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Modelling Retail Gas Price in California: Time series analysis approach

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ABSTRACT : The retail gas price is critical as it serves as an important influencer in the daily livelihood of the residents in California and the world at large. The sole objective of this research paper is to model the retail gas price in California as well as predict the future pattern of the retail gas price in the state using suitable time series models. Secondary data was used for this study, and it is extracted from the online publication of the U.S. Energy Information Administration. The collected data for this research ranges from the period of January 2001 to July 2022.The unit root test was performed, and the series became stationary after the first difference. The ACF and PACF show similarity in exponential decay which points to the suitability of the ARIMA model. Then, several tentative ARIMA models were estimated and ARIMA (2,1,8) was the best based on the selection criteria of having the highest number of significant coefficients, highest adjusted R-squared, lowest volatility, lowest AIC, and BIC. Furthermore, the test of the presence of the ARCH (1) effect was also conducted and the ARCH effect model was estimated and was also found to be statistically significant at a 5% level.Meanwhile, ARIMA (2,1,8) shows a future downward trend in the future retail gas price in California state while the ARCH (1) model shows a future upward pattern or trend in the retail gas price of California state. Additionally, the retail gas price hit about 5.9 U. S dollars per gallon in July 2022 which also contributed to the current increase in the U.S inflation rate and this also brings about an increase in the cost of living and constitutes serious difficulties in the livelihood. As a result of this, the government need to fully implement the newly proposed inflation reduction Act which will positively impact the energy, environmental and health sector of the country and thereby making a better livelihood for the entire citizens possible and facilitate industrial growth exceedingly. Consequently, the united nation needs to take drastic measures to end the Russian-Ukraine war to prevent the further economic surge that could emanate from a possible rise in the price of retail gas if the war continues as more European countries would need to rely on the US for gas supply.

KEYWORDS: *Retail gas price, Unit root test, ACF, PACF, ARIMA, ARCH.*

I. INTRODUCTION

Gasoline price is a crucial determinant of inflation and a key factor that influences the daily livelihood of the people in the United States of America and the world at large. Meanwhile, the Russian-Ukraine war has drastically contributed to the high cost of gasoline consumption in the United States of America because the other European countries that solely rely on Russia for gasoline supply have shifted attention to the U.S thereby resulting in high demand from America (world bank, 2022). Furthermore, the United States of America's inflation recently rose to 8.6% due to the high cost of gasoline particularly in California (Patterson and Goldforb, 2022). The hike in the retail gasoline price in California is due to unusual government spending and banned on Russian gas imports (World bank, 2022; Patterson, 2022).

The average price of retail gasoline has hit about 5.9 U. S dollars per gallon in California as of July 2022 which has contributed to a surge in the inflation rate in California state (EIA, 2022).It is very crucial to note that oil and gas are very close commodities and the increase in global oil pr360ice due to the global covid-19 pandemic effect and the cost of refining crude oil to gas also contribute to the surge in the retail gas price in America and particularly in California (EIA, 2022; World bank, 2022).California's demand for cleaner fuel of very low emission also affects the supply chain as only a few refineries outside the state can produce the special blend of oil and thereby contributing to the hike in the retail price within the state (Borenstein, 2018).However, the untold hike in the retail gas price in California has become a major subject matter to the residents of the state, industries and even the U.S residents at large as this has contributed to about a 5.6% increase in the annual gas tax (EIA, 2022; World bank, 2022).The surge in the price of gasoline has dramatically clamped down on consumer demand for gasoline and thereby reduce consumption as the recent pain of purchasing gasoline is much higher compared to the relief in the previous years (Ziemba, 2022).

Consequently, this research study's sole objective is to model retail gas prices in California using appropriate time series models and to predict the future pattern in gasoline prices within California state. This will also contribute immensely to the existing body of knowledge as the trend in retail gas price hike in California is a current global phenomenon.

II. LITERATURE REVIEW

Scanty research studies have been carried out in the recent past in modelling and forecasting retail gasoline prices. According to Baumeister, Kilian and Lee (2017), most studies have sufficiently focused on oil prices and other energy variables.Xu, Valentine, and Wang (2014) applied Autoregressive (AR) and Autoregressive conditional Heteroscedasticity (ARCH) for forecasting retail gas prices in the United States using a Michigan survey of consumers.Shi and Sun (2017) applied the ARIMA model in predicting energy crude prices in China and the study reveals that the model has a good forecast.Sen, Roy, and Pal (2016) examined the application of the ARIMA model for the forecast of energy consumption in India and the study reveals that the forecast provides a future insight into the manufacturing organization in India. Other various studies also focused on energy generation, supply, and consumption (Baumeister, 2017).

Borenstein (2018) established that California gas price is about 80 cents higher than the average of all other states due to an increase in the gas tax and demand for a special blend of cleaner fuel with low emissions which constitute the mystery behind the surge in California retail gas price.Besides, Mugabe, Elbakidze and Carr (2021) conducted research on natural gas production in the United States of America and the findings reveal that the number of oils producing wells is a crucial determinant of variation of gas production in the country.Frank (2019) also studied the reason for the hike in retail gas prices in California and he finds out that the refusal of California to permit more refineries makes them a net importer of oil even though they may have more oil than any other state in the country.

