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1 OPEN DATA "C:\Users\judem\OneDrive\USF\Spring 2024\Time Series Analysis &
Forecasting\Final Project\projectData.xlsx"
2 CALENDAR(M) 2000:1
3 DATA(FORMAT=XLSX,ORG=COLUMNS) 2000:01 2019:12 MEDCPI tradeBal unemp
4
5
6 ***Graphing Data***
7 GRAPH(STYLE=LINE,HEADER="CPI Over Time") 1
8 # MEDCPI
9 GRAPH(STYLE=LINE,HEADER="Trade Balance Over Time") 1
10 # TRADEBAL
11 GRAPH(STYLE=LINE,HEADER="Unemployment Over Time") 1
12 # UNEMP
13
14 *All appear to be covariance stationary
15
16 GRAPH(STYLE=LINE,OVERLAY=LINE,HEADER="All Variables",KEY=LOLEFT) 3
17 # MEDCPI
18 # UNEMP
19 # TRADEBAL
20
21 *Unemployment and Trade Balance appear to move together and CPI appear to move
inverse to the others.
22
23 @bjident MEDCPI
24 @bjident TRADEBAL
25 @bjident UNEMP
26
27 *Autocorrelations and partials show stationarity for all variables.
28
29
30 CROSS(FROM=-12,TO=12,RESULTS=CCCPITRADE) MEDCPI TRADEBAL
31
32 Cross Correlations of Series MEDCPI and TRADEBAL
33 Monthly Data From 2000:01 To 2019:12
34
35
36      -12      -11      -10      -9      -8      -7      -6      -5
-4      -3
37 -0.01705 -0.03046 -0.06434 -0.07424 -0.10539 -0.10393 -0.12254 -0.14659 -0.18520
-0.21345
38      -2      -1      0      1      2      3      4      5
6      7
39 -0.22050 -0.22666 -0.24098 -0.23765 -0.23499 -0.25478 -0.23060 -0.23784 -0.26542
-0.27680
40      8      9      10      11      12
41 -0.24094 -0.21810 -0.21616 -0.19183 -0.17478
42
43 CROSS(FROM=-12,TO=12,RESULTS=CCCPIUNEMP) MEDCPI UNEMP
44
45 Cross Correlations of Series MEDCPI and UNEMP
46 Monthly Data From 2000:01 To 2019:12
47
48
49      -12      -11      -10      -9      -8      -7      -6      -5
-4      -3
50 -0.39525 -0.41932 -0.44276 -0.46682 -0.48697 -0.50834 -0.53040 -0.55401 -0.57445
-0.58559
51      -2      -1      0      1      2      3      4      5
6      7
52 -0.59018 -0.60393 -0.60619 -0.60242 -0.60339 -0.59683 -0.59460 -0.57904 -0.56600

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-0.54416
53      8      9      10      11      12
54 -0.52395 -0.50520 -0.48390 -0.46183 -0.43679
55
56 CROSS (FROM=-12,TO=12,RESULTS=CCTRADEUNEMP) TRADEBAL UNEMP
57
58 Cross Correlations of Series TRADEBAL and UNEMP
59 Monthly Data From 2000:01 To 2019:12
60
61
62      -12      -11      -10      -9      -8      -7      -6      -5
-4      -3
63 0.072343 0.094734 0.113528 0.133212 0.151698 0.170421 0.185691 0.199351 0.212125
0.218409
64      -2      -1      0      1      2      3      4      5
6      7
65 0.220915 0.220660 0.218729 0.219323 0.215680 0.211510 0.203552 0.196970 0.187893
0.176087
66      8      9      10      11      12
67 0.167576 0.157501 0.148529 0.141211 0.130435
68
69 GRAPH (STYLE=LINE,OVERLAY=LINE,HEADER="Cross Correlations",KEY=LOLEFT) 3
70 # CCCPITRADE
71 # CCTRADEUNEMP
72 # CCCPIUNEMP
73
74 *Cross Correlations are nonzero, ready for VAR
75
76 *****Starting out with VAR*****
77 @varlagselect(lags=8,crit=aic)
78 # MEDCPI TRADEBAL UNEMP
79
80 VAR Lag Selection
81 Lags AICC
82 0 27.2029898
83 1 20.1956860
84 2 20.0787835
85 3 20.0196727
86 4 19.9965148
87 5 19.9660412
88 6 19.9380157
89 7 19.9343669*
90 8 19.9524568
91
92 @varlagselect(lags=7, crit=sbc)
93 # MEDCPI TRADEBAL UNEMP
94
95 VAR Lag Selection
96 Lags SBC/BIC
97 0 27.2543780
98 1 20.3711836
99 2 20.3631310*
100 3 20.4407538
101 4 20.5418732
102 5 20.6335273
103 6 20.7270327
104 7 20.8390295
105
106 * Going with VAR(2) from SBC
107
108 SYSTEM(MODEL=VAR2)

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109 VARIABLES MEDCPI TRADEBAL UNEMP
110 LAGS 1 to 2
111 DET CONSTANT
112 END(SYSTEM)
113 ESTIMATE
114
115 VAR/System - Estimation by Least Squares
116 Monthly Data From 2000:03 To 2019:12
117 Usable Observations                238
118
119 Dependent Variable MEDCPI
120 Mean of Dependent Variable          2.4121778936
