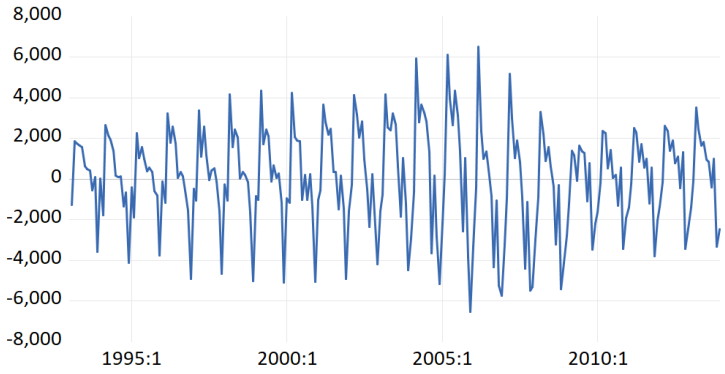
Homework 5

Eco 4306 Economic and Business Forecasting
Spring 2019
Due: Friday, March 22, before the class

Problem 1

(a) The time series plot and correlogram of the total private residential construction spending for the period 1993M01-2013M12 are below.



Date: 04/13/19 Time: 10:04
Sample: 1993M01 2013M12
Included observations: 251

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.503	0.503	64.252	0.000
		2	0.278	0.033	83.892	0.000
		3	-0.095	-0.330	86.205	0.000
		4	-0.285	-0.189	107.16	0.000
		5	-0.389	-0.129	146.29	0.000
		6	-0.576	-0.439	232.16	0.000
		7	-0.396	-0.040	273.07	0.000
		8	-0.299	-0.142	296.38	0.000
		9	-0.101	-0.255	299.04	0.000
		10	0.256	0.276	316.29	0.000
		11	0.473	0.239	375.38	0.000
		12	0.926	0.822	603.25	0.000
		13	0.458	-0.477	659.31	0.000
		14	0.249	-0.117	675.93	0.000
		15	-0.113	0.021	679.38	0.000
		16	-0.282	0.028	700.83	0.000
		17	-0.383	0.006	740.55	0.000
		18	-0.564	0.044	827.12	0.000
		19	-0.390	0.002	868.71	0.000
		20	-0.300	-0.033	893.42	0.000
		21	-0.090	0.062	895.64	0.000
		22	0.233	-0.158	910.68	0.000
		23	0.448	0.060	966.62	0.000
		24	0.861	0.017	1174.0	0.000
		25	0.423	-0.004	1224.1	0.000
		26	0.225	-0.036	1238.5	0.000
		27	-0.131	-0.039	1243.3	0.000
		28	-0.281	-0.046	1265.8	0.000
		29	-0.377	0.014	1306.5	0.000
		30	-0.549	0.023	1393.1	0.000
		31	-0.385	-0.089	1435.8	0.000
		32	-0.308	-0.056	1463.2	0.000
		33	-0.080	0.050	1465.1	0.000
		34	0.210	-0.049	1478.0	0.000
		35	0.423	-0.050	1530.6	0.000
		36	0.790	-0.089	1715.1	0.000

(b) The shape of the correlogram in (a) is similar to the one in Figure 7.19 suggesting that the U.S. residential construction in 1993M01-2013M12 follows a similar process as in 2002M01-2011M01

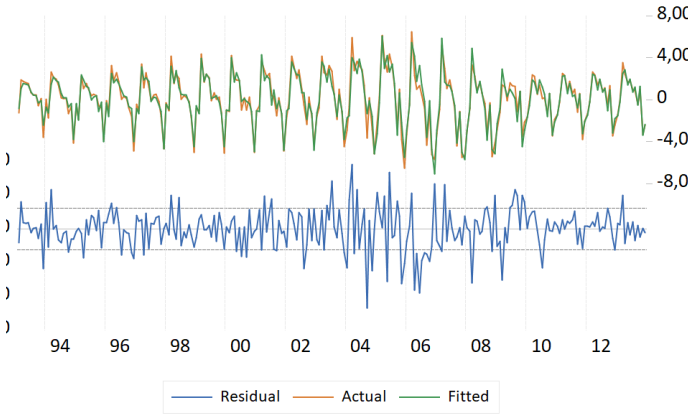
(c) Since in the correlogram in (a) ACF decays in a wave like pattern and PACF has dominant lags 1, 6, 12, 13, we first consider a multiplicative AR(1)+SAR(1) model

