Research article

Modelling and forecasting the volatility of bitcoin futures: the role of distributional assumption in GARCH models

Samuel Asante Gyamerah [1,2,*] **and Collins Abaitey** [1]

[1] Department of Statistics and Actuarial Science, Kwame Nkrumah University of Science and Technology, Kumasi-Ghana

[2] Laboratory for Interdisciplinary Statistical Analysis – Kwame Nkrumah University of Science and Technology (KNUST-LISA), Kumasi-Ghana

* **Correspondence:** Email: saasgyam@gmail.com.

Supplementary

Table A1. Estimation results of sGARCH family models for Bitcoin futures return with different error distribution assumption.

Model	Estimated Parameters										
	μ	ω	α_1	β_1	η_{11}	γ_1	δ	Skew	shape	AIC	BIC
sGARCH(1,1)-STD	0.001664*	0.000060*	0.105875	0.893125	-	-	-		2.999262	-3.5373	-3.5096
	(0.001069)	(0.000033)	(0.026727)	(0.021343)	(-)	(-)	(-)		(0.294213)		
sGARCH(1,1)-GED	0.000681	0.000076***	0.086968	0.884133	-	-	-		0.900692	-3.5359	-3.5082
	(0.000154)	(0.000034)	(0.023399)	(0.027653)	(-)	(-)	(-)		(0.053196)		
sGARCH(1,1)-NIG	0.001215*	0.000059***	0.096789	0.890399	-	-	-	−0.027705*	0.422959	-3.5398	-3.5066
	(0.001427)	(0.000028)	(0.024861)	(0.023035)	(-)	(-)	(-)	(0.074202)	(0.088495)		

standard errors are in bracket, ***, **, and * imply statistical significance at the 1%, 5%, and 10% level, respectively

Table A2. Estimation results of tGARCH family models for Bitcoin futures return with different error distribution assumption

Model	Estimated Parameters										
	μ	ω	α_1	β_1	η_{11}	γ_1	δ	Skew	shape	AIC	BIC
tGARCH(1,1)-STD	0.001252	0.001258	0.163539	0.886712	-0.086243	(-)	(-)		2.672477	-3.5390	-3.5058
	(0.001254)	(0.000716)	(0.037106)	(0.021241)	(0.113943)	(-)	(-)		(0.277959)		
tGARCH(1,1)-GED	0.000000*	0.002391***	0.128371	0.862617	−0.015097*	(-)	(-)		0.876118	-3.5318	-3.4986
	(0.000048)	(0.000939)	(0.028177)	(0.031352)	(0.129982)	(-)	(-)		(0.052555)		
tGARCH(1,1)-NIG	0.001220*	0.000058***	0.099548	0.890794	-	−0.005154*	-	−0.028101*	0.422188	-3.5375	-3.4988
	(0.001634)	(0.000033)	(0.038197)	(0.018084)	(-)	(0.044743)	(-)	(0.080220)	(0.104442)		

standard errors are in bracket, ***, **, and * imply statistical significance at the 1%, 5%, and 10% level, respectively

Table A3. Estimation results of iGARCH family models for Bitcoin futures return with different error distribution assumption.

Model	Estimated Parameters										
	μ	ω	α_1	β_1	η_{11}	γ_1	δ	Skew	shape	AIC	BIC
iGARCH(1,1)-STD	0.001663*	0.000059***	0.106635	0.893365	-	-	-		2.990437	-3.5397	-3.5175
	(0.001068)	(0.000030)	(0.020543)	(-)	(-)	(-)	(-)		(0.213747)		
iGARCH(1,1)-GED	0.000000*	0.000053***	0.111739	0.888261	-	-	-		0.848831	-3.5353	-3.5132
	(0.000044)	(0.000024)	(0.026253)	(-)	(-)	(-)	(-)		(0.047908)		
iGARCH(1,1)-NIG	0.001169*	0.000049***	0.107657	0.892343	-	-	-	−0.028807*	0.390402	-3.5416	-3.5139
	(0.001457)	(0.000022)	(.022101)	(-)	(-)	(-)	(-)	(0.077171)	(0.069449)		

standard errors are in bracket, ***, **, and * imply statistical significance at the 1%, 5%, and 10% level, respectively

Table A4. Estimation results of eGARCH family models for Bitcoin futures return with different error distribution assumption.

