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Applying ARCH, GARCH, GARCH MLR models to forecast Volatility of transportation sector through its three subscribe modes like Road, Water, Seas ways: empirical case of HCM Vietnam

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Abstract
The paper aims to empirically apply ARCH, GARCH (a,b) model to weight the average of the variance in historical data. (a,b) is order of model which this paper applies a = 1 and b = 1 in which b is order of GARCH, and a is order of ARCH which is square residual of the previous day. The objective of empirical Application is to forecast the volatility of GDP of Transportation Logistics (TL) through GDP of its three sub-sectors which are Road Transportation (RT), Inland Water Transportation (IWT), and Seas Transportation (ST). The author then has proposal models are MLR, ARCH MIR and GARCH (a,b) MLR to assess the dependence GDP of TL on GDP of its three sub-sectors which are RT, IWT, and ST. The first finding of study is ARCH and GARCH (a,b) which a = 1 and b = 1 can be empirically applied to predict the volatility of GDP of TL through GDP of RT, IWT, and ST. The second finding is that after tested MLR, ARCH MLR, and MLR GARCH (1,1), the output results show that almost values are not statistical significance, that means we cannot use MLR, ARCH MLR, and GARCH (1,1) MLR to assess the dependence of GDP of TL on GDP of its three sub-sectors which are RT, IWT, and ST.

Keywords: ARCH, GARCH, GARCH (1,1) MLR, forecast, volatility, Transportation Logistics, Road Transportation, Inland Water Transportation, Sea Transportation

1. Introduction
Besides the major economic sectors are popularly such as Agriculture - Forestry - Fisheries, Industry - Construction, and of course it cannot forget the role of Transportation Logistics which it can be treated as the backbone of other economics industries in the economy. In particular, Logistics including two components which are transport and warehouse are contributing significantly to the national GDP as well as affirming the role in Economic Development nationally and globally. Transportation consists not only of the physical and organizational elements which interact each other to produce transportation opportunities, but also of the demand that takes advantage of such opportunities to travel from one place to another for goods, people and other materials, a transportation logistics can be defined as a set of elements and the interactions between them that produce both the demand for travel within a given area and the provision of transportation services to satisfy this demand. (Ennio Cascetta, 2009) [17]. Transportation costs are often to be estimated on a fixed-cost approach, the cost be understood as part of the overhead cost rather than conducting detailed estimation of actual transportation operations (SangJun Ahn, SangUk Han, Mohamed Al-Hussein, 2020) [16]. Cost can change the decision to make the best choice for a transportation system, transportation networks affect the costs of TLin different ways (MD Sarder, 2020) [15].
In 2016, transportation logistics of Hochiminh City VN (HCMC VN) has small number of business enterprises comparing with other industries, but it has quite large GDP and it is just lower than two other service with GDP is 7.35% of the whole GDP of nine other service industries (HCM City Statistics Department). However, the year after year TL's GDP does not keep stable, it makes the business owner as well as authorities are hard to control operation, business plan, and development-investment.
If we look at the time data in finance, we can see that in some periods where the data is more volatile than the others. Thus, when we modify a model, this will result in a more intense residue. Additionally, the "sharp peaks" of the variance are not randomized which arraged by time, instead there is the existence of "auto-correlation". Simply, it can be said as "volatility clustering", it means periods when large variances tend to group together. The non-fixed Variance is called Heteroskedasticity. And this is the time the GARCH model is to be used and helps us find the oscillation measures used to predict the residuals in the models.
The objectives of this paper are to empirically apply ARCH, GARCH (a,b) models which a =1, and b =1 to forecast Volatility of GDP of Transportation Logistic through GDP of its three sub-sectors are RT, IWT, and ST, each

sub-sector of RT, IWT, and ST is mearsued separately by each ARCH and each GARCH (1,1). The author then propose the MLR, ARCH MLR and GARCH (a,b) MLR which a =1, and b =1 to assess the dependence of GDP of TL on GDP of its three sub-sectors which are RT, IWT, and ST, and GDP of TL is dependent variable, there are three independent variables are GDP of RT, GDP of IWT, and GDP of ST. The analysis resutls and findings will be discussed and commente by author.

2. Literature review

Robert F. Engle (Jul., 1982, p. 989) [2] said that "The ARCH regression model has a variety of characteristics which make it attractive for econometric applications. Econometric forecasters have found that their ability to predict the future varies from one period to another. Economic theory frequently suggests that economic agents respond not only to the mean, but also to higher moments of economic random variables. In financial theory, the variance as well as the mean of the rate of return are determinants of portfolio decision (Engle, 1982) [2]. These ARCH and GARCH models were widely used in econometric mathematical models, especially in the analysis of financial time series were studied by Bollerslev *et al*., 1988; Bollerslev, 1990. Bollerslev, Chou, Kroner did in 1992 and Bolleslev, Engle, Nelson did year 1994 [2].

3. Data

Data is GDP of Road transportation, Inland water transportation, Sea transportation monthly from Jauary 2011 to August 2020, the data is result of the general investigations and surveys nationally of Vietnam and has officially published by Hochiminh City Statistics Department (HCMC SD). All data of this research were extracted, refined, then consolidated, and calculated by the author accurately.

