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Final Project
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Testing ZION stock against Gaussian (i.i.d.) and the t-GARCH Model

The idea for this project came from the previous academic work of John Geweke and William McCausland on "Bayesian Specification Analysis in Econometrics". It was published by Oxford University Press in 2001. The paper tests two different distributions on the stocks returns for the S&P 500 with data from January3, 1928 through April 29, 1991 creating 17,052 observations.

This project redefines the scope of the study and focuses on ZION stock returns from December 14, 2006 through December 14th, 2016 accumulating 10 years of 2,518 observations. Variables like volume, day high/low, and opening price are not considered since our focus is the closing stock price.

Applying Bayesian Analysis requires to set up a prior density, predictive specification analysis, and then through the analysis we will be able to discover the post predictive specification analysis. Before starting, it is important to ask what is the data telling you and then see if then prepare a prediction for the observables you have and see if it matches. The Bayesian approach provides the flexibility to test a spectrum of likely values instead of just "accepting or rejecting a null hypothesis". The likelihood function is very powerful and is not something that this paper will address.

To test which of the two distributions matches ZION stock the best, the first stop was to gather the data and construct the following formulas:

Table 1. Definition of Vector of Interest

Preliminary Statistics:		
	$\bar{y}_T = \sum_{t=1}^{T} y_t / T$	$S_T = \sum_{t=1}^{T} (y_t - \bar{y}_T)^2 / T$
	$\bar{y}_T^{(2)} = \sum_{t=1}^{T} y_t^2 / T$	$S_T^{(2)} = \sum_{t=1}^{T} (y_t^2 - \bar{y}_T^{(2)})^2 / T$
ω_1	First-order volatility	$\sum_{t=1}^{T-1} (y_t^2 - \bar{y}_T^{(2)})(y_{t+1}^2 - \bar{y}_T^{(2)}) / (T\, s_T^{(2)})$
ω_2	Twentieth order volatility	$\sum_{t=1}^{T-20} (y_t^2 - \bar{y}_T^{(2)})(y_{t+20}^2 - \bar{y}_T^{(2)}) / (T\, s_T^{(2)})$
ω_3	Volatility decay	ω_2 / ω_1
ω_4	Excess kurtosis	$\sum_{t=1}^{T} (y_t - \bar{y}_T)^4 / T\, (s_T)^2 - 3$
ω_5	Quantile ratio	$(y_{(T)} - y_{(1)}) / (y_{(3T/4)} - y_{(T/4)})$
ω_6	Skewness	$\sum_{t=2}^{T} (y_t - \bar{y}_T)^3 / T\, (s_T)^{3/2}$
ω_7	Leverage ahead	$\sum_{t=1}^{T-1} (y_t - \bar{y}_T)(y_{t-1}^2 - \bar{y}_T^{(2)}) / T\, (s_T \cdot s_T^{(2)})^{1/2}$
ω_8	Leverage behind	$\sum_{t=2}^{T} (y_t - \bar{y}_T)(y_{t+1}^2 - \bar{y}_T^2) / T\, (s_T \cdot s_T^{(2)})^{1/2}$
ω_9	Standard deviation	$(S_T)^{1/2}$

The values from ω_1 - ω_9 will be placed in both tables to compare. The following are the obtained values for ZION:

		Data
ω1	First-order volatility	0.242
ω2	Twentieth order volatility	0.198
ω3	Volatility decay	0.815
ω4	Excess kurtosis	-0.001
ω5	Quantile ratio	-0.103
ω6	Skewness	0.086
ω7	Leverage ahead	0.793
ω8	Leverage behind	0.072
ω9	Standard deviation	0.015

After this, the next step is to get random values generated by the normal distribution. For both, 10,000 simulations will be drawn using R. The formulas to construct the desired values are the following:

$$y_t \sim t(\mu, h_t; \nu)$$

$$h_t = \alpha + \gamma(y_{t-1} - \mu)^2 + \delta h_{t-1}.$$

For the t-GARCH model, there are very important specification when it comes to getting the previous values. Different distributions are used and variance is specified to get alpha:

$$\begin{aligned}
&\log(\alpha) \sim N(-12, 2.2) \\
&(\gamma, \delta, 1-\gamma-\delta) \sim Beta(1, 1, 1) \\
&\nu - 4 \sim \chi^2(4).
\end{aligned}$$

Solve for the obtained values to get y_t and h_t in the different corresponding models. By taking the median of the values generated for both distributions, and then creating intervals of (25%, 75%) and (1%, 99%), we will be able to see which intervals contain the data values shown in Table 2 or get the closest to those. The project generated by Geweke and McCausland attributed a better approximation to the predictive distribution the vector of interest t-GARCH Model we could expect a similar result for ZION, but until it's not proven nothing can be concluded.