US tourism before and after 9-11 and financial crisis

Econometrics of seasonal timeseries

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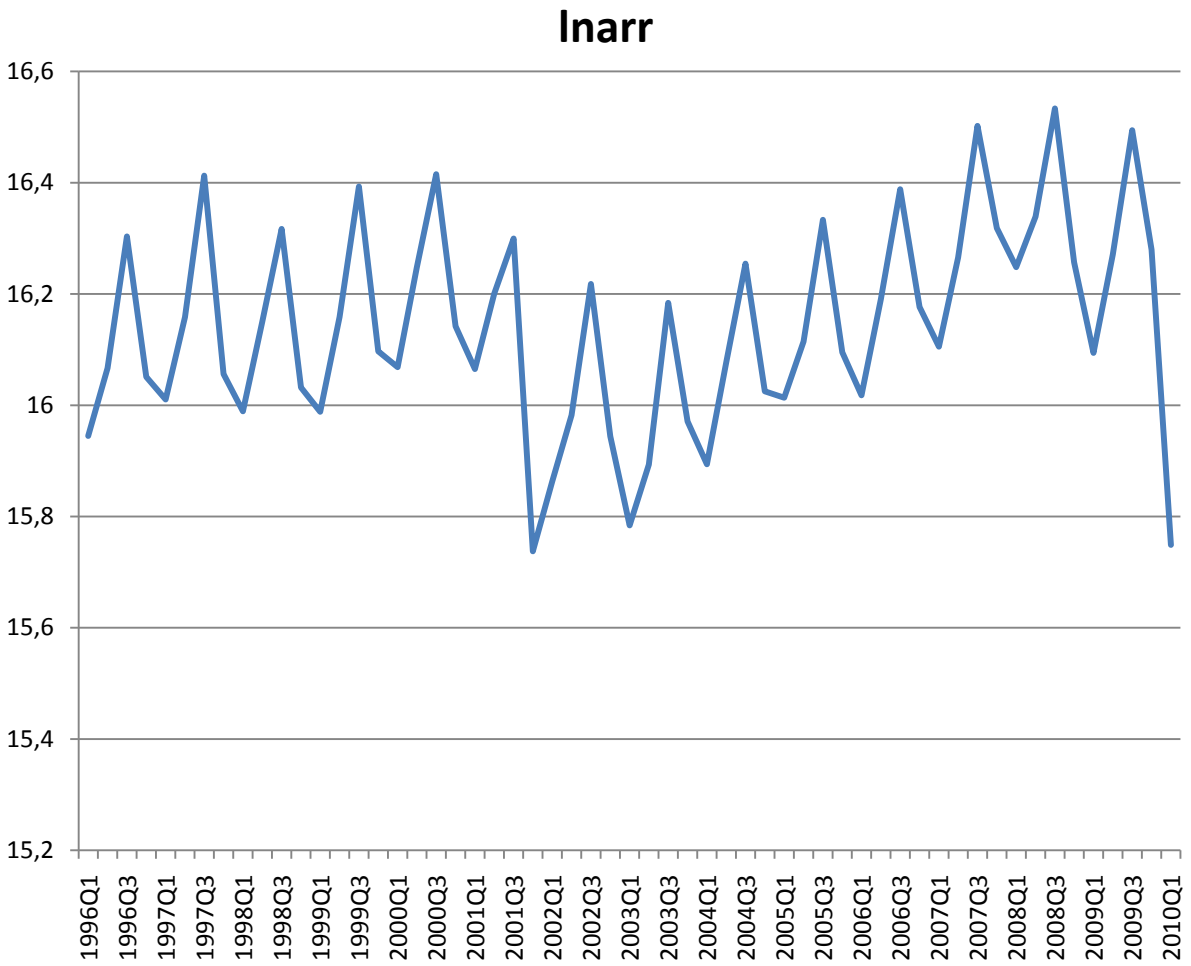
Objectives:

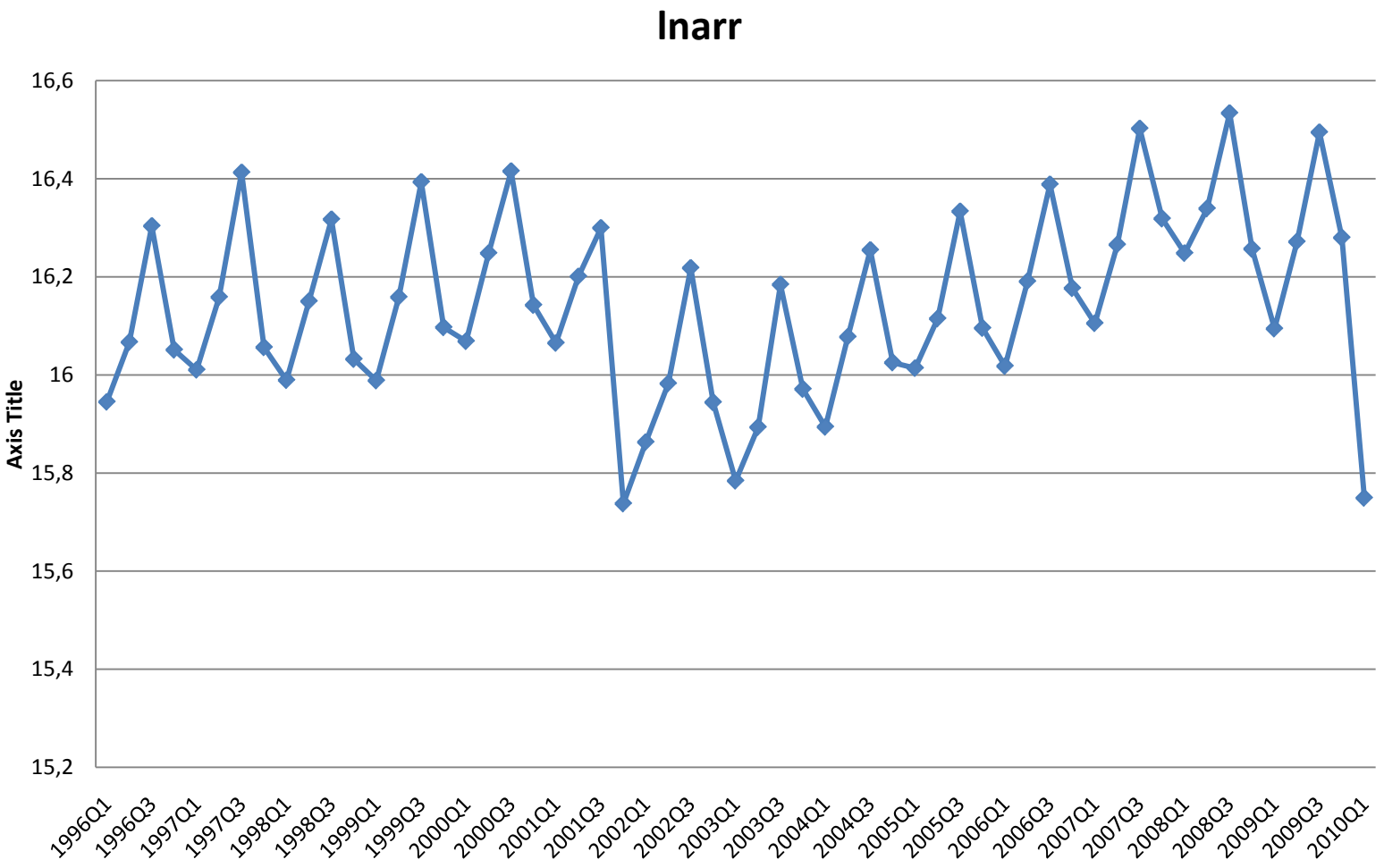
- To observe the seasonal patterns of US tourism (Arrivals)
- To show 9-11 and financial crisis impact
- Regression with seasonal trend effects (ARMA)
- Insample and out-of-sample forecasting
- Model selection by using AIC & SC
- References