Model	Estimated Parameters										
	μ	ω	α_1	β_1	η_{11}	γ_1	δ	Skew	shape	AIC	BIC
eGARCH(1,1)-STD	0.001303	-0.112149	0.015673*	0.980604	-	0.278848	-		2.721974	-3.5427	-3.5095
	(0.000289)	(0.041624)	(0.030645)	(0.007757)	(-)	(0.067328)	(-)		(0.305861)		
eGARCH(1,1)-GED	0.00000*	-0.29120	−0.00426*	0.95283	(-)	0.22056	-		0.87908	-3.5349	-3.5017
	(0.000049)	(0.101340)	(0.026079)	(0.016309)	(-)	(0.043414)	(-)		(0.052749)		
eGARCH(1,1)-NIG	0.000542*	-0.191458	0.009095*	0.968640	(-)	0.232120	-	−0.055214*	0.397532	-3.5416	-3.5028
	(0.001412)	(0.073537)	(0.025764)	(0.011902)	(-)	(0.042221)	(-)	(0.075690)	(0.082720)		

standard errors are in bracket, ***, **, and * imply statistical significance at the 1%, 5%, and 10% level, respectively

Table A5. Estimation results of apGARCH family models for Bitcoin futures return with different error distribution assumption.

Model	Estimated Parameters										
	μ	ω	α_1	β_1	η_{11}	γ_1	δ	Skew	shape	AIC	BIC
apARCH(1,1)-STD	0.001340*	0.000588*	0.163180	0.890757	-	−0.071496*	1.213898*		2.694736	-3.5371	-3.4983
	(0.001107)	(0.001094)	(0.045643)	(0.017330)	(-)	(0.130387)	(0.590110)		(0.311436)		
apARCH(1,1)-GED	0.000493***	0.000187*	0.100026	0.879429	-	0.022567*	1.737045		0.898400	-3.5315	-3.4927
	(0.000203)	(0.000240)	(0.030610)	(0.028709)	(-)	(0.104785)	(0.391820)		(0.053134)		
apARCH(1,1)-NIG	0.000653*	0.000668*	0.129881	0.884082	-	−0.050379*	1.252465	−0.051396*	0.398624	-3.5373	-3.4930
	(0.001459)	(0.001080)	(0.030803)	(0.025187)	(-)	(0.116375)	(0.450200)	(0.077003)	(0.084866)		

standard errors are in bracket, ***, **, and * imply statistical significance at the 1%, 5%, and 10% level, respectively

Table A6. Estimation results of gjrGARCH family models for Bitcoin futures return with different error distribution assumption.

Model	Estimated Parameters										
	μ	ω	α_1	β_1	η_{11}	γ_1	δ	Skew	shape	AIC	BIC
gjrGARCH(1,1)-STD	0.001676*	0.000059**	0.108898***	0.893594	-	−0.006984*	-		3.005712	-3.5350	-3.5018
	(0.001084)	(0.000034)	(0.034112)	(0.021714)	(-)	(0.038282)	(-)		(0.293892)		
gjrGARCH(1,1)	0.000000*	0.000079***	0.082188	0.882615	-	0.011581*	-		0.891387	-3.5339	-3.5007
	(0.000053)	(0.000035)	(0.028770)	(0.028068)	(-)	(0.034613)	(-)		(0.053999)		
gjrGARCH(1,1)	0.001220*	0.000058***	0.099548	0.890794	-	−0.005154*	-	−0.028101*	0.422188	-3.5375	-3.4988
	(0.001427)	(0.000029)	(0.032236)	(0.023174)	(-)	(0.037028)	(-)	(0.074273)	(0.088494)		

