Time Series Winter 2012

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Monthly Rice Prices

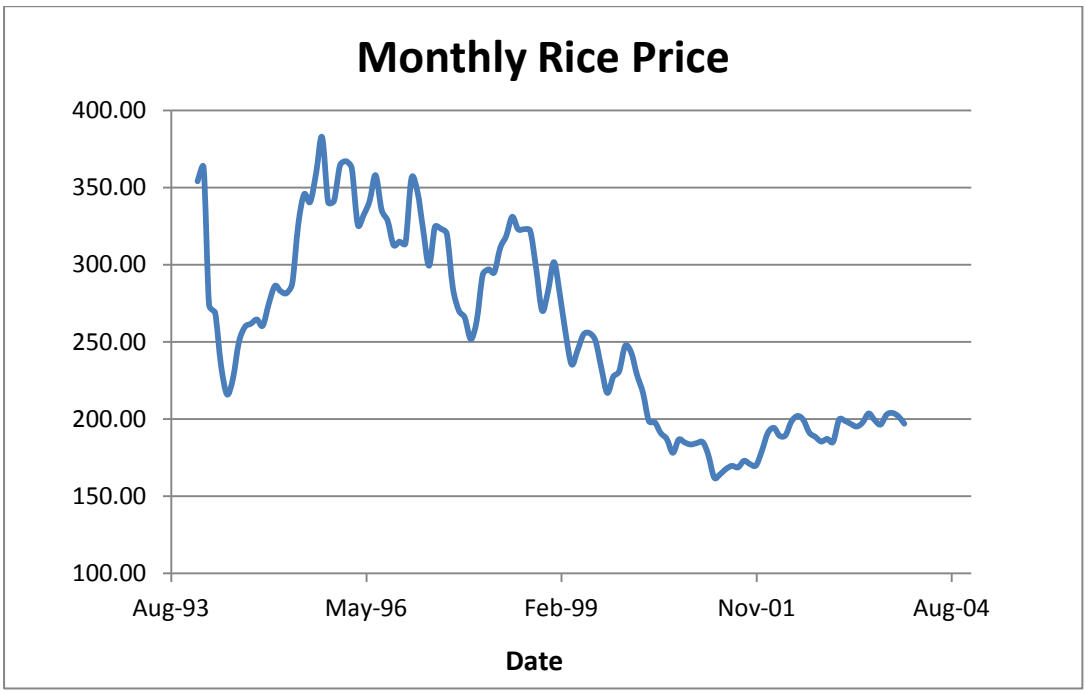
Introduction

This project aims to study the nature of the monthly rice prices per metric ton by using the techniques of the time series. The data comes from the following website:

http://www.indexmundi.com/commodities/?commodity=rice&months=240

Trend

This data shows the 10-year monthly price of rice per metric ton in US dollars from Jan 1993 to December 2003. The line chart below shows a graph of the data.