121 Std Error of Dependent Variable     0.8328618905
122 Standard Error of Estimate          0.6206079671
123 Sum of Squared Residuals            88.970631488
124 Durbin-Watson Statistic             2.0135
125
126      Variable                Coeff      Std Error      T-Stat      Signif
127 *****
128 1.  MEDCPI{1}                0.278063226  0.065668128    4.23437    0.00003310
129 2.  MEDCPI{2}                0.127879459  0.064887835    1.97078    0.04994347
130 3.  TRADEBAL{1}              -0.000006894  0.000012420   -0.55505    0.57939660
131 4.  TRADEBAL{2}              0.000001504  0.000012296    0.12228    0.90278361
132 5.  UNEMP{1}                 0.071360401  0.256730854    0.27796    0.78129320
133 6.  UNEMP{2}                 -0.232442308  0.258110338   -0.90055    0.36876338
134 7.  Constant                 2.142104542  0.371281893    5.76948    0.00000003
135
136      F-Tests, Dependent Variable MEDCPI
137      Variable      F-Statistic      Signif
138 *****
139 MEDCPI              15.3888      0.0000005
140 TRADEBAL            0.8727      0.4191977
141 UNEMP              13.9041      0.0000020
142
143
144 Dependent Variable TRADEBAL
145 Mean of Dependent Variable          -44699.84034
146 Std Error of Dependent Variable     10106.90674
147 Standard Error of Estimate          3205.07901
148 Sum of Squared Residuals            2372954762.9
149 Durbin-Watson Statistic             2.1151
150
151      Variable                Coeff      Std Error      T-Stat      Signif
152 *****
153 1.  MEDCPI{1}                2.572408     339.137666     0.00759    0.99395454
154 2.  MEDCPI{2}               73.113343     335.107910     0.21818    0.82748265
155 3.  TRADEBAL{1}              0.648503      0.064141     10.11065    0.00000000
156 4.  TRADEBAL{2}              0.300150      0.063499      4.72682    0.00000397
157 5.  UNEMP{1}                 3632.946793    1325.865466     2.74006    0.00662270
158 6.  UNEMP{2}                 -3562.715382    1332.989698    -2.67273    0.00806015
159 7.  Constant                 -2958.284940    1917.454924    -1.54282    0.12424360
160
161      F-Tests, Dependent Variable TRADEBAL
162      Variable      F-Statistic      Signif
163 *****
164 MEDCPI                0.0274      0.9729583
165 TRADEBAL             960.1282      0.0000000
166 UNEMP                 3.8358      0.0229714
167
168
169 Dependent Variable UNEMP

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170 Mean of Dependent Variable      5.8966386555
171 Std Error of Dependent Variable  1.8092557517
172 Standard Error of Estimate      0.1570070258
173 Sum of Squared Residuals        5.6944286198
174 Durbin-Watson Statistic          2.1005
175
176      Variable                      Coeff      Std Error      T-Stat      Signif
177 *****
178 1.  MEDCPI{1}                     -0.012429760  0.016613318   -0.74818    0.45511233
179 2.  MEDCPI{2}                     0.022871407  0.016415912    1.39325    0.16488455
180 3.  TRADEBAL{1}                   0.000004376  0.000003142    1.39264    0.16506901
181 4.  TRADEBAL{2}                   -0.000004400  0.000003111   -1.41437    0.15860116
182 5.  UNEMP{1}                      1.187831269  0.064950097   18.28837    0.00000000
183 6.  UNEMP{2}                      -0.188497963  0.065299092   -2.88669    0.00426235
184 7.  Constant                      -0.023951140  0.093930257   -0.25499    0.79895881
185
186      F-Tests, Dependent Variable UNEMP
187      Variable      F-Statistic      Signif
188 *****
189      MEDCPI          1.0161      0.3636250
190      TRADEBAL        1.0161      0.3636030
191      UNEMP           8458.4070      0.0000000
192
193 *** CPI exhibits no significant predictive causality
194 *** TRADEBAL exhibits no significant predictive causality
195 *** UNEMP exhibits predictively causality on CPI and Trade Balance (up to 2%
significance for Trade Balance).