4. Methodology and Calculation

4.1 Return (U)

$U_t = (U_t - U_{t-1})/ U_{t-1}$

4.2 Residual (R)

$R = U_t - C$

4.3 Squared Residual (SR)

$SR = R^2$

4.4 Lagged Squared Residual (LSR)

$LSR_t = SR_{t-1}$

4.5 Long-run volatility (LRV)

LRV = $\sqrt{\omega/(1-\alpha)}$ which apply for ARCH

LRV = $\sqrt{\omega/(1-\alpha-\beta)}$ which apply for GARCH

4.6 Conditional Variance (CV)

Apply for ARCH

$CV_{t-1} = LRV^2$

$CV_t = \omega + (\alpha * LSR_t)$

Apply for GARCH

$CV_{t-1} = \omega/(1-\alpha-\beta)$

$CVt = \omega + (\alpha * LSRt) + (\beta * CVt-1)$

4.7 Log Likelihood (LH)

$LH = Log\{1/(CV_t\sqrt{2\pi})*EXP(-SR/2*CV_t)\}$

4.8 EWMA

$EWMA_t = \sqrt{SR_t}$

4.9 ARCH

$$v_t^2 = \omega + \alpha\varepsilon_{t-1}^2$$

$$\varepsilon_t^2 = v_t^2 + u_t$$

$$L(\mu, \omega, \alpha) = \frac{1}{v_t\sqrt{2\pi}} e^{-\frac{\varepsilon_t^2}{2v_t^2}}$$

Where

Constant parameter (C)

$-0.001 < C < 0.001$

Standard deviation (SD)

$SD = STDEV.S\sum_{i=1}^{n} U$

Variance (V)

$V = SD^2$

$0.000001 < \omega < V$

$0 < \alpha < 1$

4.10 GARCH (a,b)

$$v_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta v_{t-1}^2$$

$$\varepsilon_t^2 = v_t^2 + u_t$$

$$L(\mu, \omega, \alpha, \beta) = \frac{1}{v_t\sqrt{2\pi}} e^{-\frac{\varepsilon_t^2}{2v_t^2}}$$

Where a = 1, b = 1, b is order of GARCH, a is order of ARCH which is square residual of the previous day.

Constant parameter (C)

$-0.001 < C < 0.001$

Standard deviation (SD)

$SD = STDEV.S\sum_{i=1}^{n} U$

Variance (V)

$V = SD^2$

$0.000001 < \omega < V$

$0 < \alpha, \beta < 1$

4.11 MLR, ARCH MLR, GARCH (a,b) MLR.

4.11.1. *Multivariate linear regression*

$Y = a_0 + a_1X_1 + a_2 X_2 + a_3 X_3$

Where

Y is TL's GDP which is dependent variable

X_1 is RT's GDP which is independent variable

X_2 is IWT's GDP which is independent variable

X_3 is ST which is indepdent variable

a_0 is intersection between vertical axis and regression line which this paper does not focus on

a_1 = regression coefficient of X_1

a_2 = regression coefficient of X_2

a_3 = regression coefficient of X_3

4.11.2 *ARCH Multivariate linear regression (ARCH MLR)*

$Z = \beta_0 + \beta_1A_1 + \beta_2 A_2 + \beta_3A_3$

Where

Z is TL's GDP which is dependent variable

A_1 is RT's GDP ARCH which is independent variable
A_2 IWT's GDP ARCH which is independent variable
A_3 ST's GDP ARCH which is indepdent variable
β_0 is intersection between vertical axis and regression line which this paper does not focus on
β_1 = regression coefficient of A_1
β_2 = regression coefficient of A_2
β_3 = regression coefficient of A_3

4.11.3. *GARCH (a,b) Multivariate linear regression (GARCH(a,b) MLR)*

$H = \omega_0 + \omega_1 B_1 + \omega_2 B_2 + \omega_3 B_3$

Where

Where a = 1, b = 1, b is order of GARCH, a is order of ARCH which is square residual of the previous day.
H = is TL's GDP which is dependent variable
B_1 is RT's GDP GARCH (1,1) which is independent variable
B_2 IWT's GDP GARCH (1,1) which is independent variable
B_3 ST's GDP GARCH (1,1) which is indepdent variable
ω_0 is intersection between vertical axis and regression line which this paper does not focus on
ω_1 = regression coefficient of B_1
ω_2 = regression coefficient of B_2
ω_3 = regression coefficient of B_3

5. Research result

5.1 The results of ARCH, GARCH (1,1) empirical Application to forecast the volatility of GDP of TL through GDP of its three sub-sectors are RT, IWT, and ST.

Tabel 1: Parameters in ARCH and GARCH (1,1) of GDP of TL monthly consists of RT, IWT, and ST between Jan 2011 and Aug 2020.

	RT		IWT		ST	
	ARCH	**GARCH**	**ARCH**	**GARCH**	**ARCH**	**GARCH**
Average	0.0152	0.0152	0.0018	0.0018	-0.0047	-0.0047
Standard Deviation	0.1389	0.1389	0.1070	0.1070	0.1287	0.1287
Variance	0.0193	0.0193	0.0114	0.0114	0.0166	0.0166
Solver researches over						
Constant	0.0147	0.0152	0.0017	0.0147	0.0166	0.0141
ω (Uncondional Variance)	0.0187	0.0019	0.0113	0.0033	0.0053	0.0048
α	0.0086	0.7565	0.0022	0.7178	0.9336	0.9804
β		0.2416		0.2642		0.0190
α+ β		0.9981		0.9820		0.9994
Long-run volatility	0.1375	1.0016	0.1066	0.4271	0.2813	2.7693

***Source*:** HCMC SD, consolidated and calculated by author.

"**Average**" is the averages of the Ut which formula is $U_t = (U_t - U_{t-1})/ U_{t-1}$ that the higher values the averages are, the large GDP grown the variables have. Average for both ARCH and GARCH (1,1) of RT and IWT are 0.0152, 0.0018 respectively which are all > 0 indicates GDP of RT & IWT sounds well. The one of ST = - 0.0047 < 0 shows the GDP of ST is not good business situation.