Data

- Quarterly data of US tourism
- Time Period: 1996-2010
- Source: Office of Travel and Tourism Industries (ITA)
- Measurment unit: No. Of Arrivals

Number of Arrivals in US from 1996-2010




lnarr
Axis Title
16,6
16,4
16,2
16
15,8
15,6
15,4
15,2
1996Q1
1996Q3
1997Q1
1997Q3
1998Q1
1998Q3
1999Q1
1999Q3
2000Q1
2000Q3
2001Q1
2001Q3
2002Q1
2002Q3
2003Q1
2003Q3
2004Q1
2004Q3
2005Q1
2005Q3
2006Q1
2006Q3
2007Q1
2007Q3
2008Q1
2008Q3
2009Q1
2009Q3
2010Q1

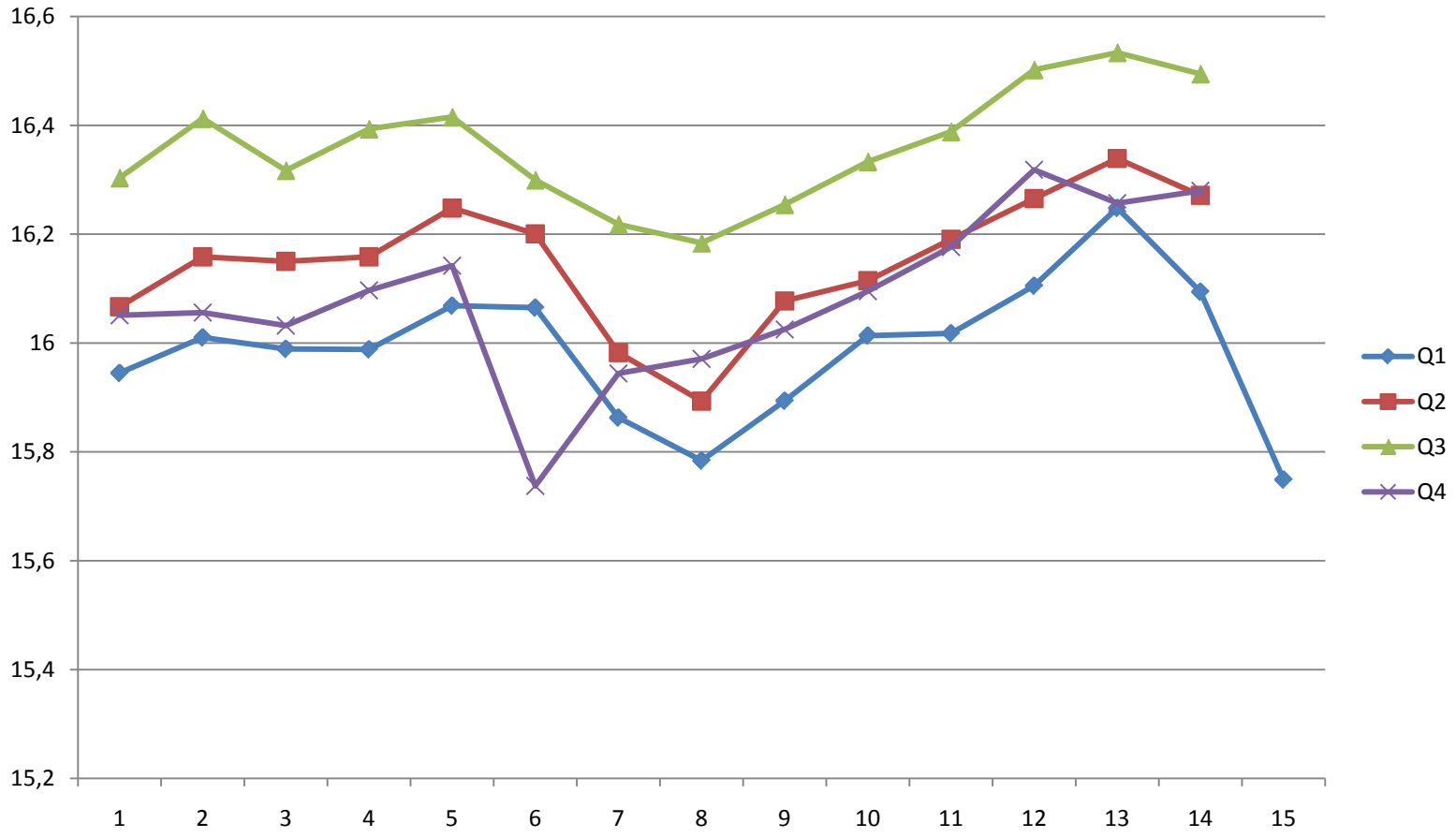
- Figure 1 shows a very slight upward trend which is very minimal but seasonal in nature.

- A break has shown the impact of 9-11 in the figure but the figure clearly has upward trend after 9-11.

- Another low in the last year, showing the recession process of Europe and central Asia which has a high proportion of overall arrivals.

- There is only one peak in whole year (some variables show double peaks in a year)

Quarter wise US arrivals



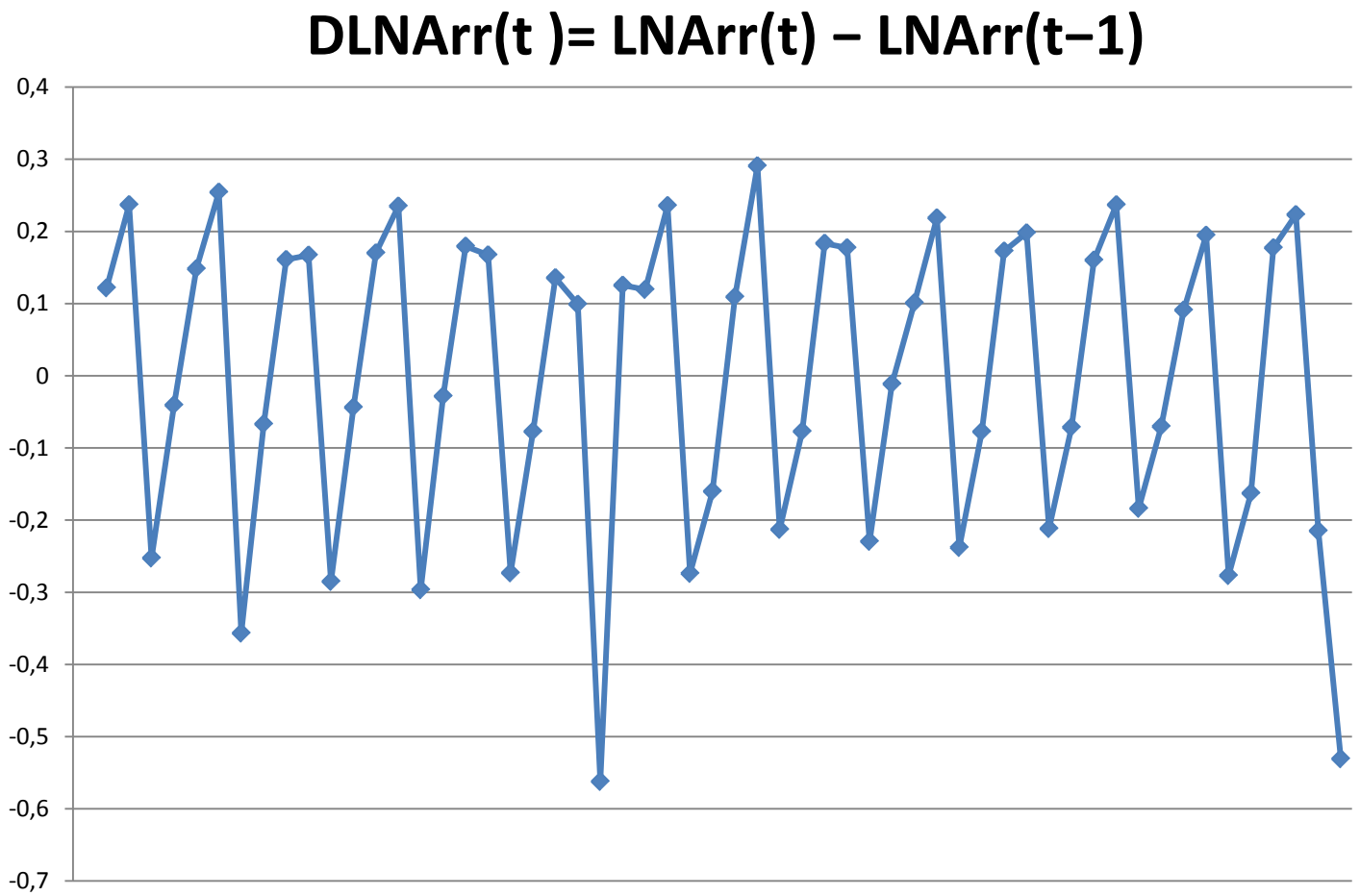
- There is one peak in every year (3rd Quarter)