This research is a new area of study, and the primary objective is to model retail gas prices in California as well as predict the gasoline price using a suitable time series model to have an insight into future patterns in gasoline prices within the state and this will contribute greatly to the existing body of knowledge.

III. DATA AND METHODOLOGY

This section will be exposing the description of the data and methodology used for this research paper.

3.1 Data

This study adopted a quantitative research design, and the variable of interest is the retail gas price which is secondary data that was extracted from the U.S. Energy Information Administration (EIA) online publication from January 2001 to July 2022 based on purposive sampling and current global trending of the subject matter.

3.2 Variable Measurement

Retail gas price (RGP) is measured in U.S dollars per gallon.

3.3 Methodology

The method of analysis for this study is descriptive statistics (using mean and standard deviation) and time series analysis (using ARIMA and ARCH).

3.4 Model specification

The term ARMA and ARIMA models are specifically developed using Box-Jenkins (1976) approach to form a parsimonious model suitable for an adequate forecast. The difference between the ARMA and ARIMA is the integration component (d) that will draw our attention to the subject of stationarity.ARMA is an autoregressive moving average and can be expressed in the form (p, q) which can be split into two forms: p for Autoregressive (AR) and q for Moving average (MA) for modelling the serial correlation of the error terms (Gujarati and Damodar, 2009).

ARIMA model is the autoregressive integrated moving average in the form (p, d, q) which was developed that can be divided into three levels: p for Autoregressive (AR), d for Integration order term (I) and q for Moving Average (MA) for modelling the serial correlation of the error term. This means that both ARMA and ARIMA consider both the previous values (AR) and the mean residuals of the error term (MA).

In the real world, most economic variables are nonstationary and will be made stationary via the process called differencing.

The AR (p) can be expressed in the order of lags and the generalized below as:

AR (2): $rgp_t = \beta_0 + \beta_1 rgp_{t-1} + \beta_2 rgp_{t-2} + u_t$ .... (1)

AR (3): $rgp_t = \beta_0 + \beta_1 rgp_{t-1} + \beta_2 rgp_{t-2} + \beta_3 rgp_{t-3} + u_t$.. (2)

From equation 1 and 2, we can write a generalized model of AR(p) as:

AR(p): $rgp_t = \beta_0 + \sum^{p}_{i=1} \beta_i rgp_{t-i} + u_t$.. (3)

The MA (q) can be expressed in lag and the generalized form as:

MA (1): $rgp_t = \delta + d_0 u_t + d_1 u_{t-1}$... (4)

MA (2): $rgp_t = \delta + d_0 u_t + d_1 u_{t-1} + d_2 u_{t-2}$.. (5)

The generalized MA (q) can be written as:

MA (q): $rgp_t = \delta + d_0 u_t + \sum^{q}_{j=1} d_j u_{t-j}$... (6)

Hence, ARIMA process of order (p, d, q) can be specify using backward shift operator as:

$\Phi(B)\Delta^d rgp_t = \delta + d(B)u_t$.. (7)

$\Phi(B) = 1 - \varphi_1 B - \varphi_2 B^2 - \ldots\ldots - \varphi_p B^p$.. (8)

And $\theta(B) = 1 - d_1 B - d_2 B^2 - \ldots\ldots - d_q B^q$... (9)

Where Φ(B) is the autoregressive operator (AR) while d (B) is the moving average (MA) operator

However, ARIMA (p, d, q) can also be expressed as:

$rgp_t = \beta_0 + \sum^{p}_{i=1} \beta_i rgp_{t-I} + \sum^{q}_{j=1} d_j u_t$.. (10)

3.5 ARCH model

ARCH is the Autoregressive conditional heteroscedasticity and it is also a univariate time series model which implies that the variable or series in question has a time-varying variance (heteroscedasticity) that depends on lagged effects (autocorrelation). The basic assumption of ARCH (1) coefficient is $\beta_0 > 0$, $0 \le \beta_1 < 1$.

The generalized ARCH model can be written as:

$u_t^2 = \beta_0 + \beta_i u^2_{t-I} + e_t$... (1)

The ARCH (1) effect can be deduced from equation 1 as:

$u_t^2 = \beta_0 + \beta_1 u^2_{t-1} + e_t$.. (2)

It is important to understand that there is need to estimate to test for the presence of ARCH effect before estimating ARCH model (Asteriou and Hall, 2016).

Testing for ARCH (1) effect

Ho: $\beta_1 = 0$ (there is no ARCH (1) effect)

Ha: $\beta_1 \neq 0$ (there is presence of ARCH (1) effect)

IV. RESULT AND DISCUSSION

This section will be presenting the result of the analysis of this study as well as the discussion of the notable findings.