"Standard Deviation (SD)" is the value to measure the scatter of the data comparing with their average values, the formula is SD = STDEV.S$\sum_{i=1}^{n} U$ which $\sum_{i=1}^{n} U$ is average of U from Ut to Un. The bigger the ST is, the more scattered the data is. This study has n = 1, 2, ..., 116 which are GDP of TL consist of its three sub-sectors are RT, IWT, and ST monthly from Jan 2011 to Aug 2020. Table 1 shows SD of both ARCH and GARCH for all RT, IWT, and ST are 0.1389, 0.1070, and 0.1287 respectively which are all quite small. The small values of SD give us information that the data for GDP monthly from Jan 2011 to Aug 2020 of TL were not scattered strongly.

"Variance" is the square of SD which is the measure indicates of distance between figures of data and between each figure and the average value of their data. And the fact is variance can never be equally Zero "0". Table 1 shows output results with variances of ARCH, GARCH for RT is 0.0193, IWT is 0.0114, and ST is 0.0166 that are all quite small.

"α, β, ω" are the parameters by using Solving Parameter function of Excel in which have to be based on the rules that are $0 < \alpha, \beta < 1$, and $0.000001 < \omega < V$

"Long-run volatility" which ARCH uses formula is SQRT (ω / (1- α)), and GARCH uses formula is SQRT (ω / (1 – ($\alpha + \beta$))).

Tabel 2: Parameters in ARCH for GDP of RT monthly between Jan 2011 and Aug 2020.

							Maximun Likelihood =	**66.1692**	**Volatility**	
Time	**Time$_t$**	**RT's GDP**	**Return (U)**	**Residual**	**Squared Residual**	**Lagged Squared Residual**	**Conditional Variance**	**Log Likelihood**	**EWMA**	**ARCH**
Jan-11	1	1,685								
Feb-11	2	1,338	-0.206	-0.221	0.049		0.019	-0.225	0.221	0.137
Mar-11	3	2,390	0.786	0.771	0.595	0.049	0.019	-14.471	0.771	0.138
Apr-11	4	1,614	-0.324	-0.339	0.115	0.595	0.024	-1.460	0.339	0.154
May-11	5	1,614	0.000	-0.015	0.000	0.115	0.020	1.038	0.015	0.140
Jun-11	.	991	-0.386	-0.401	0.161	0.000	0.019	-3.220	0.401	0.137
Jul-11	.	1,748	0.764	0.750	0.562	0.161	0.020	-12.934	0.750	0.142
Aug-11	.	1,810	0.035	0.021	0.000	0.562	0.024	0.946	0.021	0.154
Aug-19	.	5,185	0.021	0.006	0.000	0.000	0.019	1.069	0.006	0.137
Sep-19	.	5,329	0.028	0.013	0.000	0.000	0.019	1.065	0.013	0.137

Oct-19	.	5,406	0.014	0.000	0.000	0.000	0.019	1.070	0.000	0.137
Nov-19	.	5,414	0.001	-0.013	0.000	0.000	0.019	1.065	0.013	0.137
Dec-19	.	5,660	0.045	0.031	0.001	0.000	0.019	1.044	0.031	0.137
Jan-20	.	5,483	-0.031	-0.046	0.002	0.001	0.019	1.013	0.046	0.137
Feb-20	.	4,481	-0.183	-0.197	0.039	0.002	0.019	0.030	0.197	0.137
Mar-20	.	4,211	-0.060	-0.075	0.006	0.039	0.019	0.914	0.075	0.138
Apr-20	112	2,900	-0.311	-0.326	0.106	0.006	0.019	-1.760	0.326	0.137
May-20	113	4,162	0.435	0.420	0.177	0.106	0.020	-3.453	0.420	0.140
Jun-20	114	4,373	0.051	0.036	0.001	0.177	0.020	0.999	0.036	0.142
Jul-20	115	4,410	0.008	-0.006	0.000	0.001	0.019	1.068	0.006	0.137
Aug-20	116	3,639	-0.175	-0.190	0.036	0.000	0.019	0.111	0.190	0.137

Source: HCMC SD, consolidated and calculated by author

Tabel 3: Parameters in GARCH (1,1) for GDP RT monthly between Jan 2011 and Aug 2020.