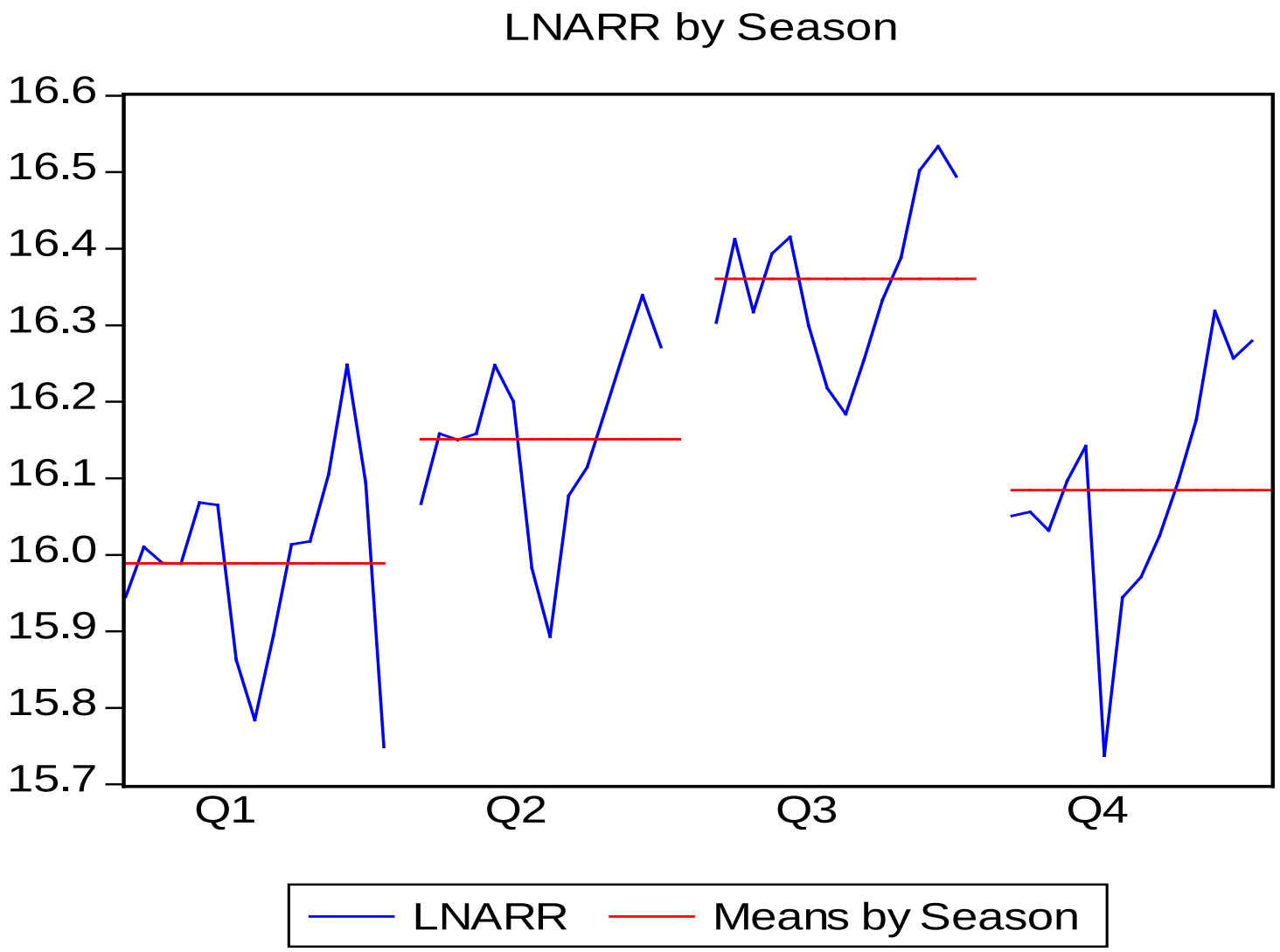
- According to the diagram Q3 is dominating whereas Q2 and Q1 is following same pattern however Q1 low in last year due to recession of Europe and Asia.

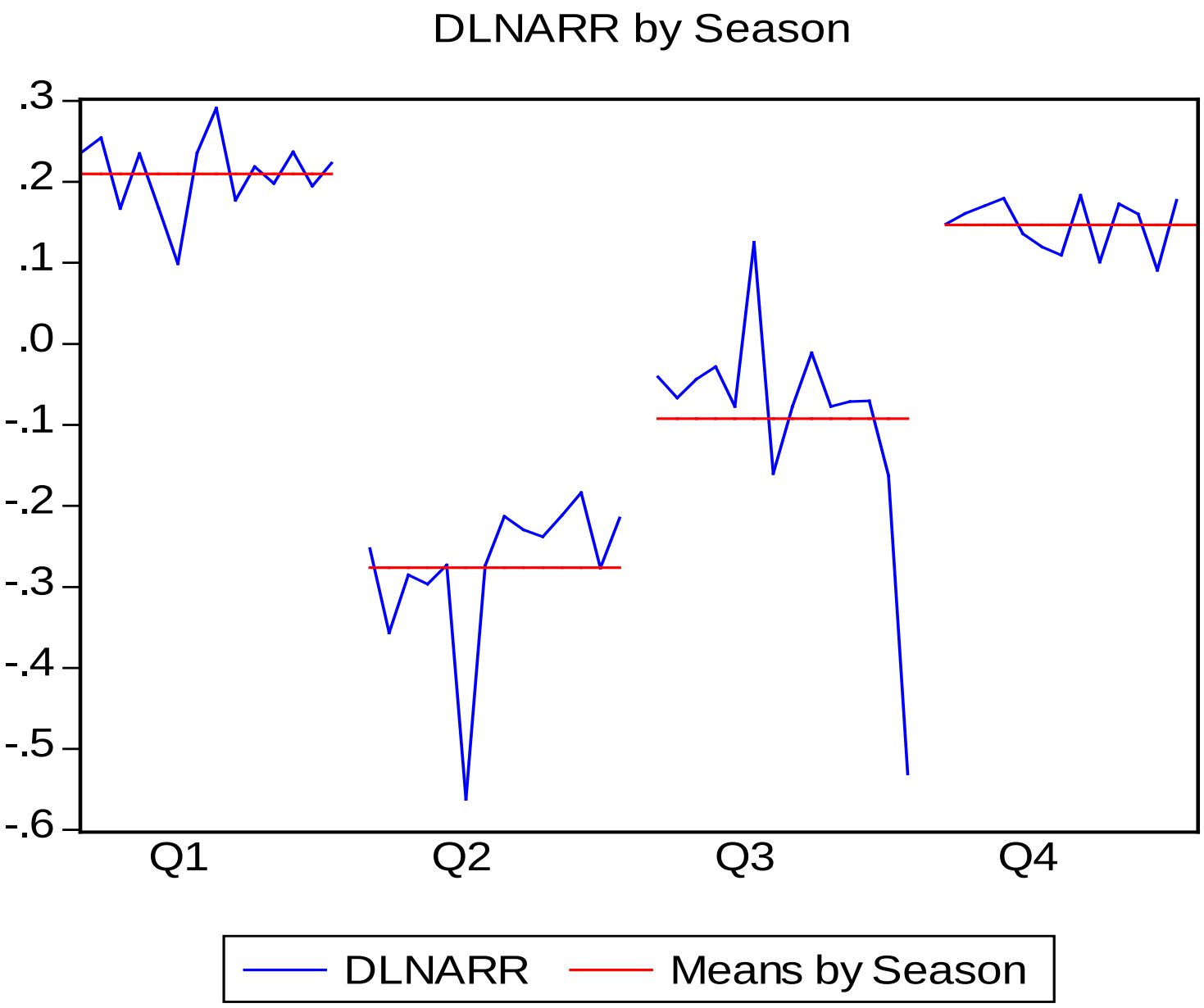
- 9-11 impact seen in 4th Quarter after that, arrivals in 4th Q increased tremendously (many crossings afterwards).