Table 1: Descriptive statistics

	Retail Gas Price
Mean	3.133556
Std. Dev.	0.900544
Skewness	0.196631
Kurtosis	3.364287
Jarque-Bera	3.101092
Probability	0.212132
Observations	259

Table 1 show the descriptive statistics results of the retail gas price in California, and we can see that the average gas price is about 3 U.S dollars per gallon during the period under review from January 2001 to July 2022 with the variability of 0.9 U. S dollars per gallon. The Kurtosis is approximately 3 and Skewness approaches zero which implies the normal distribution of the data. The Jarque-Bera Probability value (P>0.05) which also indicate that the data is normally distributed.

Table 2: Results of estimated tentative ARIMA models of Retail Gas Price in California

Model	No of significant Coefficients	Adjusted R-squared	Volatility (SIGMASQ)	Akaike Info Criterion (AIC)	Schwarz Criterion (SBIC)
ARIMA (2,1,2)	3	0.84	0.115	0.73	0.78
ARIMA (2,1,8)	3	0.85	0.111	0.71	0.75
ARIMA (2,1,9)	2	0.84	0.114	0.73	0.77
ARIMA (3,1,5)	3	0.84	0.182	1.22	1.26
ARIMA (3,1,8)	3	0.75	0.182	1.22	1.25
ARIMA (3,1,12)	3	0.76	0.179	1.20	1.24

Source: Author's computation using EViews software

The pattern of ACF and PACF in the appendix shows that the retail gas price is not stationary. This also indicates a nonstationary series. We can see that both the ACF and PACF show similarity in exponential decay pattern after differencing the series to become stationary (or integrated of order 1) and this point to the use of autoregressive integrated moving average (ARIMA). The unit root test was also applied using augmented dickey fuller to test for the stationarity of the series and show that the series becomes stationary after the first difference (see appendix).

Table 2 shows the estimation of the tentative ARIMA models, and we can see that ARIMA (2,1,8) is the best performing ARIMA model because it has the highest number of significant coefficients, the highest adjusted R-squared, lowest volatility, lowest AIC and BIC.

Figure1: Time plot of retail gas price in California

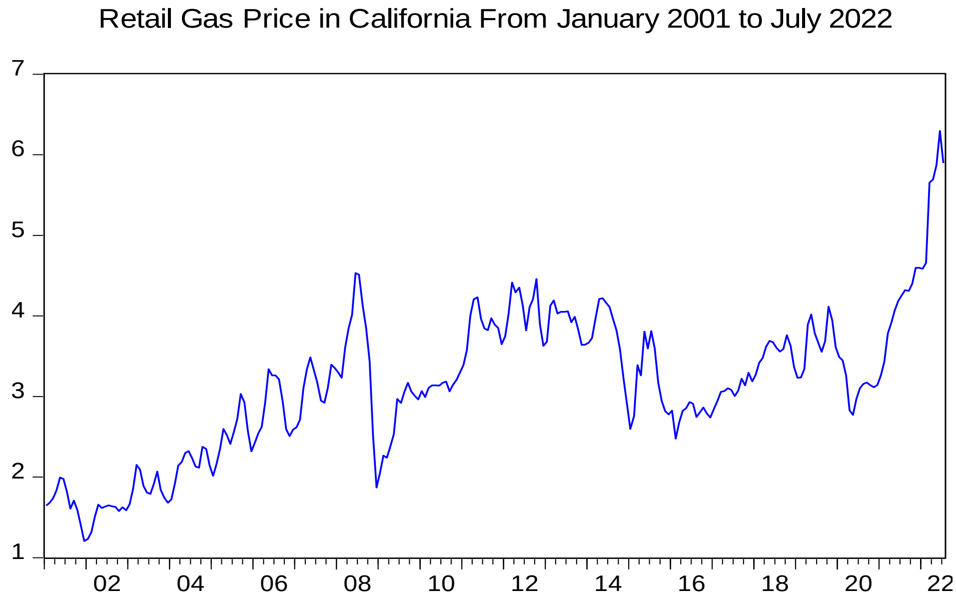


Figure 1 shows the time plot of the actual retail gas price in California from January 2001 to July 2022, and we could see that the retail gas price hit about 5.9 U. S dollars per gallon in July 2022 which also contributed to the current increase in the U.S inflation rate.