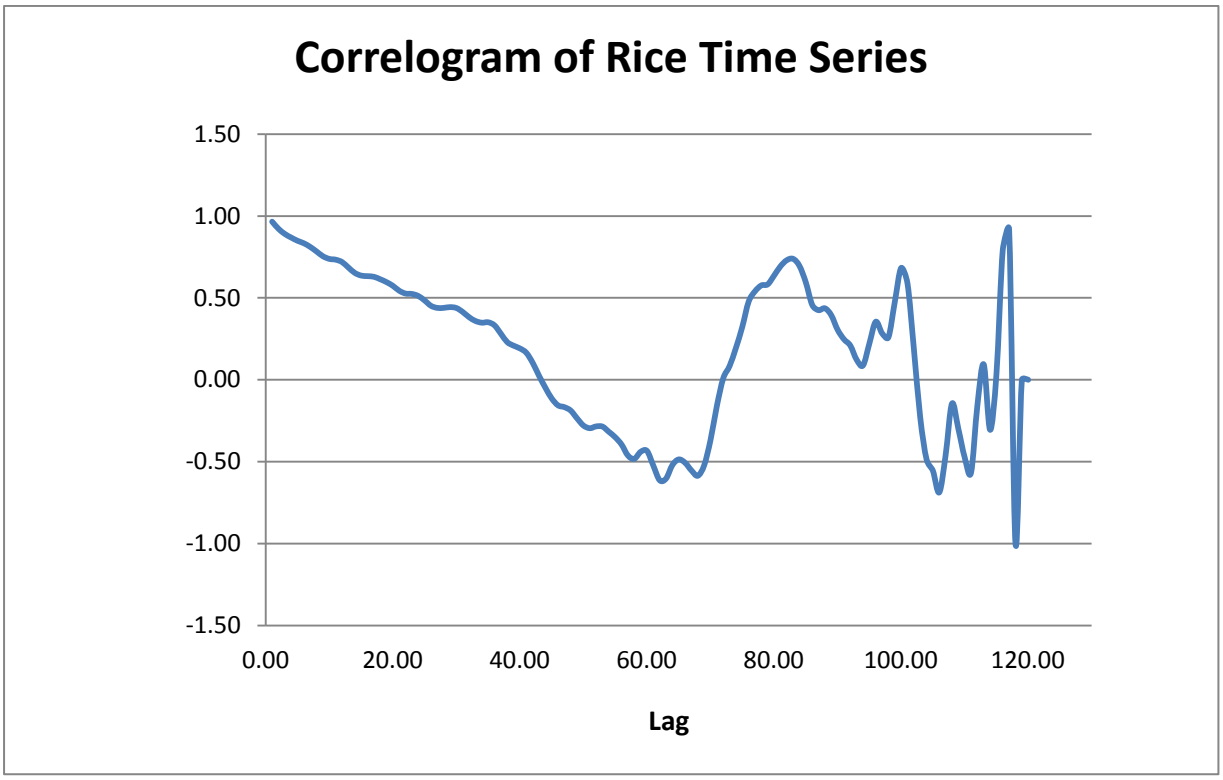


From this chart, we see that the price of rice per metric ton fluctuates between 150 and 400 approximately between 1993-2003. It reaches the maximal price in 1995 and decreases to lowest point in 2000. The trend of the price change does not show much seasonality. Moreover, the price does not show a continuous upward trend for the whole period even it does increase 200 comparing to the Jan-93. It shows large variance of the price change.

Autocorrelation

Considering the autocorrelation function below, the dependence of on time will be given in the following picture:

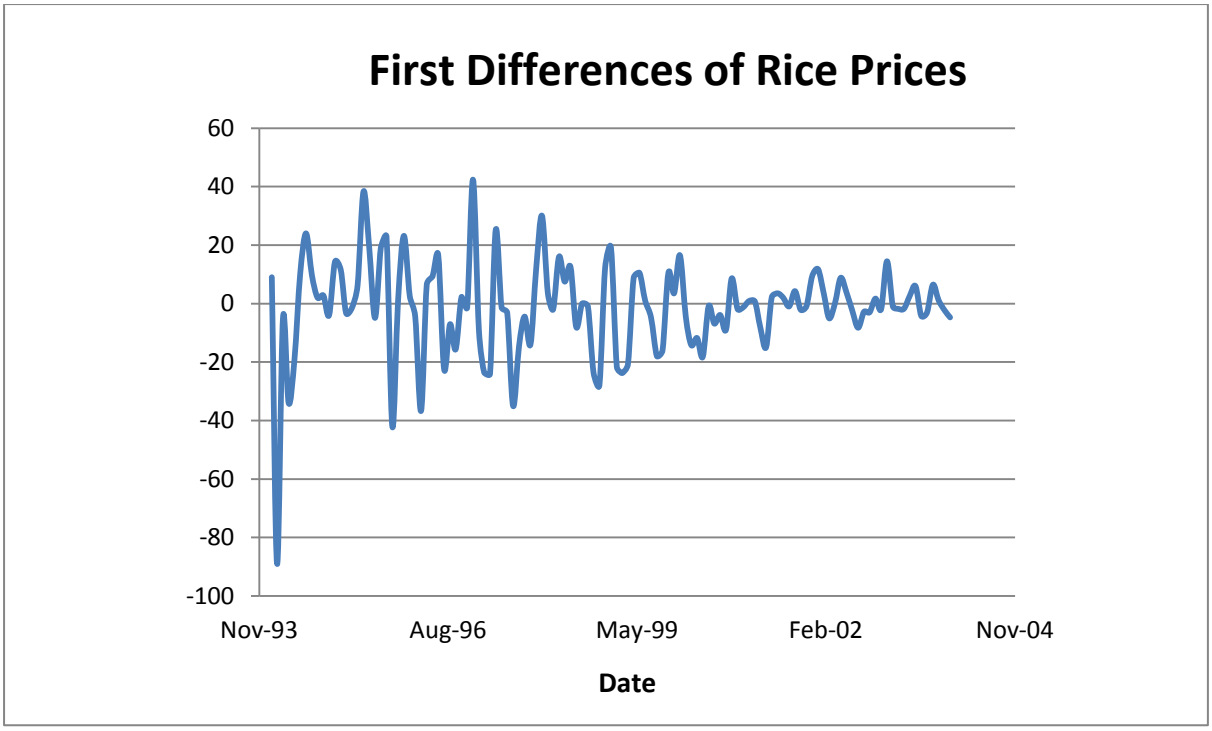
$$r_k = \frac{\sum_{t=k+1}^{n}(Y_t - \overline{Y})(Y_{t-k} - \overline{Y})}{\sum_{t=1}^{n}(Y_t - \overline{Y})^2} \quad for\ \ k = 1, 2, \ldots$$