196
197 **We can see from the F-tests that UNEMP Exhibits Granger Causality on CPI and
TRADEBAL (up to 2% significance for Trade Balance).
198
199
200 ***Now we'll run the truncated model for forecasting
201 SYSTEM(MODEL=VARTRUNC)
202 VARIABLES MEDCPI TRADEBAL UNEMP
203 LAGS 1 TO 2
204 DET Constant
205 END(SYSTEM)
206 ESTIMATE * 2018:12
207
208 VAR/System - Estimation by Least Squares
209 Monthly Data From 2000:03 To 2018:12
210 Usable Observations      226
211
212 Dependent Variable MEDCPI
213 Mean of Dependent Variable  2.3887793006
214 Std Error of Dependent Variable  0.8461254526
215 Standard Error of Estimate  0.6326714165
216 Sum of Squared Residuals    87.659813550
217 Durbin-Watson Statistic     2.0149
218
219      Variable                      Coeff      Std Error      T-Stat      Signif
220 *****
221 1.  MEDCPI{1}                     0.276861876  0.067365211    4.10986    0.00005597
222 2.  MEDCPI{2}                     0.132388069  0.066793293    1.98206    0.04872331
223 3.  TRADEBAL{1}                   -0.000007739  0.000012982   -0.59616    0.55168094
224 4.  TRADEBAL{2}                   0.000002365  0.000012839    0.18422    0.85401456
225 5.  UNEMP{1}                      0.071216420  0.264824380    0.26892    0.78824486
226 6.  UNEMP{2}                      -0.236062025  0.265914901   -0.88774    0.37565711
227 7.  Constant                      2.163854208  0.385556463    5.61229    0.00000006
228

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229 F-Tests, Dependent Variable MEDCPI
230 Variable F-Statistic Signif
231 *****
232 MEDCPI 14.8105 0.0000009
233 TRADEBAL 0.8478 0.4297367
234 UNEMP 13.1327 0.0000041
235
236
237 Dependent Variable TRADEBAL
238 Mean of Dependent Variable -44598.08850
239 Std Error of Dependent Variable 10334.11179
240 Standard Error of Estimate 3221.16883
241 Sum of Squared Residuals 2272328368.8
242 Durbin-Watson Statistic 2.1203
243
244 Variable Coeff Std Error T-Stat Signif
245 *****
246 1. MEDCPI{1} 97.655636 342.981699 0.28473 0.77612351
247 2. MEDCPI{2} 55.900082 340.069852 0.16438 0.86958501
248 3. TRADEBAL{1} 0.643516 0.066095 9.73618 0.00000000
249 4. TRADEBAL{2} 0.308079 0.065368 4.71300 0.00000434
250 5. UNEMP{1} 3657.063192 1348.320810 2.71231 0.00721237
251 6. UNEMP{2} -3517.752876 1353.873067 -2.59829 0.01000497
252 7. Constant -3497.799977 1963.013385 -1.78185 0.07615894
253
254 F-Tests, Dependent Variable TRADEBAL
255 Variable F-Statistic Signif
256 *****
257 MEDCPI 0.0786 0.9244379
258 TRADEBAL 950.0171 0.0000000
259 UNEMP 3.9785 0.0200814
260
261
262 Dependent Variable UNEMP
263 Mean of Dependent Variable 6.0146017699
264 Std Error of Dependent Variable 1.7804142017
265 Standard Error of Estimate 0.1593380220
266 Sum of Squared Residuals 5.5601045514
267 Durbin-Watson Statistic 2.1065
268
269 Variable Coeff Std Error T-Stat Signif
270 *****
271 1. MEDCPI{1} -0.012090587 0.016965899 -0.71264 0.47682682
272 2. MEDCPI{2} 0.022605266 0.016821862 1.34380 0.18040273
273 3. TRADEBAL{1} 0.000004860 0.000003269 1.48646 0.13859663
274 4. TRADEBAL{2} -0.000004924 0.000003233 -1.52284 0.12924029