Figure 2: ARIMA MODEL Dynamic in-sample FORECAST

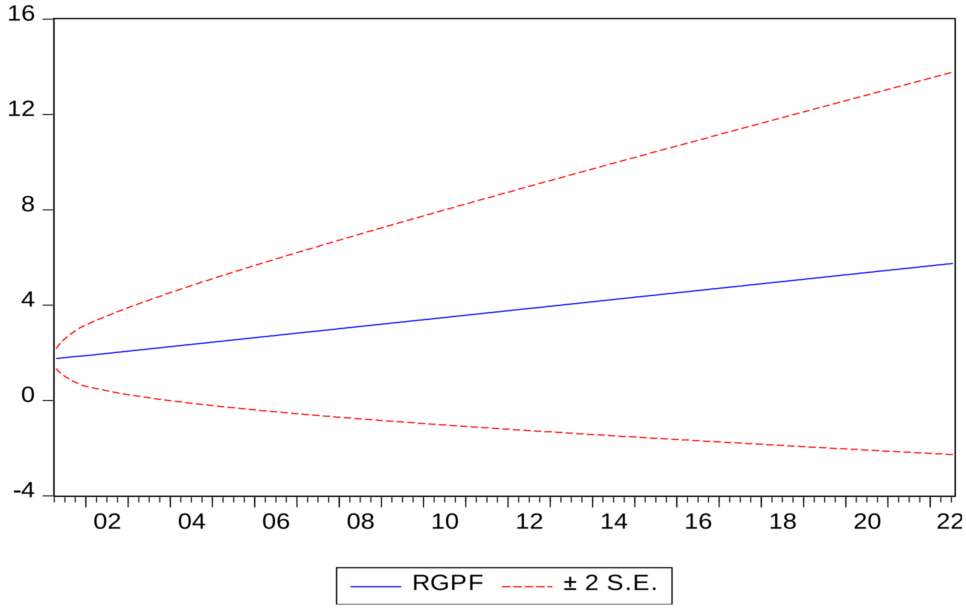


Figure 3: ARIMA static in-sample forecast

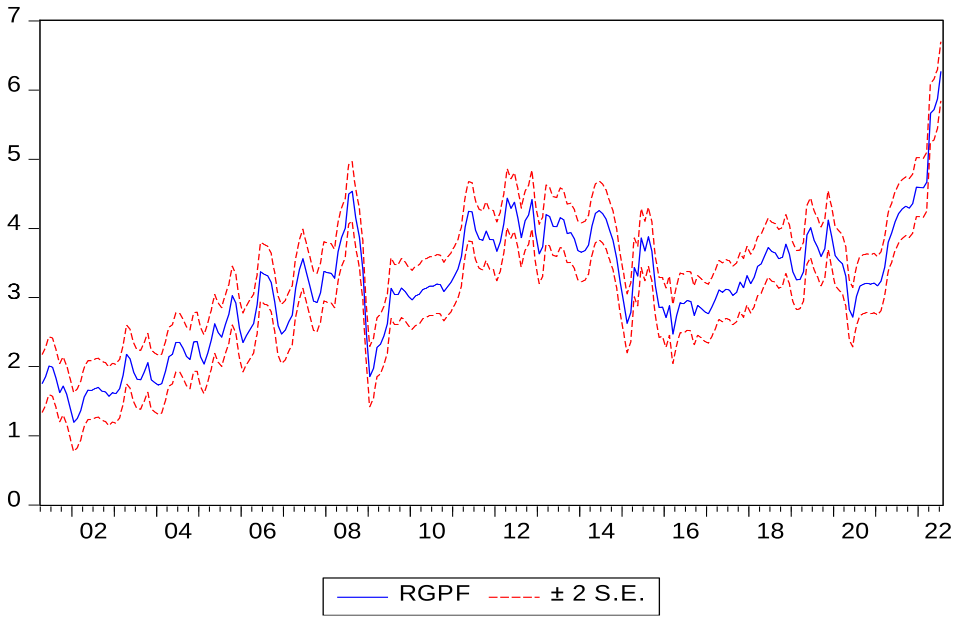


Figure 2 and 3 shows the dynamic and Static in-sample forecast of ARIMA (2,1,8) and we could see that the forecast show that there is no evidence of volatility clustering in the retail price of gasoline within the period under review and the forecast falls within the two-confidence interval band which shows stability in the forecast. This suggests that the forecast is good and stable over time.

Table 3: Test of presence of ARCH EFFECT

Heteroskedasticity Test: ARCH

F-statistic	7.676183	Prob. F (1,255)	0.0060
Obs*R-squared	7.510308	Prob. Chi-Square (1)	0.0061

Table 3 shows that P = 0.0061<0.05 significant level which means that we reject the null hypothesis and conclude that there is presence of ARCH (1) effect in the residuals, hence there is a need to estimate ARCH (1) model.