							Maximun Likelihood =	**125.42**	**Volatility**		
Time	**Time$_t$**	**RT's GDP**	**Return (U)**	**Residual**	**Squared Residual**	**Lagged Squared Residual**	**Conditional Variance**	**Log Likelihood**	**Realised**	**GARCH**	**ARCH**
Jan-11	1	1,685									
Feb-11	2	1,338	(0.206)	(0.221)	0.049		1.003	(0.945)	0.221	1.002	0.137
Mar-11	3	2,390	0.786	0.771	0.594	0.049	0.281	(1.341)	0.771	0.530	0.138
Apr-11	4	1,614	(0.324)	(0.340)	0.115	0.594	0.519	(0.702)	0.340	0.721	0.154
May-11	5	1,614	-	(0.015)	0.000	0.115	0.215	(0.150)	0.015	0.463	0.140
Jun-11	.	991	(0.386)	(0.401)	0.161	0.000	0.054	(0.954)	0.401	0.232	0.137
Jul-11	.	1,748	0.764	0.749	0.561	0.161	0.137	(1.976)	0.749	0.370	0.142
Aug-11	.	1,810	0.035	0.020	0.000	0.561	0.460	(0.531)	0.020	0.678	0.154
Sep-11	.	1,886	0.042	0.027	0.001	0.000	0.113	0.167	0.027	0.336	0.137
Oct-11	.	1,930	0.023	0.008	0.000	0.001	0.030	0.837	0.008	0.173	0.137
Nov-11	.	2,050	0.062	0.047	0.002	0.000	0.009	1.310	0.047	0.095	0.137
Dec-11	.	2,119	0.034	0.019	0.000	0.002	0.006	1.633	0.019	0.076	0.137
Jan-12	.	2,140	0.010	(0.005)	0.000	0.000	0.004	1.904	0.005	0.059	0.137
Aug-19	.	5,185	0.021	0.005	0.000	0.000	0.003	1.982	0.005	0.055	0.137
Sep-19	.	5,329	0.028	0.013	0.000	0.000	0.003	2.026	0.013	0.051	0.137
Oct-19	.	5,406	0.014	(0.001)	0.000	0.000	0.003	2.056	0.001	0.051	0.137
Nov-19	.	5,414	0.001	(0.014)	0.000	0.000	0.002	2.042	0.014	0.050	0.137
Dec-19	.	5,660	0.045	0.030	0.001	0.000	0.003	1.881	0.030	0.051	0.137
Jan-20	.	5,483	(0.031)	(0.046)	0.002	0.001	0.003	1.617	0.046	0.056	0.137
Feb-20	.	4,481	(0.183)	(0.198)	0.039	0.002	0.004	(2.791)	0.198	0.065	0.137
Mar-20	.	4,211	(0.060)	(0.075)	0.006	0.039	0.033	0.706	0.075	0.180	0.138
Apr-20	112	2,900	(0.311)	(0.327)	0.107	0.006	0.014	(2.587)	0.327	0.118	0.137
May-20	113	4,162	0.435	0.420	0.176	0.107	0.086	(0.718)	0.420	0.293	0.140
Jun-20	114	4,373	0.051	0.036	0.001	0.176	0.156	0.006	0.036	0.395	0.142
Jul-20	115	4,410	0.008	(0.007)	0.000	0.001	0.041	0.684	0.007	0.201	0.137
Aug-20	116	3,639	(0.175)	(0.190)	0.036	0.000	0.012	(0.240)	0.190	0.108	0.137

Source: HCMC SD, consolidated and calculated by author.

Tabel 4: Parameters in ARCH for GDP of IWT monthly between Jan 2011 and Aug 2020.

							Maximun Likelihood =	**94.440353**	**Volatility**	
Time	**Time$_t$**	**IWT's GDP**	**Return (U)**	**Residual**	**Squared Residual**	**Lagged Squared Residual**	**Conditional Variance**	**Log Likelihood**	**EWMA**	**ARCH**
Jan-11	1	426.600								
Feb-11	2	376.100	(0.118)	(0.120)	0.014		0.011	0.686	0.120	0.107
Mar-11	3	229.581	(0.390)	(0.391)	0.153	0.014	0.011	(5.414)	0.391	0.107
Apr-11	4	188.600	(0.179)	(0.180)	0.032	0.153	0.012	(0.085)	0.180	0.108
May-11	5	188.600	-	(0.002)	0.000	0.032	0.011	1.318	0.002	0.107
Jun-11	.	178.600	(0.053)	(0.055)	0.003	0.000	0.011	1.189	0.055	0.106
Jul-11	.	201.000	0.125	0.124	0.015	0.003	0.011	0.646	0.124	0.107
Oct-19	.	255.000	0.045	0.043	0.002	0.001	0.011	1.238	0.043	0.106
Nov-19	.	249.000	(0.024)	(0.025)	0.001	0.002	0.011	1.293	0.025	0.106
Dec-19	.	256.000	0.028	0.026	0.001	0.001	0.011	1.290	0.026	0.106
Jan-20	.	249.000	(0.027)	(0.029)	0.001	0.001	0.011	1.284	0.029	0.106
Feb-20	.	227.000	(0.088)	(0.090)	0.008	0.001	0.011	0.963	0.090	0.106
Mar-20	.	271.000	0.194	0.192	0.037	0.008	0.011	(0.306)	0.192	0.107
Apr-20	112	217.000	(0.199)	(0.201)	0.040	0.037	0.011	(0.451)	0.201	0.107
May-20	113	280.000	0.290	0.289	0.083	0.040	0.011	(2.330)	0.289	0.107
Jun-20	114	339.000	0.211	0.209	0.044	0.083	0.012	(0.584)	0.209	0.107
Jul-20	115	306.000	(0.097)	(0.099)	0.010	0.044	0.011	0.888	0.099	0.107
Aug-20	116	246.000	(0.196)	(0.198)	0.039	0.010	0.011	(0.402)	0.198	0.107

Source: HCMC SD, consolidated and calculated by author.

Tabel 5: Parameters in GARCH (1,1) for GDP of IWT monthly between Jan 2011 and Aug 2020.

