0.002117   4.469342  0.000008
alpha4    0.041158   0.001903  21.629300  0.000000
alpha5    0.030325   0.034113   0.888954  0.374028
alpha6    0.032665   0.012494   2.614505  0.008936
beta1     0.308457   0.211136   1.460939  0.144032
beta2     0.000021   0.020113   0.001021  0.999185
beta3     0.000017   0.188906   0.000088  0.999929
beta4     0.000004   0.313741   0.000014  0.999989
beta5     0.000003   0.425952   0.000008  0.999994
beta6     0.000006   0.323357   0.000020  0.999984
beta7     0.000008   0.273491   0.000029  0.999977
beta8     0.424767   0.052218   8.134547  0.000000

Robust Standard Errors:
          Estimate  Std. Error    t value  Pr(>|t|)
mu       -0.000001    0.000128  -0.007983   0.99363
ar1       0.002320    0.016493   0.140681   0.88812
omega     0.000004    0.000006   0.543033   0.58711
alpha1    0.068349    0.041783   1.635826   0.10188
alpha2    0.045539    0.103158   0.441444   0.65889
alpha3    0.009462    0.055751   0.169715   0.86523
alpha4    0.041158    0.039741   1.035678   0.30035
```

```
alpha5   0.030325    0.144215  0.210275  0.83345
alpha6   0.032665    0.034430  0.948744  0.34275
beta1    0.308457    0.884778  0.348626  0.72737
beta2    0.000021    0.010041  0.002045  0.99837
beta3    0.000017    0.533738  0.000031  0.99997
beta4    0.000004    0.795289  0.000005  1.00000
beta5    0.000003    1.433362  0.000002  1.00000
beta6    0.000006    1.251000  0.000005  1.00000
beta7    0.000008    0.891192  0.000009  0.99999
beta8    0.424767    0.452832  0.938024  0.34823

LogLikelihood : 15795.81

Information Criteria
------------------------------------

Akaike        -6.6367
Bayes         -6.6136
Shibata       -6.6367
Hannan-Quinn  -6.6286


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(6,9)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000118  -0.008661  0.99309
ar1       0.002241    0.015431   0.145261  0.88450
omega     0.000001    0.000000  21.376776  0.00000
alpha1    0.080874    0.012378   6.533482  0.00000
alpha2    0.000017    0.024401   0.000706  0.99944
alpha3    0.000002    0.031678   0.000048  0.99996
alpha4    0.000003    0.021765   0.000123  0.99990
alpha5    0.000003    0.030057   0.000101  0.99992
alpha6    0.000011    0.030830   0.000343  0.99973
beta1     0.777879    0.019524  39.842474  0.00000
beta2     0.000056    0.145201   0.000388  0.99969
beta3     0.037690    0.111326   0.338557  0.73494
beta4     0.000098    0.032485   0.003003  0.99760
beta5     0.000013    0.209454   0.000063  0.99995
beta6     0.000006    0.573689   0.000011  0.99999
beta7     0.000005    0.378204   0.000014  0.99999
beta8     0.000013    0.256538   0.000049  0.99996
```

```
beta9   0.089758    0.145441  0.617148  0.53714

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000125 -0.008203 0.993455
ar1     0.002241    0.016432  0.136405 0.891501
omega   0.000001    0.000000  4.359274 0.000013
alpha1  0.080874    0.024728  3.270537 0.001073
alpha2  0.000017    0.042682  0.000403 0.999678
alpha3  0.000002    0.072174  0.000021 0.999983
alpha4  0.000003    0.067609  0.000040 0.999968
alpha5  0.000003    0.065623  0.000046 0.999963
alpha6  0.000011    0.094022  0.000112 0.999910
beta1   0.777879    0.118488  6.565041 0.000000
beta2   0.000056    0.166472  0.000338 0.999730
beta3   0.037690    0.660773  0.057040 0.954514
beta4   0.000098    0.352818  0.000276 0.999779
beta5   0.000013    1.090060  0.000012 0.999990
beta6   0.000006    1.326963  0.000005 0.999996
beta7   0.000005    1.156339  0.000004 0.999996
beta8   0.000013    0.553684  0.000023 0.999982
beta9   0.089758    0.232232  0.386503 0.699125

LogLikelihood : 15795.37

Information Criteria
```

```
-------------------------------------

Akaike        -6.6361
Bayes         -6.6116
Shibata       -6.6361
Hannan-Quinn  -6.6275


*-----------------------------------*
*          GARCH Model Fit          *
*-----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model       : sGARCH(6,10)
Mean Model        : ARFIMA(1,0,0)
Distribution      : norm

Optimal Parameters
------------------------------------
        Estimate   Std. Error   t value  Pr(>|t|)
mu     -0.000001    0.000118  -0.008669  0.993084
ar1     0.002625    0.015446   0.169923  0.865071
omega   0.000002    0.000000   5.888943  0.000000
alpha1  0.078363    0.014599   5.367547  0.000000
alpha2  0.020264    0.042254   0.479563  0.631538
```

```
alpha3   0.000004    0.011517   0.000369 0.999706
alpha4   0.002631    0.007070   0.372227 0.709724
alpha5   0.000020    0.003271   0.006161 0.995085
alpha6   0.012019    0.010856   1.107121 0.268242
beta1    0.646990    0.213236   3.034152 0.002412
beta2    0.000041    0.052254   0.000786 0.999373
beta3    0.000217    0.238302   0.000909 0.999275
beta4    0.090302    0.513358   0.175904 0.860369
beta5    0.000030    0.084269   0.000359 0.999714
beta6    0.000010    0.766986   0.000013 0.999989
beta7    0.000005    0.755497   0.000007 0.999994
beta8    0.000006    0.258379   0.000023 0.999982
beta9    0.000007    0.202661   0.000035 0.999972
beta10   0.130057    0.140670   0.924549 0.355201

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000130 -0.007848 0.993739
ar1       0.002625    0.016578  0.158327 0.874199
omega     0.000002    0.000001  1.724634 0.084593
alpha1    0.078363    0.043526  1.800375 0.071802
alpha2    0.020264    0.183179  0.110622 0.911916
alpha3    0.000004    0.077828  0.000055 0.999956
alpha4    0.002631    0.067725  0.038855 0.969006
alpha5    0.000020    0.055812  0.000361 0.999712
alpha6    0.012019    0.081126  0.148148 0.882226
```

```
beta1    0.646990   0.986191  0.656050  0.511792
beta2    0.000041   0.128932  0.000318  0.999746
beta3    0.000217   0.276329  0.000784  0.999374
beta4    0.090302   2.205236  0.040949  0.967337
beta5    0.000030   0.243754  0.000124  0.999901
beta6    0.000010   3.112558  0.000003  0.999997
beta7    0.000005   3.268898  0.000002  0.999999
beta8    0.000006   1.294814  0.000005  0.999996
beta9    0.000007   0.979698  0.000007  0.999994
beta10   0.130057   0.649860  0.200130  0.841379

LogLikelihood : 15796.51

Information Criteria
------------------------------------

Akaike        -6.6362
Bayes         -6.6103
Shibata       -6.6362
Hannan-Quinn  -6.6271


*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(7,1)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000119  -0.008624 0.993119
ar1     0.005243    0.015210   0.344735 0.730294
omega   0.000001    0.000000   7.213647 0.000000
alpha1  0.056781    0.015143   3.749696 0.000177
alpha2  0.000001    0.020027   0.000029 0.999977
alpha3  0.000000    0.021333   0.000013 0.999990
alpha4  0.000000    0.023803   0.000011 0.999992
alpha5  0.000000    0.022285   0.000010 0.999992
alpha6  0.000000    0.021225   0.000009 0.999992
alpha7  0.000000    0.014364   0.000011 0.999992
beta1   0.932408    0.004839 192.703348 0.000000

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000127 -0.008064 0.993566
ar1     0.005243    0.016106  0.325541 0.744772
omega   0.000001    0.000000  3.446323 0.000568
```

```
alpha1   0.056781   0.018286   3.105107  0.001902
alpha2   0.000001   0.023365   0.000025  0.999980
alpha3   0.000000   0.024543   0.000011  0.999991
alpha4   0.000000   0.027966   0.000009  0.999993
alpha5   0.000000   0.025220   0.000009  0.999993
alpha6   0.000000   0.020749   0.000010  0.999992
alpha7   0.000000   0.021924   0.000007  0.999994
beta1    0.932408   0.019227  48.493793  0.000000

LogLikelihood : 15789.08

Information Criteria
------------------------------------

Akaike       -6.6364
Bayes        -6.6215
Shibata      -6.6364
Hannan-Quinn -6.6312


*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*

Conditional Variance Dynamics
-----------------------------------
```

```
GARCH Model      : sGARCH(7,2)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000118  -0.008633 0.993112
ar1     0.004744    0.015341   0.309246 0.757134
omega   0.000001    0.000000   6.767538 0.000000
alpha1  0.066730    0.016005   4.169303 0.000031
alpha2  0.000002    0.017805   0.000093 0.999926
alpha3  0.000000    0.019707   0.000013 0.999989
alpha4  0.000000    0.021426   0.000012 0.999991
alpha5  0.000000    0.019843   0.000011 0.999991
alpha6  0.000000    0.018984   0.000012 0.999991
alpha7  0.000000    0.014437   0.000011 0.999991
beta1   0.718813    0.008384  85.732180 0.000000
beta2   0.201950    0.008526  23.686390 0.000000

Robust Standard Errors:
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000126  -0.008107 0.993532
ar1     0.004744    0.016136   0.294027 0.768737
omega   0.000001    0.000000   3.266116 0.001090
alpha1  0.066730    0.019362   3.446520 0.000568
```

```
alpha2   0.000002   0.021014   0.000079  0.999937
alpha3   0.000000   0.022985   0.000011  0.999991
alpha4   0.000000   0.025382   0.000010  0.999992
alpha5   0.000000   0.022325   0.000010  0.999992
alpha6   0.000000   0.018871   0.000012  0.999991
alpha7   0.000000   0.021789   0.000007  0.999994
beta1    0.718813   0.011870  60.556231  0.000000
beta2    0.201950   0.010014  20.166007  0.000000

LogLikelihood : 15789.83

Information Criteria
------------------------------------

Akaike        -6.6363
Bayes         -6.6200
Shibata       -6.6363
Hannan-Quinn  -6.6306


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
```

```
GARCH Model      : sGARCH(7,3)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000118  -0.004662 0.996280
ar1     0.003741    0.015471   0.241831 0.808911
omega   0.000001    0.000000   5.423330 0.000000
alpha1  0.076913    0.016925   4.544259 0.000006
alpha2  0.001892    0.018127   0.104371 0.916875
alpha3  0.000018    0.017480   0.001006 0.999197
alpha4  0.000009    0.020305   0.000454 0.999638
alpha5  0.000008    0.019205   0.000415 0.999669
alpha6  0.000011    0.018029   0.000617 0.999508
alpha7  0.000006    0.014564   0.000405 0.999677
beta1   0.675927    0.018511  36.515740 0.000000
beta2   0.000773    0.100016   0.007733 0.993830
beta3   0.229967    0.028171   8.163318 0.000000

Robust Standard Errors:
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000125  -0.004394 0.996494
ar1     0.003741    0.016227   0.230575 0.817645
omega   0.000001    0.000000   2.636959 0.008365
```

```
alpha1   0.076913   0.021049   3.653968  0.000258
alpha2   0.001892   0.022060   0.085759  0.931658
alpha3   0.000018   0.022043   0.000798  0.999363
alpha4   0.000009   0.023804   0.000387  0.999691
alpha5   0.000008   0.021290   0.000374  0.999702
alpha6   0.000011   0.017927   0.000620  0.999505
alpha7   0.000006   0.020082   0.000294  0.999766
beta1    0.675927   0.045409  14.885180  0.000000
beta2    0.000773   0.036860   0.020983  0.983259
beta3    0.229967   0.048174   4.773627  0.000002

LogLikelihood : 15791.52

Information Criteria
------------------------------------

Akaike        -6.6366
Bayes         -6.6189
Shibata       -6.6366
Hannan-Quinn  -6.6304


*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*
```

```
Conditional Variance Dynamics
-----------------------------------
GARCH Model       : sGARCH(7,4)
Mean Model        : ARFIMA(1,0,0)
Distribution      : norm

Optimal Parameters
-----------------------------------
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000118 -0.008550 0.993178
ar1      0.003405    0.015450  0.220412 0.825551
omega    0.000001    0.000000  8.014808 0.000000
alpha1   0.076099    0.016780  4.535029 0.000006
alpha2   0.017810    0.015112  1.178547 0.238579
alpha3   0.000003    0.013046  0.000201 0.999840
alpha4   0.000002    0.011265  0.000203 0.999838
alpha5   0.000001    0.018311  0.000040 0.999968
alpha6   0.000001    0.017058  0.000037 0.999970
alpha7   0.000000    0.014489  0.000030 0.999976
beta1    0.607654    0.121522  5.000377 0.000001
beta2    0.000071    0.206900  0.000341 0.999728
beta3    0.000135    0.223315  0.000606 0.999516
beta4    0.281679    0.096240  2.926837 0.003424

Robust Standard Errors:
         Estimate  Std. Error   t value Pr(>|t|)
```

mu	−0.000001	0.000125	−0.008112	0.993528
ar1	0.003405	0.016277	0.209221	0.834275
omega	0.000001	0.000000	5.686639	0.000000
alpha1	0.076099	0.021883	3.477494	0.000506
alpha2	0.017810	0.024564	0.725041	0.468427
alpha3	0.000003	0.020181	0.000130	0.999897
alpha4	0.000002	0.025972	0.000088	0.999930
alpha5	0.000001	0.020983	0.000035	0.999972
alpha6	0.000001	0.019390	0.000033	0.999974
alpha7	0.000000	0.018414	0.000023	0.999981
beta1	0.607654	0.149819	4.055925	0.000050
beta2	0.000071	0.049161	0.001434	0.998856
beta3	0.000135	0.095983	0.001411	0.998874
beta4	0.281679	0.210271	1.339599	0.180376

LogLikelihood : 15793.12

Information Criteria

Akaike	−6.6369
Bayes	−6.6178
Shibata	−6.6369
Hannan−Quinn	−6.6302

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(7,5)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008452 0.993257
ar1     0.002798    0.015548  0.179946 0.857195
omega   0.000002    0.000000 21.436547 0.000000
alpha1  0.080304    0.016927  4.744222 0.000002
alpha2  0.034792    0.051723  0.672657 0.501166
alpha3  0.000615    0.061328  0.010035 0.991993
alpha4  0.000039    0.010491  0.003758 0.997002
alpha5  0.000003    0.023452  0.000148 0.999882
alpha6  0.000002    0.028403  0.000067 0.999946
alpha7  0.000001    0.018688  0.000065 0.999948
beta1   0.432326    0.570537  0.757752 0.448599
beta2   0.003197    1.154324  0.002770 0.997790
beta3   0.152545    0.534505  0.285394 0.775342
```

```
beta4    0.000096    0.137227   0.000703 0.999439
beta5    0.276348    0.085547   3.230374 0.001236

Robust Standard Errors:
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000126  -0.007947 0.993659
ar1       0.002798    0.016810   0.166435 0.867815
omega     0.000002    0.000000   3.919497 0.000089
alpha1    0.080304    0.020784   3.863652 0.000112
alpha2    0.034792    0.113816   0.305688 0.759842
alpha3    0.000615    0.117711   0.005228 0.995828
alpha4    0.000039    0.031805   0.001239 0.999011
alpha5    0.000003    0.060110   0.000058 0.999954
alpha6    0.000002    0.063656   0.000030 0.999976
alpha7    0.000001    0.039160   0.000031 0.999975
beta1     0.432326    1.346520   0.321069 0.748158
beta2     0.003197    2.309993   0.001384 0.998896
beta3     0.152545    1.212235   0.125838 0.899860
beta4     0.000096    0.128054   0.000753 0.999399
beta5     0.276348    0.194929   1.417688 0.156282

LogLikelihood : 15793.97

Information Criteria
```

```
Akaike        -6.6368
Bayes         -6.6164
Shibata       -6.6368
Hannan-Quinn  -6.6296


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(7,6)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008588 0.993148
ar1     0.002441    0.015538  0.157077 0.875184
omega   0.000003    0.000001  4.999535 0.000001
alpha1  0.082076    0.017317  4.739506 0.000002
alpha2  0.066685    0.015547  4.289256 0.000018
alpha3  0.029653    0.005730  5.175171 0.000000
alpha4  0.010153    0.009346  1.086296 0.277348
```

```
alpha5   0.000004    0.010043   0.000408  0.999675
alpha6   0.000003    0.034250   0.000096  0.999923
alpha7   0.000002    0.018419   0.000097  0.999923
beta1    0.000037    0.053558   0.000692  0.999448
beta2    0.000032    0.052322   0.000617  0.999508
beta3    0.248364    0.178984   1.387634  0.165249
beta4    0.000015    0.308541   0.000048  0.999962
beta5    0.309315    0.302808   1.021490  0.307022
beta6    0.221340    0.189225   1.169719  0.242114

Robust Standard Errors:
         Estimate  Std. Error   t value  Pr(>|t|)
mu      -0.000001    0.000125 -0.008165  0.993485
ar1      0.002441    0.016402  0.148799  0.881712
omega    0.000003    0.000002  1.727664  0.084048
alpha1   0.082076    0.022162  3.703511  0.000213
alpha2   0.066685    0.028385  2.349290  0.018809
alpha3   0.029653    0.015406  1.924691  0.054268
alpha4   0.010153    0.050455  0.201225  0.840523
alpha5   0.000004    0.037586  0.000109  0.999913
alpha6   0.000003    0.049951  0.000066  0.999947
alpha7   0.000002    0.028610  0.000062  0.999950
beta1    0.000037    0.126299  0.000293  0.999766
beta2    0.000032    0.107047  0.000301  0.999759
beta3    0.248364    0.610058  0.407115  0.683924
beta4    0.000015    0.402377  0.000037  0.999971
```

```
beta5    0.309315    0.487595   0.634369  0.525840
beta6    0.221340    0.481152   0.460021  0.645501

LogLikelihood : 15794.47

Information Criteria
------------------------------------

Akaike        -6.6366
Bayes         -6.6148
Shibata       -6.6366
Hannan-Quinn  -6.6289


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(7,7)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
```

```
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000121 -0.008479 0.993235
ar1     0.002318    0.016457  0.140855 0.887985
omega   0.000003    0.000000  6.756815 0.000000
alpha1  0.084235    0.019343  4.354858 0.000013
alpha2  0.066222    0.039657  1.669886 0.094942
alpha3  0.029266    0.013790  2.122242 0.033817
alpha4  0.000007    0.030777  0.000232 0.999815
alpha5  0.000001    0.084363  0.000011 0.999991
alpha6  0.000002    0.120295  0.000018 0.999986
alpha7  0.000002    0.041856  0.000050 0.999960
beta1   0.000020    0.031154  0.000648 0.999483
beta2   0.000089    0.039963  0.002229 0.998222
beta3   0.335397    0.265663  1.262489 0.206773
beta4   0.000009    0.632390  0.000014 0.999989
beta5   0.289693    1.391499  0.208188 0.835082
beta6   0.164204    1.281644  0.128120 0.898054
beta7   0.000007    0.434779  0.000016 0.999987

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000202 -0.005067 0.995957
ar1     0.002318    0.038191  0.060695 0.951602
omega   0.000003    0.000001  2.661608 0.007777
alpha1  0.084235    0.060900  1.383181 0.166609
alpha2  0.066222    0.242991  0.272529 0.785215
```

```
alpha3   0.029266    0.073245   0.399562  0.689479
alpha4   0.000007    0.109011   0.000065  0.999948
alpha5   0.000001    0.533392   0.000002  0.999999
alpha6   0.000002    0.749116   0.000003  0.999998
alpha7   0.000002    0.214443   0.000010  0.999992
beta1    0.000020    0.073510   0.000275  0.999781
beta2    0.000089    0.680595   0.000131  0.999896
beta3    0.335397    1.431628   0.234276  0.814770
beta4    0.000009    3.988032   0.000002  0.999998
beta5    0.289693    8.704784   0.033280  0.973452
beta6    0.164204    8.115610   0.020233  0.983857
beta7    0.000007    2.643120   0.000003  0.999998

LogLikelihood : 15794.37

Information Criteria
------------------------------------

Akaike        -6.6361
Bayes         -6.6130
Shibata       -6.6361
Hannan-Quinn  -6.6280


*---------------------------------*
*          GARCH Model Fit        *
```

```
*---------------------------------*

 Conditional Variance Dynamics
-----------------------------------
GARCH Model    : sGARCH(7,8)
Mean Model     : ARFIMA(1,0,0)
Distribution   : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008637 0.993109
ar1     0.002034    0.015394  0.132151 0.894865
omega   0.000003    0.000001  2.769453 0.005615
alpha1  0.070326    0.013954  5.039923 0.000000
alpha2  0.042988    0.015782  2.723843 0.006453
alpha3  0.002334    0.013458  0.173456 0.862293
alpha4  0.040134    0.012431  3.228505 0.001244
alpha5  0.025399    0.017744  1.431422 0.152309
alpha6  0.028341    0.018145  1.561904 0.118310
alpha7  0.000004    0.011220  0.000326 0.999740
beta1   0.365046    0.101924  3.581562 0.000342
beta2   0.000047    0.062743  0.000753 0.999399
beta3   0.000022    0.037710  0.000590 0.999529
beta4   0.000003    0.155789  0.000017 0.999986
beta5   0.000001    0.411993  0.000003 0.999997
```

beta6	0.000005	0.271947	0.000017	0.999986
beta7	0.000006	0.232734	0.000024	0.999981
beta8	0.389093	0.300486	1.294881	0.195361