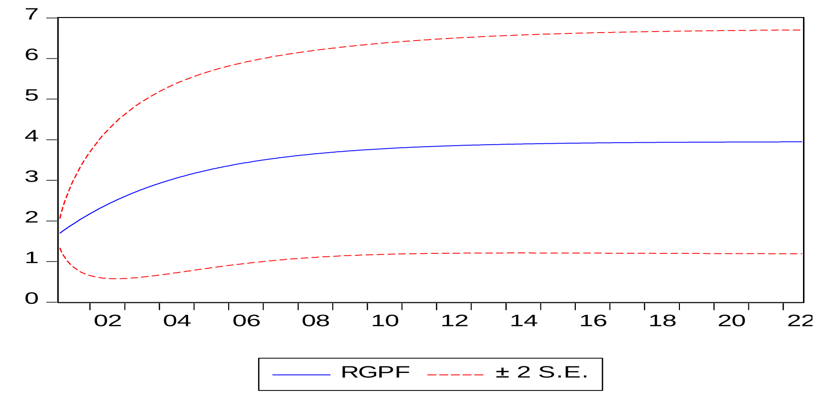
Table 4: Estimating ARCH (1) model

$ARCH = 0.089 + 0.589u^2_{t-1}$

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.089070	0.040838	2.181043	0.0292
RGP (-1)	0.977477	0.012574	77.73587	0.0000
	Variance Equation			
C	0.026836	0.005729	4.683786	0.0000
RESID (-1)^2	0.589155	0.243487	2.419660	0.0155
T-DIST. DOF	4.446927	1.301348	3.417168	0.0006
R-squared	0.945095	Mean dependent var		3.139322
Adjusted R-squared	0.944881	S.D. dependent var		0.897491
S.E. of regression	0.210709	Akaike info criterion		-0.418433
Sum squared resid	11.36594	Schwarz criterion		-0.349577
Log likelihood	58.97788	Hannan-Quinn criter.		-0.390746
Durbin-Watson stat	1.335581			

Table 4 shows the estimation of ARCH (1) model:$ARCH = 0.089 + 0.589u^2_{t-1}$with the mean equation at the upper section and variance equation at the lower section and we could see that ARCH effect, $0.589u^2_{t-1}$at the variance equation section is statistically significant at 5% level.The mean equation = 0.089 is also statistically significant at 5% level. This suggest that California state can still maintain the risk of holding the current retail gas price at an average of 0.089.

Figure 4: ARCH Dynamic in-sampleForecast



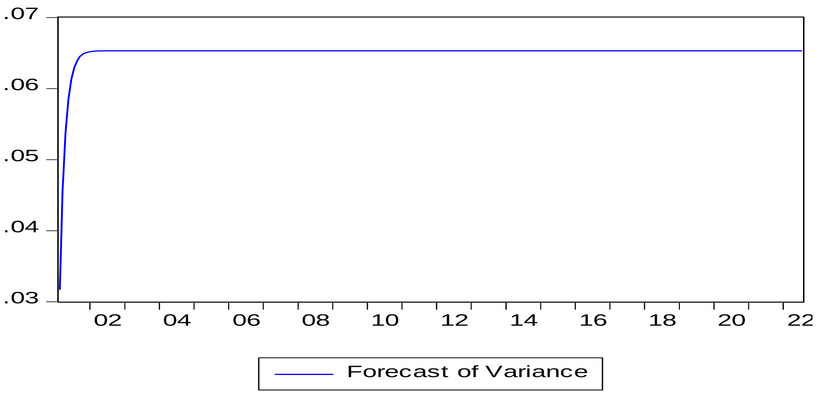


Figure 4 shows the dynamic forecast of the ARCH (1) model and the forecast fall with the two-confidence interval which means the dynamic in-sample ARCH forecast is stable.

Figure 5: ARCH static in-sample forecast

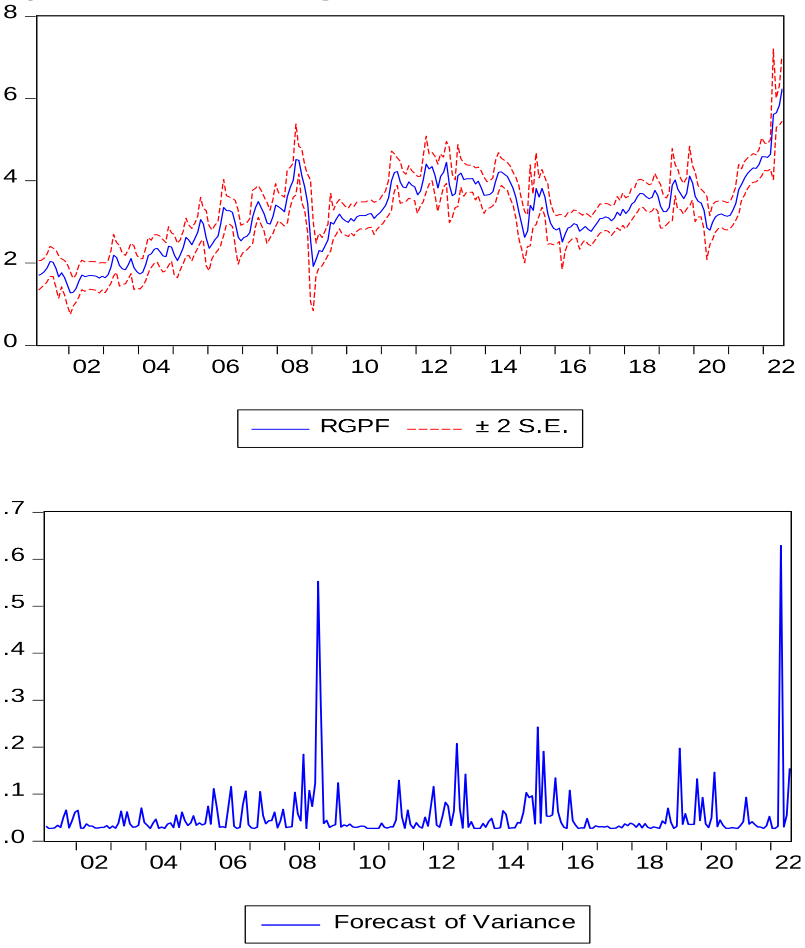


Figure 5 shows the static forecast of the ARCH (1) model and the forecast fall with the two-confidence interval which means the static in-sample ARCH forecast is also stable and there is no evidence of volatility clustering.