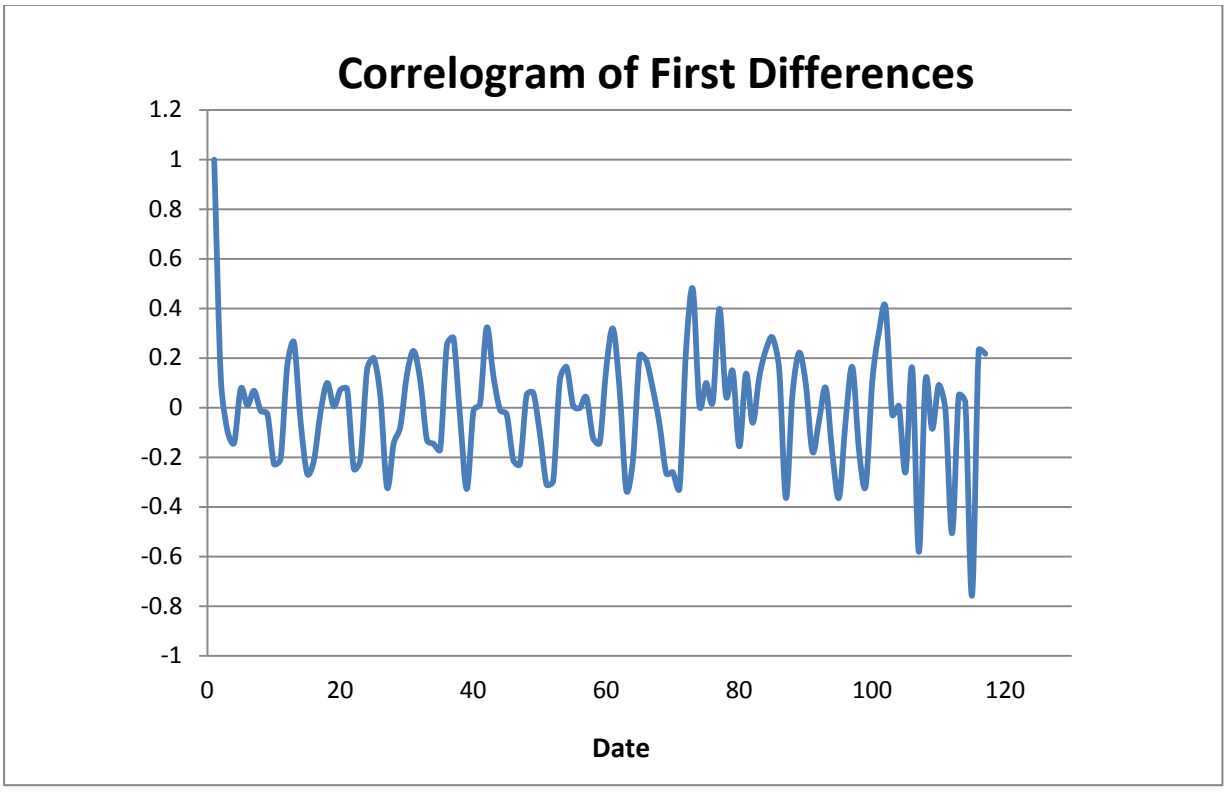
The graph does not drop to zero quickly. It also fluctuates around zero with big variance. Therefore this phenomenon doesn't show a stationary process for the rice price. Due to the graph above, we may assume the rice price process will be stationary by taking differences.