Dependent Variable: DCONST
Method: ARMA Maximum Likelihood (BFGS)
Date: 04/13/19 Time: 10:04
Sample: 1993M02 2013M12
Included observations: 251
Convergence achieved after 5 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	218.5690	1235.621	0.176890	0.8597
AR(1)	0.563509	0.044817	12.57349	0.0000
SAR(12)	0.944410	0.013547	69.71517	0.0000
SIGMASQ	379202.0	27048.41	14.01938	0.0000

R-squared	0.933686	Mean dependent var	49.44223
Adjusted R-squared	0.932881	S.D. dependent var	2396.078
S.E. of regression	620.7600	Akaike info criterion	15.82347
Sum squared resid	95179704	Schwarz criterion	15.87965
Log likelihood	-1981.845	Hannan-Quinn criter.	15.84608
F-statistic	1159.242	Durbin-Watson stat	2.130377
Prob(F-statistic)	0.000000		

Inverted AR Roots	1.00	.86-.50i	.86+.50i	.56
	.50+.86i	.50-.86i	.00+1.00i	-.00-1.00i
	-.50+.86i	-.50-.86i	-.86+.50i	-.86-.50i
	-1.00			



Date: 04/13/19 Time: 10:04
Sample: 1993M01 2013M12
Included observations: 251
Q-statistic probabilities adjusted for 2 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.066	-0.066	1.1109	
		2	0.136	0.132	5.8246	
		3	-0.022	-0.005	5.9460	0.015
		4	-0.010	-0.030	5.9704	0.051
		5	0.058	0.061	6.8484	0.077
		6	-0.075	-0.065	8.3212	0.080
		7	-0.081	-0.109	10.030	0.074
		8	0.116	0.132	13.549	0.035
		9	-0.088	-0.054	15.602	0.029
		10	-0.017	-0.073	15.675	0.047
		11	-0.044	-0.013	16.196	0.063
		12	-0.004	0.010	16.201	0.094
		13	-0.016	-0.046	16.267	0.132
		14	-0.008	0.010	16.284	0.179
		15	0.004	0.030	16.288	0.234
		16	0.009	-0.027	16.308	0.295
		17	0.050	0.054	16.997	0.319
		18	-0.093	-0.085	19.357	0.251
		19	0.047	0.020	19.956	0.276
		20	0.068	0.098	21.224	0.268
		21	-0.041	-0.048	21.684	0.300
		22	0.029	-0.011	21.918	0.345
		23	-0.020	0.022	22.033	0.398
		24	0.152	0.147	28.514	0.159
		25	-0.000	-0.029	28.514	0.197
		26	-0.059	-0.051	29.501	0.202
		27	-0.028	-0.033	29.724	0.235
		28	0.025	0.020	29.903	0.272
		29	-0.047	-0.041	30.532	0.291
		30	-0.033	-0.026	30.842	0.324
		31	-0.043	0.000	31.369	0.348
		32	0.058	0.025	32.353	0.351
		33	0.002	0.019	32.354	0.400
		34	0.033	0.043	32.675	0.434
		35	-0.022	-0.003	32.818	0.476
		36	-0.072	-0.129	34.329	0.452

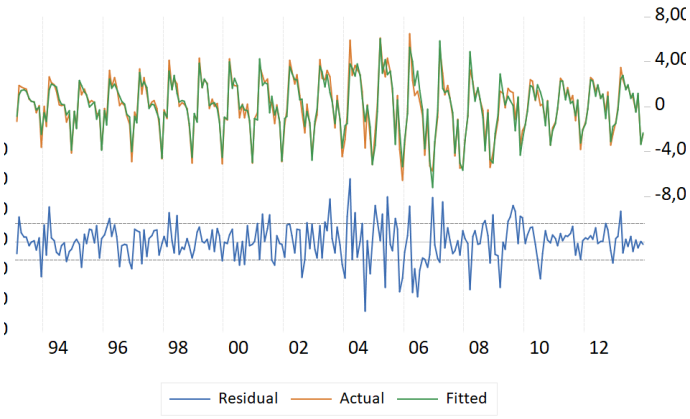
The low p-value of the Ljung-Box test for residuals at lag 3 and the marginally significant lag 2 in the PACF of the residuals from AR(1)-SAR(1) model suggest that a modified AR(2)+SAR(1) model will likely yield better results. As shown below, adding the second lag really improves the results of ACF and PACF for residuals, and the AIC also favors AR(2)+SAR(1) model (but note that the SIC prefers the AR(1)+SAR(1) model).