Figure 6: Out-sample forecast

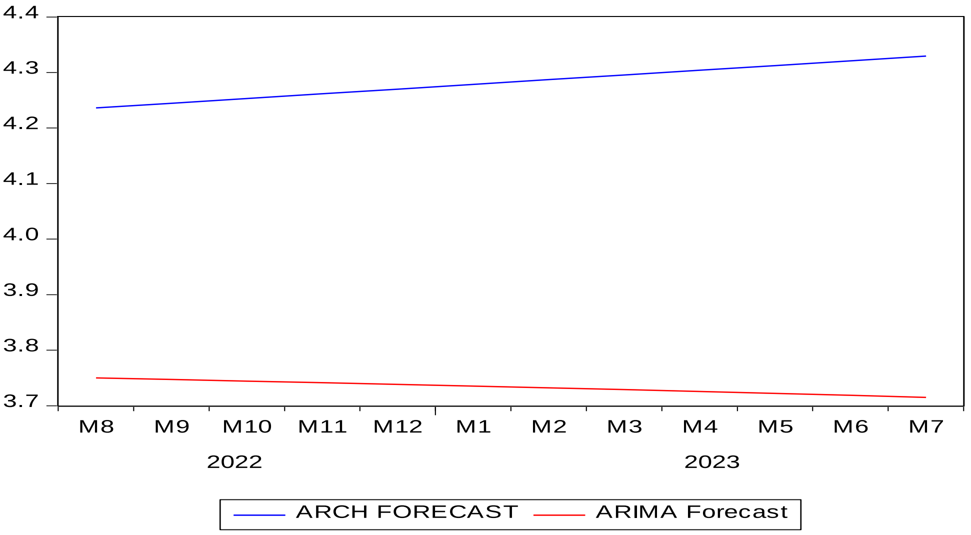


Figure 6 shows the out-sample forecast or future prediction of retail gas price in California using the fitted ARIMA (2,1,8) and ARCH (1). We could see that the ARIMA shows a future downward trend in the future retail gas price in California state while ARCH shows a future upward pattern or trend in the retail gas price of California state.

Table 5: Forecast Accuracy Measure

Samples	ARIMA (MAPE)	ARCH (MAPE)
In-Samples	5.078	5.086
Out-Samples	14.697	17.595

Table 5 shows the forecasting accuracy measure using the mean absolute percentage error (MAPE) and we can see that ARIMA (2,1,8) has the least MAPE which indicate that the fitted ARIMA (2,1,8) has the best forecast.

4.2 Discussion of findings

Based on the analysis of the study above, the following are the notable findings.The ACF and PACF of the actual retail gas price indicate that the series is non-stationary with a correlogram as shown in the appendix. The series became stationary after the first difference as shown by the unit root test in the appendix.

The ACF and PACF show similarities in exponential decay, and this makes the ARIMA model suitable (see appendix).Several tentative ARIMA models were estimated and the ARIMA (2,1,8) was the best based on meeting the selection criteria of having the highest number of significant coefficients, highest adjusted R-squared, lowest volatility, lowest AIC, and BIC.Besides, the test of the ARCH effect shows that there is a presence of the ARCH (1) effect, and the ARCH effect model was estimated and was statistically significant at a 5% level of significance.

Meanwhile, ARIMA (2,1,8) shows a future downward trend in the future retail gas price in California state. In contrast, the ARCH (1) model offers a future upward pattern or trend in the retail gas price of California state. The future upward trend pattern indicated by the ARCH model implies that the retail gas price in California will continue to surge higher and this is currently causing untold hardship in the life of the entire resident of the state which has also contributed to an increase in the annual gas tax and even drop in demand of gasoline by both the resident and companies for survivability which is consistent too with the research conducted by Ziemba (2022).

Conclusively, Figure 1 shows the time plot of the actual retail gas price in California from January 2001 to July 2022, and we could see that the retail gas price hit about 5.9 U. S dollars per gallon in July 2022 which also contributed to the current increase in the U.S inflation rate. This also suggests that the request for low-emission fuel and the refusal of California to create more refineries make them net oil importer despite the fact they have more oil than other states in America which therefore make gas supply low as more cost will be incurred in refining the oil to gas and thereby constitute retail gas price surge. This also supports the research conducted by Frank (2019).

V. CONCLUSION AND POLICY IMPLICATION

The retail price of gasoline greatly influences the daily livelihood of the residents of California state with serious multiplier effects on all economic activities and the world at large. The hike in the current price of gasoline in the U.S particularly in California is very worrisome and these increments have become a global trending matter.

This research paper, therefore, focuses on modelling the retail gas price in California using time series models like unit root, ARIMA and ARCH models. The fitted ARIMA (2,1,8) is the best model among the other tentative models while the ARCH (1) model is also very adequate, the forecast of the retail gas prices shows that ARIMA (2,1,8) shows a future downward trend of retail gas price in California state while ARCH (1) model shows a future upward pattern in the retail gas price of California state.