standard errors are in bracket, ***, **, and * imply statistical significance at the 1%, 5%, and 10% level, respectively
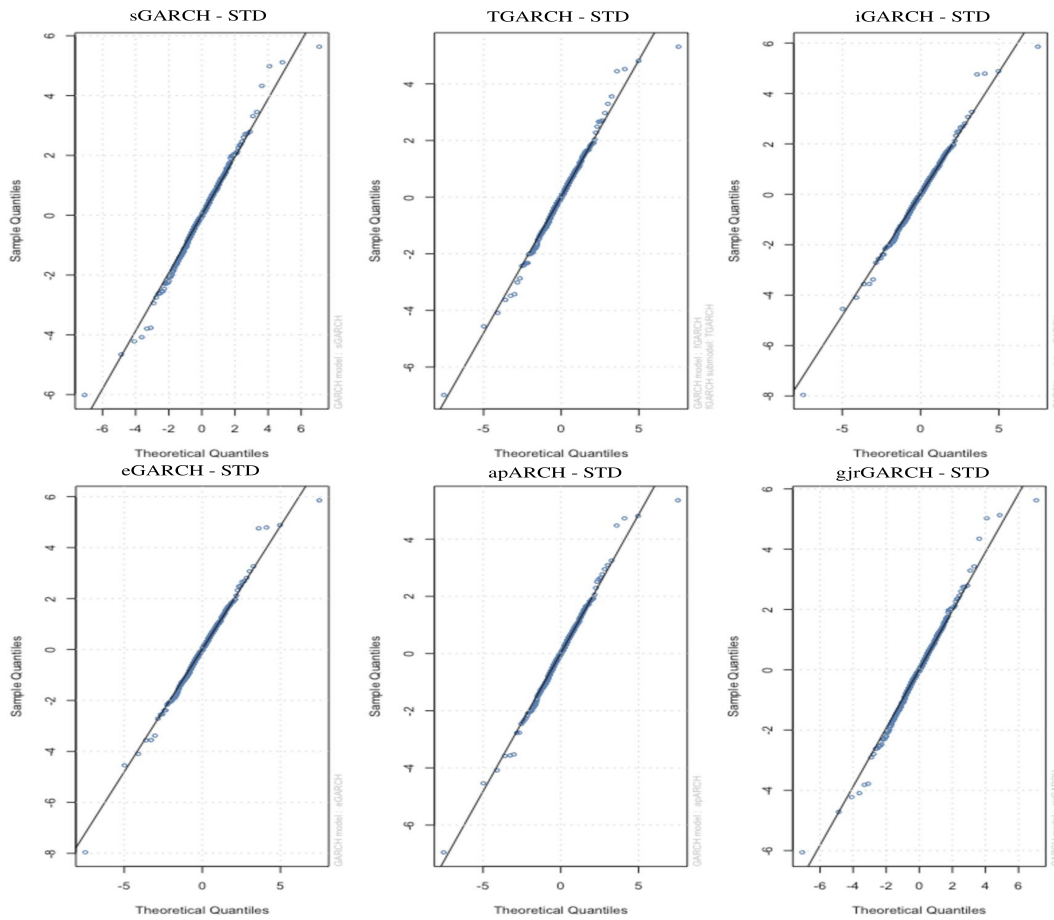