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000153	−0.006693	0.994660
ar1	0.002034	0.017536	0.116009	0.907645
omega	0.000003	0.000007	0.433899	0.664362
alpha1	0.070326	0.031955	2.200793	0.027751
alpha2	0.042988	0.054355	0.790868	0.429021
alpha3	0.002334	0.026782	0.087165	0.930540
alpha4	0.040134	0.032241	1.244804	0.213204
alpha5	0.025399	0.130142	0.195160	0.845267
alpha6	0.028341	0.066756	0.424544	0.671169
alpha7	0.000004	0.042904	0.000085	0.999932
beta1	0.365046	0.627734	0.581530	0.560883
beta2	0.000047	0.049126	0.000962	0.999232
beta3	0.000022	0.077324	0.000288	0.999771
beta4	0.000003	0.542327	0.000005	0.999996
beta5	0.000001	2.420229	0.000001	1.000000
beta6	0.000005	0.446709	0.000010	0.999992
beta7	0.000006	0.427411	0.000013	0.999990
beta8	0.389093	1.860900	0.209089	0.834379

LogLikelihood : 15795.72

```
Information Criteria
------------------------------------

Akaike       -6.6363
Bayes        -6.6118
Shibata      -6.6363
Hannan-Quinn -6.6277


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(7,9)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008632 0.993113
ar1     0.002101    0.015844  0.132624 0.894490
omega   0.000001    0.000000 11.796329 0.000000
```

```
alpha1   0.080703    0.033038   2.442723 0.014577
alpha2   0.000004    0.018420   0.000233 0.999814
alpha3   0.000002    0.022189   0.000070 0.999944
alpha4   0.000002    0.050552   0.000049 0.999961
alpha5   0.000003    0.039135   0.000079 0.999937
alpha6   0.000006    0.023009   0.000250 0.999801
alpha7   0.000001    0.035529   0.000018 0.999986
beta1    0.779358    0.146584   5.316785 0.000000
beta2    0.000056    0.146009   0.000383 0.999694
beta3    0.037030    0.467857   0.079148 0.936915
beta4    0.000112    0.917613   0.000122 0.999902
beta5    0.000023    0.093620   0.000250 0.999800
beta6    0.000007    0.451370   0.000015 0.999988
beta7    0.000005    0.842917   0.000007 0.999995
beta8    0.000014    0.408472   0.000033 0.999974
beta9    0.089103    0.112148   0.794513 0.426897

Robust Standard Errors:
         Estimate  Std. Error    t value Pr(>|t|)
mu      -0.000001    0.000125  -0.008155 0.993493
ar1      0.002101    0.019586   0.107285 0.914563
omega    0.000001    0.000000   3.142729 0.001674
alpha1   0.080703    0.105241   0.766843 0.443175
alpha2   0.000004    0.023054   0.000186 0.999852
alpha3   0.000002    0.032517   0.000048 0.999962
alpha4   0.000002    0.153144   0.000016 0.999987
```

```
alpha5   0.000003    0.110906   0.000028  0.999978
alpha6   0.000006    0.068729   0.000084  0.999933
alpha7   0.000001    0.102564   0.000006  0.999995
beta1    0.779358    0.511405   1.523954  0.127520
beta2    0.000056    0.531890   0.000105  0.999916
beta3    0.037030    1.713351   0.021613  0.982757
beta4    0.000112    3.221178   0.000035  0.999972
beta5    0.000023    0.292784   0.000080  0.999936
beta6    0.000007    1.729686   0.000004  0.999997
beta7    0.000005    2.877163   0.000002  0.999998
beta8    0.000014    1.588405   0.000008  0.999993
beta9    0.089103    0.633759   0.140595  0.888190

LogLikelihood : 15795.37

Information Criteria
------------------------------------

Akaike        -6.6357
Bayes         -6.6099
Shibata       -6.6357
Hannan-Quinn  -6.6266


*---------------------------------*
*          GARCH Model Fit        *
```

```
*---------------------------------------------*

 Conditional Variance Dynamics
-----------------------------------------------
GARCH Model      : sGARCH(7,10)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------------------
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000118 -0.008649 0.993099
ar1       0.002571    0.015492  0.165976 0.868176
omega     0.000002    0.000000  9.804133 0.000000
alpha1    0.078338    0.016561  4.730245 0.000002
alpha2    0.020317    0.014167  1.434137 0.151533
alpha3    0.000004    0.022751  0.000188 0.999850
alpha4    0.002766    0.025191  0.109816 0.912555
alpha5    0.000020    0.016567  0.001215 0.999030
alpha6    0.012102    0.012843  0.942293 0.346042
alpha7    0.000001    0.008233  0.000141 0.999887
beta1     0.646161    0.123238  5.243189 0.000000
beta2     0.000042    0.047282  0.000888 0.999292
beta3     0.000139    0.173043  0.000801 0.999361
beta4     0.090575    0.199876  0.453155 0.650437
beta5     0.000028    0.026754  0.001035 0.999174
```

```
beta6     0.000010    0.325121  0.000031 0.999975
beta7     0.000005    0.177451  0.000031 0.999976
beta8     0.000006    0.211566  0.000028 0.999977
beta9     0.000007    0.247234  0.000029 0.999977
beta10    0.130387    0.165176  0.789383 0.429888

Robust Standard Errors:
           Estimate  Std. Error    t value Pr(>|t|)
mu        -0.000001    0.000125 -0.008162 0.993488
ar1        0.002571    0.016262  0.158109 0.874371
omega      0.000002    0.000000  4.170575 0.000030
alpha1     0.078338    0.024001  3.263980 0.001099
alpha2     0.020317    0.041753  0.486595 0.626546
alpha3     0.000004    0.035402  0.000121 0.999904
alpha4     0.002766    0.026670  0.103726 0.917387
alpha5     0.000020    0.027231  0.000739 0.999410
alpha6     0.012102    0.024047  0.503256 0.614785
alpha7     0.000001    0.030632  0.000038 0.999970
beta1      0.646161    0.250516  2.579325 0.009899
beta2      0.000042    0.043977  0.000955 0.999238
beta3      0.000139    0.381343  0.000364 0.999710
beta4      0.090575    0.701929  0.129037 0.897328
beta5      0.000028    0.080021  0.000346 0.999724
beta6      0.000010    0.377888  0.000027 0.999979
beta7      0.000005    0.458101  0.000012 0.999991
beta8      0.000006    0.626330  0.000010 0.999992
```

```
beta9    0.000007     0.447544  0.000016 0.999987
beta10   0.130387     0.509921  0.255700 0.798183

LogLikelihood : 15796.51

Information Criteria
------------------------------------


Akaike        -6.6358
Bayes         -6.6086
Shibata       -6.6358
Hannan-Quinn  -6.6262



*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(8,1)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
```

```
          Estimate  Std. Error     t value Pr(>|t|)
mu       -0.000001    0.000119   -0.008616 0.993126
ar1       0.005241    0.015211    0.344578 0.730411
omega     0.000001    0.000000    8.294891 0.000000
alpha1    0.056755    0.015181    3.738426 0.000185
alpha2    0.000001    0.020086    0.000027 0.999978
alpha3    0.000000    0.021340    0.000014 0.999989
alpha4    0.000000    0.023826    0.000012 0.999990
alpha5    0.000000    0.022340    0.000012 0.999990
alpha6    0.000000    0.021231    0.000013 0.999990
alpha7    0.000000    0.021273    0.000010 0.999992
alpha8    0.000000    0.014402    0.000011 0.999991
beta1     0.932435    0.004760  195.881652 0.000000

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000127 -0.008037 0.993587
ar1       0.005241    0.016094  0.325673 0.744672
omega     0.000001    0.000000  3.975230 0.000070
alpha1    0.056755    0.018224  3.114290 0.001844
alpha2    0.000001    0.023204  0.000023 0.999981
alpha3    0.000000    0.024579  0.000012 0.999991
alpha4    0.000000    0.027834  0.000011 0.999992
alpha5    0.000000    0.024960  0.000011 0.999991
alpha6    0.000000    0.020734  0.000013 0.999990
alpha7    0.000000    0.020749  0.000010 0.999992
```

```
alpha8   0.000000     0.020166   0.000008  0.999993
beta1    0.932435     0.018486  50.440516  0.000000

LogLikelihood : 15789.03

Information Criteria
------------------------------------

Akaike        -6.6360
Bayes         -6.6197
Shibata       -6.6360
Hannan-Quinn  -6.6302



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(8,2)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
```

```
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000118  -0.008473 0.993240
ar1       0.004524    0.015344   0.294837 0.768118
omega     0.000001    0.000000   7.757508 0.000000
alpha1    0.066903    0.016066   4.164145 0.000031
alpha2    0.000004    0.017926   0.000229 0.999818
alpha3    0.000000    0.019713   0.000023 0.999982
alpha4    0.000000    0.021442   0.000020 0.999984
alpha5    0.000000    0.019871   0.000019 0.999985
alpha6    0.000000    0.019168   0.000020 0.999984
alpha7    0.000000    0.019189   0.000014 0.999988
alpha8    0.000000    0.014336   0.000015 0.999988
beta1     0.721127    0.008488  84.959551 0.000000
beta2     0.199301    0.008595  23.187285 0.000000

Robust Standard Errors:
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000127  -0.007903 0.993694
ar1       0.004524    0.016128   0.280504 0.779091
omega     0.000001    0.000000   3.890886 0.000100
alpha1    0.066903    0.019297   3.467075 0.000526
alpha2    0.000004    0.020955   0.000196 0.999844
alpha3    0.000000    0.022978   0.000019 0.999985
alpha4    0.000000    0.025224   0.000017 0.999987
alpha5    0.000000    0.022082   0.000017 0.999987
alpha6    0.000000    0.019308   0.000019 0.999985
```

```
alpha7   0.000000    0.019647   0.000014  0.999989
alpha8   0.000000    0.021044   0.000010  0.999992
beta1    0.721127    0.011142  64.718909  0.000000
beta2    0.199301    0.009757  20.425558  0.000000

LogLikelihood : 15789.79

Information Criteria
------------------------------------

Akaike       -6.6359
Bayes        -6.6182
Shibata      -6.6359
Hannan-Quinn -6.6297



*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(8,3)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm
```

```
Optimal Parameters
------------------------------------
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000118  -0.008612 0.993129
ar1     0.003515    0.015469   0.227220 0.820253
omega   0.000001    0.000000   5.834707 0.000000
alpha1  0.076431    0.016374   4.667824 0.000003
alpha2  0.000061    0.016805   0.003611 0.997119
alpha3  0.000001    0.017774   0.000042 0.999966
alpha4  0.000000    0.020440   0.000022 0.999982
alpha5  0.000000    0.019311   0.000022 0.999983
alpha6  0.000000    0.018247   0.000024 0.999981
alpha7  0.000000    0.018659   0.000015 0.999988
alpha8  0.000000    0.014400   0.000014 0.999989
beta1   0.691116    0.016765  41.224162 0.000000
beta2   0.000020    0.043801   0.000446 0.999644
beta3   0.218438    0.017819  12.258993 0.000000

Robust Standard Errors:
        Estimate  Std. Error    t value Pr(>|t|)
mu     -0.000001    0.000127  -0.008035 0.993589
ar1     0.003515    0.016216   0.216757 0.828398
omega   0.000001    0.000000   2.984666 0.002839
alpha1  0.076431    0.019368   3.946265 0.000079
alpha2  0.000061    0.018375   0.003302 0.997365
alpha3  0.000001    0.021005   0.000036 0.999971
```

```
alpha4   0.000000    0.024069   0.000019 0.999985
alpha5   0.000000    0.021559   0.000019 0.999985
alpha6   0.000000    0.017970   0.000025 0.999980
alpha7   0.000000    0.018743   0.000015 0.999988
alpha8   0.000000    0.022252   0.000009 0.999993
beta1    0.691116    0.019674  35.129178 0.000000
beta2    0.000020    0.019812   0.000986 0.999213
beta3    0.218438    0.013063  16.722152 0.000000

LogLikelihood : 15791.48

Information Criteria
------------------------------------

Akaike        -6.6362
Bayes         -6.6171
Shibata       -6.6362
Hannan-Quinn  -6.6295


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
```

```
GARCH Model       : sGARCH(8,4)
Mean Model        : ARFIMA(1,0,0)
Distribution      : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008629 0.993115
ar1     0.003407    0.015453  0.220445 0.825525
omega   0.000001    0.000000 10.213370 0.000000
alpha1  0.076116    0.016942  4.492739 0.000007
alpha2  0.017556    0.019556  0.897750 0.369319
alpha3  0.000001    0.018779  0.000054 0.999957
alpha4  0.000001    0.020062  0.000053 0.999957
alpha5  0.000001    0.019005  0.000026 0.999979
alpha6  0.000001    0.018592  0.000030 0.999976
alpha7  0.000000    0.018090  0.000021 0.999983
alpha8  0.000000    0.015076  0.000017 0.999986
beta1   0.609120    0.115017  5.295892 0.000000
beta2   0.000023    0.044569  0.000525 0.999581
beta3   0.000075    0.147044  0.000508 0.999595
beta4   0.280599    0.124138  2.260374 0.023798

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000126 -0.008124 0.993518
```

ar1	0.003407	0.016254	0.209584	0.833992
omega	0.000001	0.000000	6.659708	0.000000
alpha1	0.076116	0.021567	3.529301	0.000417
alpha2	0.017556	0.025017	0.701788	0.482811
alpha3	0.000001	0.023240	0.000044	0.999965
alpha4	0.000001	0.020575	0.000052	0.999958
alpha5	0.000001	0.022038	0.000023	0.999982
alpha6	0.000001	0.019109	0.000029	0.999977
alpha7	0.000000	0.017931	0.000021	0.999983
alpha8	0.000000	0.019895	0.000013	0.999990
beta1	0.609120	0.181399	3.357894	0.000785
beta2	0.000023	0.007483	0.003126	0.997506
beta3	0.000075	0.034589	0.002160	0.998276
beta4	0.280599	0.145335	1.930703	0.053520

LogLikelihood : 15793.05

Information Criteria

Akaike	−6.6364
Bayes	−6.6160
Shibata	−6.6364
Hannan−Quinn	−6.6292

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(8,5)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000119 -0.008609 0.993131
ar1     0.002780    0.016632  0.167165 0.867240
omega   0.000002    0.000000  4.536201 0.000006
alpha1  0.080314    0.016951  4.738059 0.000002
alpha2  0.034191    0.218310  0.156618 0.875546
alpha3  0.000412    0.275727  0.001495 0.998807
alpha4  0.000016    0.047842  0.000340 0.999729
alpha5  0.000002    0.185964  0.000009 0.999993
alpha6  0.000001    0.114062  0.000007 0.999994
alpha7  0.000000    0.092129  0.000005 0.999996
alpha8  0.000000    0.068400  0.000004 0.999997
beta1   0.438956    2.514464  0.174572 0.861416
beta2   0.000929    5.348140  0.000174 0.999861
```

```
beta3     0.150597    3.290628   0.045765  0.963497
beta4     0.000049    0.072749   0.000672  0.999463
beta5     0.274962    0.377832   0.727735  0.466776

Robust Standard Errors:
          Estimate  Std. Error    t value  Pr(>|t|)
mu       -0.000001    0.000152  -0.006736  0.994626
ar1       0.002780    0.047681   0.058311  0.953501
omega     0.000002    0.000003   0.578554  0.562890
alpha1    0.080314    0.022624   3.549968  0.000385
alpha2    0.034191    1.610705   0.021227  0.983064
alpha3    0.000412    2.022470   0.000204  0.999837
alpha4    0.000016    0.359074   0.000045  0.999964
alpha5    0.000002    1.372626   0.000001  0.999999
alpha6    0.000001    0.843206   0.000001  0.999999
alpha7    0.000000    0.675303   0.000001  0.999999
alpha8    0.000000    0.489800   0.000001  1.000000
beta1     0.438956   18.615580   0.023580  0.981188
beta2     0.000929   39.314337   0.000024  0.999981
beta3     0.150597   24.204503   0.006222  0.995036
beta4     0.000049    0.638493   0.000077  0.999939
beta5     0.274962    2.930997   0.093812  0.925259