First Differncing: To get difference stationary

It shows trendless growth from the series.




LNARR by Season
16.6
16.5
16.4
16.3
16.2
16.1
16.0
15.9
15.8
15.7
Q1
Q2
Q3
Q4
LNARR
Means by Season


DLNARR by Season
.3
.2
.1
.0
-.1
-.2
-.3
-.4
-.5
-.6
Q1
Q2
Q3
Q4
DLNARR
Means by Season

Models

- Model 1:

$$Y_{it} = \beta_1 (Time) + \sum_{i=1}^{s} \gamma_i D_{it} + \varepsilon_t$$

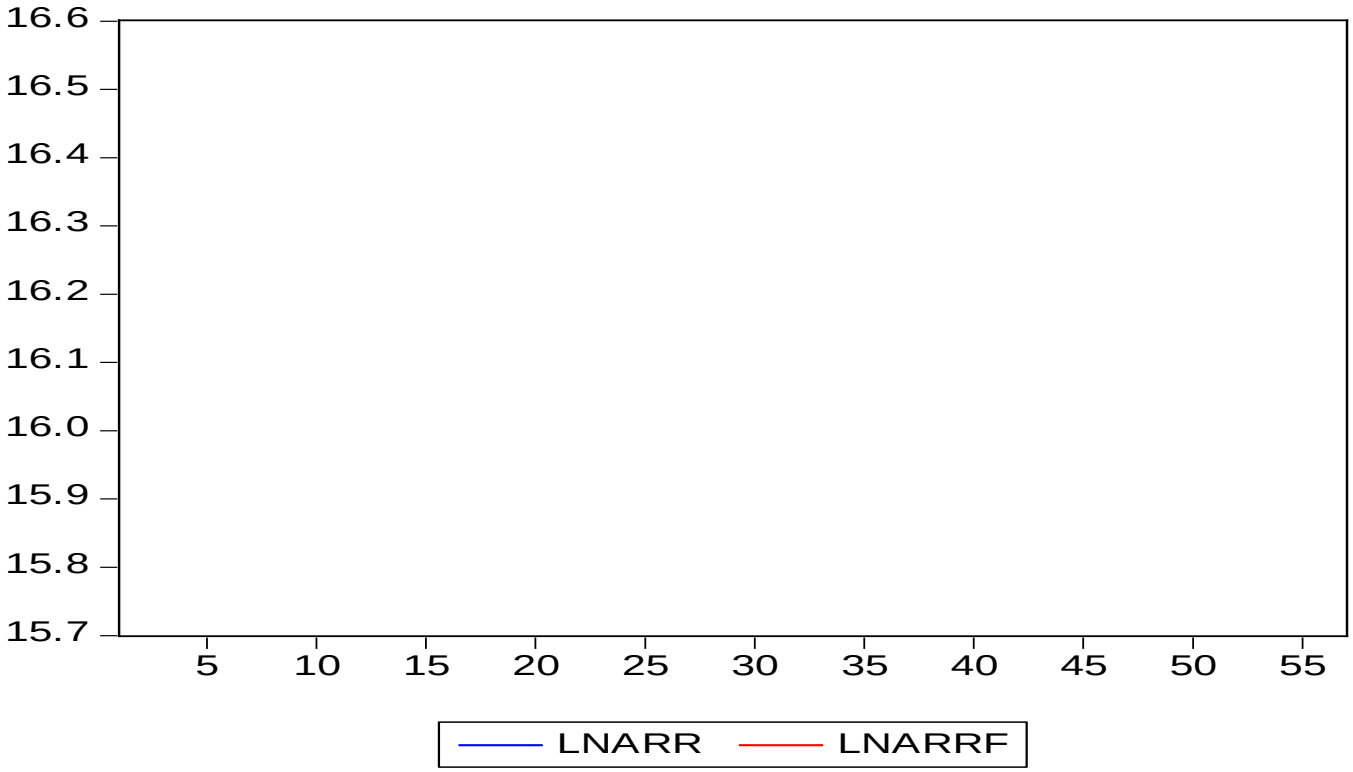
- Model 2:

$$Y_{it} = \beta_1 (Time) + \sum_{i=1}^{s} \gamma_i D_{it} + \sum_{i=1}^{p} \varphi_i X_{t-1} + \sum_{i=1}^{q} \theta_i \varepsilon_{t-1}$$

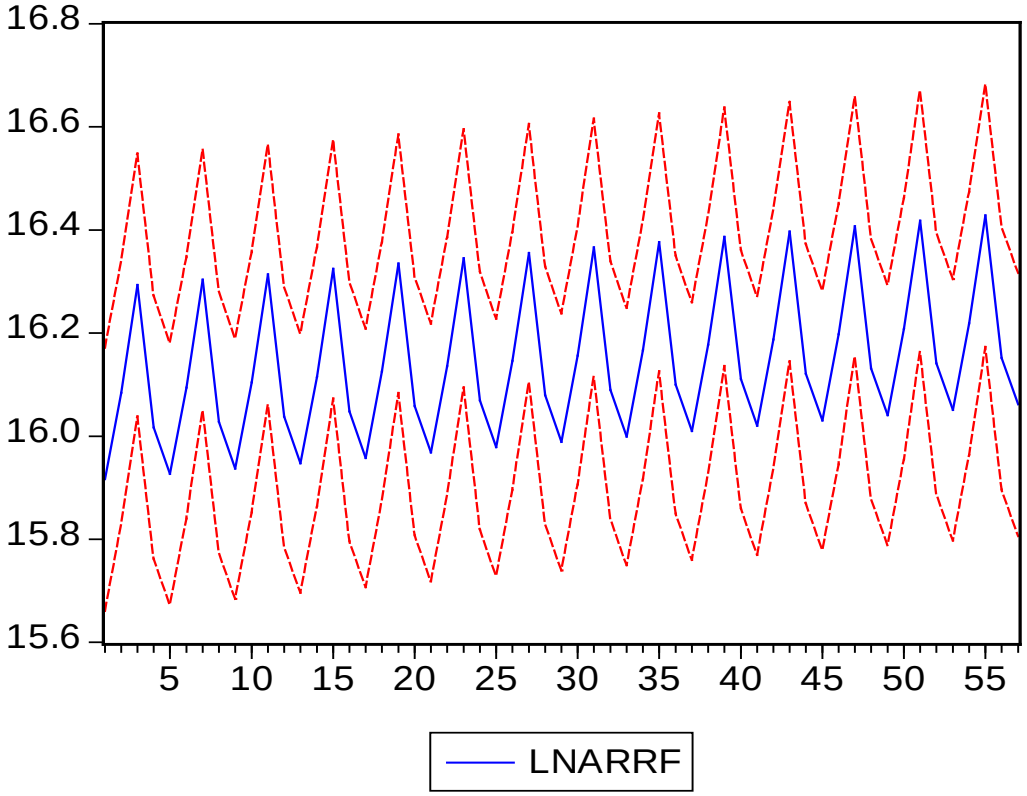
Model 1: Trend with Season

Dependent Variable: LNARR				
Method: Least Squares				
Date: 06/14/10 Time: 15:05				
Sample: 1 57				
Included observations: 57				
	Coefficient	Std. Error	t-Statistic	Prob.
Constant	16.00666	0.043500	367.9713	0.0000
TIME	0.002593	0.000973	2.666015	0.0102
D1	-0.092894	0.044867	-2.070452	0.0434
D2	0.071848	0.045664	1.573399	0.1217
D3	0.278845	0.045633	6.110557	0.0000
R-squared	0.607341			
Adjusted R-squared	0.577137			
S.E. of regression	0.120707	Akaike info criterion		-1.307271
Sum squared resid	0.757648	Schwarz criterion		-1.128056
Log likelihood	42.25724			
F-statistic	20.10764	Durbin-Watson stat		0.566673
Prob(F-statistic)	0.000000			