First Differences

From the last section, we see our observations don't follow a stationary process. Now we transform it to the first differences model. Below is the graph showing the first differences of the monthly 18-year rice prices.



The graph shows much less trend than the original observations. The autocorrelation curve decrease to zero sharply and has small fluctuations from then on. Even the curve is not perfect to be centered on zero with tiny fluctuations, we can still assume to have a possible stationary model. Moreover, we will continue to analyze the first differences of rice prices.



Model Fitting

Since we have the stationary model, I will fit the data to various ARIMA models. I will use the excel regression tool to test the following models: ARIMA (3,1,0), ARIMA (2,1,0) and ARIMA (1,1,0). The results are as followed:

After using the 3 variables Y(t-1), Y(t-2), and Y(t-3) to describe the rice prices, I came up with the following statistics:

ARIMA (3,1,0): Y(t) = 8.94 + 1.13Y(t-1) +0.27Y(t-2) + 0.12Y(t-3)

Regression Statistics	
Multiple R	0.966161122
R Square	0.933467315
Adjusted R Square	0.93170096
Standard Error	16.39176583
Observations	117

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	425984.6875	141994.9	528.4711	2.61905E-66
Residual	113	30361.96853	268.69		
Total	116	456346.656			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	8.939448291	6.5351541	1.367902	0.174057
Y(t-1)	1.125159233	0.094318183	11.9294	9.95E-22
Y(t-2)	0.274653445	0.154386674	-1.779	0.077929
Y(t-3)	0.118978678	0.108629831	1.095267	0.275729

From the result above, we see that the P-value of Y(t-3) is 0.275729, which is relatively high and shows that it is not a necessary variable to demonstrate the relationship between explanatory variables and dependent variables. We then can consider remove the variable Y(t-3).

After using the 2 variables Y(t-1) and Y(t-2) to describe the rice price, I came up with the following statistics:

ARIMA (2,1,0): Y(t) = 9.68 + 1.11Y(t-1) + 0.14Y(t-2)

Regression Statistics	
Multiple R	0.966002222
R Square	0.933160294
Adjusted R Square	0.931997864
Standard Error	16.33508002
Observations	118

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	428412.4562	214206.2	802.7671	2.75097E-68
Residual	115	30686.0065	266.8348		
Total	117	459098.4627			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	9.675957678	6.438698497	1.502782	0.135636
Y(t-1)	1.106342874	0.092427711	11.96982	6.18E-22
Y(t-2)	0.140007683	0.093314068	-1.50039	0.136253

From the result above, we show that F statistics is 802.7671. It is higher than ARIMA(3,1,0) model and shows the 2 variable is more reasonable. However, we see that the P-value of Y(t-2) is 0.136253, which is also relatively high based on the rule of 95% confidence level and shows that it is not a necessary variable to demonstrate the relationship between explanatory variables and dependent variables. We then can consider remove the variable Y(t-2).

After using the 2 variables Y(t-1) and Y(t-2) to describe the rice price, I came up with the following statistics:

ARIMA (1,1,0): Y(t) = 8.37 + 0.97Y(t-1)

Regression Statistics	
Multiple R	0.965545757
R Square	0.932278608
Adjusted R Square	0.931699793
Standard Error	16.35350285
Observations	119