LogLikelihood : 15793.91

Information Criteria
```

```
----------------------------------------

Akaike        -6.6363
Bayes         -6.6146
Shibata       -6.6364
Hannan-Quinn  -6.6287


*---------------------------------------*
*            GARCH Model Fit            *
*---------------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model         : sGARCH(8,6)
Mean Model          : ARFIMA(1,0,0)
Distribution        : norm

Optimal Parameters
----------------------------------------
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000118  -0.008636 0.993110
ar1       0.002440    0.015538   0.157042 0.875212
omega     0.000003    0.000001   4.908281 0.000001
alpha1    0.082236    0.017232   4.772386 0.000002
alpha2    0.066499    0.009839   6.758890 0.000000
```

```
alpha3   0.029724    0.012396   2.397968 0.016486
alpha4   0.010177    0.007241   1.405469 0.159882
alpha5   0.000004    0.017065   0.000207 0.999835
alpha6   0.000002    0.057390   0.000041 0.999967
alpha7   0.000001    0.016884   0.000075 0.999941
alpha8   0.000000    0.020902   0.000017 0.999987
beta1    0.000031    0.072792   0.000425 0.999661
beta2    0.000034    0.106783   0.000319 0.999745
beta3    0.246766    0.121228   2.035552 0.041795
beta4    0.000020    0.028884   0.000694 0.999446
beta5    0.306604    0.510669   0.600397 0.548242
beta6    0.225582    0.237717   0.948949 0.342647

Robust Standard Errors:
         Estimate  Std. Error    t value Pr(>|t|)
mu      -0.000001    0.000126  -0.008101 0.993537
ar1      0.002440    0.016385   0.148921 0.881616
omega    0.000003    0.000002   1.300331 0.193488
alpha1   0.082236    0.023564   3.489878 0.000483
alpha2   0.066499    0.042541   1.563164 0.118014
alpha3   0.029724    0.033734   0.881138 0.378243
alpha4   0.010177    0.044857   0.226879 0.820518
alpha5   0.000004    0.060188   0.000059 0.999953
alpha6   0.000002    0.172294   0.000014 0.999989
alpha7   0.000001    0.026198   0.000048 0.999962
alpha8   0.000000    0.080059   0.000004 0.999996
```

```
beta1    0.000031    0.124840   0.000248  0.999802
beta2    0.000034    0.187069   0.000182  0.999855
beta3    0.246766    0.797124   0.309570  0.756888
beta4    0.000020    0.023352   0.000858  0.999315
beta5    0.306604    1.491063   0.205628  0.837081
beta6    0.225582    1.343329   0.167927  0.866640

LogLikelihood : 15794.4

Information Criteria
------------------------------------

Akaike       -6.6361
Bayes        -6.6130
Shibata      -6.6362
Hannan-Quinn -6.6280


*---------------------------------*
*         GARCH Model Fit         *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(8,7)
Mean Model      : ARFIMA(1,0,0)
```

```
Distribution       : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008682 0.993073
ar1     0.002442    0.015552  0.157003 0.875242
omega   0.000003    0.000000  8.632111 0.000000
alpha1  0.082226    0.016286  5.048728 0.000000
alpha2  0.066492    0.011304  5.881964 0.000000
alpha3  0.029706    0.011391  2.607822 0.009112
alpha4  0.010146    0.017453  0.581323 0.561023
alpha5  0.000005    0.017339  0.000305 0.999757
alpha6  0.000003    0.055939  0.000054 0.999957
alpha7  0.000001    0.016130  0.000088 0.999930
alpha8  0.000000    0.019088  0.000019 0.999985
beta1   0.000027    0.033681  0.000811 0.999353
beta2   0.000032    0.038066  0.000840 0.999330
beta3   0.247163    0.239035  1.034004 0.301134
beta4   0.000019    0.030779  0.000621 0.999505
beta5   0.306565    0.522751  0.586445 0.557577
beta6   0.225283    0.456690  0.493296 0.621804
beta7   0.000009    0.193659  0.000047 0.999962

Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
```

mu	−0.000001	0.000123	−0.008308	0.993371
ar1	0.002442	0.016374	0.149127	0.881454
omega	0.000003	0.000002	1.787387	0.073875
alpha1	0.082226	0.031408	2.617989	0.008845
alpha2	0.066492	0.029833	2.228818	0.025826
alpha3	0.029706	0.027501	1.080157	0.280072
alpha4	0.010146	0.047123	0.215309	0.829527
alpha5	0.000005	0.058120	0.000091	0.999927
alpha6	0.000003	0.173641	0.000017	0.999986
alpha7	0.000001	0.050209	0.000028	0.999977
alpha8	0.000000	0.078892	0.000005	0.999996
beta1	0.000027	0.011227	0.002433	0.998059
beta2	0.000032	0.033493	0.000954	0.999239
beta3	0.247163	0.666237	0.370984	0.710649
beta4	0.000019	0.023538	0.000812	0.999352
beta5	0.306565	1.548333	0.197997	0.843048
beta6	0.225283	1.126232	0.200033	0.841455
beta7	0.000009	0.483865	0.000019	0.999985

```
LogLikelihood : 15794.4

Information Criteria
------------------------------------

Akaike       -6.6357
Bayes        -6.6112
```

```
Shibata        -6.6357
Hannan-Quinn  -6.6271


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(8,8)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000119 -0.008085 0.993549
ar1     0.002009    0.015627  0.128558 0.897708
omega   0.000002    0.000000 12.529296 0.000000
alpha1  0.080860    0.017873  4.524080 0.000006
alpha2  0.020523    0.107378  0.191131 0.848423
alpha3  0.000035    0.069471  0.000500 0.999601
alpha4  0.000164    0.027248  0.006023 0.995194
alpha5  0.000030    0.000415  0.072408 0.942277
alpha6  0.003947    0.032415  0.121752 0.903095
```

```
alpha7   0.000004    0.038879   0.000115  0.999908
alpha8   0.000002    0.024995   0.000067  0.999947
beta1    0.599346    1.183833   0.506276  0.612663
beta2    0.001725    1.872735   0.000921  0.999265
beta3    0.148714    0.595525   0.249719  0.802805
beta4    0.000169    0.068069   0.002482  0.998019
beta5    0.000059    0.057051   0.001035  0.999174
beta6    0.000035    0.027977   0.001253  0.999001
beta7    0.000036    0.045615   0.000779  0.999379
beta8    0.126458    0.067291   1.879263  0.060209

Robust Standard Errors:
         Estimate   Std. Error    t value  Pr(>|t|)
mu      -0.000001    0.000131  -0.007314  0.994164
ar1      0.002009    0.017185   0.116907  0.906934
omega    0.000002    0.000000   7.200916  0.000000
alpha1   0.080860    0.030947   2.612879  0.008978
alpha2   0.020523    0.318593   0.064418  0.948637
alpha3   0.000035    0.205889   0.000169  0.999865
alpha4   0.000164    0.060364   0.002719  0.997831
alpha5   0.000030    0.019672   0.001529  0.998780
alpha6   0.003947    0.094418   0.041800  0.966658
alpha7   0.000004    0.113999   0.000039  0.999969
alpha8   0.000002    0.062743   0.000027  0.999979
beta1    0.599346    3.500228   0.171231  0.864042
beta2    0.001725    5.525793   0.000312  0.999751
```

```
beta3    0.148714    1.909245   0.077891  0.937914
beta4    0.000169    0.049810   0.003392  0.997293
beta5    0.000059    0.291974   0.000202  0.999839
beta6    0.000035    0.097567   0.000359  0.999713
beta7    0.000036    0.173831   0.000204  0.999837
beta8    0.126458    0.181019   0.698593  0.484806

LogLikelihood : 15794.77

Information Criteria
------------------------------------

Akaike       -6.6354
Bayes        -6.6096
Shibata      -6.6355
Hannan-Quinn -6.6264


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(8,9)
Mean Model      : ARFIMA(1,0,0)
```

```
Distribution      : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error  t value  Pr(>|t|)
mu     -0.000001  0.000118  -0.008677  0.99308
ar1     0.002183  0.015479   0.141049  0.88783
omega   0.000001  0.000000   9.112025  0.00000
alpha1  0.080746  0.012620   6.398392  0.00000
alpha2  0.000016  0.016425   0.000998  0.99920
alpha3  0.000001  0.020057   0.000072  0.99994
alpha4  0.000003  0.016143   0.000173  0.99986
alpha5  0.000003  0.004409   0.000670  0.99947
alpha6  0.000010  0.003471   0.003015  0.99760
alpha7  0.000001  0.012804   0.000045  0.99996
alpha8  0.000000  0.022720   0.000011  0.99999
beta1   0.778969  0.032134  24.241017  0.00000
beta2   0.000061  0.065340   0.000930  0.99926
beta3   0.037080  0.201238   0.184259  0.85381
beta4   0.000105  0.073147   0.001434  0.99886
beta5   0.000023  0.016052   0.001426  0.99886
beta6   0.000006  0.416258   0.000015  0.99999
beta7   0.000005  0.507511   0.000010  0.99999
beta8   0.000012  0.348057   0.000035  0.99997
beta9   0.089417  0.154097   0.580263  0.56174
```

```
Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000127 -0.008076 0.993556
ar1       0.002183    0.016275  0.134153 0.893281
omega     0.000001    0.000000  4.689325 0.000003
alpha1    0.080746    0.020814  3.879426 0.000105
alpha2    0.000016    0.021488  0.000763 0.999391
alpha3    0.000001    0.022788  0.000063 0.999949
alpha4    0.000003    0.031542  0.000088 0.999929
alpha5    0.000003    0.029176  0.000101 0.999919
alpha6    0.000010    0.027011  0.000387 0.999691
alpha7    0.000001    0.043427  0.000013 0.999989
alpha8    0.000000    0.046819  0.000005 0.999996
beta1     0.778969    0.104625  7.445358 0.000000
beta2     0.000061    0.056356  0.001078 0.999140
beta3     0.037080    0.298139  0.124371 0.901021
beta4     0.000105    0.051445  0.002039 0.998373
beta5     0.000023    0.010992  0.002082 0.998338
beta6     0.000006    0.613124  0.000010 0.999992
beta7     0.000005    0.612623  0.000008 0.999993
beta8     0.000012    0.438155  0.000028 0.999978
beta9     0.089417    0.196503  0.455040 0.649081

LogLikelihood : 15795.37


Information Criteria
```

```
---------------------------------------

Akaike        -6.6353
Bayes         -6.6081
Shibata       -6.6353
Hannan-Quinn  -6.6257


*-------------------------------------*
*           GARCH Model Fit           *
*-------------------------------------*

Conditional Variance Dynamics
-------------------------------------
GARCH Model     : sGARCH(8,10)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
---------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008649 0.993099
ar1     0.002626    0.015428  0.170228 0.864831
omega   0.000002    0.000000  8.876806 0.000000
alpha1  0.078367    0.016490  4.752335 0.000002
alpha2  0.020267    0.022096  0.917239 0.359017
```

```
alpha3   0.000004    0.017201   0.000256 0.999796
alpha4   0.002637    0.019064   0.138298 0.890005
alpha5   0.000016    0.012727   0.001289 0.998972
alpha6   0.012007    0.010276   1.168461 0.242621
alpha7   0.000001    0.012005   0.000106 0.999915
alpha8   0.000000    0.011650   0.000032 0.999974
beta1    0.646936    0.174590   3.705467 0.000211
beta2    0.000042    0.013560   0.003107 0.997521
beta3    0.000194    0.080382   0.002409 0.998078
beta4    0.090394    0.087765   1.029947 0.303035
beta5    0.000047    0.025358   0.001853 0.998521
beta6    0.000011    0.296842   0.000036 0.999972
beta7    0.000006    0.336893   0.000016 0.999987
beta8    0.000006    0.322520   0.000019 0.999985
beta9    0.000007    0.232888   0.000032 0.999975
beta10   0.130025    0.154344   0.842436 0.399544

Robust Standard Errors:
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000126 -0.008129 0.993514
ar1      0.002626    0.016436   0.159787 0.873049
omega    0.000002    0.000000   3.948555 0.000079
alpha1   0.078367    0.022647   3.460400 0.000539
alpha2   0.020267    0.039524   0.512770 0.608112
alpha3   0.000004    0.043006   0.000102 0.999918
alpha4   0.002637    0.023454   0.112412 0.910497
```

```
alpha5   0.000016   0.035466   0.000463  0.999631
alpha6   0.012007   0.020124   0.596631  0.550753
alpha7   0.000001   0.034345   0.000037  0.999970
alpha8   0.000000   0.039770   0.000009  0.999992
beta1    0.646936   0.242802   2.664459  0.007711
beta2    0.000042   0.055099   0.000765  0.999390
beta3    0.000194   0.164888   0.001174  0.999063
beta4    0.090394   0.504596   0.179140  0.857827
beta5    0.000047   0.072239   0.000650  0.999481
beta6    0.000011   0.363217   0.000029  0.999977
beta7    0.000006   0.311355   0.000018  0.999986
beta8    0.000006   0.794856   0.000008  0.999994
beta9    0.000007   0.357449   0.000021  0.999984
beta10   0.130025   0.538963   0.241251  0.809361

LogLikelihood : 15796.51

Information Criteria
------------------------------------

Akaike        −6.6353
Bayes         −6.6068
Shibata       −6.6354
Hannan−Quinn  −6.6253
```

```
*---------------------------------------*
*          GARCH Model Fit              *
*---------------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(9,1)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error    t value Pr(>|t|)
mu      -0.000001    0.000119  -0.008614 0.993127
ar1      0.005239    0.015226   0.344121 0.730756
omega    0.000001    0.000000   8.899480 0.000000
alpha1   0.056746    0.015182   3.737668 0.000186
alpha2   0.000001    0.020079   0.000025 0.999980
alpha3   0.000000    0.021334   0.000011 0.999991
alpha4   0.000000    0.023798   0.000010 0.999992
alpha5   0.000000    0.022346   0.000011 0.999991
alpha6   0.000000    0.021215   0.000012 0.999991
alpha7   0.000000    0.021267   0.000009 0.999993
alpha8   0.000000    0.022784   0.000007 0.999995
alpha9   0.000000    0.016744   0.000011 0.999991
beta1    0.932438    0.004741 196.669072 0.000000
```

```
Robust Standard Errors:
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000127 -0.008062 0.993568
ar1     0.005239    0.016112  0.325180 0.745045
omega   0.000001    0.000000  4.158513 0.000032
alpha1  0.056746    0.018138  3.128509 0.001757
alpha2  0.000001    0.023269  0.000022 0.999983
alpha3  0.000000    0.024538  0.000010 0.999992
alpha4  0.000000    0.027760  0.000009 0.999993
alpha5  0.000000    0.024872  0.000010 0.999992
alpha6  0.000000    0.020695  0.000012 0.999990
alpha7  0.000000    0.020736  0.000009 0.999993
alpha8  0.000000    0.025793  0.000006 0.999995
alpha9  0.000000    0.020580  0.000009 0.999993
beta1   0.932438    0.018288 50.987279 0.000000

LogLikelihood : 15789

Information Criteria
------------------------------------

Akaike       -6.6355
Bayes        -6.6179
Shibata      -6.6356
Hannan-Quinn -6.6293
```

```
*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(9,2)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000119 -0.008607 0.993133
ar1     0.004739    0.015353  0.308666 0.757576
omega   0.000001    0.000000  8.446184 0.000000
alpha1  0.066684    0.016057  4.152847 0.000033
alpha2  0.000002    0.017879  0.000108 0.999914
alpha3  0.000000    0.019702  0.000020 0.999984
alpha4  0.000000    0.021419  0.000018 0.999986
alpha5  0.000000    0.019908  0.000016 0.999987
alpha6  0.000000    0.019147  0.000018 0.999986
alpha7  0.000000    0.019459  0.000010 0.999992
alpha8  0.000000    0.020405  0.000009 0.999993
```

```
alpha9   0.000000    0.016365   0.000009 0.999992
beta1    0.719003    0.008430  85.295813 0.000000
beta2    0.201799    0.008518  23.690242 0.000000

Robust Standard Errors:
         Estimate   Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000126  -0.008065 0.993565
ar1      0.004739    0.016141   0.293585 0.769075
omega    0.000001    0.000000   4.147827 0.000034
alpha1   0.066684    0.019156   3.481155 0.000499
alpha2   0.000002    0.020978   0.000092 0.999926
alpha3   0.000000    0.022892   0.000017 0.999987
alpha4   0.000000    0.025109   0.000015 0.999988
alpha5   0.000000    0.022030   0.000015 0.999988
alpha6   0.000000    0.019291   0.000017 0.999986
alpha7   0.000000    0.019456   0.000010 0.999992
alpha8   0.000000    0.023436   0.000008 0.999994
alpha9   0.000000    0.020375   0.000008 0.999994
beta1    0.719003    0.010783  66.682045 0.000000
beta2    0.201799    0.009647  20.917710 0.000000

LogLikelihood : 15789.75

Information Criteria
------------------------------------
```

```
Akaike        -6.6354
Bayes         -6.6164
Shibata       -6.6355
Hannan-Quinn  -6.6287


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(9,3)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.008381 0.993313
ar1     0.003560    0.015487  0.229894 0.818174
omega   0.000001    0.000000  6.062269 0.000000
alpha1  0.076339    0.016822  4.537976 0.000006
alpha2  0.000134    0.018010  0.007458 0.994049
alpha3  0.000002    0.017864  0.000113 0.999910
alpha4  0.000001    0.020393  0.000071 0.999944
```

```
alpha5   0.000001    0.019365   0.000065  0.999948
alpha6   0.000001    0.018470   0.000076  0.999939
alpha7   0.000001    0.018625   0.000050  0.999960
alpha8   0.000001    0.020076   0.000033  0.999973
alpha9   0.000001    0.015697   0.000052  0.999959
beta1    0.690918    0.013365  51.694712  0.000000
beta2    0.000057    0.064271   0.000892  0.999288
beta3    0.218588    0.016838  12.981937  0.000000

Robust Standard Errors:
          Estimate   Std. Error    t value  Pr(>|t|)
mu       -0.000001    0.000126  -0.007841  0.993744
ar1       0.003560    0.016240   0.219237  0.826466
omega     0.000001    0.000000   3.179217  0.001477
alpha1    0.076339    0.019951   3.826428  0.000130
alpha2    0.000134    0.020941   0.006415  0.994882
alpha3    0.000002    0.021354   0.000094  0.999925
alpha4    0.000001    0.023908   0.000060  0.999952
alpha5    0.000001    0.021609   0.000058  0.999954
alpha6    0.000001    0.018210   0.000077  0.999938
alpha7    0.000001    0.018593   0.000051  0.999960
alpha8    0.000001    0.022944   0.000029  0.999977
alpha9    0.000001    0.019895   0.000041  0.999968
beta1     0.690918    0.013204  52.326561  0.000000
beta2     0.000057    0.030853   0.001859  0.998517
beta3     0.218588    0.016666  13.115673  0.000000
```