							Maximun Likelihood =	104.24726	Volatility		
Time	Time$_t$	IWT's GDP	Return (U)	Residual	Squared Residual	Lagged Squared Residual	Conditional Variance	Log Likelihood	EWMA	GARCH	ARCH
Jan-11	1	426.600									
Feb-11	2	376.100	(0.118)	(0.133)	0.018		0.182	(0.117)	0.133	0.427	0.107
Mar-11	3	229.581	(0.390)	(0.404)	0.163	0.018	0.064	(0.819)	0.404	0.253	0.107
Apr-11	4	188.600	(0.179)	(0.193)	0.037	0.163	0.138	(0.063)	0.193	0.371	0.108
May-11	5	188.600	-	(0.015)	0.000	0.037	0.066	0.435	0.015	0.258	0.107
Jun-11	.	178.600	(0.053)	(0.068)	0.005	0.000	0.021	0.903	0.068	0.145	0.106
Jul-11	.	201.000	0.125	0.111	0.012	0.005	0.012	0.782	0.111	0.110	0.107
Aug-11	.	212.500	0.057	0.042	0.002	0.012	0.015	1.112	0.042	0.124	0.107
Sep-11	.	221.200	0.041	0.026	0.001	0.002	0.009	1.418	0.026	0.093	0.107
Oct-11	.	225.300	0.019	0.004	0.000	0.001	0.006	1.632	0.004	0.078	0.106
Nov-11	.	243.800	0.082	0.067	0.005	0.000	0.005	1.277	0.067	0.070	0.106
Jul-19	.	231.300	(0.009)	(0.024)	0.001	0.000	0.044	0.639	0.024	0.209	0.106
Aug-19	.	235.000	0.016	0.001	0.000	0.001	0.015	1.172	0.001	0.124	0.106
Sep-19	.	244.000	0.038	0.024	0.001	0.000	0.007	1.501	0.024	0.086	0.106
Oct-19	.	255.000	0.045	0.030	0.001	0.001	0.006	1.589	0.030	0.075	0.106
Nov-19	.	249.000	(0.024)	(0.038)	0.001	0.001	0.005	1.554	0.038	0.074	0.106
Dec-19	.	256.000	0.028	0.013	0.000	0.001	0.006	1.642	0.013	0.076	0.106
Jan-20	.	249.000	(0.027)	(0.042)	0.002	0.000	0.005	1.557	0.042	0.070	0.106
Feb-20	.	227.000	(0.088)	(0.103)	0.011	0.002	0.006	0.745	0.103	0.077	0.106
Mar-20	.	271.000	0.194	0.179	0.032	0.011	0.012	(0.013)	0.179	0.112	0.107
Apr-20	112	217.000	(0.199)	(0.214)	0.046	0.032	0.030	0.068	0.214	0.172	0.107
May-20	113	280.000	0.290	0.276	0.076	0.046	0.044	(0.220)	0.276	0.210	0.107
Jun-20	114	339.000	0.211	0.196	0.038	0.076	0.069	0.138	0.196	0.263	0.107
Jul-20	115	306.000	(0.097)	(0.112)	0.013	0.038	0.049	0.459	0.112	0.222	0.107
Aug-20	116	246.000	(0.196)	(0.211)	0.044	0.013	0.025	0.041	0.211	0.159	0.107

Source: HCMC SD, consolidated and calculated by author.

Tabel 6: Parameters in ARCH for GDP of ST monthly between Jan 2011 and Aug 2020.

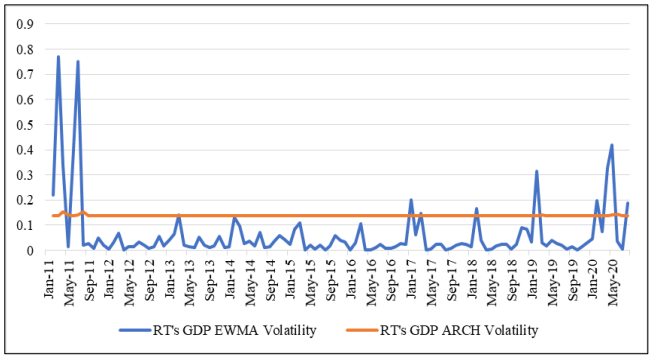
							Maximun Likelihood =	97.34509	Volatility	
Time	Time$_t$	ST's GDP	Return (U)	Residual	Squared Residual	Lagged Squared Residual	Conditional Variance	Log Likelihood	EWMA	ARCH
Jan-11	1	6,171.200								
Feb-11	2	5,236.300	(0.151)	(0.168)	0.028		0.079	0.171	0.168	0.281
Mar-11	3	2,026.357	(0.613)	(0.630)	0.396	0.028	0.032	(5.459)	0.630	0.178
Apr-11	4	789.600	(0.610)	(0.627)	0.393	0.396	0.375	(0.952)	0.627	0.613
May-11	5	789.600	-	(0.017)	0.000	0.393	0.372	(0.425)	0.017	0.610
Jun-11	.	871.500	0.104	0.087	0.008	0.000	0.006	0.992	0.087	0.074
Jul-11	.	950.100	0.090	0.074	0.005	0.008	0.012	1.059	0.074	0.111
Aug-11		895.000	(0.058)	(0.075)	0.006	0.005	0.010	1.099	0.075	0.102
Sep-11		847.400	(0.053)	(0.070)	0.005	0.006	0.010	1.129	0.070	0.102
Sep-19		1,574.000	0.032	0.016	0.000	0.000	0.005	1.679	0.016	0.073
Oct-19		1,602.000	0.018	0.001	0.000	0.000	0.005	1.684	0.001	0.074
Nov-19		1,657.000	0.034	0.018	0.000	0.000	0.005	1.675	0.018	0.073
Dec-19	.	1,725.000	0.041	0.024	0.001	0.000	0.006	1.624	0.024	0.075
Jan-20	.	1,545.000	(0.104)	(0.121)	0.015	0.001	0.006	0.398	0.121	0.076
Feb-20	.	1,372.000	(0.112)	(0.129)	0.017	0.015	0.019	0.628	0.129	0.137
Mar-20	.	1,208.000	(0.120)	(0.136)	0.019	0.017	0.021	0.573	0.136	0.144
Apr-20	112	985.000	(0.185)	(0.201)	0.040	0.019	0.023	0.080	0.201	0.150
May-20	113	1,230.000	0.249	0.232	0.054	0.040	0.043	0.028	0.232	0.207
Jun-20	114	1,553.000	0.263	0.246	0.061	0.054	0.056	(0.019)	0.246	0.236
Jul-20	115	1,221.000	(0.214)	(0.230)	0.053	0.061	0.062	0.044	0.230	0.249
Aug-20	116	963.000	(0.211)	(0.228)	0.052	0.053	0.055	0.059	0.228	0.234

Source: HCMC SD, consolidated and calculated by author.