Model 1: Insample forecasting

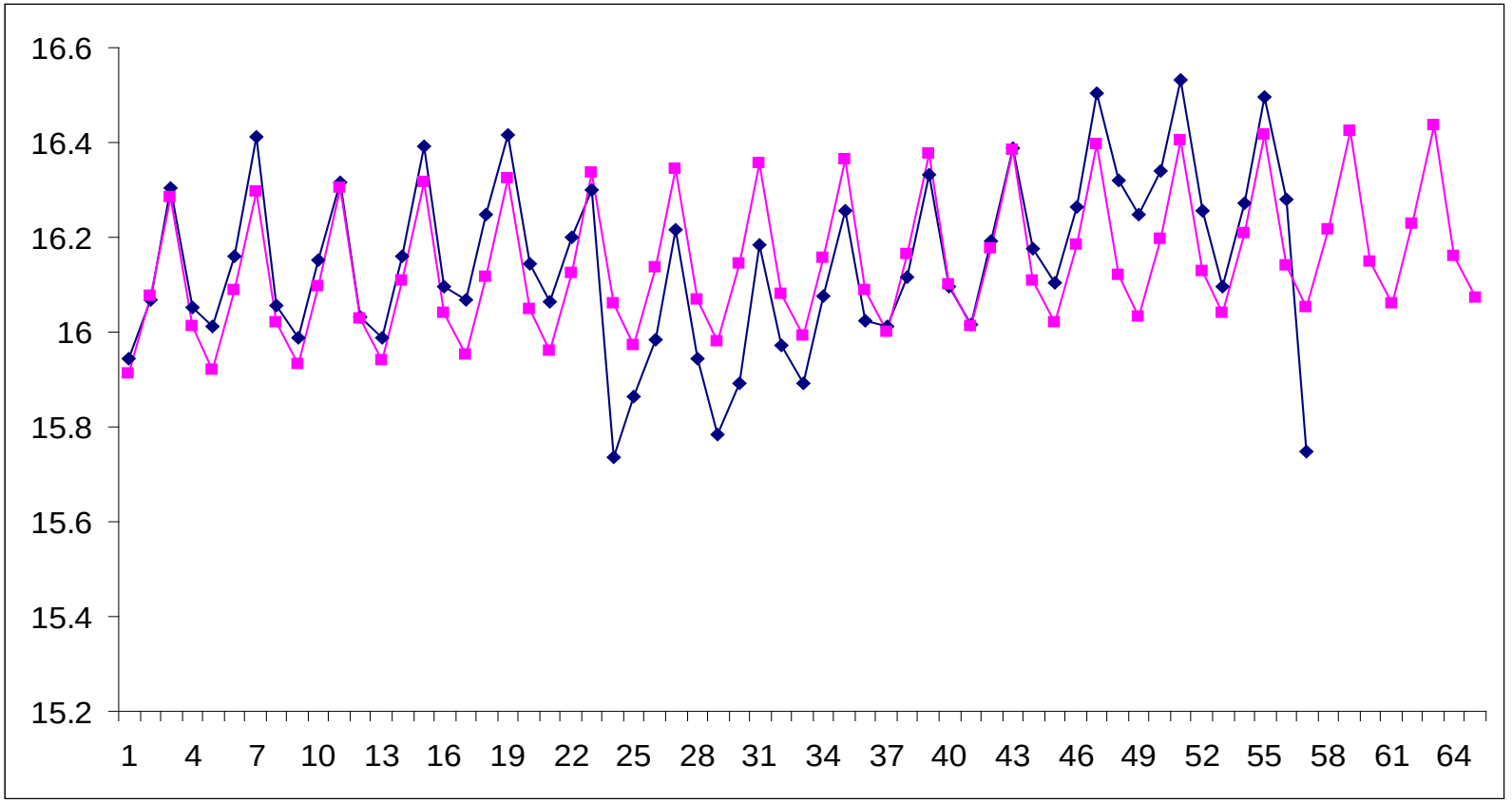


Model 1: Forecasting stats



Forecast: LNARRF	
Actual: LNARR	
Forecast sample: 1 57	
Included observations: 57	
Root Mean Squared Error	0.115291
Mean Absolute Error	0.090057
Mean Abs. Percent Error	0.559588
Theil Inequality Coefficient	0.003571
Bias Proportion	0.000000
Variance Proportion	0.124024
Covariance Proportion	0.875976

Model 1: Out of Sample Forecast: Expand to 2 years



Model 2: Only with AR(1) Element

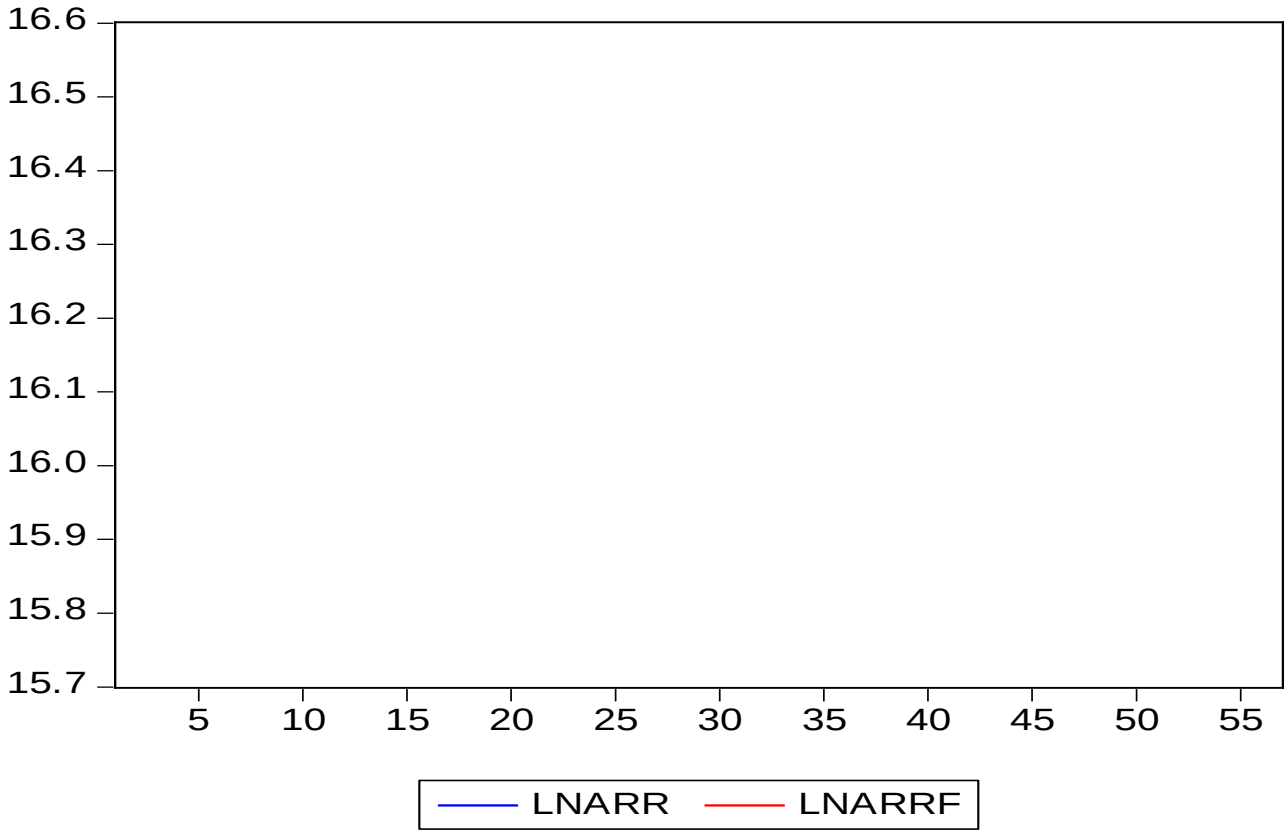
Dependent Variable: LNARR
Method: Least Squares
Date: 06/14/10 Time: 15:55
Sample (adjusted): 2 57
Included observations: 56 after adjustments
Convergence achieved after 3 iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C	**16.04978**	**0.115423**	**139.0514**	**0.0000**
TIME	**0.000775**	**0.003244**	**0.238893**	**0.8122**
D1	**-0.090397**	**0.022840**	**-3.957894**	**0.0002**
D2	**0.059971**	**0.026235**	**2.285945**	**0.0265**
D3	**0.273462**	**0.022799**	**11.99442**	**0.0000**
AR(1)	**0.762323**	**0.108497**	**7.026219**	**0.0000**