```
LogLikelihood : 15791.43

Information Criteria
------------------------------------

Akaike       -6.6357
Bayes        -6.6153
Shibata      -6.6357
Hannan-Quinn -6.6286


*-----------------------------------*
*          GARCH Model Fit          *
*-----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(9,4)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000118 -0.008640 0.993106
```

```
ar1       0.003397     0.015456   0.219783  0.826041
omega     0.000001     0.000000  10.536120  0.000000
alpha1    0.076070     0.016913   4.497633  0.000007
alpha2    0.017634     0.018498   0.953273  0.340452
alpha3    0.000002     0.017838   0.000084  0.999933
alpha4    0.000001     0.016580   0.000078  0.999938
alpha5    0.000001     0.018598   0.000027  0.999978
alpha6    0.000001     0.017771   0.000029  0.999977
alpha7    0.000000     0.017995   0.000020  0.999984
alpha8    0.000000     0.018129   0.000014  0.999989
alpha9    0.000000     0.014885   0.000018  0.999986
beta1     0.608534     0.058121  10.470163  0.000000
beta2     0.000039     0.071951   0.000545  0.999565
beta3     0.000085     0.125491   0.000680  0.999458
beta4     0.281109     0.035762   7.860442  0.000000

Robust Standard Errors:
          Estimate   Std. Error    t value  Pr(>|t|)
mu       -0.000001     0.000126  -0.008141  0.993505
ar1       0.003397     0.016266   0.208846  0.834569
omega     0.000001     0.000000   6.475984  0.000000
alpha1    0.076070     0.021292   3.572642  0.000353
alpha2    0.017634     0.024779   0.711634  0.476692
alpha3    0.000002     0.022331   0.000067  0.999946
alpha4    0.000001     0.021743   0.000060  0.999952
alpha5    0.000001     0.021645   0.000024  0.999981
```

alpha6	0.000001	0.018705	0.000027	0.999978
alpha7	0.000000	0.017973	0.000020	0.999984
alpha8	0.000000	0.021808	0.000011	0.999991
alpha9	0.000000	0.015448	0.000017	0.999987
beta1	0.608534	0.164836	3.691750	0.000223
beta2	0.000039	0.007159	0.005480	0.995628
beta3	0.000085	0.046376	0.001840	0.998532
beta4	0.281109	0.157875	1.780581	0.074981

LogLikelihood : 15793.02

Information Criteria

Akaike	−6.6360
Bayes	−6.6142
Shibata	−6.6360
Hannan−Quinn	−6.6283

———————————————————————

* GARCH Model Fit *

———————————————————————

Conditional Variance Dynamics

```
GARCH Model      : sGARCH(9,5)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error   t value  Pr(>|t|)
mu       -0.000001    0.000118 -0.004999  0.996011
ar1       0.002970    0.015480  0.191830  0.847875
omega     0.000002    0.000000 16.866932  0.000000
alpha1    0.080118    0.016966  4.722336  0.000002
alpha2    0.034824    0.037927  0.918170  0.358530
alpha3    0.000924    0.027784  0.033266  0.973462
alpha4    0.000284    0.019194  0.014773  0.988213
alpha5    0.000037    0.024570  0.001510  0.998795
alpha6    0.000017    0.011271  0.001531  0.998778
alpha7    0.000011    0.010481  0.001030  0.999178
alpha8    0.000005    0.013050  0.000413  0.999670
alpha9    0.000006    0.008541  0.000680  0.999457
beta1     0.429183    0.505719  0.848658  0.396072
beta2     0.007123    0.786416  0.009058  0.992773
beta3     0.151157    0.423494  0.356929  0.721145
beta4     0.000918    0.420681  0.002182  0.998259
beta5     0.275487    0.240122  1.147281  0.251265

Robust Standard Errors:
```

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000124	−0.004761	0.996201
ar1	0.002970	0.016394	0.181134	0.856262
omega	0.000002	0.000000	5.956239	0.000000
alpha1	0.080118	0.020971	3.820433	0.000133
alpha2	0.034824	0.051197	0.680193	0.496382
alpha3	0.000924	0.046088	0.020054	0.984000
alpha4	0.000284	0.035356	0.008020	0.993601
alpha5	0.000037	0.044429	0.000835	0.999334
alpha6	0.000017	0.020066	0.000860	0.999314
alpha7	0.000011	0.023166	0.000466	0.999628
alpha8	0.000005	0.017946	0.000301	0.999760
alpha9	0.000006	0.020193	0.000288	0.999770
beta1	0.429183	0.617827	0.694665	0.487265
beta2	0.007123	0.973601	0.007316	0.994163
beta3	0.151157	0.424931	0.355722	0.722049
beta4	0.000918	0.516043	0.001779	0.998581
beta5	0.275487	0.337492	0.816277	0.414342

LogLikelihood : 15793.88

Information Criteria

Akaike	−6.6359
Bayes	−6.6128

```
Shibata        -6.6359
Hannan-Quinn   -6.6278


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(9,6)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000119 -0.008588 0.993148
ar1     0.002475    0.015559  0.159067 0.873616
omega   0.000003    0.000000  6.207036 0.000000
alpha1  0.082231    0.017199  4.781042 0.000002
alpha2  0.066489    0.015763  4.218128 0.000025
alpha3  0.029719    0.010559  2.814637 0.004883
alpha4  0.010360    0.003262  3.175742 0.001495
alpha5  0.000008    0.023450  0.000352 0.999719
alpha6  0.000004    0.076855  0.000054 0.999957
```

```
alpha7   0.000002    0.013623  0.000130 0.999896
alpha8   0.000000    0.030369  0.000014 0.999989
alpha9   0.000001    0.016623  0.000035 0.999972
beta1    0.000030    0.045777  0.000662 0.999472
beta2    0.000034    0.056832  0.000591 0.999528
beta3    0.244027    0.173049  1.410161 0.158492
beta4    0.000020    0.029500  0.000674 0.999462
beta5    0.307083    0.726549  0.422659 0.672544
beta6    0.227619    0.333655  0.682199 0.495113

Robust Standard Errors:
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000133 -0.007680 0.993872
ar1      0.002475    0.016532  0.149704 0.880998
omega    0.000003    0.000003  1.036423 0.300005
alpha1   0.082231    0.025898  3.175144 0.001498
alpha2   0.066489    0.053871  1.234228 0.217118
alpha3   0.029719    0.032874  0.904017 0.365986
alpha4   0.010360    0.079343  0.130575 0.896111
alpha5   0.000008    0.097359  0.000085 0.999932
alpha6   0.000004    0.307860  0.000013 0.999989
alpha7   0.000002    0.049338  0.000036 0.999971
alpha8   0.000000    0.139514  0.000003 0.999998
alpha9   0.000001    0.022582  0.000026 0.999979
beta1    0.000030    0.021740  0.001394 0.998888
beta2    0.000034    0.135535  0.000248 0.999802
```

```
beta3    0.244027    1.086471   0.224605  0.822286
beta4    0.000020    0.013067   0.001522  0.998786
beta5    0.307083    2.798418   0.109734  0.912620
beta6    0.227619    2.064907   0.110232  0.912225

LogLikelihood : 15794.41

Information Criteria
------------------------------------

Akaike        −6.6357
Bayes         −6.6112
Shibata       −6.6357
Hannan−Quinn  −6.6271


*-----------------------------------*
*          GARCH Model Fit          *
*-----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(9,7)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm
```

Optimal Parameters

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000118	−0.008474	0.993239
ar1	0.002506	0.015503	0.161644	0.871587
omega	0.000003	0.000000	5.994655	0.000000
alpha1	0.082288	0.016506	4.985468	0.000001
alpha2	0.066444	0.004777	13.907814	0.000000
alpha3	0.029799	0.009450	3.153148	0.001615
alpha4	0.010204	0.005015	2.034493	0.041902
alpha5	0.000010	0.026693	0.000385	0.999693
alpha6	0.000006	0.104418	0.000059	0.999953
alpha7	0.000003	0.011715	0.000274	0.999781
alpha8	0.000001	0.045847	0.000020	0.999984
alpha9	0.000001	0.012621	0.000095	0.999924
beta1	0.000065	0.041651	0.001561	0.998754
beta2	0.000069	0.098235	0.000706	0.999437
beta3	0.245800	0.160507	1.531399	0.125671
beta4	0.000043	0.088005	0.000493	0.999607
beta5	0.306291	0.933192	0.328219	0.742746
beta6	0.226471	0.546467	0.414428	0.678561
beta7	0.000022	0.025914	0.000852	0.999320

Robust Standard Errors:

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000139	−0.007181	0.994271

ar1	0.002506	0.017307	0.144794	0.884873
omega	0.000003	0.000003	1.027583	0.304146
alpha1	0.082288	0.031998	2.571655	0.010121
alpha2	0.066444	0.080521	0.825182	0.409268
alpha3	0.029799	0.031189	0.955414	0.339368
alpha4	0.010204	0.094586	0.107878	0.914092
alpha5	0.000010	0.127374	0.000081	0.999936
alpha6	0.000006	0.488997	0.000013	0.999990
alpha7	0.000003	0.072331	0.000044	0.999965
alpha8	0.000001	0.225460	0.000004	0.999997
alpha9	0.000001	0.021135	0.000057	0.999955
beta1	0.000065	0.174715	0.000372	0.999703
beta2	0.000069	0.318045	0.000218	0.999826
beta3	0.245800	1.092887	0.224909	0.822050
beta4	0.000043	0.081469	0.000533	0.999575
beta5	0.306291	4.351967	0.070380	0.943891
beta6	0.226471	2.970428	0.076242	0.939227
beta7	0.000022	0.116273	0.000190	0.999848

LogLikelihood : 15794.41

Information Criteria

Akaike	−6.6353
Bayes	−6.6095

```
Shibata        -6.6353
Hannan-Quinn  -6.6262


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(9,8)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000114 -0.009005 0.992815
ar1      0.002334    0.015307  0.152495 0.878796
omega    0.000003    0.000001  3.036871 0.002390
alpha1   0.068837    0.010375  6.634576 0.000000
alpha2   0.044401    0.004528  9.806604 0.000000
alpha3   0.008732    0.013748  0.635139 0.525338
alpha4   0.040377    0.014307  2.822217 0.004769
alpha5   0.028928    0.025716  1.124893 0.260634
alpha6   0.031506    0.029657  1.062339 0.288082
```

```
alpha7   0.000047    0.009777   0.004780  0.996186
alpha8   0.000000    0.020033   0.000024  0.999981
alpha9   0.000000    0.014461   0.000025  0.999980
beta1    0.323869    0.320238   1.011339  0.311854
beta2    0.000021    0.032505   0.000638  0.999491
beta3    0.000011    0.121649   0.000088  0.999930
beta4    0.000004    0.419154   0.000010  0.999992
beta5    0.000004    0.380847   0.000010  0.999992
beta6    0.000006    0.396056   0.000015  0.999988
beta7    0.000008    0.209008   0.000038  0.999970
beta8    0.414748    0.253162   1.638273  0.101365

Robust Standard Errors:
          Estimate  Std. Error   t value  Pr(>|t|)
mu       -0.000001    0.000202 -0.005049   0.99597
ar1       0.002334    0.016387  0.142446   0.88673
omega     0.000003    0.000005  0.624596   0.53224
alpha1    0.068837    0.051169  1.345272   0.17854
alpha2    0.044401    0.062549  0.709866   0.47779
alpha3    0.008732    0.104088  0.083890   0.93314
alpha4    0.040377    0.041268  0.978400   0.32788
alpha5    0.028928    0.055078  0.525209   0.59944
alpha6    0.031506    0.122110  0.258013   0.79640
alpha7    0.000047    0.021420  0.002182   0.99826
alpha8    0.000000    0.130706  0.000004   1.00000
alpha9    0.000000    0.136194  0.000003   1.00000
```

beta1	0.323869	1.820645	0.177887	0.85881
beta2	0.000021	0.022690	0.000914	0.99927
beta3	0.000011	0.422838	0.000025	0.99998
beta4	0.000004	1.433975	0.000003	1.00000
beta5	0.000004	0.558347	0.000007	0.99999
beta6	0.000006	1.495386	0.000004	1.00000
beta7	0.000008	0.516264	0.000015	0.99999
beta8	0.414748	1.291288	0.321189	0.74807

LogLikelihood : 15795.71

Information Criteria

Akaike	−6.6354
Bayes	−6.6082
Shibata	−6.6355
Hannan−Quinn	−6.6259

———————————————————

*   GARCH Model Fit   *

———————————————————

Conditional Variance Dynamics

```
GARCH Model       : sGARCH(9,9)
Mean Model        : ARFIMA(1,0,0)
Distribution      : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000118 -0.008672  0.99308
ar1       0.002182    0.015498  0.140762  0.88806
omega     0.000001    0.000000  7.937652  0.00000
alpha1    0.080760    0.013409  6.022593  0.00000
alpha2    0.000023    0.016175  0.001417  0.99887
alpha3    0.000002    0.020396  0.000081  0.99994
alpha4    0.000003    0.015737  0.000189  0.99985
alpha5    0.000003    0.007622  0.000401  0.99968
alpha6    0.000014    0.010415  0.001358  0.99892
alpha7    0.000001    0.017446  0.000036  0.99997
alpha8    0.000000    0.018771  0.000014  0.99999
alpha9    0.000000    0.011283  0.000026  0.99998
beta1     0.779003    0.045502 17.120092  0.00000
beta2     0.000065    0.109842  0.000590  0.99953
beta3     0.036963    0.159513  0.231723  0.81675
beta4     0.000121    0.206072  0.000588  0.99953
beta5     0.000025    0.035469  0.000716  0.99943
beta6     0.000007    0.409955  0.000016  0.99999
beta7     0.000005    0.403888  0.000013  0.99999
```

```
beta8     0.000013     0.279467   0.000047   0.99996
beta9     0.089438     0.142800   0.626315   0.53111
```

```
Robust Standard Errors:
           Estimate  Std. Error    t value Pr(>|t|)
mu        -0.000001    0.000128  -0.008002 0.993616
ar1        0.002182    0.016247   0.134272 0.893187
omega      0.000001    0.000000   3.530546 0.000415
alpha1     0.080760    0.022655   3.564719 0.000364
alpha2     0.000023    0.022835   0.001004 0.999199
alpha3     0.000002    0.025677   0.000065 0.999948
alpha4     0.000003    0.047337   0.000063 0.999950
alpha5     0.000003    0.027563   0.000111 0.999912
alpha6     0.000014    0.029929   0.000473 0.999623
alpha7     0.000001    0.060122   0.000010 0.999992
alpha8     0.000000    0.044721   0.000006 0.999995
alpha9     0.000000    0.019277   0.000015 0.999988
beta1      0.779003    0.051949  14.995518 0.000000
beta2      0.000065    0.192627   0.000337 0.999731
beta3      0.036963    0.491982   0.075130 0.940111
beta4      0.000121    0.371505   0.000326 0.999740
beta5      0.000025    0.040712   0.000624 0.999502
beta6      0.000007    0.818934   0.000008 0.999994
beta7      0.000005    0.474165   0.000011 0.999991
beta8      0.000013    0.250153   0.000053 0.999958
beta9      0.089438    0.175121   0.510720 0.609547
```

```
LogLikelihood : 15795.37

Information Criteria
------------------------------------

Akaike       -6.6349
Bayes        -6.6063
Shibata      -6.6349
Hannan-Quinn -6.6248


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(9,10)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000118 -0.006722 0.994637
```

```
ar1       0.002645    0.015491   0.170755 0.864416
omega     0.000002    0.000000  14.770439 0.000000
alpha1    0.078306    0.017340   4.515854 0.000006
alpha2    0.020525    0.032215   0.637129 0.524041
alpha3    0.000073    0.016888   0.004348 0.996531
alpha4    0.002619    0.009042   0.289657 0.772079
alpha5    0.000125    0.011950   0.010470 0.991646
alpha6    0.012061    0.025723   0.468875 0.639159
alpha7    0.000022    0.010639   0.002090 0.998332
alpha8    0.000007    0.007740   0.000867 0.999308
alpha9    0.000008    0.014631   0.000516 0.999588
beta1     0.643372    0.302829   2.124539 0.033625
beta2     0.000688    0.211442   0.003255 0.997403
beta3     0.002526    0.498310   0.005070 0.995955
beta4     0.088241    0.373735   0.236107 0.813350
beta5     0.000710    0.673056   0.001055 0.999158
beta6     0.000171    0.240743   0.000712 0.999432
beta7     0.000097    0.131390   0.000742 0.999408
beta8     0.000107    0.095579   0.001119 0.999107
beta9     0.000122    0.111626   0.001089 0.999131
beta10    0.131089    0.066761   1.963556 0.049582

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000125 -0.006343 0.994939
ar1       0.002645    0.016310  0.162184 0.871161
```

```
omega    0.000002    0.000000  5.209935  0.000000
alpha1   0.078306    0.024107  3.248281  0.001161
alpha2   0.020525    0.052465  0.391217  0.695637
alpha3   0.000073    0.044386  0.001654  0.998680
alpha4   0.002619    0.033916  0.077226  0.938444
alpha5   0.000125    0.032076  0.003901  0.996888
alpha6   0.012061    0.067063  0.179840  0.857278
alpha7   0.000022    0.021464  0.001036  0.999173
alpha8   0.000007    0.021392  0.000314  0.999750
alpha9   0.000008    0.017210  0.000439  0.999650
beta1    0.643372    0.482547  1.333285  0.182438
beta2    0.000688    0.708657  0.000971  0.999225
beta3    0.002526    0.735798  0.003433  0.997260
beta4    0.088241    1.110817  0.079438  0.936684
beta5    0.000710    1.294611  0.000549  0.999562
beta6    0.000171    0.554077  0.000309  0.999753
beta7    0.000097    0.223825  0.000436  0.999652
beta8    0.000107    0.129751  0.000825  0.999342
beta9    0.000122    0.105063  0.001157  0.999077
beta10   0.131089    0.157364  0.833026  0.404830

LogLikelihood : 15796.5

Information Criteria
------------------------------------
```

```
Akaike          -6.6349
Bayes           -6.6050
Shibata         -6.6350
Hannan-Quinn    -6.6244


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(10,1)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000119 -0.008599 0.993139
ar1     0.005235    0.015226  0.343801 0.730996
omega   0.000001    0.000000  9.489004 0.000000
alpha1  0.056747    0.015187  3.736446 0.000187
alpha2  0.000001    0.020114  0.000032 0.999975
alpha3  0.000000    0.021355  0.000012 0.999991
alpha4  0.000000    0.023855  0.000011 0.999991
```

```
alpha5    0.000000    0.022394    0.000011  0.999991
alpha6    0.000000    0.021241    0.000011  0.999991
alpha7    0.000000    0.021321    0.000008  0.999994
alpha8    0.000000    0.022837    0.000006  0.999996
alpha9    0.000000    0.023197    0.000007  0.999995
alpha10   0.000000    0.016313    0.000011  0.999991
beta1     0.932432    0.004722  197.461800  0.000000