Tabel 7: Parameters in GARCH (1,1) for GDP ST monthly between Jan 2011 and Aug 2020.

							Maximun Likelihood =	99.151064	Volatility		
Time	Time$_t$	ST's GDP	Return (U)	Residual	Squared Residual	Lagged Squared Residual	Conditional Variance	Log Likelihood	EWMA	GARCH	ARCH
Jan-11	1	6,171.200									
Feb-11	2	5,236.300	(0.151)	(0.166)	0.027		7.669	(1.939)	0.166	2.769	0.281
Mar-11	3	2,026.357	(0.613)	(0.627)	0.393	0.027	0.178	(1.162)	0.627	0.421	0.178
Apr-11	4	789.600	(0.610)	(0.624)	0.390	0.393	0.394	(0.948)	0.624	0.627	0.613
May-11	5	789.600	-	(0.014)	0.000	0.390	0.395	(0.454)	0.014	0.628	0.610
Jun-11	.	871.500	0.104	0.090	0.008	0.000	0.013	0.950	0.090	0.112	0.074
Jul-11	.	950.100	0.090	0.076	0.006	0.008	0.013	1.031	0.076	0.114	0.111
Aug-11	.	895.000	(0.058)	(0.072)	0.005	0.006	0.011	1.105	0.072	0.104	0.102
Sep-11	.	847.400	(0.053)	(0.067)	0.005	0.005	0.010	1.154	0.067	0.101	0.102
Oct-11	.	928.000	0.095	0.081	0.007	0.005	0.009	1.064	0.081	0.097	0.099
Apr-19	.	1,348.000	0.067	0.053	0.003	0.012	0.021	0.939	0.053	0.146	0.127
May-19	.	1,418.100	0.052	0.038	0.001	0.003	0.008	1.405	0.038	0.089	0.087
Jun-19	.	1,477.300	0.042	0.028	0.001	0.001	0.006	1.547	0.028	0.080	0.080
Jul-19	.	1,490.700	0.009	(0.005)	0.000	0.001	0.006	1.661	0.005	0.076	0.076
Aug-19	.	1,525.000	0.023	0.009	0.000	0.000	0.005	1.724	0.009	0.071	0.073
Sep-19	.	1,574.000	0.032	0.018	0.000	0.000	0.005	1.696	0.018	0.071	0.073
Oct-19	.	1,602.000	0.018	0.004	0.000	0.000	0.005	1.704	0.004	0.073	0.074
Nov-19	.	1,657.000	0.034	0.020	0.000	0.000	0.005	1.693	0.020	0.070	0.073
Dec-19	.	1,725.000	0.041	0.027	0.001	0.000	0.005	1.629	0.027	0.073	0.075
Jan-20	.	1,545.000	(0.104)	(0.118)	0.014	0.001	0.006	0.429	0.118	0.075	0.076
Feb-20	.	1,372.000	(0.112)	(0.126)	0.016	0.014	0.019	0.646	0.126	0.137	0.137
Mar-20	.	1,208.000	(0.120)	(0.134)	0.018	0.016	0.021	0.588	0.134	0.144	0.144
Apr-20	112	985.000	(0.185)	(0.199)	0.039	0.018	0.023	0.105	0.199	0.151	0.150
May-20	113	1,230.000	0.249	0.235	0.055	0.039	0.044	0.017	0.235	0.210	0.207
Jun-20	114	1,553.000	0.263	0.249	0.062	0.055	0.060	(0.027)	0.249	0.244	0.236
Jul-20	115	1,221.000	(0.214)	(0.228)	0.052	0.062	0.067	0.046	0.228	0.258	0.249
Aug-20	116	963.000	(0.211)	(0.225)	0.051	0.052	0.057	0.068	0.225	0.239	0.234

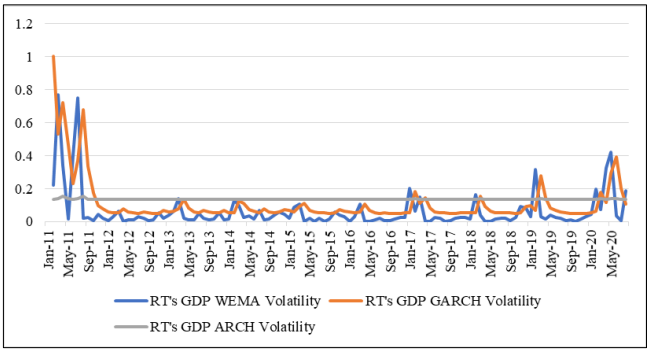
Source: HCMC SD, consolidated and calculated by author.



***Source*:** HCMC SD, consolidated, calculated and charted by author.

Fig 1: Chart of ARCH for GDP of RT monthly between Jan 2011 and Aug 2020.

The status of figure 1 tells us that there is no Volatility of ARCH, but there was the EWMA Volatility of RT's GDP, especially from Mar 2020 up to August 2020.

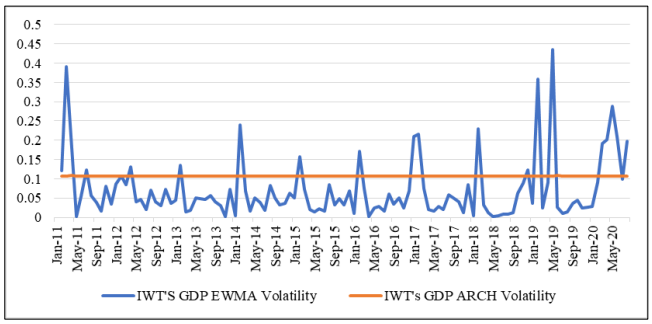


Source: HCMC SD, consolidated, calculated and charted by author.