This suggests that there is the possibility of experiencing either a decline in the future retail gas price in California, if the recommended actions and policies are seamlessly implemented or a possible further increase in the gasoline price due to the demand pulled occasioned by substantialshift of several European countries to the United States of America for gas supply following the continued escalation of the Russian-Ukraine war. The general demand for gas supply has subsequently increased and the cost of refining crude oil to gas has also increased with an increase in the gas tax and this is responsible for the current surge in the retail gas price in the state of California.

It is worthy to note that the retail gas price hit about 5.9 U. S dollars per gallon in July 2022 which also contributed to the current increase in the U.S inflation rate and this also brings about an increase in the cost of living with attendant difficulties in the livelihood and cost of doing business.

As a result of this, the government need to fully implement the newly proposed inflation reduction Act of 2022, which will positively impact the energy, environmental and health sector of the country and thereby making a better livelihood for the citizen and facilitates industrial growth exceedingly.

Additionally, the United Nation (UN) needs to take drastic measures to end the Russian-Ukraine war to prevent further economic disruptions that could emanate from a possible rise in the price of retail gas if the war continues unabated as more European countries would need to rely solely on the US for gas supply.

Putting strong measures in place to boost the domestic production of gasoline oil to match the surge in demand, in addition to the development of shale oil as an alternative to gasoline oil has the potential to lower the gas price that culminated in inflation in the United States of America.

The exploration and development of shale oil as a substitute to gasoline oil must be deeply researched in the future to forestall frequent economic interruptions that accompanied a surge in theglobal demand for gasoline oil.

REFERENCES

[1]. Asteriou, D., & Hall, S. g. (2021). *Applied Econometrics, 4rd edition.* Bloomsbury.
[2]. Baumeister, C., Kilian, L., & Lee, T. K. (2017). Inside the crystal ball: New approaches to predicting the gasoline price at the pump. . *Journal of Applied Econometrics, 32(2)*, pp.275-295.
[3]. Borenstein, S. (2018). Trying to unpack California's Mystery Gasoline Surcharge. "Research that Informs Business and Public Policy".
[4]. EIA (2022). U.S. Energy Information Administration released on retail gas price in California.
[5]. Frank, S. (2019). Reasons for California high gas prices. "California Political Review".
[6]. Gujarati, D. N., & Porter, D. C. (2009). *Basic Econometrics 5th Edition.* Irwin: McGRAW-Hill.
[7]. Mugabe, D., Elbakidze, L., & Carr, T. (2021). All the DUCs in a row: Natural gas production in U.S. *The Energy Journal, 42(3)*.
[8]. Patterson, S., & Goldforb, S. (2022). Why are the Gasoline prices so high? Ukraine-Rusian war sparks increases across U.S.
[9]. Ramakrishna, G., & Kumari, R. (2018). Arima Model for Forecasting of Rice Production in India by Using Sas. . *Siam J. Appl. Math.6*, pp.67–72.
[10]. Sen, P., Roy, M., & Pal, P. (2016). Application of ARIMA for forecasting energy consumption and GHG emission: A case study of an Indian pig iron manufacturing organization. . *Energy116* , pp.1031–1038.
[11]. Shi, X., & Sun, S. (2017). Energy price, regulatory price distortion and economic growth: A case study of China. *Energy Economics, 63*, pp. 261-271.
[12]. World Bank. (2022). "World Bank development indicator" World Bank Open Data.
[13]. Xu, F., Valentine, R., & Wang, D. (2014). International currency exchange rates and gasoline prices. *The Southern Business and Economic Journal, 37(1), ,* pp.113-125.
[14]. Ziemba, R. (2022). High U.S. gasoline price weigh on demand as consumer start to feel the pinch. A Ziemba Research Firm Insight.
[15]. Zou, Y., Yu, L., & He, K. (2015). Wavelet entropy-based analysis and forecasting of crude oil price dynamics. *Entropy, 17(10)*, pp.7167-7184.

Appendix

Correlogram for non-differenced retail gas price
Date: 08/14/22 Time: 11:24
Sample: 2001M01 2022M07
Included observations: 259

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|*******	.|*******	1	0.949	0.949	236.00	0.000
.|******|	**|. |	2	0.876	-0.251	437.75	0.000
.|******|	.|. |	3	0.807	0.060	609.81	0.000
.|***** |	.|. |	4	0.747	0.020	757.80	0.000
.|***** |	.|. |	5	0.696	0.029	886.64	0.000
.|***** |	.|* |	6	0.663	0.142	1004.0	0.000
.|***** |	.|. |	7	0.636	-0.018	1112.6	0.000
.|**** |	.|. |	8	0.615	0.045	1214.3	0.000