Figure A1. Quantile-Quantile (QQ) plot of the sGARCH, tGARCH, iGARCH, eGARCH, apARCH, gjrGARCH using the Student t-distributional assumption (STD).
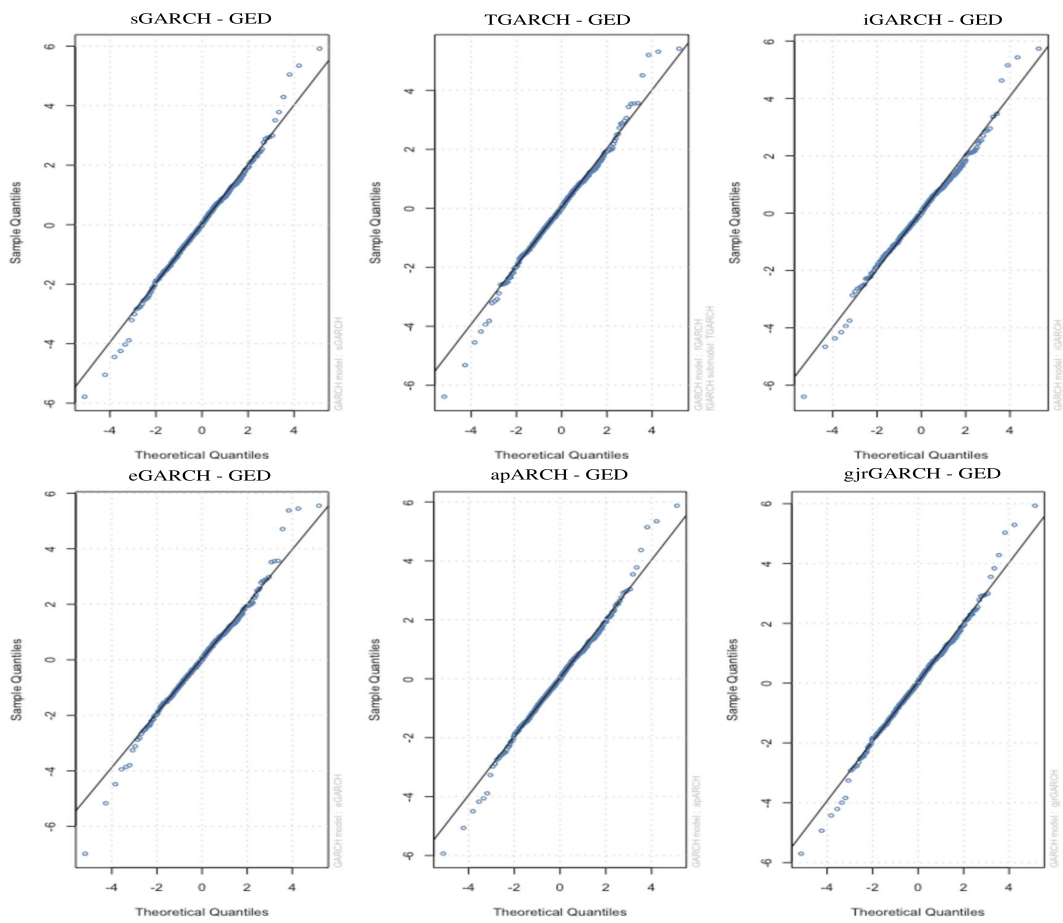
Figure A2. Quantile-Quantile (QQ) plot of the sGARCH, tGARCH, iGARCH, eGARCH, apARCH, gjrGARCH using the generalized error distributional assumption (GED).
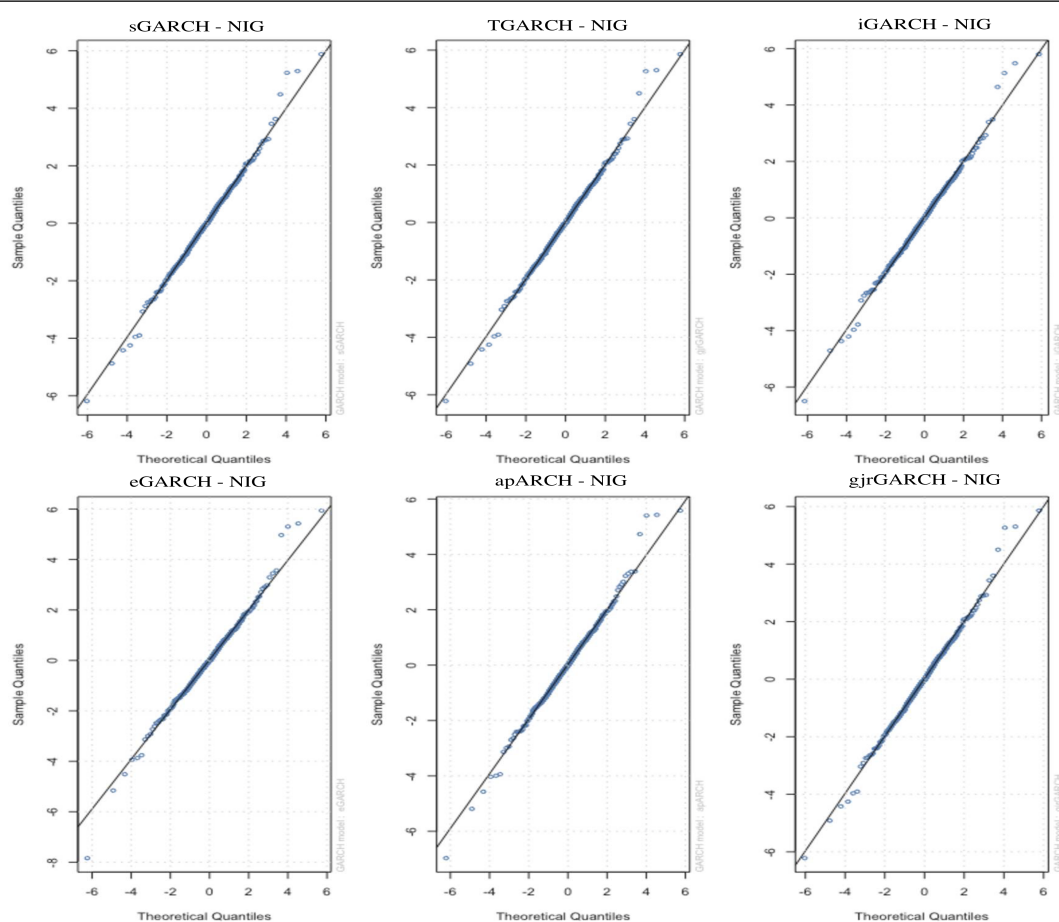
Figure A3. Quantile-Quantile (QQ) plot of the sGARCH, tGARCH, iGARCH, eGARCH, apARCH, gjrGARCH using the normal inverse gaussion distributional assumption (NIG).