275 5. UNEMP{1} 1.190567525 0.066695905 17.85068 0.00000000
276 6. UNEMP{2} -0.192315234 0.066970553 -2.87164 0.00448444
277 7. Constant -0.017694956 0.097102228 -0.18223 0.85557066
278
279 F-Tests, Dependent Variable UNEMP
280 Variable F-Statistic Signif
281 *****
282 MEDCPI 0.9415 0.3916140
283 TRADEBAL 1.1701 0.3122751
284 UNEMP 7650.3590 0.0000000
285
286 ***Forecast***
287 FORECAST (MODEL=VARTRUNC, FROM=2019:01, TO=2019:12, RESULT=VARFORE, STDERRS=VARFORESTF, PR
INT)
288

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289 Entry      MEDCPI      TRADEBAL      UNEMP
290 2019:01 3.041924022 -53507.7939 3.928634590
291 2019:02 2.945105281 -52827.9912 3.972064713
292 2019:03 3.174823254 -53597.7906 4.020358027
293 2019:04 3.038256943 -52774.4091 4.061319483
294 2019:05 3.021291498 -52442.2396 4.115666783
295 2019:06 3.032410159 -52473.7354 4.158262130
296 2019:07 3.019039001 -51930.4684 4.208709366
297 2019:08 2.996329353 -51649.0362 4.258056728
298 2019:09 2.988646968 -51472.0275 4.304806745
299 2019:10 2.968223844 -51100.4413 4.352983830
300 2019:11 2.954123927 -50841.2369 4.400106484
301 2019:12 2.940824854 -50614.1241 4.445594900
302
303 **I'll analyze MSE at the end, now ARIMA Model
304
305 ***Determine p and q***
306 @bjautofit(pmax=5, qmax=5, crit=SBC) MEDCPI
307
308 BIC analysis of models for series MEDCPI
309 MA
310 AR      0      1      2      3      4      5
311 0 1132.1346 920.5765 798.7315 753.5329 704.4559 665.6661
312 1 552.5939 477.1906* 481.9775 487.1401 490.6743 495.6802
313 2 515.1586 482.0526 487.3669 490.0220 497.4766 594.0109
314 3 501.9707 487.0245 492.1068 486.2540 499.0171 574.1701
315 4 494.5192 491.8069 497.2740 500.2554 505.7343 500.3855
316 5 497.1114 497.2874 501.5162 509.8201 499.5253 524.3008
317
318 @bjautofit(pmax=5, qmax=5, crit=SBC) TRADEBAL
319
320 BIC analysis of models for series TRADEBAL
321 MA
322 AR      0      1      2      3      4      5
323 0 5831.4861 5526.6790 5305.2768 5164.1005 5052.8266 4980.8258
324 1 4592.5841 4575.3041 4578.7616 4573.3725 4576.9364 4581.5113
325 2 4577.1360 4580.2032 4580.8787 4589.4866 4582.0325 4586.9185
326 3 4576.3762 4588.4311 4576.1435 4580.9696 4586.5488 4588.9935
327 4 4569.3148* 4574.7933 4580.1613 4585.6095 4591.7459 4592.2023
328 5 4574.7937 4579.0854 4585.6335 4589.2262 4592.8733 4598.9794
329
330 @bjautofit(pmax=5, qmax=5, crit=SBC) UNEMP
331
332 BIC analysis of models for series UNEMP
333 MA
334 AR      0      1      2      3      4      5
335 0 1553.1606 1233.5630 980.7076 749.3189 634.0846 589.0230
336 1 -188.2031 -189.3139 -198.1647 -195.1739 -192.1084 -199.0240
337 2 -192.8547 -179.1439 -221.9633* -189.8473 -215.4989 -214.3322
338 3 -206.4031 -178.4760 -220.5866 -212.5783 653.7942 -208.9461
339 4 -208.0399 480.8181 -212.2900 -210.8009 -213.9586 181.6521
340 5 -206.7932 492.6391 -193.7205 188.2497 -208.9668 -207.2108
341
342 ***Best ARMA(p,q) Models by SBC:
343 **MEDCPI -> ARMA(1,1)
344 **TRADEBAL -> ARMA(4,0)
345 **UNEMP -> ARMA(2,2)
346
347 ***Unit Root Test***
348 @DFUNIT(LAGS=2) MEDCPI
349

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```