.|**** |	.|* |	9	0.600	0.075	1311.8	0.000
.|**** |	.|. |	10	0.594	0.062	1407.5	0.000
.|**** |	.|. |	11	0.584	-0.030	1500.3	0.000
.|**** |	*|. |	12	0.562	-0.076	1586.9	0.000
.|**** |	.|. |	13	0.534	-0.028	1665.2	0.000
.|**** |	.|. |	14	0.501	-0.014	1734.4	0.000
.|*** |	.|. |	15	0.467	-0.016	1794.8	0.000
.|*** |	.|. |	16	0.434	-0.016	1847.3	0.000
.|*** |	.|. |	17	0.406	0.000	1893.4	0.000
.|*** |	.|. |	18	0.385	0.035	1935.0	0.000
.|*** |	.|. |	19	0.369	0.005	1973.5	0.000
.|*** |	.|. |	20	0.358	0.017	2009.7	0.000
.|** |	.|. |	21	0.352	0.020	2044.9	0.000
.|** |	.|. |	22	0.348	0.028	2079.5	0.000
.|** |	.|. |	23	0.343	-0.012	2113.1	0.000
.|** |	.|. |	24	0.335	0.024	2145.5	0.000
.|** |	.|. |	25	0.325	-0.020	2176.0	0.000
.|** |	.|. |	26	0.308	-0.032	2203.6	0.000
.|** |	.|. |	27	0.292	0.041	2228.5	0.000
.|** |	.|. |	28	0.281	0.024	2251.7	0.000
.|** |	.|. |	29	0.272	-0.002	2273.5	0.000
.|** |	.|. |	30	0.265	0.000	2294.1	0.000
.|** |	.|. |	31	0.259	0.006	2314.1	0.000
.|** |	.|. |	32	0.257	0.018	2333.7	0.000
.|** |	.|. |	33	0.255	0.006	2353.1	0.000
.|** |	.|. |	34	0.248	-0.058	2371.7	0.000
.|** |	.|* |	35	0.247	0.079	2390.0	0.000
.|** |	*|. |	36	0.239	-0.081	2407.3	0.000

The pattern of ACF and PACF here shows that the retail gas price is not stationary. This also indicate a nonstationary series.

Correlogram for differenced retail gas price

Date: 08/14/22 Time: 13:09
Sample: 2001M01 2022M07
Included observations: 258

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|** |	.|** |	1	0.312	0.312	25.334	0.000
.|. |	*|. |	2	0.018	-0.088	25.420	0.000
*|. |	*|. |	3	-0.106	-0.095	28.383	0.000
*|. |	*|. |	4	-0.134	-0.078	33.157	0.000
*|. |	.|. |	5	-0.102	-0.045	35.908	0.000
*|. |	*|. |	6	-0.130	-0.112	40.429	0.000
*|. |	*|. |	7	-0.117	-0.076	44.089	0.000
*|. |	*|. |	8	-0.133	-0.117	48.829	0.000
*|. |	*|. |	9	-0.111	-0.091	52.160	0.000
.|. |	.|* |	10	0.061	0.078	53.157	0.000
.|* |	.|* |	11	0.167	0.081	60.691	0.000
.|* |	.|. |	12	0.158	0.035	67.540	0.000
.|* |	.|. |	13	0.091	0.011	69.823	0.000
.|* |	.|. |	14	0.076	0.063	71.401	0.000
.|. |	.|. |	15	0.027	0.006	71.596	0.000
.|. |	.|. |	16	-0.061	-0.051	72.632	0.000
.|. |	.|. |	17	-0.046	0.027	73.233	0.000
.|. |	.|. |	18	-0.049	0.006	73.894	0.000
*|. |	.|. |	19	-0.066	-0.008	75.135	0.000
*|. |	.|. |	20	-0.083	-0.028	77.069	0.000

*|. |	.|. |	21	-0.073	-0.039	78.572	0.000
.|. |	.|. |	22	0.044	0.059	79.129	0.000
.|. |	.|. |	23	0.016	-0.054	79.198	0.000
.|* |	.|. |	24	0.087	0.061	81.367	0.000
.|* |	.|* |	25	0.163	0.100	88.999	0.000
.|. |	.|. |	26	0.072	-0.018	90.518	0.000
*|. |	*|. |	27	-0.110	-0.148	94.017	0.000
*|. |	*|. |	28	-0.172	-0.092	102.69	0.000
*|. |	.|. |	29	-0.081	0.007	104.63	0.000
.|. |	.|. |	30	-0.061	-0.048	105.72	0.000
.|. |	.|. |	31	-0.063	-0.041	106.90	0.000
*|. |	*|. |	32	-0.084	-0.082	109.02	0.000
.|. |	.|. |	33	0.012	0.058	109.06	0.000
.|. |	.|. |	34	0.005	-0.050	109.07	0.000
.|* |	.|* |	35	0.132	0.088	114.29	0.000
.|* |	.|. |	36	0.161	0.003	122.14	0.000

We can see that both the ACF and PACF show similarity in exponential decay pattern after differencing the series and this point to the use of autoregressive integrated moving average (ARIMA).

Null Hypothesis: D(RGP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.41217	0.0000
Test critical values:	1% level	-3.455685	
	5% level	-2.872586	
	10% level	-2.572730	