Fig 2: Chart of GARCH (1,1) for GDP of RT monthly between Jan 2011 and Aug 2020.

This chart shows us ARCH Volatility of RT's GDP is stable. However, EWMA and GARCH volatilities which the same

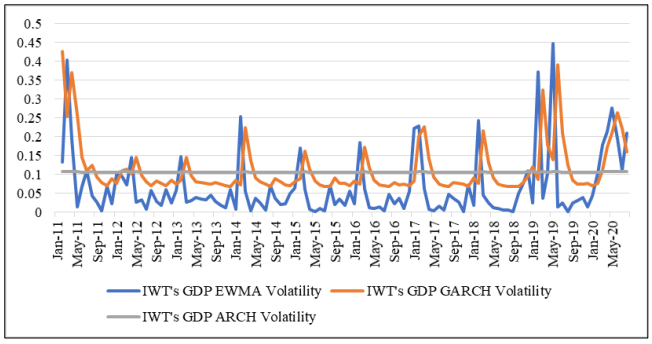
content are not stood, there were fluctuation at the period in 2020 from Jan to August.



Source: HCMC SD, consolidated, calculated and charted by author.

Fig 3: Chart of ARCH for GDP of IWT monthly between Jan 2011 and Aug 2020.

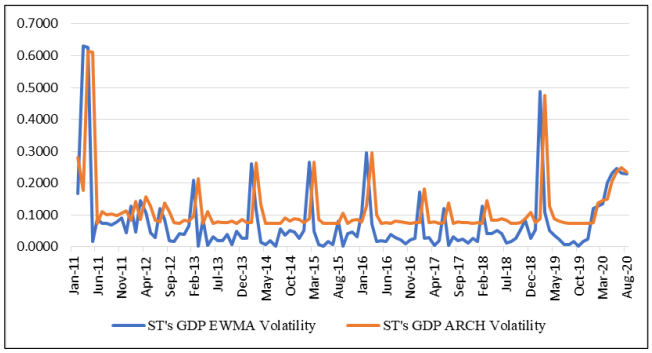
The same, there was no movement of ARCH. Nevertheless, EWMA was volatile during the period shown and strongly at time from beginning 2020 to May 2020.



Source: HCMC SD, consolidated, calculated and charted by author.

Fig 4: Chart of GARCH (1,1) for GDP of IWT monthly between Jan 2011 and Aug 2020.

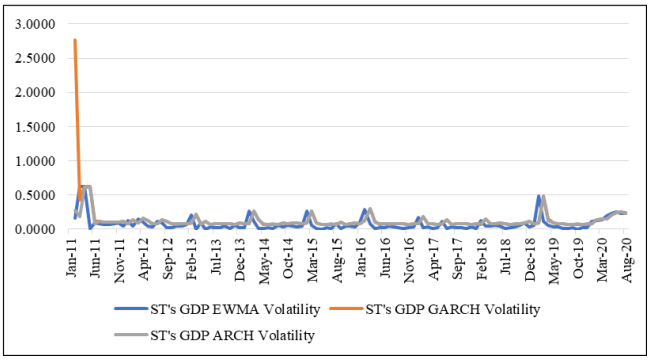
This one is also shows that there was no ARCH volatility. Nonetheless, EWMA and GARCH was volatile and quite strong from Jan 2020 to May 2020.



Source: HCMC SD, consolidated, calculated and charted by author.

Fig 5: Chart of ARCH for GDP of ST monthly between Jan 2011 and Aug 2020.

The situation of figure 5 is not same as the previous, we can see there were both EWMA and ARCH volatility and emphasized in Jan and Feb 2020.



Source: HCMC SD, consolidated, calculated and charted by author.

Fig 6: Chart of GARCH (1,1) for GDP ST monthly between Jan 2011 and Aug 2020.

It is clearly to tell us that all three lines of EWMA, ARCH and GARCH which were slightly volatile during the period shown from Jan 2011 to August 2020.

5.2 The output results of proposal models are MLR, ARCH MLR and GARCH (1,1) MLR to assess the dependence of TL's GDP on GDP of its three sub-sectors which are RT, IWT, and ST.

Table 8: Assessing the dependence of TL's GDP on GDP of its three sub-sectors are RT, IWT, and ST by MLR model.

Model		Anova	Regression Coefficient	a_1, a_2, a_3	P-value
R Square	Adjusted R Square	Significance F	X_1	5.498	5.227
0.787	0.782	1.498	X_2	- 41.718	1.499
			X_3	2.491	4.459

Source: HCMC SD, consolidated and calculated by author.

We analyse three parts which are Model, Anova and Regression coefficient. Model needs to analyse two values are R Square (RS) and Adjusted R Square (ARS). Analyse Significance F at Anova part. And there are two values in regression coefficient needs to be analysed which are regression coefficient of X_1, X_2, and X_3 that are written a_1, a_2, a_3 respectively the table 8.

Model: The most important information of output is proved by RS and ARS, RS and ARS gives the good level of the regression line if accurate with the actual data, and these number indicate the output variables' variance was explained by input variables' variance. The output result in table 8 of RS and ARS are 0.7878 (79%) and 0.7821 (78%) mean that the GDP of TL depends 78% on GDP of its three sub-sectors are RT, IWT, and ST. The left 22% of TL's GDP is out of the influence of RT, IWT and ST's GDP .

Anova: To understand if the regression output could have been obtained by chance and to know the probability of regression output, we must analyse the Significance F. The output result shows in table 8 that Significance F is 1.498. Therefore, we understand the regression output was merely a chance occurrence is 149.8%, significance F is 149.8% indicates it does not have significance of statistics.