Dependent Variable: DCONST
Method: ARMA Maximum Likelihood (BFGS)
Date: 04/13/19 Time: 10:04
Sample: 1993M02 2013M12
Included observations: 251
Convergence achieved after 7 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	214.4219	1374.109	0.156044	0.8761
AR(1)	0.497140	0.054595	9.105947	0.0000
AR(2)	0.116143	0.052147	2.227211	0.0268
SAR(12)	0.944592	0.013249	71.29646	0.0000
SIGMASQ	373960.6	26485.07	14.11968	0.0000

R-squared	0.934603	Mean dependent var	49.44223
Adjusted R-squared	0.933540	S.D. dependent var	2396.078
S.E. of regression	617.7066	Akaike info criterion	15.81783
Sum squared resid	93864109	Schwarz criterion	15.88805
Log likelihood	-1980.137	Hannan-Quinn criter.	15.84609
F-statistic	878.9103	Durbin-Watson stat	1.975678
Prob(F-statistic)	0.000000		

Inverted AR Roots	1.00	.86+.50i	.86-.50i	.67
	.50+.86i	.50-.86i	.00+1.00i	-.00-1.00i
	-.17	-.50+.86i	-.50-.86i	-.86+.50i
	-.86-.50i	-1.00		



Date: 04/13/19 Time: 10:04
Sample: 1993M01 2013M12
Included observations: 251
Q-statistic probabilities adjusted for 3 ARMA terms

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.011	0.011	0.0322	
		2	0.054	0.054	0.7743	
		3	-0.054	-0.056	1.5282	
		4	-0.032	-0.034	1.7972	0.180
		5	0.042	0.049	2.2539	0.324
		6	-0.091	-0.092	4.3953	0.222
		7	-0.081	-0.089	6.1091	0.191
		8	0.112	0.132	9.3965	0.094
		9	-0.073	-0.078	10.799	0.095
		10	-0.031	-0.065	11.048	0.137
		11	-0.041	-0.009	11.501	0.175
		12	-0.005	-0.001	11.507	0.243
		13	-0.013	-0.053	11.553	0.316
		14	-0.007	0.014	11.565	0.397
		15	0.006	0.021	11.575	0.480
		16	0.019	-0.024	11.670	0.555
		17	0.040	0.045	12.109	0.598
		18	-0.095	-0.096	14.580	0.482
		19	0.042	0.037	15.068	0.520
		20	0.070	0.082	16.416	0.495
		21	-0.041	-0.061	16.875	0.532
		22	0.010	-0.006	16.904	0.596
		23	-0.005	0.036	16.912	0.659
		24	0.158	0.146	23.933	0.296
		25	0.008	-0.038	23.952	0.350
		26	-0.075	-0.038	25.527	0.324
		27	-0.033	-0.021	25.837	0.362
		28	0.024	0.018	25.999	0.408
		29	-0.044	-0.047	26.564	0.432
		30	-0.043	-0.024	27.097	0.459
		31	-0.037	-0.000	27.498	0.491
		32	0.064	0.024	28.673	0.482
		33	0.022	0.028	28.816	0.527
		34	0.044	0.058	29.388	0.549
		35	-0.016	-0.004	29.459	0.596
		36	-0.071	-0.119	30.955	0.569

(d) The left panel in the figure below shows the multistep forecast for period 2014M01-2017M12. The RMSE for this forecast is 1126.308.

(e) The right panel in the figure below shows the fixed scheme sequence of one step ahead forecasts for period 2014M01-2017M12. The RMSE for this fixed scheme forecast is 691.004.

(f) The fixed scheme yields a lower RMSE than the multistep forecast, which is also visible in the two plots - the confidence interval of the fixed scheme forecast is narrower, and the forecast is closer to the