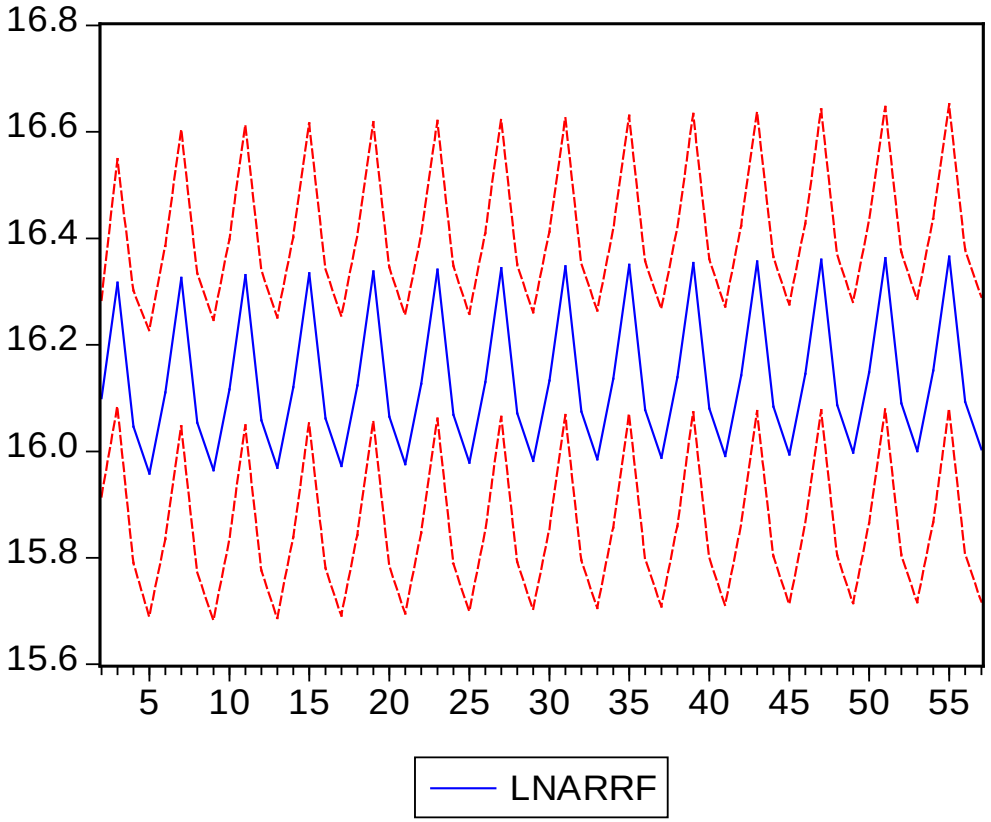
R-squared	**0.798466**	Mean dependent var	**16.14710**
Adjusted R-squared	**0.778313**	S.D. dependent var	**0.185343**
S.E. of regression	**0.087266**	Akaike info criterion	**-1.938746**
Sum squared resid	**0.380771**	Schwarz criterion	**-1.721744**
Log likelihood	**60.28490**	Hannan-Quinn criter.	**-1.854615**
F-statistic	**39.61952**	Durbin-Watson stat	**1.697776**
Prob(F-statistic)	**0.000000**		

Inverted AR Roots .76

Model 2: Insample Forecasting with AR(1)

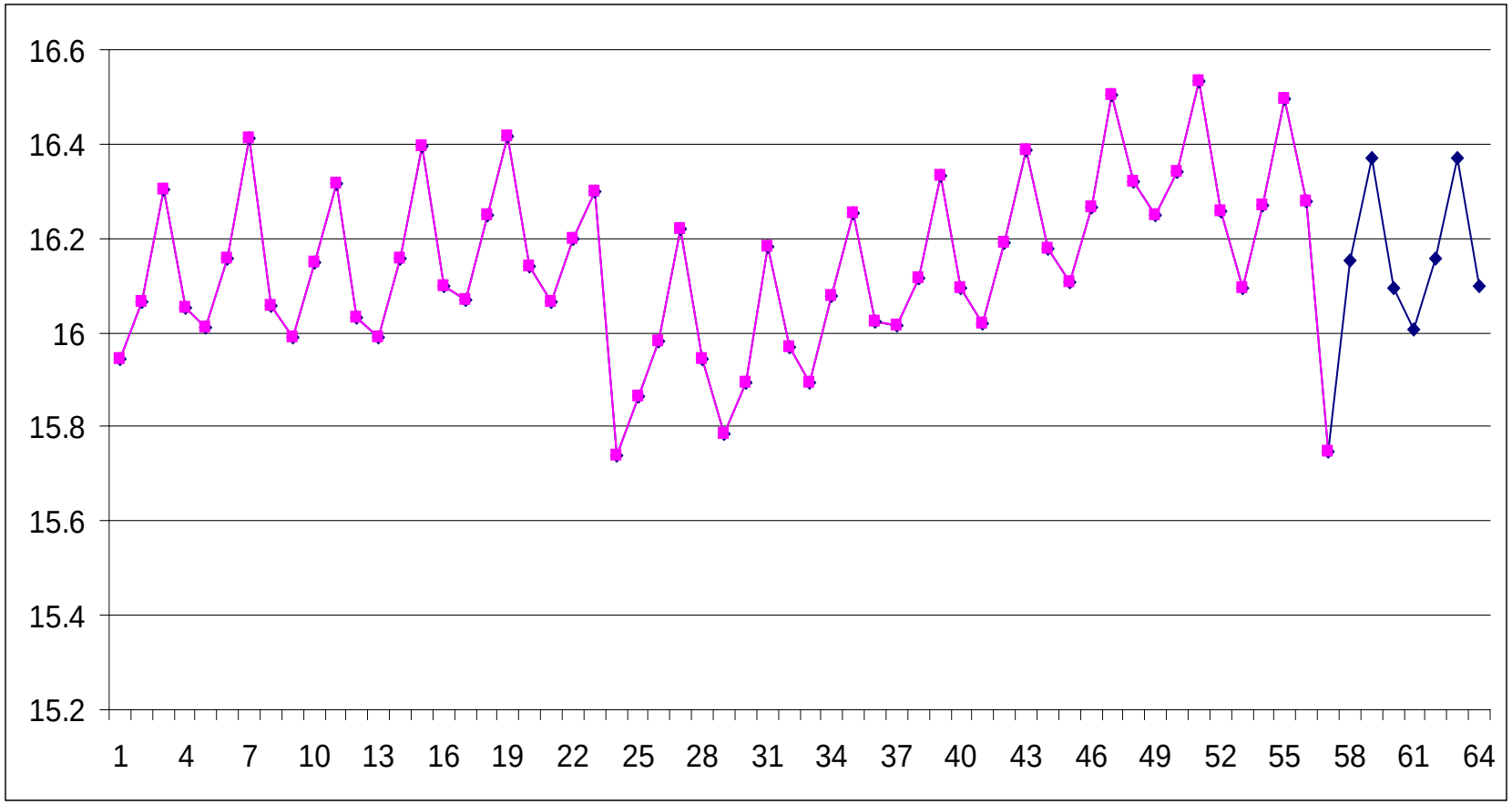


Model 2: Forecasting stats with AR(1)