Regression coefficient of a_1, and a_3 is 5.498, 2.491 respectively which are all > 0, it means the TL's GDP

depends on GDP of its two sub-sectors are RT and ST. However, regression coefficient of a_2 is - 41.718 < 0 proving there is no dependence of TL's GDP on IWT's GDP.

The P-values of independent variables give information for us to understand if the result is actual, and the likelihood of output was not occurred by chance. If P-value is low, likelihood of coefficient will have high value. P-value of X_1 = 5.227, X_2 = 1.499, and X_3 = 4.459 indicate likelihood of coefficient of IWT's GDP is at higher value, the one of RT and ST's GDP are lower value.

Table 9: Assessing the dependence of GDP of TL on GDP of RT, IWT, and ST by ARCH MLR model.

Model		Anova	Regression Coefficient	$\beta_1, \beta_2, \beta_3$	P-value
R Square	Adjusted R Square	Significance F	A_1	0	#NUM!
0.060	0.034	0.0001	A_2	9.091	#NUM!
			A_3	0	#NUM!

Source: HCMC SD, consolidated and calculated by author.

Below is analysis the output result of table 9

RS is 0.06 (6%), ARS is 0.034 (3.4%) mean that the GDP of TL depends only 3.4% on GDP of its three sub-sectors are RT, IWT, and ST. TL's GDP does not depend on GDP of its three sub-sectors consists of RT, IWT, and ST's GDP is 96.6%. There is only 3.4% is proven this model has no value. However, significance F = 0.0001 < 0.05, significance F = 0.0001 shows regression output was merely a chance occurrence is 0.01%. With 0.01% of significance F to show us that its significance of statistics is very high.

Regression coefficient of β_1 and β_3 are same rezo (0), and β_2 is 9.091, giving information is TL's GDP depends on its sub-sector IWL's GDP only, these others are RT and ST's GDP do not have influence on TL's GDP. P -values of all A_1, A_2, and A_3 are #NUM!.

Table 10: Assessing the dependence of TL's GDP on GDP of its three sub-sectors are RT, IWT, and ST by GARCH (1,1) MLR model.

Model		Anova	Regression Coefficient	$\omega_1, \omega_2, \omega_3$	P-value
R Square	Adjusted R Square	Significance F	B_1	0	#NUM!
1	0.99	#NUM!	B_2	0	#NUM!
			B_3	0	#NUM!

Source: HCMC SD, consolidated and calculated by author.

About table 10

Model: RS = 1, ARS = 0.99 (99%). It means that the GDP of TL depends 99% on GDP of its three sub-sectors are RT, IWT, and ST. There is only 1% of TL's GDP is out of the influence of RT, IWT and ST's GDP .

The other values are Anova, regression coefficient, and P-value which output results show all are #NUM!. We can conclude that there is no statistical significance for this GARCH MLR model.

6. Discussion

The approaches of paper are author is to empirically apply ARCH, GARCH (a,b) which a is order of ARCH and b is order of GARCH, this study applies a = 1 and b = 1 to predict the volatility of TL's GDP through GDP of its three sub-sectors which are RT, IWT, and ST. The author then proposes the MLR, ARCH MLR, and GRACH (a,b) MLR which also a = 1 and b = 1 to assess the dependence of GDP of TL on GDP of its three sub-sectors are RT, IWT, and ST. The first finding is ARCH, GARCH (1,1) empirical application which the values of output results are average of RT & IWT are 0.0152, 0.0018, and ST is - 0.0047. Standard Deviation of all RT, IWT, and ST are 0.1389, 0.1070, and 0.1287 respectively. Variance are RT = 0.0193, IWT = 0.0114, and ST = 0.0166 that are all quite small. α, β, ω, Long-run volatility which are the parameters by using Solving Parameter function of Excel. And all other values such of Maximun Likelihood of ARCH and GARCH (1,1) which RT is 66.1692 and 125.42, IWT is 94.440353 and 104.24726, and ST is 97.34509 and 99.151064 respectively.

All these values indicate the output results have significance of statistics, so we can go to conclude is ARCH, GARCH (1,1) can be applied to predict volatility of GDP of TL through GRP of its three sub-sectors are RT, IWT, and ST. The second finding is MLR, ARCH MLR, and GARCH (1,1) MLR which all cannot be applied to assess the dependence of GDP of TL on GDP of its three sub-sectors are RT, IWT, and ST, the reason is the statistical values are no significant such as Significance F of MLR is 1.498 meaning that there is a 149.8% chance that the regression output was merely a chance occurrence. P -values of all A_1, A_2, and A_3 are #NUM! of ARCH MLR model. And GARCH (1, 1) MLR which output results show values are ω_1, ω_2, ω_3 which is all 0. Significance F, and P-values of all B_1, B_2, and B_3 which data could not be output, the output results are all #NUM!

7. Conclusion

Based on analysis and discussion sections, we can have conclusion is that we can have ARCH, GARCH (1,1) models to apply to predict the volatility of TL's GDP through GDP of its three sub-sectors which are RT, IWT, and ST. However, the output result of proposal MLR, ARCH MLR, and MLR GARCH (1,1) indicate there are almost values are not statistical significance, that means we cannot use MLR, ARCH MLR, and GARCH (1,1) MLR to assess the dependence of GDP of TL on GDP of its three sub-sectors which are RT, IWT, and ST.

Future direction: Author will have empirical application of ARCH and GARCH (a,b) which b will be 2 or 3 to predict GDP growth of RT, IWT, ST and also Air transportation.

Limitations: The data is secondary data which comes from only one source is HCMC SD, and literature review is still poor.

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