Robust Standard Errors:
          Estimate   Std. Error   t value  Pr(>|t|)
mu       -0.000001    0.000127  -0.008046  0.993580
ar1       0.005235    0.016118   0.324772  0.745353
omega     0.000001    0.000000   4.270543  0.000019
alpha1    0.056747    0.018175   3.122339  0.001794
alpha2    0.000001    0.023214   0.000027  0.999978
alpha3    0.000000    0.024556   0.000010  0.999992
alpha4    0.000000    0.027830   0.000010  0.999992
alpha5    0.000000    0.025086   0.000010  0.999992
alpha6    0.000000    0.020728   0.000012  0.999991
alpha7    0.000000    0.020792   0.000008  0.999994
alpha8    0.000000    0.025897   0.000005  0.999996
alpha9    0.000000    0.025439   0.000006  0.999995
alpha10   0.000000    0.019376   0.000009  0.999993
beta1     0.932432    0.018119  51.461884  0.000000

LogLikelihood : 15788.98
```

```
Information Criteria
------------------------------------

Akaike       -6.6351
Bayes        -6.6161
Shibata      -6.6351
Hannan-Quinn -6.6284


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(10,2)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000119 -0.008614 0.993127
ar1     0.004739    0.015355  0.308631 0.757603
omega   0.000001    0.000000  9.035342 0.000000
```

```
alpha1    0.066647    0.016061   4.149597 0.000033
alpha2    0.000002    0.017911   0.000091 0.999927
alpha3    0.000000    0.019699   0.000017 0.999986
alpha4    0.000000    0.021485   0.000015 0.999988
alpha5    0.000000    0.019921   0.000014 0.999988
alpha6    0.000000    0.019158   0.000015 0.999988
alpha7    0.000000    0.019498   0.000011 0.999991
alpha8    0.000000    0.021023   0.000008 0.999994
alpha9    0.000000    0.020916   0.000009 0.999993
alpha10   0.000000    0.016424   0.000014 0.999989
beta1     0.719762    0.008412  85.567606 0.000000
beta2     0.201077    0.008495  23.670630 0.000000

Robust Standard Errors:
          Estimate  Std. Error   t value  Pr(>|t|)
mu       -0.000001    0.000127 -0.008060 0.993569
ar1       0.004739    0.016155  0.293344 0.769259
omega     0.000001    0.000000  4.287347 0.000018
alpha1    0.066647    0.019196  3.471858 0.000517
alpha2    0.000002    0.020892  0.000078 0.999938
alpha3    0.000000    0.022884  0.000015 0.999988
alpha4    0.000000    0.025115  0.000013 0.999990
alpha5    0.000000    0.022106  0.000013 0.999990
alpha6    0.000000    0.019229  0.000015 0.999988
alpha7    0.000000    0.019540  0.000011 0.999991
alpha8    0.000000    0.024065  0.000007 0.999995
```

```
alpha9    0.000000    0.023746   0.000008  0.999994
alpha10   0.000000    0.019516   0.000011  0.999991
beta1     0.719762    0.010619  67.782066  0.000000
beta2     0.201077    0.009557  21.040253  0.000000

LogLikelihood : 15789.73

Information Criteria
------------------------------------

Akaike       -6.6350
Bayes        -6.6146
Shibata      -6.6350
Hannan-Quinn -6.6278


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(10,3)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm
```

```
Optimal Parameters
------------------------------------
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000118 -0.008444 0.993263
ar1       0.003551    0.015486  0.229331 0.818611
omega     0.000001    0.000001  1.676708 0.093600
alpha1    0.076339    0.010834  7.045954 0.000000
alpha2    0.000078    0.048003  0.001626 0.998702
alpha3    0.000001    0.048502  0.000030 0.999976
alpha4    0.000001    0.011625  0.000049 0.999961
alpha5    0.000000    0.018756  0.000026 0.999979
alpha6    0.000001    0.013008  0.000059 0.999953
alpha7    0.000000    0.014012  0.000025 0.999980
alpha8    0.000000    0.019450  0.000013 0.999990
alpha9    0.000000    0.004021  0.000073 0.999942
alpha10   0.000000    0.005253  0.000061 0.999951
beta1     0.691991    0.334478  2.068865 0.038559
beta2     0.000044    0.707328  0.000062 0.999951
beta3     0.217606    0.357710  0.608330 0.542969

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000126 -0.007933  0.99367
ar1       0.003551    0.016209  0.219109  0.82656
omega     0.000001    0.000005  0.260224  0.79469
alpha1    0.076339    0.123806  0.616605  0.53749
```

alpha2	0.000078	0.320240	0.000244	0.99981
alpha3	0.000001	0.329465	0.000004	1.00000
alpha4	0.000001	0.143520	0.000004	1.00000
alpha5	0.000000	0.033628	0.000014	0.99999
alpha6	0.000001	0.085255	0.000009	0.99999
alpha7	0.000000	0.078946	0.000004	1.00000
alpha8	0.000000	0.044044	0.000006	1.00000
alpha9	0.000000	0.125762	0.000002	1.00000
alpha10	0.000000	0.085829	0.000004	1.00000
beta1	0.691991	2.119218	0.326531	0.74402
beta2	0.000044	4.505007	0.000010	0.99999
beta3	0.217606	2.281670	0.095371	0.92402

LogLikelihood : 15791.41

Information Criteria

Akaike	−6.6353
Bayes	−6.6135
Shibata	−6.6353
Hannan−Quinn	−6.6276

———————————————————————

* GARCH Model Fit *

```
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(10,4)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001   0.000118 -0.008638 0.993108
ar1       0.003394   0.015459  0.219560 0.826214
omega     0.000001   0.000000 10.859395 0.000000
alpha1    0.076093   0.017130  4.442062 0.000009
alpha2    0.017662   0.019611  0.900600 0.367801
alpha3    0.000001   0.019000  0.000073 0.999942
alpha4    0.000001   0.017148  0.000066 0.999947
alpha5    0.000001   0.019082  0.000027 0.999979
alpha6    0.000001   0.018082  0.000029 0.999977
alpha7    0.000000   0.018052  0.000020 0.999984
alpha8    0.000000   0.018432  0.000013 0.999989
alpha9    0.000000   0.018370  0.000014 0.999989
alpha10   0.000000   0.018544  0.000012 0.999990
beta1     0.608211   0.093394  6.512311 0.000000
beta2     0.000029   0.036929  0.000795 0.999366
```

```
beta3     0.000060    0.070590   0.000844 0.999327
beta4     0.281403    0.072393   3.887174 0.000101

Robust Standard Errors:
          Estimate  Std. Error    t value Pr(>|t|)
mu       -0.000001    0.000125  -0.008149 0.993498
ar1       0.003394    0.016268   0.208643 0.834727
omega     0.000001    0.000000   6.374970 0.000000
alpha1    0.076093    0.022250   3.419943 0.000626
alpha2    0.017662    0.026184   0.674512 0.499986
alpha3    0.000001    0.024003   0.000058 0.999954
alpha4    0.000001    0.021486   0.000053 0.999958
alpha5    0.000001    0.022743   0.000022 0.999982
alpha6    0.000001    0.018403   0.000028 0.999977
alpha7    0.000000    0.017895   0.000020 0.999984
alpha8    0.000000    0.022693   0.000011 0.999991
alpha9    0.000000    0.022558   0.000012 0.999991
alpha10   0.000000    0.025598   0.000009 0.999993
beta1     0.608211    0.214037   2.841624 0.004488
beta2     0.000029    0.018382   0.001597 0.998726
beta3     0.000060    0.032550   0.001830 0.998540
beta4     0.281403    0.183162   1.536360 0.124450

LogLikelihood : 15793

Information Criteria
```

```
---------------------------------------------

Akaike         -6.6355
Bayes          -6.6124
Shibata        -6.6356
Hannan-Quinn   -6.6274


*-------------------------------------------*
*           GARCH Model Fit                 *
*-------------------------------------------*

Conditional Variance Dynamics
---------------------------------------------
GARCH Model         : sGARCH(10,5)
Mean Model          : ARFIMA(1,0,0)
Distribution        : norm

Optimal Parameters
---------------------------------------------
         Estimate  Std. Error    t value Pr(>|t|)
mu      -0.000001    0.000119  -0.008393 0.993304
ar1      0.002744    0.015539   0.176560 0.859854
omega    0.000002    0.000000  17.978166 0.000000
alpha1   0.080321    0.016927   4.745237 0.000002
alpha2   0.034746    0.014946   2.324805 0.020082
```

```
alpha3    0.000667    0.010256   0.065051 0.948134
alpha4    0.000036    0.005225   0.006879 0.994512
alpha5    0.000004    0.016063   0.000251 0.999800
alpha6    0.000002    0.018579   0.000132 0.999895
alpha7    0.000002    0.015305   0.000101 0.999920
alpha8    0.000001    0.020568   0.000039 0.999969
alpha9    0.000001    0.009955   0.000090 0.999928
alpha10   0.000001    0.010380   0.000081 0.999936
beta1     0.432939    0.105351   4.109486 0.000040
beta2     0.001569    0.295345   0.005311 0.995762
beta3     0.151737    0.102947   1.473930 0.140500
beta4     0.000126    0.533977   0.000236 0.999812
beta5     0.278103    0.296628   0.937547 0.348477

Robust Standard Errors:
           Estimate  Std. Error    t value Pr(>|t|)
mu        -0.000001    0.000127  -0.007822 0.993759
ar1        0.002744    0.016394   0.167359 0.867088
omega      0.000002    0.000000   5.928140 0.000000
alpha1     0.080321    0.021056   3.814658 0.000136
alpha2     0.034746    0.035717   0.972839 0.330633
alpha3     0.000667    0.032207   0.020715 0.983473
alpha4     0.000036    0.026626   0.001350 0.998923
alpha5     0.000004    0.027533   0.000147 0.999883
alpha6     0.000002    0.026842   0.000091 0.999927
alpha7     0.000002    0.020737   0.000074 0.999941
```

```
alpha8     0.000001     0.030635   0.000026  0.999979
alpha9     0.000001     0.014902   0.000060  0.999952
alpha10    0.000001     0.012101   0.000069  0.999945
beta1      0.432939     0.405498   1.067674  0.285668
beta2      0.001569     0.589621   0.002660  0.997877
beta3      0.151737     0.599168   0.253246  0.800078
beta4      0.000126     0.696242   0.000181  0.999856
beta5      0.278103     0.446765   0.622480  0.533626

LogLikelihood : 15793.85

Information Criteria
------------------------------------

Akaike        -6.6355
Bayes         -6.6110
Shibata       -6.6355
Hannan-Quinn  -6.6269


*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*

Conditional Variance Dynamics
-----------------------------------
```

```
GARCH Model        : sGARCH(10,6)
Mean Model         : ARFIMA(1,0,0)
Distribution       : norm

Optimal Parameters
------------------------------------
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000116 -0.008800 0.992979
ar1       0.002442    0.015479  0.157751 0.874653
omega     0.000003    0.000001  2.256389 0.024046
alpha1    0.082044    0.016604  4.941341 0.000001
alpha2    0.066629    0.011664  5.712119 0.000000
alpha3    0.029562    0.010123  2.920325 0.003497
alpha4    0.010162    0.032588  0.311840 0.755162
alpha5    0.000007    0.038615  0.000180 0.999856
alpha6    0.000003    0.040979  0.000075 0.999940
alpha7    0.000002    0.003211  0.000469 0.999626
alpha8    0.000000    0.016308  0.000022 0.999983
alpha9    0.000000    0.012560  0.000039 0.999969
alpha10   0.000001    0.015133  0.000037 0.999971
beta1     0.000025    0.056633  0.000438 0.999650
beta2     0.000032    0.038084  0.000830 0.999338
beta3     0.245791    0.565603  0.434565 0.663878
beta4     0.000016    0.238036  0.000067 0.999946
beta5     0.310362    0.476218  0.651724 0.514579
beta6     0.223055    0.428814  0.520167 0.602947
```

```
Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000163 -0.006265 0.995002
ar1       0.002442    0.017633  0.138478 0.889863
omega     0.000003    0.000006  0.480848 0.630624
alpha1    0.082044    0.025187  3.257384 0.001124
alpha2    0.066629    0.082038  0.812170 0.416694
alpha3    0.029562    0.085132  0.347248 0.728405
alpha4    0.010162    0.161982  0.062738 0.949975
alpha5    0.000007    0.179281  0.000039 0.999969
alpha6    0.000003    0.088144  0.000035 0.999972
alpha7    0.000002    0.075273  0.000020 0.999984
alpha8    0.000000    0.045992  0.000008 0.999994
alpha9    0.000000    0.091808  0.000005 0.999996
alpha10   0.000001    0.082027  0.000007 0.999995
beta1     0.000025    0.411483  0.000060 0.999952
beta2     0.000032    0.328804  0.000096 0.999923
beta3     0.245791    2.521356  0.097484 0.922342
beta4     0.000016    0.577079  0.000028 0.999978
beta5     0.310362    1.404719  0.220943 0.825137
beta6     0.223055    1.456323  0.153163 0.878270

LogLikelihood : 15794.32


Information Criteria
```

```
----------------------------------------------------

Akaike        -6.6353
Bayes         -6.6094
Shibata       -6.6353
Hannan-Quinn  -6.6262


*---------------------------------*
*          GARCH Model Fit        *
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model    : sGARCH(10,7)
Mean Model     : ARFIMA(1,0,0)
Distribution   : norm

Optimal Parameters
------------------------------------
        Estimate  Std. Error   t value Pr(>|t|)
mu     -0.000001    0.000113 -0.009079 0.992756
ar1     0.002451    0.015051  0.162852 0.870635
omega   0.000003    0.000002  1.347154 0.177931
alpha1  0.082031    0.017652  4.647038 0.000003
alpha2  0.066657    0.021790  3.059056 0.002220
```

```
alpha3    0.029555    0.017380    1.700577 0.089023
alpha4    0.010203    0.047745    0.213707 0.830776
alpha5    0.000002    0.049228    0.000048 0.999961
alpha6    0.000002    0.058958    0.000028 0.999978
alpha7    0.000001    0.016726    0.000057 0.999954
alpha8    0.000000    0.040152    0.000008 0.999993
alpha9    0.000000    0.041141    0.000011 0.999992
alpha10   0.000000    0.039029    0.000011 0.999991
beta1     0.000053    0.075233    0.000707 0.999436
beta2     0.000057    0.225724    0.000250 0.999800
beta3     0.245764    1.000422    0.245660 0.805945
beta4     0.000022    0.111215    0.000194 0.999845
beta5     0.310454    0.390204    0.795621 0.426253
beta6     0.222862    0.523704    0.425550 0.670436
beta7     0.000011    0.430568    0.000026 0.999980

Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001    0.000334 -0.003057  0.99756
ar1       0.002451    0.037155  0.065970  0.94740
omega     0.000003    0.000018  0.159925  0.87294
alpha1    0.082031    0.192824  0.425420  0.67053
alpha2    0.066657    0.210415  0.316789  0.75140
alpha3    0.029555    0.185916  0.158971  0.87369
alpha4    0.010203    0.404941  0.025197  0.97990
alpha5    0.000002    0.412606  0.000006  0.99999
```

alpha6	0.000002	0.367987	0.000004	1.00000
alpha7	0.000001	0.090501	0.000011	0.99999
alpha8	0.000000	0.321447	0.000001	1.00000
alpha9	0.000000	0.369143	0.000001	1.00000
alpha10	0.000000	0.342229	0.000001	1.00000
beta1	0.000053	0.629872	0.000084	0.99993
beta2	0.000057	2.039984	0.000028	0.99998
beta3	0.245764	8.308438	0.029580	0.97640
beta4	0.000022	0.973241	0.000022	0.99998
beta5	0.310454	1.568332	0.197952	0.84308
beta6	0.222862	3.335811	0.066809	0.94673
beta7	0.000011	3.180727	0.000003	1.00000

LogLikelihood : 15794.32

Information Criteria

Akaike	−6.6348
Bayes	−6.6076
Shibata	−6.6349
Hannan–Quinn	−6.6253

————————————————————

*   GARCH Model Fit   *

```
*---------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(10,8)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000117 -0.008762 0.993009
ar1      0.002534    0.015329  0.165284 0.868720
omega    0.000003    0.000001  4.680012 0.000003
alpha1   0.069244    0.014919  4.641238 0.000003
alpha2   0.043322    0.005908  7.332576 0.000000
alpha3   0.008448    0.013201  0.639961 0.522198
alpha4   0.040078    0.013449  2.979927 0.002883
alpha5   0.028022    0.026688  1.049968 0.293733
alpha6   0.030510    0.017165  1.777446 0.075495
alpha7   0.000004    0.010024  0.000413 0.999670
alpha8   0.000000    0.021461  0.000022 0.999982
alpha9   0.000000    0.012134  0.000032 0.999974
alpha10  0.000000    0.013680  0.000036 0.999971
beta1    0.334552    0.148692  2.249972 0.024451
beta2    0.000025    0.039017  0.000642 0.999488
```

```
beta3     0.000010    0.157844   0.000063 0.999950
beta4     0.000005    0.361405   0.000015 0.999988
beta5     0.000002    0.395424   0.000005 0.999996
beta6     0.000006    0.329907   0.000017 0.999986
beta7     0.000008    0.171849   0.000048 0.999961
beta8     0.407516    0.154922   2.630459 0.008527

Robust Standard Errors:
          Estimate  Std. Error  t value Pr(>|t|)
mu       -0.000001    0.000128 -0.007986 0.993628
ar1       0.002534    0.016430  0.154213 0.877442
omega     0.000003    0.000002  2.002825 0.045196
alpha1    0.069244    0.021060  3.287994 0.001009
alpha2    0.043322    0.037671  1.150028 0.250132
alpha3    0.008448    0.024895  0.339351 0.734345
alpha4    0.040078    0.053178  0.753655 0.451057
alpha5    0.028022    0.070731  0.396178 0.691974
alpha6    0.030510    0.031023  0.983453 0.325384
alpha7    0.000004    0.021767  0.000190 0.999848
alpha8    0.000000    0.034252  0.000014 0.999989
alpha9    0.000000    0.055647  0.000007 0.999994
alpha10   0.000000    0.049170  0.000010 0.999992
beta1     0.334552    0.531187  0.629819 0.528813
beta2     0.000025    0.010782  0.002322 0.998147
beta3     0.000010    0.427774  0.000023 0.999982
beta4     0.000005    0.482752  0.000011 0.999991
```

```
beta5       0.000002     0.693594   0.000003  0.999998
beta6       0.000006     0.472596   0.000012  0.999991
beta7       0.000008     0.314225   0.000026  0.999979
beta8       0.407516     0.390499   1.043578  0.296681

LogLikelihood : 15795.69

Information Criteria
------------------------------------

Akaike        -6.6350
Bayes         -6.6064
Shibata       -6.6350
Hannan-Quinn  -6.6250