350 Dickey-Fuller Unit Root Test, Series MEDCPI
351 Regression Run From 2000:04 to 2019:12
352 Observations      238
353 With intercept
354 Using fixed lags 2
355 Null is unit root. Reject in left tail.
356
357 Sig Level      Crit Value
358 1%(**)        -3.45922
359 5%(*)         -2.87375
360 10%           -2.57322
361
362 T-Statistic    -4.20522**
363
364 @DFUNIT(LAGS=5) TRADEBAL
365
366 Dickey-Fuller Unit Root Test, Series TRADEBAL
367 Regression Run From 2000:07 to 2019:12
368 Observations      235
369 With intercept
370 Using fixed lags 5
371 Null is unit root. Reject in left tail.
372
373 Sig Level      Crit Value
374 1%(**)        -3.45956
375 5%(*)         -2.87390
376 10%           -2.57330
377
378 T-Statistic    -2.44062
379
380 @DFUNIT(LAGS=3) UNEMP
381
382 Dickey-Fuller Unit Root Test, Series UNEMP
383 Regression Run From 2000:05 to 2019:12
384 Observations      237
385 With intercept
386 Using fixed lags 3
387 Null is unit root. Reject in left tail.
388
389 Sig Level      Crit Value
390 1%(**)        -3.45933
391 5%(*)         -2.87380
392 10%           -2.57325
393
394 T-Statistic    -1.35640
395
396 **Fail to reject null hypothesis of a unit root in Trade Balance and Unemployment
397
398 **Check if Trade Balance and Unemployment need differencing
399 BOXJENK(CONST,AR=4) TRADEBAL
400
401 Box-Jenkins - Estimation by LS Gauss-Newton
402 Convergence in    4 Iterations. Final criterion was  0.0000018 <=  0.0000100
403
404 Dependent Variable TRADEBAL
405 Monthly Data From 2000:05 To 2019:12
406 Usable Observations      236
407 Degrees of Freedom      231
408 Centered R^2            0.9050521
409 R-Bar^2                 0.9034080
410 Uncentered R^2          0.9954726

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```

411 Mean of Dependent Variable      -44827.99576
412 Std Error of Dependent Variable  10052.26372
413 Standard Error of Estimate       3124.16817
414 Sum of Squared Residuals         2254658585.9
415 Regression F(4,231)              550.4786
416 Significance Level of F          0.0000000
417 Log Likelihood                   -2231.4165
418 Durbin-Watson Statistic          1.9977
419 Q(36-4)                          38.5525
420 Significance Level of Q          0.1973463
421
422      Variable      Coeff      Std Error      T-Stat      Signif
423 *****
424 1.  CONSTANT      -46007.13883    4184.16829    -10.99553    0.00000000
425 2.  AR{1}         0.67651      0.06399      10.57200    0.00000000
426 3.  AR{2}         0.21019      0.07579      2.77352    0.00599845
427 4.  AR{3}         0.30383      0.07572      4.01236    0.00008123
428 5.  AR{4}        -0.23959      0.06384      -3.75303    0.00022105
429
430 @regcrits
431
432 Information Criteria
433 AIC      18.961
434 SBC      19.049
435 Hannan-Quinn 18.997
436 (log) FPE 18.961
437
438 BOXJENK (DIFFS=1,CONST,AR=4) TRADEBAL
439
440 Box-Jenkins - Estimation by LS Gauss-Newton
441 Convergence in      3 Iterations. Final criterion was  0.0000000 <=  0.0000100
442
443 Dependent Variable TRADEBAL, differenced 1 times
444 Monthly Data From 2000:06 To 2019:12
445 Usable Observations      235
446 Degrees of Freedom      230
447 Centered R^2             0.9017220
448 R-Bar^2                 0.9000128
449 Uncentered R^2          0.9953545
450 Mean of Dependent Variable -44894.64681
451 Std Error of Dependent Variable 10021.32513
452 Standard Error of Estimate  3168.81845
453 Sum of Squared Residuals    2309524388.9
454 Regression F(4,230)        527.5749
455 Significance Level of F     0.0000000
456 Log Likelihood             -2225.2854
457 Durbin-Watson Statistic    1.9884
458 Q(36-4)                   38.6979