Forecast: LNARRF	
Actual: LNARR	
Forecast sample: 1 57	
Adjusted sample: 2 57	
Included observations: 56	
Root Mean Squared Error	0.121006
Mean Absolute Error	0.095929
Mean Abs. Percent Error	0.594876
Theil Inequality Coefficient	0.003748
Bias Proportion	0.014515
Variance Proportion	0.168386
Covariance Proportion	0.817099

Model 2: Out of sample Forecasting with AR(1)



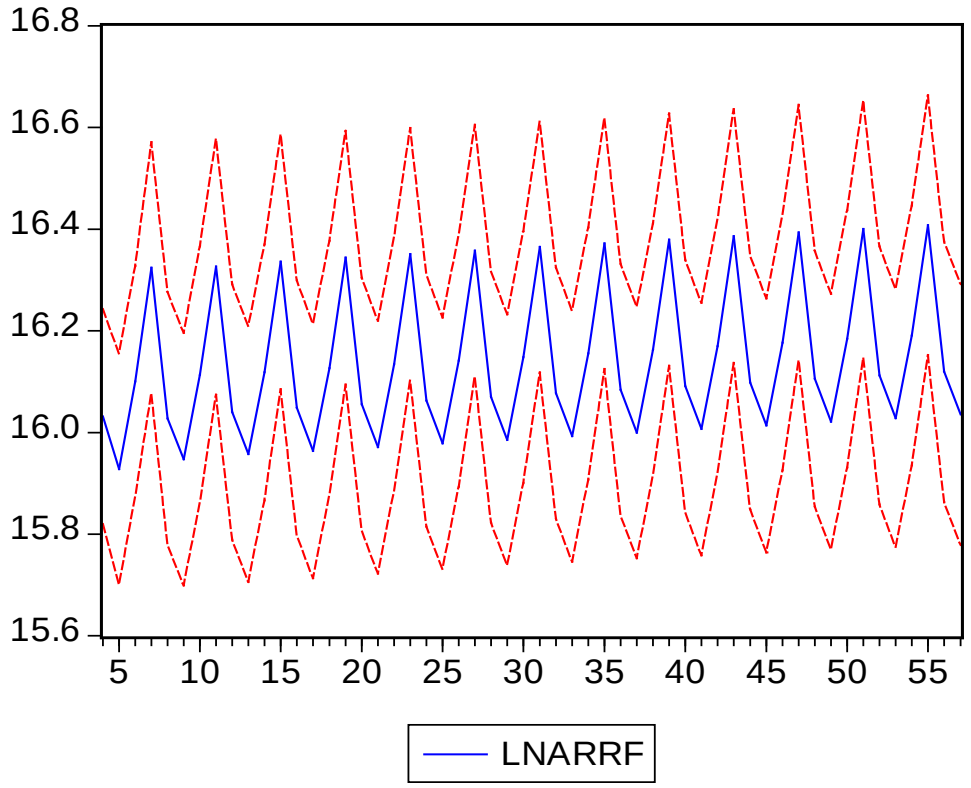
- Model 2: with AR(3) and MA(1)

- Dependent Variable: LNARR
- Method: Least Squares
- Date: 06/15/10 Time: 00:05
- Sample (adjusted): 4 57
- Included observations: 54 after adjustments
- Convergence achieved after 24 iterations
- Backcast: 3

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16.02020	0.084687	189.1690	0.0000
TIME	0.001776	0.002276	0.780221	0.4392
D1	-0.086067	0.028070	-3.066136	0.0036
D2	0.074875	0.037939	1.973570	0.0543
D3	0.289741	0.028294	10.24041	0.0000
AR(3)	0.464107	0.171863	2.700449	0.0096
MA(1)	0.437196	0.195086	2.241041	0.0298

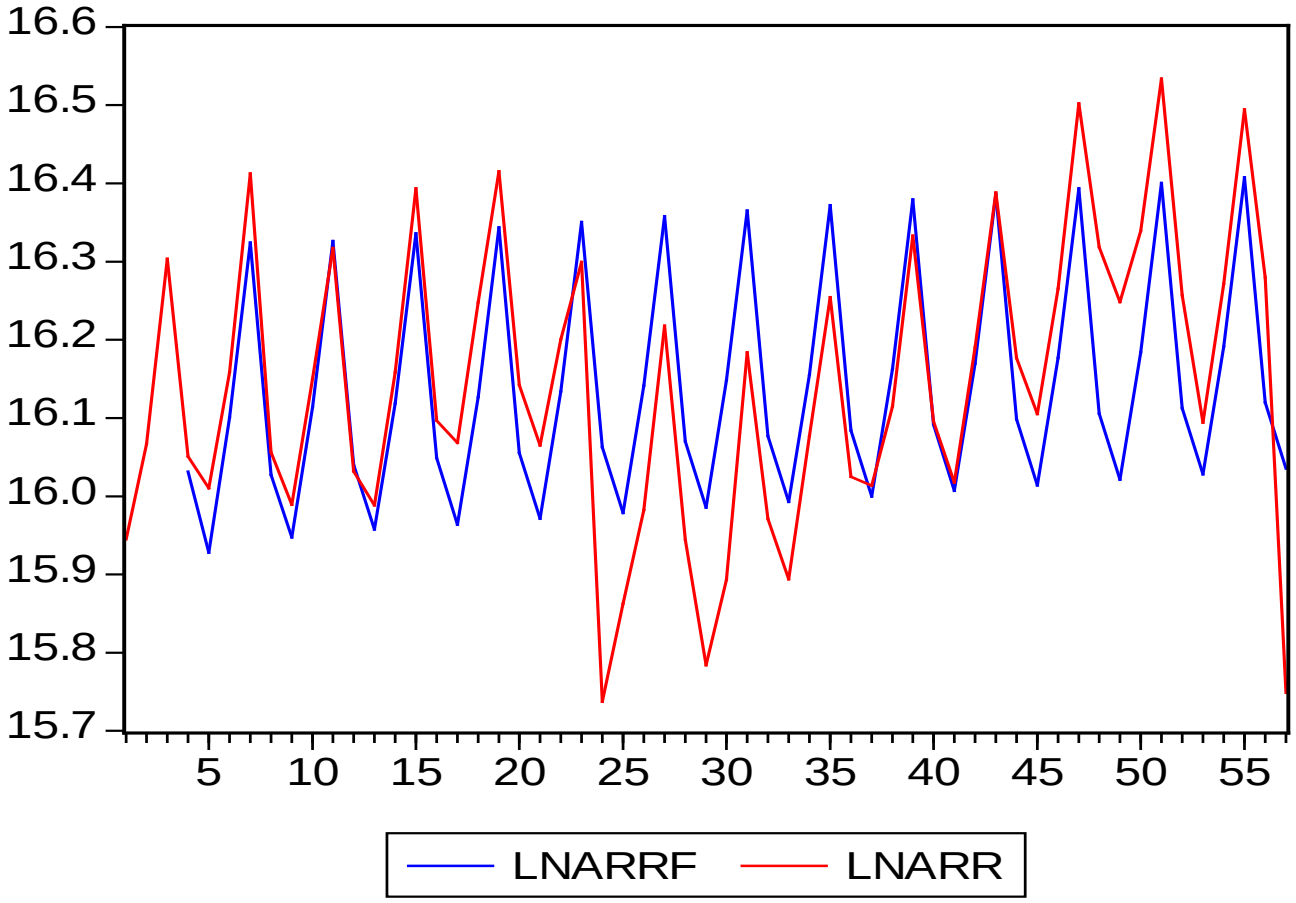
R-squared	**0.763562**	**Mean dependent var**	**16.14569**
Adjusted R-squared	**0.733378**	**S.D. dependent var**	**0.187250**
S.E. of regression	**0.096687**	**Akaike info criterion**	**-1.714246**
Sum squared resid	**0.439377**	**Schwarz criterion**	**-1.456414**
Log likelihood	**53.28463**	**F-statistic**	**25.29727**
Durbin-Watson stat	**1.438066**	**Prob(F-statistic)**	**0.000000**