*------------------------------------*
*           GARCH Model Fit          *
*------------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model      : sGARCH(10,9)
Mean Model       : ARFIMA(1,0,0)
Distribution     : norm
```

Optimal Parameters

	Estimate	Std. Error	t value	Pr(>|t|)
mu	−0.000001	0.000118	−0.008660	0.99309
ar1	0.002206	0.015510	0.142239	0.88689
omega	0.000001	0.000000	10.554008	0.00000
alpha1	0.080725	0.014621	5.521342	0.00000
alpha2	0.000015	0.017432	0.000867	0.99931
alpha3	0.000001	0.021101	0.000069	0.99994
alpha4	0.000002	0.021836	0.000110	0.99991
alpha5	0.000003	0.015369	0.000192	0.99985
alpha6	0.000005	0.012014	0.000396	0.99968
alpha7	0.000001	0.008845	0.000067	0.99995
alpha8	0.000000	0.009877	0.000026	0.99998
alpha9	0.000000	0.015610	0.000018	0.99999
alpha10	0.000000	0.012027	0.000020	0.99998
beta1	0.778883	0.049170	15.840533	0.00000
beta2	0.000054	0.066194	0.000820	0.99935
beta3	0.037340	0.070202	0.531894	0.59480
beta4	0.000103	0.077554	0.001326	0.99894
beta5	0.000023	0.022394	0.001007	0.99920
beta6	0.000006	0.353627	0.000018	0.99999
beta7	0.000005	0.377432	0.000014	0.99999
beta8	0.000013	0.262579	0.000048	0.99996
beta9	0.089265	0.128222	0.696174	0.48632

```
Robust Standard Errors:
          Estimate  Std. Error   t value Pr(>|t|)
mu       -0.000001   0.000125 -0.008144 0.993502
ar1       0.002206   0.016259  0.135683 0.892072
omega     0.000001   0.000000  5.885090 0.000000
alpha1    0.080725   0.019882  4.060272 0.000049
alpha2    0.000015   0.021958  0.000688 0.999451
alpha3    0.000001   0.024952  0.000058 0.999954
alpha4    0.000002   0.029557  0.000081 0.999935
alpha5    0.000003   0.019855  0.000149 0.999881
alpha6    0.000005   0.018804  0.000253 0.999798
alpha7    0.000001   0.036802  0.000016 0.999987
alpha8    0.000000   0.028281  0.000009 0.999993
alpha9    0.000000   0.024124  0.000012 0.999991
alpha10   0.000000   0.019438  0.000012 0.999990
beta1     0.778883   0.049236 15.819524 0.000000
beta2     0.000054   0.068089  0.000797 0.999364
beta3     0.037340   0.153438  0.243356 0.807730
beta4     0.000103   0.030452  0.003378 0.997305
beta5     0.000023   0.023560  0.000957 0.999236
beta6     0.000006   0.464318  0.000014 0.999989
beta7     0.000005   0.363143  0.000014 0.999989
beta8     0.000013   0.196389  0.000065 0.999948
beta9     0.089265   0.106555  0.837732 0.402181

LogLikelihood : 15795.35
```

```
Information Criteria
------------------------------------

Akaike       -6.6344
Bayes        -6.6045
Shibata      -6.6345
Hannan-Quinn -6.6239


*----------------------------------*
*          GARCH Model Fit         *
*----------------------------------*

Conditional Variance Dynamics
-----------------------------------
GARCH Model     : sGARCH(10,10)
Mean Model      : ARFIMA(1,0,0)
Distribution    : norm

Optimal Parameters
------------------------------------
         Estimate  Std. Error   t value Pr(>|t|)
mu      -0.000001    0.000118 -0.007865 0.993725
ar1      0.002771    0.015461  0.179234 0.857754
omega    0.000002    0.000000 12.049800 0.000000
```

```
alpha1     0.078294     0.017286   4.529221 0.000006
alpha2     0.020505     0.026550   0.772318 0.439926
alpha3     0.000031     0.010369   0.003014 0.997595
alpha4     0.002131     0.014921   0.142785 0.886460
alpha5     0.000137     0.008685   0.015765 0.987422
alpha6     0.012510     0.018307   0.683377 0.494368
alpha7     0.000008     0.014452   0.000549 0.999562
alpha8     0.000003     0.008444   0.000300 0.999761
alpha9     0.000003     0.014959   0.000189 0.999849
alpha10    0.000002     0.014384   0.000156 0.999875
beta1      0.647667     0.156481   4.138954 0.000035
beta2      0.000306     0.151021   0.002028 0.998382
beta3      0.004140     0.460642   0.008988 0.992828
beta4      0.083673     0.423744   0.197462 0.843466
beta5      0.000270     0.318606   0.000847 0.999324
beta6      0.000063     0.021089   0.002965 0.997634
beta7      0.000035     0.012054   0.002915 0.997674
beta8      0.000039     0.003230   0.012064 0.990375
beta9      0.000048     0.101990   0.000475 0.999621
beta10     0.131018     0.092403   1.417898 0.156221

Robust Standard Errors:
           Estimate   Std. Error    t value Pr(>|t|)
mu        −0.000001     0.000125  −0.007429 0.994073
ar1        0.002771     0.016237   0.170667 0.864486
omega      0.000002     0.000000   6.386880 0.000000
```

alpha1	0.078294	0.021723	3.604117	0.000313
alpha2	0.020505	0.035903	0.571137	0.567907
alpha3	0.000031	0.032554	0.000960	0.999234
alpha4	0.002131	0.029221	0.072912	0.941876
alpha5	0.000137	0.036184	0.003784	0.996981
alpha6	0.012510	0.024062	0.519921	0.603119
alpha7	0.000008	0.017496	0.000453	0.999638
alpha8	0.000003	0.019710	0.000128	0.999898
alpha9	0.000003	0.020514	0.000138	0.999890
alpha10	0.000002	0.019517	0.000115	0.999908
beta1	0.647667	0.278039	2.329414	0.019837
beta2	0.000306	0.410233	0.000747	0.999404
beta3	0.004140	0.446816	0.009267	0.992606
beta4	0.083673	0.548972	0.152418	0.878857
beta5	0.000270	0.425343	0.000635	0.999494
beta6	0.000063	0.074521	0.000839	0.999330
beta7	0.000035	0.026755	0.001313	0.998952
beta8	0.000039	0.030008	0.001299	0.998964
beta9	0.000048	0.123727	0.000391	0.999688
beta10	0.131018	0.153244	0.854968	0.392569

LogLikelihood : 15796.51

Information Criteria

Akaike	-6.6345
Bayes	-6.6032
Shibata	-6.6345
Hannan–Quinn	-6.6235

C. Anexo: Código R

```
#Ingresando base de datos
datos_dolar<-read.table("dolar.txt",sep="         ",header=TRUE)
datos_euro<-read.table("euro.txt",sep="  ",header=TRUE)

#########
# Dolar #
#########
d<-data.frame(datos_dolar[1,])
for(i in 2:nrow(datos_dolar)) {
if (datos_dolar[i,2]=="0"){
d<-rbind(d,datos_dolar[i,])
}
if (datos_dolar[i,2]=="1" & datos_dolar[i,2]!=datos_dolar[i-1,2]){
d<-rbind(d,datos_dolar[i,])
}
}
sd<-data.frame(d[1,])
for(i in 2:nrow(d)) {
if (d[i,2]=="0") {
sd<-rbind(sd,d[i,])
```

```
}
}
########
# Euro #
########
e<-data.frame(datos_euro[1,])
for(i in 2:nrow(datos_euro)) {
if (datos_euro[i,2]=="0"){
e<-rbind(e,datos_euro[i,])
}
if (datos_euro[i,2]=="1" & datos_euro[i,2]!=datos_euro[i-1,2]){
e<-rbind(e,datos_euro[i,])
}
}

#Dejando datos con misma fecha
se<-data.frame(e[1,])
for(i in 2:nrow(sd)) {
for(j in 2:nrow(e)) {
if (sd[i,1]==e[j,1]){
se<-rbind(se,e[j,])
}
}
}
dolar<-data.frame(sd[1,])
for(i in 2:nrow(se)) {
```

```
for(j in 2:nrow(sd)) {
if (se[i,1]==sd[j,1]){
dolar<-rbind(dolar,sd[j,])
}
}
}

#########
# Dolar #
#########
s_d<-ts(dolar[,3])
#Graficando
plot(s_d)
########
# Euro #
########
s_e<-ts(se[,3])
#Graficando
plot(s_e)

#Sacando logaritmo natural a las series
s_dlog=log(s_d)
s_elog=log(s_e)
#Diferenciando
s_ddif=diff(s_dlog)
s_edif=diff(s_elog)
```

```
#Eliminando primer valor
s_dret<-s_ddif[-1]
s_eret<-s_edif[-1]

#Graficando retornos
plot(s_dret)
plot(s_eret)

#Prueba QQ-plot
#install.packages("EnvStats")
library(EnvStats)
par(mfrow=c(1,2))
qqnorm(s_dret, pch = 1, frame = FALSE,main="Normal QQ-Plot USD")
qqline(s_dret, col = "red", lwd = 2)
qqnorm(s_eret, pch = 1, frame = FALSE,main="Normal QQ-Plot EUR")
qqline(s_eret, col = "red", lwd = 2)

#Graficando ACF y PACF
par(mfrow=c(2,2))
acf(s_dret,main="ACF Retornos USD")
pacf(s_dret,main="PACF Retornos USD")
acf(s_eret,main="ACF Retornos EUR")
pacf(s_eret,main="PACF Retornos EUR")

#Prueba de independencia
#H0: Retornos son independientes
```

```
#install.packages("xts")
library(xts)
#########
# Dolar #
#########
Box.test(s_dret, type="Ljung-Box", lag=1)
#Rechazo H0 al 1%
########
# Euro #
########
Box.test(s_eret, type="Ljung-Box", lag=1)
#Rechazo H0 al 5%

#Test de ra\'iz unitaria
#H0: Tiene ra\'iz unitaria
install.packages("aTSA")
library(aTSA)
#########
# Dolar #
#########
adf.test(s_dret,output=TRUE)
#Rechazo H0, no tiene raiz unitaria entonces es estacionaria
########
# Euro #
########
adf.test(s_eret,output=TRUE)
```

```
#Rechazo H0, no tiene raiz unitaria entonces es estacionaria


#########
# Dolar #
#########
#Se tienen en cuenta ACF y PACF de los retornos de las series
arima100_d<-arima(s_dret,order=c(1,0,0))
arima001_d<-arima(s_dret,order=c(0,0,1))
arima002_d<-arima(s_dret,order=c(0,0,2))
arima101_d<-arima(s_dret,order=c(1,0,1))
arima102_d<-arima(s_dret,order=c(1,0,2))
arima103_d<-arima(s_dret,order=c(1,0,3))
arima200_d<-arima(s_dret,order=c(2,0,0))
arima201_d<-arima(s_dret,order=c(2,0,1))
arima202_d<-arima(s_dret,order=c(2,0,2))
arima203_d<-arima(s_dret,order=c(2,0,3))
arima300_d<-arima(s_dret,order=c(3,0,0))
arima301_d<-arima(s_dret,order=c(3,0,1))
arima302_d<-arima(s_dret,order=c(3,0,2))
arima303_d<-arima(s_dret,order=c(3,0,3))
#AIC Para establecer el modelo que mejor se ajusta
aic100_d<-arima100_d$aic
aic001_d<-arima001_d$aic
aic002_d<-arima002_d$aic
aic101_d<-arima101_d$aic
aic102_d<-arima102_d$aic
```

```
aic103_d<-arima103_d$aic
aic200_d<-arima200_d$aic
aic201_d<-arima201_d$aic
aic202_d<-arima202_d$aic
aic203_d<-arima203_d$aic
aic300_d<-arima300_d$aic
aic301_d<-arima301_d$aic
aic302_d<-arima302_d$aic
aic303_d<-arima303_d$aic
#Poniendo resultados en una tabla
nombres_d<-c("aic100_d","aic001_d","aic002_d","aic101_d",
"aic102_d","aic103_d","aic200_d","aic201_d","aic202_d",
"aic203_d","aic300_d","aic301_d","aic302_d","aic303_d")
aic_d<-as.numeric(c(aic100_d,aic001_d,aic002_d,aic101_d
,aic102_d,aic103_d,aic200_d,aic201_d,aic202_d,aic203_d,
aic300_d,aic301_d,aic302_d,aic303_d))
table_d<-data.frame(nombres_d,aic_d);table_d
#Menor AIC lo tiene el modelo ARIMA(3,0,1).
arima301_d
########
# Euro #
########
#Se tienen en cuenta ACF y PACF de los retornos de las series
arima001_e<-arima(s_eret,order=c(0,0,1))
arima100_e<-arima(s_eret,order=c(1,0,0))
arima101_e<-arima(s_eret,order=c(1,0,1))
```

```
#AIC Para establecer el modelo que mejor se ajusta
aic001_e<-arima001_e$aic
aic100_e<-arima100_e$aic
aic101_e<-arima101_e$aic
#Poniendo resultados en una tabla
nombres_e<-c("aic001_e","aic100_e","aic101_e")
aic_e<-as.numeric(c(aic001_e,aic100_e,aic101_e))
table_e<-data.frame(nombres_e,aic_e);table_e
#Menor AIC lo tiene el modelo ARIMA(1,0,0).
arima100_e

#Residuales al cuadrado para el modelo GARCH
#########
# Dolar #
#########
res_d=arima301_d$residuals
res2_d=res_d^2
########
# Euro #
########
res_e=arima100_e$residuals
res2_e=res_e^2

#Test de raiz unitaria
#H0: Tiene raiz unitaria
#########
```

```
# Dolar #
#########
adf.test(res2_d,output=TRUE)
#Rechazo H0, no tiene raiz unitaria entonces es estacionaria
########
# Euro #
########
adf.test(res2_e,output=TRUE)
#Rechazo H0, no tiene raiz unitaria entonces es estacionaria

#Estimando modelo GARCH
#install.packages(c("quantmod","rugarch","rmgarch"))
library(quantmod)
library(rugarch)
library(rmgarch)

#Graficando ACF y PACF
par(mfrow=c(2,2))
acf(res2_d,main="ACF Retornos USD")
pacf(res2_d,main="PACF Retornos USD")
acf(res2_e,main="ACF Retornos EUR")
pacf(res2_e,main="PACF Retornos EUR")

#########
# Dolar #
#########
```

```
#Tabla vacia para almacenar resultados
tabla_garch_d<-data.frame()
#Estimando diferentes modelos GARCH(p,q) con
q y p variando desde 1 hasta 10.
for (p in 1:10){
for (q in 1:10){
ug_spec<-ugarchspec(variance.model=list(garchOrder=c(p,q)),
mean.model=list(armaOrder=c(3,1)))
garch_d<- ugarchfit(spec = ug_spec, data = res_d,
solver.control = list(trace=0))
tabla_garch_d<-rbind(tabla_garch_d,c(p,q,
infocriteria(garch_d)[1]))
}
}
#Resultados
tabla_garch_d
#GARCH(4,8)
ug_spec_d<-ugarchspec(variance.model=list(garchOrder=c(4,8)),
mean.model=list(armaOrder=c(3,1)))
garch_d<- ugarchfit(spec = ug_spec_d, data = res_d,
solver.control = list(trace=0));garch_d
########
# Euro #
########
#Tabla vac\'ia para almacenar resultados
tabla_garch_e<-data.frame()
```

```
#Estimando diferentes modelos GARCH(p,q) con q y p variando
desde 0 hasta 10.
for (p in 1:10){
for (q in 1:10){
ug_spec<-ugarchspec(variance.model=list(garchOrder=c(p,q)),
mean.model=list(armaOrder=c(1,0)))
garch_e<- ugarchfit(spec = ug_spec, data = res_e,
solver.control= list(trace=0))
tabla_garch_e<-rbind(tabla_garch_e,c(p,q,
infocriteria(garch_e)[1]))
}
}
#Resultados
tabla_garch_e
#GARCH(1,3)
ug_spec_e<-ugarchspec(variance.model=
list(garchOrder=c(1,3)),mean.model=list(armaOrder=c(1,0)))
garch_e<- ugarchfit(spec = ug_spec_e, data = res_e,
solver.control = list(trace=0));garch_e

#Errores estandarizados de las series
#########
# Dolar #
#########
ee_d<-residuals(garch_d,standardize=T)
install.packages("spd")
```

```
hist(ee_d, ylab="Frecuencia", xlab="Errores estandarizados
GARCH(4,8)",
main="Errores estandarizados retornos USD")
########
# Euro #
########
ee_e<-residuals(garch_e,standardize=T)
hist(ee_e,ylab="Frecuencia", xlab="Errores estandarizados GARCH(1,3)",
main="Errores estandarizados retornos EUR")

#Para saber dist de ee_d y ee_e
#install.packages("rriskDistributions")
library(rriskDistributions)
#########
# Dolar #
#########
distee_d<-fit.cont(as.vector(ee_d))
#Dist log
location_d <-0.03048653
scale_d <-0.54811418
#install.packages("EnvStats")
library(EnvStats)
qqPlot(as.vector(ee_d), y = NULL, distribution = "logis")
#install.packages("robcbi")
library(robcbi)
QQline(as.vector(ee_d))
```

```
########
# Euro #
########
distee_e<-fit.cont(as.vector(ee_e))
#Dist log
location_e <-0.003032194
scale_e <-0.557600718
qqPlot(as.vector(ee_e), y = NULL, distribution = "logis")
#install.packages("robcbi")
library(robcbi)
QQline(as.vector(ee_e))

#Estandarizando
fit_d <-(ee_d-location_d)/scale_d
fit_e <-(ee_e-location_e)/scale_e

#Seleccionando cop
#install.packages("VineCopula")
library(VineCopula)
#Valores entre 0 y 1
x<-pobs(fit_d)
y<-pobs(fit_e)
#Seleccionando cop
copula<-BiCopSelect(as.vector(x),as.vector(y),familyset = NA)
summary(copula)
#Cop t. Par\'ametros = 0.66 y 6.43
```

```
copula$par
copula$par2
copula$tau
#Medidas de dependencia
#install.packages("copula")
library(copula)
tau_c<-tau(tCopula(copula$par,copula$par2))
rho_c<-rho(tCopula(copula$par,copula$par2))
#Resumiendo resultados
nombres_c<-c("C\'opula","Par\'ametro 1",
"Par\'ametro 2", "Tau de Kendall", "Rho de Spearman")
datos_c<-c("t",round(copula$par,3),round(copula$par2,3),
round(tau_c,3),round(rho_c,3))
table_c<-data.frame(nombres_c,datos_c);table_c

#Construcci\'on de distribuci\'on marginal con c\'opulas
B<-1000
dist_mvdc<-mvdc(tCopula(copula$par),c("logis","logis"),
list(list(location_d,scale_d),
list(location_e,scale_e)))
#Generando 59 datos B veces(01/02/2019 - 31/03/2019)
u<-data.frame(rMvdc(59,dist_mvdc))
u_d<-data.frame(u[,1])
u_e<-data.frame(u[,2])
for(i in 1:B) {
u<-rMvdc(59,dist_mvdc)
```