ANOVA

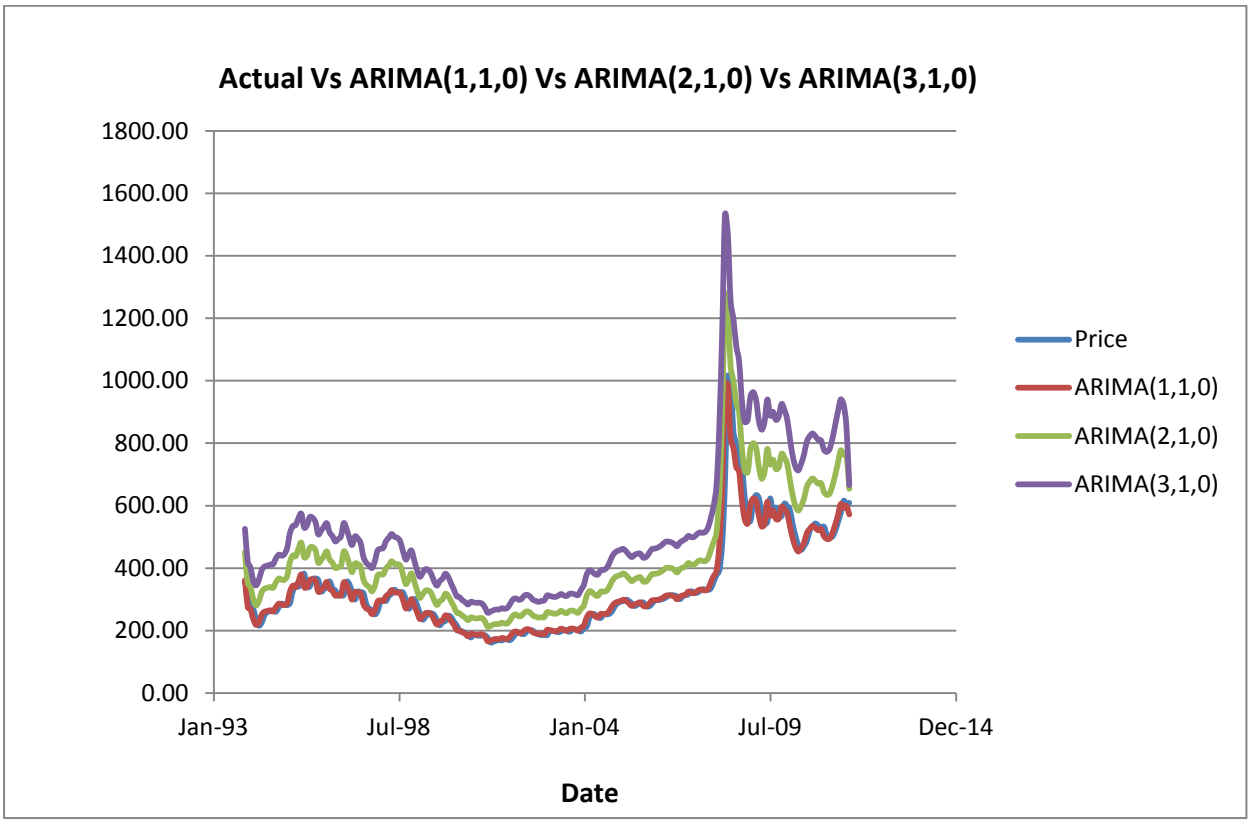
	df	*SS*	*MS*	*F*	*Significance F*

Regression	1	430751.987	430752	1610.667	3.0154E-70
Residual	117	31290.1355	267.4371		
Total	118	462042.1225			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	8.366957136	6.344395646	1.318795	0.189813
Y(t-1)	0.972303339	0.02422696	40.13311	3.02E-70

Viewing the result of the result of ARIMA(1,1,0), the P-value for the coefficient of Y(t-1) is perfect, and it shows a strong relationship of time lag 1 to Y(t). In addition, F statistics continues to be improved. The R=0.965545757 and does not decrease much comparing to the previous two models. Based on the analysis above, it is shown that ARIMA(1,1,0) is the best fitted model.

At last, I plot the graph of prediction of rice price with all three ARIMA models to predict the price of rice price. We compare the actual price from 2004-2012 with the predicted price with the three modes, and come up with the following graph



Conclusion

Based on the above analysis and the prediction graph, all of the three models can predict the similar fluctuations of the rice price in the next 8years. But we can conclude that ARIMA(1,1,0) is the best fit model to predict the rice price. This is consistent with our regression analysis.