Model 2: Forecast stats with Ar(1) and MA(3)

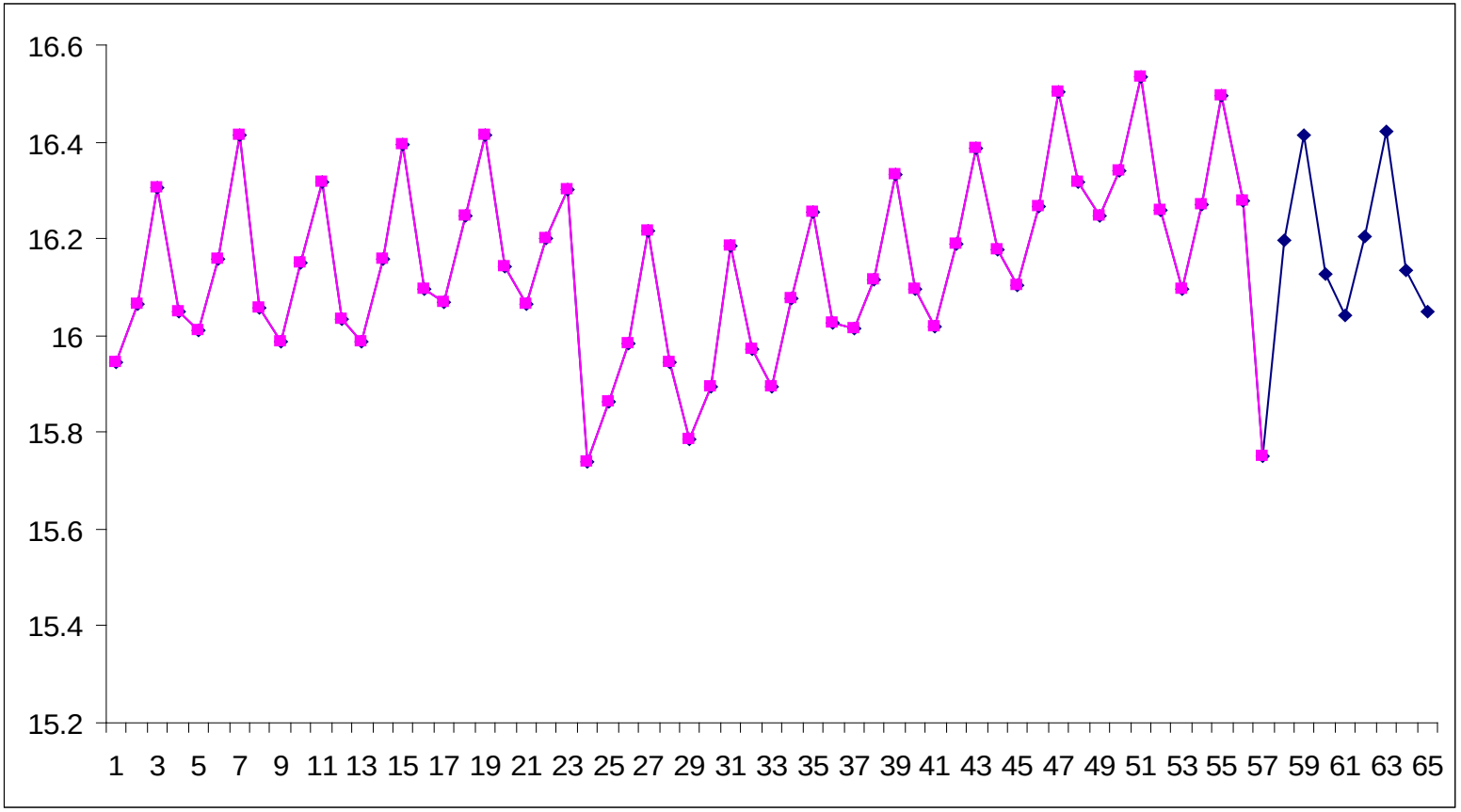


Forecast: LNARRF	
Actual: LNARR	
Forecast sample: 1 57	
Adjusted sample: 4 57	
Included observations: 54	
Root Mean Squared Error	0.119575
Mean Absolute Error	0.095757
Mean Abs. Percent Error	0.594522
Theil Inequality Coefficient	0.003704
Bias Proportion	0.002886
Variance Proportion	0.132580
Covariance Proportion	0.864533

In sample forecasting: with AR(3) and MA(1)



- Model 2: out of sample forecasting with AR(1) and MA(3)



- Akaike Information Criteria by Hirotsogu Akaike: measure of goodness of fit of a model
  - Model having lowest value considered best

- Schwarz Criterion : Bayesian information criterion or schewarz criterion among a class of parameteric models with different number of parameters.
  - Log liklihood increased by increasing parameters

Comparison of Regression Results

Model	R-square	Adjusted R-square	Akaike Info Criteria	Schwarz Criterion
Model 1	0.607	0.577	-1.30	-1.12
Model 2 with AR(1) only	0.798	0.778	-1.93	-1.72
Model 2 with AR(1) and MA(3)	0.763	0.733	-1.71	-1.45

- Root Mean Square Error (RMSE): measure of the differences between the values predicted by the model and the values actually observed from the estimated.

- Theil Inequality Coefficient:
  - Is used to measure economic inquality
  - It will lie between 0 and 1, if 0 then perfect fit otherwise performance is bad
  - It has three proportions (Bias, Variance and Covariance)
  - Bias (large bias suggests system over and under prediction)
  - Variance(if large then actual series (fluctuated) but forecast is not.
  - Unsystmetic errors (highest proportion of inequality)

Comparison of Forecasting measures

Model	Root Mean Square Error	Mean Absolute Error	Mean Absolute Percentage Error	Theil Inequality Coefficient
Model 1	0.1152	0.0900	0.5595	0.003771
Model 2 with AR(1) only	0.1210	0.0959	0.5948	0.003748
Model 2 with AR(1) and MA(3)	0.1195	0.0957	0.5945	0.003704

Comparison of Theil Inequality components

Model	BIAS	VARIANCE	COVARIANCE
Model 1	0.0000	0.1240	0.8759
Model 2 with AR(1) only	0.0145	0.168	0.817
Model 2 with AR(1) and MA(3)	0.0028	0.1325	0.8645

References:

- The Econometric Analysis of Seasonal Time Series by **Eric Ghysels**, **Thomas J Sargent** and **Denise R Osborn**

- **Elements of Forecasting"by Francis X. Diebold, University of Pennsylvania 2ndEdition, University of Pennsylvania**

- **Box-Jenkins Analysis on Seasonal Data**
- **http://www.itl.nist.gov/div898/handbook/pmc/section4/pmc44a.htm**

- **Box-Jenkins Model Identification.**
- http://www.itl.nist.gov/div898/handbook/pmc/section4/pmc446.htm