```
u_d<-cbind(u_e,u[,1])
u_e<-cbind(u_e,u[,2])
}

#Simulando retornos
#########
# Dolar #
#########
#Funci\'on de distribuci\'on inversa
#install.packages("spd")
library(spd)
qspd_u_d<-data.frame(qspd(pobs(u_d[,1]),spdfit(ee_d)))
for(i in 1:B){
qspd_u_d<-cbind(qspd_u_d,qspd(pobs(u_d[,i+1])
,spdfit(ee_d)))
}
#Simulando GARCH
sim_d=ugarchsim(garch_d, n.sim=59, n.start=0,
startMethod="sample", m.sim=(B+1),custom.dist=list(name=
"sample",
distfit=as.matrix(qspd_u_d)))
sim_d
#Retornos simulados (01/02/2019 - 31/03/2019)
sim_d_retornos<-data.frame(sim_d@simulation$seriesSim)
#Calculando valores
#install.packages("qrmtools")
```

```
library(qrmtools)
TRM_estimate<-returns(sim_d_retornos[,1],
inverse = TRUE, start=s_d[length(s_d)])
for(i in 1:B){
TRM_estimate<-cbind(TRM_estimate,returns(sim_d_retornos[,(i+1)],
inverse = TRUE, start=s_d[length(s_d)]))
}
#Intervalo de confianza al 95%
h<-data.frame(TRM_estimate[1,1]+(1.96*var(TRM_estimate[,1])/
sqrt(60)))
for(i in 2:60){
h<-rbind(h,TRM_estimate[i,1]+(1.96*var(TRM_estimate[,1])/
sqrt(60)))
}
l<-data.frame(TRM_estimate[1,1]-(1.96*var(TRM_estimate[,1])/
sqrt(60)))
for(i in 2:60){
l<-rbind(l,TRM_estimate[i,1]-(1.96*var(TRM_estimate[,1])/
sqrt(60)))
}
########
# Euro #
########
#Funci\'on de distribuci\'on inversa
qspd_u_e<-data.frame(qspd(pobs(u_e[,1]),spdfit(ee_e)))
for(i in 1:B){
```

```
qspd_u_e<-cbind(qspd_u_e,qspd(pobs(u_e[,i+1]),spdfit(ee_e)))
}
#Simulando GARCH
sim_e=ugarchsim(garch_e, n.sim=59, n.start=0,
startMethod="sample", m.sim=(B+1),custom.dist=
list(name="sample",
distfit=as.matrix(qspd_u_e)))
#Retornos simulados (01/02/2019 - 31/03/2019)
sim_e_retornos<-data.frame(sim_e@simulation$seriesSim)
#Calculando valores
EUR_estimate<-returns(sim_e_retornos[,1],
inverse = TRUE,start=s_e[length(s_e)])
for(i in 1:B){
EUR_estimate<-cbind(EUR_estimate,returns(sim_e_retornos
[,(i+1)], method = c("logarithmic", "simple", "diff"),
inverse = TRUE,start=s_e[length(s_e)]))
}
#Intervalo de confianza al 95%
h_e<-data.frame(EUR_estimate[1,1]+(1.96*var
(EUR_estimate[,1])/sqrt(60)))
for(i in 2:60){
h_e<-rbind(h_e,EUR_estimate[i,1]+(1.96*
var(EUR_estimate[,1])/sqrt(60)))
}
l_e<-data.frame(EUR_estimate[1,1]-(1.96*
var(EUR_estimate[,1])/sqrt(60)))
```

```
for(i in 2:60){
l_e<-rbind(l_e,EUR_estimate[i,1]-(1.96*
var(EUR_estimate[,1])/sqrt(60)))
}
#Para comparar
datos_dolar_real<-read.table("d_real.txt",
sep="	",header=FALSE)
datos_euro_real<-read.table("e_real.txt",
sep="	",header=FALSE)
Fechas<- seq(as.Date("2019-01-31"),
as.Date("2019-03-31"), "day")
par(mfrow=c(1,2))
plot(ts(datos_dolar_real),main=Pronostico TRM vs TRM real,ylab="Valores")
lines(ts(TRM_estimate[,1]),col='red')
lines(ts(h[,1]),col='blue')
lines(ts(l[,1]),col='blue')
months <- seq(min(fechas), max(fechas), "month")
axis(1, months, format(months, "%Y\n%b"))
plot(ts(datos_euro_real),main=Pron\'ostico EUR vs Real EUR,ylab="Valores")
lines(ts(EUR_estimate[,1]),col='red')
lines(ts(h_e[,1]),col='blue')
lines(ts(l_e[,1]),col='blue')
months <- seq(min(fechas), max(fechas), "month")
axis(1, months, format(months, "%Y\n%b"))

#CASO PRACTICO
```

```
#Portafolio valor nominal: COP 1.000.000.000
#Valor portafolio
portafolio<-1000000000
#Creando tabla con valores por moneda seg\'un porcentaje de inversi\'on
valor_dolar<-datos_dolar_real[1,]
valor_euro<-datos_euro_real[1,]
part<-data.frame()
v_portafolio<-data.frame()
for(i in seq(from=0, to=100, by=10)){
p_d<-i
p_e<-100-i
part<-rbind(part,c(p_d,p_e))
v_portafolio<-rbind(v_portafolio,c((p_d/100)*
portafolio/valor_dolar,(p_e/100)*portafolio/valor_euro))
}
####################
#0% USD - 100% EUR#
####################
#Porcentaje USD
porcentaje_d<-part[1,1]
valor_d<-v_portafolio[1,1]
#Porcentaje EUR
porcentaje_e<-part[1,2]
valor_e<-v_portafolio[1,2]
#Matriz de valores de portafolio
valor_portafolio<-data.frame((valor_d*
```

```
TRM_estimate[1,1])+(valor_e*EUR_estimate[1,1]))
for(i in 2:nrow(TRM_estimate)){
valor_portafolio<-rbind(valor_portafolio,(valor_d*
TRM_estimate[i,1])+(valor_e*EUR_estimate[i,1]))
}
for(i in 2:ncol(TRM_estimate)){
valor<-(valor_d*TRM_estimate[1,i])+(valor_e*
EUR_estimate[1,i])
for(j in 2:nrow(TRM_estimate)){
valor<-rbind(valor,(valor_d*TRM_estimate[j,i])+
(valor_e*EUR_estimate[j,i]))
}
valor_portafolio<-cbind(valor_portafolio,valor)
}
#Restando primer valor
v<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(i in 2:nrow(valor_portafolio)){
v<-rbind(v,valor_portafolio[1,1]-valor_portafolio[i,1])
}
for(i in 2:ncol(valor_portafolio)){
a<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(j in 2:nrow(valor_portafolio)){
a<-rbind(a,valor_portafolio[1,1]-valor_portafolio[j,i])
}
v<-cbind(v,a)
}
```

```
#Hallando VaR
alpha<-0.99
VaR<-data.frame(quantile(v[1,], probs = alpha))
for(i in 2:nrow(valor_portafolio)){
VaR<-rbind(VaR,data.frame(quantile(v[i,], probs = alpha)))
}
#Para comparar
data.frame(datos_dolar_real)
data.frame(datos_euro_real)
#Valor portafolio real
valor_portafolio_real<-data.frame((valor_d*
datos_dolar_real[1,1])+(valor_e*datos_euro_real[1,1]))
for(i in 2:nrow(datos_dolar_real)){
valor_portafolio_real<-rbind(valor_portafolio_real,
((valor_d*datos_dolar_real[i,1])+(valor_e*datos_euro_real[i,1])))
}
#Restando primer valor
v_portafolio_real<-data.frame(valor_portafolio_real[1,1]
-valor_portafolio_real[1,1])
for (i in 1:nrow(valor_portafolio_real)){
v_portafolio_real<-rbind(v_portafolio_real,
valor_portafolio_real[1,1]-valor_portafolio_real[i,1])
}
#Graficando
plot(ts(VaR),main='VaR 0% USD - 100% EUR',col='black',ylab="Valores")
for (i in 1:B){
```

```
lines(ts(v[,i]),col="lightblue")
}
lines(ts(v_portafolio_real),col='red')
lines(ts(VaR),col='black')
####################
#10% USD - 90% EUR#
####################
#Porcentaje USD
porcentaje_d<-part[2,1]
valor_d<-v_portafolio[2,1]
#Porcentaje EUR
porcentaje_e<-part[2,2]
valor_e<-v_portafolio[2,2]
#Matriz de valores de portafolio
valor_portafolio<-data.frame((valor_d*
TRM_estimate[1,1])+(valor_e*EUR_estimate[1,1]))
for(i in 2:nrow(TRM_estimate)){
valor_portafolio<-rbind(valor_portafolio,(valor_d*
TRM_estimate[i,1])+(valor_e*EUR_estimate[i,1]))
}
for(i in 2:ncol(TRM_estimate)){
valor<-(valor_d*TRM_estimate[1,i])+(valor_e*
EUR_estimate[1,i])
for(j in 2:nrow(TRM_estimate)){
valor<-rbind(valor,(valor_d*TRM_estimate[j,i])+
(valor_e*EUR_estimate[j,i]))
```

```
}
valor_portafolio<-cbind(valor_portafolio ,valor)
}
#Restando primer valor
v<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(i in 2:nrow(valor_portafolio)){
v<-rbind(v,valor_portafolio[1,1]-valor_portafolio[i,1])
}
for(i in 2:ncol(valor_portafolio)){
a<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(j in 2:nrow(valor_portafolio)){
a<-rbind(a,valor_portafolio[1,1]-valor_portafolio[j,i])
}
v<-cbind(v,a)
}
#Hallando VaR
alpha<-0.99
VaR<-data.frame(quantile(v[1,], probs = alpha))
for(i in 2:nrow(valor_portafolio)){
VaR<-rbind(VaR,data.frame(quantile(v[i,], probs = alpha)))
}
#Para comparar
data.frame(datos_dolar_real)
data.frame(datos_euro_real)
#Valor portafolio real
valor_portafolio_real<-data.frame((valor_d*
```

```
datos_dolar_real[1,1])+(valor_e*datos_euro_real[1,1]))
for(i in 2:nrow(datos_dolar_real)){
valor_portafolio_real<-rbind(valor_portafolio_real,
((valor_d*datos_dolar_real[i,1])+(valor_e*datos_euro_real[i,1])))
}
#Restando primer valor
v_portafolio_real<-data.frame(valor_portafolio_real[1,1]
-valor_portafolio_real[1,1])
for (i in 1:nrow(valor_portafolio_real)){
v_portafolio_real<-rbind(v_portafolio_real,
valor_portafolio_real[1,1]-valor_portafolio_real[i,1])
}
#Graficando
plot(ts(VaR),main='VaR 10% USD - 90% EUR',col='black',ylab="Valores")
for (i in 1:B){
lines(ts(v[,i]),col="lightblue")
}
lines(ts(v_portafolio_real),col='red')
lines(ts(VaR),col='black')
###################
#20% USD - 80% EUR#
###################
#Porcentaje USD
porcentaje_d<-part[3,1]
valor_d<-v_portafolio[3,1]
#Porcentaje EUR
```

```
porcentaje_e<-part[3,2]
valor_e<-v_portafolio[3,2]
#Matriz de valores de portafolio
valor_portafolio<-data.frame((valor_d*
TRM_estimate[1,1])+(valor_e*EUR_estimate[1,1]))
for(i in 2:nrow(TRM_estimate)){
valor_portafolio<-rbind(valor_portafolio,(valor_d*
TRM_estimate[i,1])+(valor_e*EUR_estimate[i,1]))
}
for(i in 2:ncol(TRM_estimate)){
valor<-(valor_d*TRM_estimate[1,i])+(valor_e*
EUR_estimate[1,i])
for(j in 2:nrow(TRM_estimate)){
valor<-rbind(valor,(valor_d*TRM_estimate[j,i])+
(valor_e*EUR_estimate[j,i]))
}
valor_portafolio<-cbind(valor_portafolio,valor)
}
#Restando primer valor
v<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(i in 2:nrow(valor_portafolio)){
v<-rbind(v,valor_portafolio[1,1]-valor_portafolio[i,1])
}
for(i in 2:ncol(valor_portafolio)){
a<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(j in 2:nrow(valor_portafolio)){
```

```
a<-rbind(a, valor_portafolio[1,1] - valor_portafolio[j,i])
}
v<-cbind(v,a)
}
#Hallando VaR
alpha<-0.99
VaR<-data.frame(quantile(v[1,], probs = alpha))
for(i in 2:nrow(valor_portafolio)){
VaR<-rbind(VaR,data.frame(quantile(v[i,], probs = alpha)))
}
#Para comparar
data.frame(datos_dolar_real)
data.frame(datos_euro_real)
#Valor portafolio real
valor_portafolio_real<-data.frame((valor_d*
datos_dolar_real[1,1])+(valor_e*datos_euro_real[1,1]))
for(i in 2:nrow(datos_dolar_real)){
valor_portafolio_real<-rbind(valor_portafolio_real,
((valor_d*datos_dolar_real[i,1])+(valor_e*datos_euro_real[i,1])))
}
#Restando primer valor
v_portafolio_real<-data.frame(valor_portafolio_real[1,1]-
valor_portafolio_real[1,1])
for (i in 1:nrow(valor_portafolio_real)){
v_portafolio_real<-rbind(v_portafolio_real,
valor_portafolio_real[1,1] - valor_portafolio_real[i,1])
```

```
}
#Graficando
plot(ts(VaR),main='VaR 20% USD - 80% EUR',col='black',ylab="Valores")
for (i in 1:B){
lines(ts(v[,i]),col="lightblue")
}
lines(ts(v_portafolio_real),col='red')
lines(ts(VaR),col='black')
####################
#30% USD - 70% EUR#
####################
#Porcentaje USD
porcentaje_d<-part[4,1]
valor_d<-v_portafolio[4,1]
#Porcentaje EUR
porcentaje_e<-part[4,2]
valor_e<-v_portafolio[4,2]
#Matriz de valores de portafolio
valor_portafolio<-data.frame((valor_d*
TRM_estimate[1,1])+(valor_e*EUR_estimate[1,1]))
for(i in 2:nrow(TRM_estimate)){
valor_portafolio<-rbind(valor_portafolio,
(valor_d*TRM_estimate[i,1])+(valor_e*EUR_estimate[i,1]))
}
for(i in 2:ncol(TRM_estimate)){
valor<-(valor_d*TRM_estimate[1,i])+(valor_e*
```

```
EUR_estimate[1,i])
for(j in 2:nrow(TRM_estimate)){
valor<-rbind(valor,(valor_d*TRM_estimate[j,i])+
(valor_e*EUR_estimate[j,i]))
}
valor_portafolio<-cbind(valor_portafolio,valor)
}
#Restando primer valor
v<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(i in 2:nrow(valor_portafolio)){
v<-rbind(v,valor_portafolio[1,1]-valor_portafolio[i,1])
}
for(i in 2:ncol(valor_portafolio)){
a<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(j in 2:nrow(valor_portafolio)){
a<-rbind(a,valor_portafolio[1,1]-valor_portafolio[j,i])
}
v<-cbind(v,a)
}
#Hallando VaR
alpha<-0.99
VaR<-data.frame(quantile(v[1,], probs = alpha))
for(i in 2:nrow(valor_portafolio)){
VaR<-rbind(VaR,data.frame(quantile(v[i,], probs = alpha)))
}
#Para comparar
```

```
data.frame(datos_dolar_real)
data.frame(datos_euro_real)
#Valor portafolio real
valor_portafolio_real<-data.frame((valor_d*
datos_dolar_real[1,1])+(valor_e*datos_euro_real[1,1]))
for(i in 2:nrow(datos_dolar_real)){
valor_portafolio_real<-rbind(valor_portafolio_real,
((valor_d*datos_dolar_real[i,1])+(valor_e*datos_euro_real[i,1])))
}
#Restando primer valor
v_portafolio_real<-data.frame(valor_portafolio_real
[1,1]-valor_portafolio_real[1,1])
for (i in 1:nrow(valor_portafolio_real)){
v_portafolio_real<-rbind(v_portafolio_real,
valor_portafolio_real[1,1]-valor_portafolio_real[i,1])
}
#Graficando
plot(ts(VaR),main='VaR 30% USD - 70% EUR',col='black',ylab="Valores")
for (i in 1:B){
lines(ts(v[,i]),col="lightblue")
}
lines(ts(v_portafolio_real),col='red')
lines(ts(VaR),col='black')
####################
#40% USD - 60% EUR#
####################
```

```
#Porcentaje USD
porcentaje_d<-part[5,1]
valor_d<-v_portafolio[5,1]
#Porcentaje EUR
porcentaje_e<-part[5,2]
valor_e<-v_portafolio[5,2]
#Matriz de valores de portafolio
valor_portafolio<-data.frame((valor_d*
TRM_estimate[1,1])+(valor_e*EUR_estimate[1,1]))
for(i in 2:nrow(TRM_estimate)){
valor_portafolio<-rbind(valor_portafolio,(valor_d*
TRM_estimate[i,1])+(valor_e*EUR_estimate[i,1]))
}
for(i in 2:ncol(TRM_estimate)){
valor<-(valor_d*TRM_estimate[1,i])+(valor_e*
EUR_estimate[1,i])
for(j in 2:nrow(TRM_estimate)){
valor<-rbind(valor,(valor_d*TRM_estimate[j,i])+
(valor_e*EUR_estimate[j,i]))
}
valor_portafolio<-cbind(valor_portafolio,valor)
}
#Restando primer valor
v<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(i in 2:nrow(valor_portafolio)){
v<-rbind(v,valor_portafolio[1,1]-valor_portafolio[i,1])
```

```
}
for(i in 2:ncol(valor_portafolio)){
a<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(j in 2:nrow(valor_portafolio)){
a<-rbind(a,valor_portafolio[1,1]-valor_portafolio[j,i])
}
v<-cbind(v,a)
}
#Hallando VaR
alpha<-0.99
VaR<-data.frame(quantile(v[1,], probs = alpha))
for(i in 2:nrow(valor_portafolio)){
VaR<-rbind(VaR,data.frame(quantile(v[i,], probs = alpha)))
}
#Para comparar
data.frame(datos_dolar_real)
data.frame(datos_euro_real)
#Valor portafolio real
valor_portafolio_real<-data.frame((valor_d*
datos_dolar_real[1,1])+(valor_e*datos_euro_real[1,1]))
for(i in 2:nrow(datos_dolar_real)){
valor_portafolio_real<-rbind(valor_portafolio_real,
((valor_d*datos_dolar_real[i,1])+(valor_e*datos_euro_real[i,1])))
}
#Restando primer valor
v_portafolio_real<-data.frame(valor_portafolio_real
```

```
[1,1]-valor_portafolio_real[1,1])
for (i in 1:nrow(valor_portafolio_real)){
v_portafolio_real<-rbind(v_portafolio_real,
valor_portafolio_real[1,1]-valor_portafolio_real[i,1])
}
#Graficando
plot(ts(VaR),main='VaR 40% USD - 60% EUR',col='black',ylab="Valores")
for (i in 1:B){
lines(ts(v[,i]),col="lightblue")
}
lines(ts(v_portafolio_real),col='red')
lines(ts(VaR),col='black')
####################
#50% USD - 50% EUR#
####################
#Porcentaje USD
porcentaje_d<-part[6,1]
valor_d<-v_portafolio[6,1]
#Porcentaje EUR
porcentaje_e<-part[6,2]
valor_e<-v_portafolio[6,2]
#Matriz de valores de portafolio
valor_portafolio<-data.frame((valor_d*
TRM_estimate[1,1])+(valor_e*EUR_estimate[1,1]))
for(i in 2:nrow(TRM_estimate)){
valor_portafolio<-rbind(valor_portafolio,
```

```
(valor_d*TRM_estimate[i,1])+(valor_e*EUR_estimate[i,1]))
}
for(i in 2:ncol(TRM_estimate)){
valor<-(valor_d*TRM_estimate[1,i])+
(valor_e*EUR_estimate[1,i])
for(j in 2:nrow(TRM_estimate)){
valor<-rbind(valor,(valor_d*TRM_estimate[j,i])+
(valor_e*EUR_estimate[j,i]))
}
valor_portafolio<-cbind(valor_portafolio,valor)
}
#Restando primer valor
v<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(i in 2:nrow(valor_portafolio)){
v<-rbind(v,valor_portafolio[1,1]-valor_portafolio[i,1])
}
for(i in 2:ncol(valor_portafolio)){
a<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(j in 2:nrow(valor_portafolio)){
a<-rbind(a,valor_portafolio[1,1]-valor_portafolio[j,i])
}
v<-cbind(v,a)
}
#Hallando VaR
alpha<-0.99
VaR<-data.frame(quantile(v[1,], probs = alpha))
```

```
for(i in 2:nrow(valor_portafolio)){
VaR<-rbind(VaR,data.frame(quantile(v[i,], probs = alpha)))
}
#Para comparar
data.frame(datos_dolar_real)
data.frame(datos_euro_real)
#Valor portafolio real
valor_portafolio_real<-data.frame((valor_d*
datos_dolar_real[1,1])+(valor_e*datos_euro_real[1,1]))
for(i in 2:nrow(datos_dolar_real)){
valor_portafolio_real<-rbind(valor_portafolio_real,
((valor_d*datos_dolar_real[i,1])+(valor_e*datos_euro_real[i,1])))
}
#Restando primer valor
v_portafolio_real<-data.frame(valor_portafolio_real[1,1]
-valor_portafolio_real[1,1])
for (i in 1:nrow(valor_portafolio_real)){
v_portafolio_real<-rbind(v_portafolio_real,
valor_portafolio_real[1,1]-valor_portafolio_real[i,1])
}
#Graficando
plot(ts(VaR),main='VaR 50% USD - 50% EUR',col='black',ylab="Valores")
for (i in 1:B){
lines(ts(v[,i]),col="lightblue")
}
lines(ts(v_portafolio_real),col='red')
```

```
lines(ts(VaR),col='black')
####################
#60% USD - 40% EUR#
####################
#Porcentaje USD
porcentaje_d<-part[7,1]
valor_d<-v_portafolio[7,1]
#Porcentaje EUR
porcentaje_e<-part[7,2]
valor_e<-v_portafolio[7,2]
#Matriz de valores de portafolio
valor_portafolio<-data.frame((valor_d*
TRM_estimate[1,1])+(valor_e*EUR_estimate[1,1]))
for(i in 2:nrow(TRM_estimate)){
valor_portafolio<-rbind(valor_portafolio,
(valor_d*TRM_estimate[i,1])+(valor_e*EUR_estimate[i,1]))
}
for(i in 2:ncol(TRM_estimate)){
valor<-(valor_d*TRM_estimate[1,i])+(valor_e*EUR_estimate[1,i])
for(j in 2:nrow(TRM_estimate)){
valor<-rbind(valor,(valor_d*TRM_estimate[j,i])+
(valor_e*EUR_estimate[j,i]))
}
valor_portafolio<-cbind(valor_portafolio,valor)
}
#Restando primer valor
```

```
v<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(i in 2:nrow(valor_portafolio)){
v<-rbind(v,valor_portafolio[1,1]-valor_portafolio[i,1])
}
for(i in 2:ncol(valor_portafolio)){
a<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(j in 2:nrow(valor_portafolio)){
a<-rbind(a,valor_portafolio[1,1]-valor_portafolio[j,i])
}
v<-cbind(v,a)
}
#Hallando VaR
alpha<-0.99
VaR<-data.frame(quantile(v[1,], probs = alpha))
for(i in 2:nrow(valor_portafolio)){
VaR<-rbind(VaR,data.frame(quantile(v[i,], probs = alpha)))
}
#Para comparar
data.frame(datos_dolar_real)
data.frame(datos_euro_real)
#Valor portafolio real
valor_portafolio_real<-data.frame((valor_d*
datos_dolar_real[1,1])+(valor_e*datos_euro_real[1,1]))
for(i in 2:nrow(datos_dolar_real)){
valor_portafolio_real<-rbind(valor_portafolio_real,
((valor_d*datos_dolar_real[i,1])+(valor_e*datos_euro_real[i,1])))
```

```
}
#Restando primer valor
v_portafolio_real<-data.frame(valor_portafolio_real[1,1]
-valor_portafolio_real[1,1])
for (i in 1:nrow(valor_portafolio_real)){
v_portafolio_real<-rbind(v_portafolio_real,
valor_portafolio_real[1,1]-valor_portafolio_real[i,1])
}
#Graficando
plot(ts(VaR),main='VaR 60% USD - 40% EUR',col='black',ylab="Valores")
for (i in 1:B){
lines(ts(v[,i]),col="lightblue")
}
lines(ts(v_portafolio_real),col='red')
lines(ts(VaR),col='black')
####################
#70% USD - 30% EUR#
####################
#Porcentaje USD
porcentaje_d<-part[8,1]
valor_d<-v_portafolio[8,1]
#Porcentaje EUR
porcentaje_e<-part[8,2]
valor_e<-v_portafolio[8,2]
#Matriz de valores de portafolio
valor_portafolio<-data.frame((valor_d*
```

```
TRM_estimate[1,1])+(valor_e*EUR_estimate[1,1]))
for(i in 2:nrow(TRM_estimate)){
valor_portafolio<-rbind(valor_portafolio,
(valor_d*TRM_estimate[i,1])+(valor_e*EUR_estimate[i,1]))
}
for(i in 2:ncol(TRM_estimate)){
valor<-(valor_d*TRM_estimate[1,i])+(valor_e*EUR_estimate[1,i])
for(j in 2:nrow(TRM_estimate)){
valor<-rbind(valor,(valor_d*TRM_estimate[j,i])+
(valor_e*EUR_estimate[j,i]))
}
valor_portafolio<-cbind(valor_portafolio,valor)
}
#Restando primer valor
v<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(i in 2:nrow(valor_portafolio)){
v<-rbind(v,valor_portafolio[1,1]-valor_portafolio[i,1])
}
for(i in 2:ncol(valor_portafolio)){
a<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(j in 2:nrow(valor_portafolio)){
a<-rbind(a,valor_portafolio[1,1]-valor_portafolio[j,i])
}
v<-cbind(v,a)
}
#Hallando VaR
```

```
alpha<-0.99
VaR<-data.frame(quantile(v[1,], probs = alpha))
for(i in 2:nrow(valor_portafolio)){
VaR<-rbind(VaR,data.frame(quantile(v[i,], probs = alpha)))
}
#Para comparar
data.frame(datos_dolar_real)
data.frame(datos_euro_real)
#Valor portafolio real
valor_portafolio_real<-data.frame((valor_d*
datos_dolar_real[1,1])+(valor_e*datos_euro_real[1,1]))
for(i in 2:nrow(datos_dolar_real)){
valor_portafolio_real<-rbind(valor_portafolio_real,
((valor_d*datos_dolar_real[i,1])+(valor_e*datos_euro_real[i,1])))
}
#Restando primer valor
v_portafolio_real<-data.frame(valor_portafolio_real
[1,1]-valor_portafolio_real[1,1])
for (i in 1:nrow(valor_portafolio_real)){
v_portafolio_real<-rbind(v_portafolio_real,
valor_portafolio_real[1,1]-valor_portafolio_real[i,1])
}
#Graficando
plot(ts(VaR),main='VaR 70% USD - 30% EUR',col='black',ylab="Valores")
for (i in 1:B){
lines(ts(v[,i]),col="lightblue")
```

```
}
lines(ts(v_portafolio_real),col='red')
lines(ts(VaR),col='black')
####################
#80% USD - 20% EUR#
####################
#Porcentaje USD
porcentaje_d<-part[9,1]
valor_d<-v_portafolio[9,1]
#Porcentaje EUR
porcentaje_e<-part[9,2]
valor_e<-v_portafolio[9,2]
#Matriz de valores de portafolio
valor_portafolio<-data.frame((valor_d*TRM_estimate
[1,1])+(valor_e*EUR_estimate[1,1]))
for(i in 2:nrow(TRM_estimate)){
valor_portafolio<-rbind(valor_portafolio,(valor_d
*TRM_estimate[i,1])+(valor_e*EUR_estimate[i,1]))
}
for(i in 2:ncol(TRM_estimate)){
valor<-(valor_d*TRM_estimate[1,i])+(valor_e*
EUR_estimate[1,i])
for(j in 2:nrow(TRM_estimate)){
valor<-rbind(valor,(valor_d*TRM_estimate[j,i])+
(valor_e*EUR_estimate[j,i]))
}
```

```
valor_portafolio<-cbind(valor_portafolio ,valor)
}
#Restando primer valor
v<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(i in 2:nrow(valor_portafolio)){
v<-rbind(v,valor_portafolio[1,1]-valor_portafolio[i,1])
}
for(i in 2:ncol(valor_portafolio)){
a<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(j in 2:nrow(valor_portafolio)){
a<-rbind(a,valor_portafolio[1,1]-valor_portafolio[j,i])
}
v<-cbind(v,a)
}
#Hallando VaR
alpha<-0.99
VaR<-data.frame(quantile(v[1,], probs = alpha))
for(i in 2:nrow(valor_portafolio)){
VaR<-rbind(VaR,data.frame(quantile(v[i,], probs = alpha)))
}
#Para comparar
data.frame(datos_dolar_real)
data.frame(datos_euro_real)
#Valor portafolio real
valor_portafolio_real<-data.frame((valor_d*
datos_dolar_real[1,1])+(valor_e*datos_euro_real[1,1]))
```

```
for(i in 2:nrow(datos_dolar_real)){
valor_portafolio_real<-rbind(valor_portafolio_real,
((valor_d*datos_dolar_real[i,1])+(valor_e*datos_euro_real[i,1])))
}
#Restando primer valor
v_portafolio_real<-data.frame(valor_portafolio_real[1,1]
-valor_portafolio_real[1,1])
for (i in 1:nrow(valor_portafolio_real)){
v_portafolio_real<-rbind(v_portafolio_real,
valor_portafolio_real[1,1]-valor_portafolio_real[i,1])
}
#Graficando
plot(ts(VaR),main='VaR 80% USD - 20% EUR',col='black',ylab="Valores")
for (i in 1:B){
lines(ts(v[,i]),col="lightblue")
}
lines(ts(v_portafolio_real),col='red')
lines(ts(VaR),col='black')
####################
#90% USD - 10% EUR#
####################
#Porcentaje USD
porcentaje_d<-part[10,1]
valor_d<-v_portafolio[10,1]
#Porcentaje EUR
porcentaje_e<-part[10,2]
```

```
valor_e<-v_portafolio[10,2]
#Matriz de valores de portafolio
valor_portafolio<-data.frame((valor_d*
TRM_estimate[1,1])+(valor_e*EUR_estimate[1,1]))
for(i in 2:nrow(TRM_estimate)){
valor_portafolio<-rbind(valor_portafolio,
(valor_d*TRM_estimate[i,1])+(valor_e*EUR_estimate[i,1]))
}
for(i in 2:ncol(TRM_estimate)){
valor<-(valor_d*TRM_estimate[1,i])+(valor_e*
EUR_estimate[1,i])
for(j in 2:nrow(TRM_estimate)){
valor<-rbind(valor,(valor_d*TRM_estimate[j,i])
+(valor_e*EUR_estimate[j,i]))
}
valor_portafolio<-cbind(valor_portafolio,valor)
}
#Restando primer valor
v<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(i in 2:nrow(valor_portafolio)){
v<-rbind(v,valor_portafolio[1,1]-valor_portafolio[i,1])
}
for(i in 2:ncol(valor_portafolio)){
a<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(j in 2:nrow(valor_portafolio)){
a<-rbind(a,valor_portafolio[1,1]-valor_portafolio[j,i])
```

```
}
v<-cbind(v,a)
}
#Hallando VaR
alpha<-0.99
VaR<-data.frame(quantile(v[1,], probs = alpha))
for(i in 2:nrow(valor_portafolio)){
VaR<-rbind(VaR,data.frame(quantile(v[i,], probs = alpha)))
}
#Para comparar
data.frame(datos_dolar_real)
data.frame(datos_euro_real)
#Valor portafolio real
valor_portafolio_real<-data.frame((valor_d*
datos_dolar_real[1,1])+(valor_e*datos_euro_real[1,1]))
for(i in 2:nrow(datos_dolar_real)){
valor_portafolio_real<-rbind(valor_portafolio_real,
((valor_d*datos_dolar_real[i,1])+(valor_e*datos_euro_real[i,1])))
}
#Restando primer valor
v_portafolio_real<-data.frame(valor_portafolio_real
[1,1]-valor_portafolio_real[1,1])
for (i in 1:nrow(valor_portafolio_real)){
v_portafolio_real<-rbind(v_portafolio_real,
valor_portafolio_real[1,1]-valor_portafolio_real[i,1])
}
```

```
#Graficando
plot(ts(VaR),main='VaR 90% USD - 10% EUR',col='black',ylab="Valores")
for (i in 1:B){
lines(ts(v[,i]),col="lightblue")
}
lines(ts(v_portafolio_real),col='red')
lines(ts(VaR),col='black')
####################
#100% USD - 0% EUR#
####################
#Porcentaje USD
porcentaje_d<-part[11,1]
valor_d<-v_portafolio[11,1]
#Porcentaje EUR
porcentaje_e<-part[11,2]
valor_e<-v_portafolio[11,2]
#Matriz de valores de portafolio
valor_portafolio<-data.frame((valor_d*
TRM_estimate[1,1])+(valor_e*EUR_estimate[1,1]))
for(i in 2:nrow(TRM_estimate)){
valor_portafolio<-rbind(valor_portafolio,
(valor_d*TRM_estimate[i,1])+(valor_e*EUR_estimate[i,1]))
}
for(i in 2:ncol(TRM_estimate)){
valor<-(valor_d*TRM_estimate[1,i])+(valor_e*EUR_estimate[1,i])
for(j in 2:nrow(TRM_estimate)){
```

```
valor<-rbind(valor,(valor_d*TRM_estimate[j,i])+
(valor_e*EUR_estimate[j,i]))
}
valor_portafolio<-cbind(valor_portafolio,valor)
}
#Restando primer valor
v<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(i in 2:nrow(valor_portafolio)){
v<-rbind(v,valor_portafolio[1,1]-valor_portafolio[i,1])
}
for(i in 2:ncol(valor_portafolio)){
a<-data.frame(valor_portafolio[1,1]-valor_portafolio[1,1])
for(j in 2:nrow(valor_portafolio)){
a<-rbind(a,valor_portafolio[1,1]-valor_portafolio[j,i])
}
v<-cbind(v,a)
}
#Hallando VaR
alpha<-0.99
VaR<-data.frame(quantile(v[1,], probs = alpha))
for(i in 2:nrow(valor_portafolio)){
VaR<-rbind(VaR,data.frame(quantile(v[i,], probs = alpha)))
}
#Para comparar
data.frame(datos_dolar_real)
data.frame(datos_euro_real)
```

```
#Valor portafolio real
valor_portafolio_real<-data.frame((valor_d*
datos_dolar_real[1,1])+(valor_e*datos_euro_real[1,1]))
for(i in 2:nrow(datos_dolar_real)){
valor_portafolio_real<-rbind(valor_portafolio_real,
((valor_d*datos_dolar_real[i,1])+(valor_e*datos_euro_real[i,1])))
}
#Restando primer valor
v_portafolio_real<-data.frame(valor_portafolio_real[1,1]-
valor_portafolio_real[1,1])
for (i in 1:nrow(valor_portafolio_real)){
v_portafolio_real<-rbind(v_portafolio_real,
valor_portafolio_real[1,1]-valor_portafolio_real[i,1])
}
#Graficando
plot(ts(VaR),main='VaR 100% USD - 0% EUR',col='black',ylab="Valores")
for (i in 1:B){
lines(ts(v[,i]),col="lightblue")
}
lines(ts(v_portafolio_real),col='red')
lines(ts(VaR),col='black')
```

Bibliografía

[Cherubini et al., 2004] Cherubini, U., Luciano, E., and Vecchiato, W. (2004). *Copula: methods in finance*. John Wiley Sons, Ltd, Chichester.

[Cummins and Derrig, 1989] Cummins, J. D. and Derrig, R. (1989). *Financial Models of Insurance Solvency*. Kluwer Academic Publishers, Massachusetts.

[Díaz, 2013] Díaz, A. M. (2013). *Apuntes de Clase: Econometría Avanzada*.

[EIOPA, 2010] EIOPA (2010). Qis5 technical specifications. Technical report, EIOPA.

[Gourieroux and Jasiak, 2001] Gourieroux, C. and Jasiak, J. (2001). *Financial Econometrics: Problems, Models, and Methods*. Princeton University Press, New Jersey.

[MinHacienda, 2010] MinHacienda (2010). Decreto 2954 de 2010, por el cual se modifica el decreto 2555 de 2010 y se establece el régimen de patrimonio adecuado de las entidades aseguradoras.

[Montengro, 2004] Montengro, A. (2004). *Análisis de Series de Tiempo*. Editorial Pontificia Universidad Javeriana, Bogotá.

[Nelsen, 2006] Nelsen, R. (2006). *An Introduction to Copulas*. Springer, New York.

[Sandstrõn, 2010] Sandstrõn, A. (2010). *Handbook of Solvency for Actuaries and Risk Managers: Theory and Practice*. CRC Press, Chicago.

[SFC, 2012] SFC (2012). Circular básica contable y financiera.

[Tsay, 2002] Tsay, R. (2002). *Analysis of Financial Time Series*. John Wiley and Sons, INC, Chicago.

[Wei, 2006] Wei, W. (2006). *Time Series Analysis: Univariate and Multivariate Methods*. Pearson Addison Wesley, Philadelphia.