459 Significance Level of Q     0.1929278
460
461      Variable      Coeff      Std Error      T-Stat      Signif
462 *****
463 1.  CONSTANT      -57.6359658    177.2333813    -0.32520    0.74532674
464 2.  AR{1}         -0.3033562      0.0662863     -4.57645    0.00000774
465 3.  AR{2}         -0.0849381      0.0675380     -1.25763    0.20979925
466 4.  AR{3}         0.2265413      0.0678322      3.33973    0.00097828
467 5.  AR{4}        -0.0046728      0.0668533     -0.06990    0.94433739
468
469 @regcrits
470
471 Information Criteria

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472 AIC          18.990
473 SBC          19.078
474 Hannan-Quinn 19.025
475 (log) FPE    18.990
476
477 BOXJENK(CONST,AR=2,MA=2) UNEMP
478
479 Box-Jenkins - Estimation by LS Gauss-Newton
480 Convergence in 11 Iterations. Final criterion was 0.0000090 <= 0.0000100
481
482 Dependent Variable UNEMP
483 Monthly Data From 2000:03 To 2019:12
484 Usable Observations          238
485 Degrees of Freedom           233
486 Centered R^2                 0.9937480
487 R-Bar^2                      0.9936407
488 Uncentered R^2               0.9994641
489 Mean of Dependent Variable   5.8966386555
490 Std Error of Dependent Variable 1.8092557517
491 Standard Error of Estimate   0.1442799758
492 Sum of Squared Residuals     4.8502937626
493 Log Likelihood               125.5872
494 Durbin-Watson Statistic      1.9829
495 Q(36-4)                     56.3162
496 Significance Level of Q      0.0050149
497
498 Variable                      Coeff      Std Error    T-Stat      Signif
499 *****
500 1.  CONSTANT                   5.832549555  0.740684013   7.87454  0.000000000
501 2.  AR{1}                     1.948635263  0.030053046  64.83986  0.000000000
502 3.  AR{2}                     -0.951260647  0.029880665 -31.83532  0.000000000
503 4.  MA{1}                     -0.940959810  0.070292360 -13.38637  0.000000000
504 5.  MA{2}                     0.146279262  0.066887898   2.18693  0.02974249
505
506 @regcrits
507
508 Information Criteria
509 AIC          -1.005
510 SBC          -0.917
511 Hannan-Quinn -0.970
512 (log) FPE    -1.005
513
514 BOXJENK(DIFFS=1,CONST,AR=2,MA=2) UNEMP
515
516 Box-Jenkins - Estimation by LS Gauss-Newton
517 Convergence in 27 Iterations. Final criterion was 0.0000020 <= 0.0000100
518
519 Dependent Variable UNEMP, differenced 1 times
520 Monthly Data From 2000:04 To 2019:12
521 Usable Observations          237
522 Degrees of Freedom           232
523 Centered R^2                 0.9936328
524 R-Bar^2                      0.9935231
525 Uncentered R^2               0.9994558
526 Mean of Dependent Variable   5.9046413502
527 Std Error of Dependent Variable 1.8088587264
528 Standard Error of Estimate   0.1455760337
529 Sum of Squared Residuals     4.9166325306
530 Log Likelihood               122.9508
531 Durbin-Watson Statistic      1.9929
532 Q(36-4)                     58.8880

```

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533 Significance Level of Q          0.0026050
534
535      Variable                      Coeff      Std Error      T-Stat      Signif
536 *****
537 1.  CONSTANT                      0.001211896    0.034029512      0.03561    0.97162150
538 2.  AR{1}                        0.798636871    0.350014737      2.28172    0.02341243
539 3.  AR{2}                        0.123616144    0.337302466      0.36648    0.71433754
540 4.  MA{1}                       -0.769028133    0.352632265     -2.18082    0.03020173
541 5.  MA{2}                        0.045942442    0.298505055      0.15391    0.87781574
542
543 @regcrits
544
545 Information Criteria
546 AIC                             -0.987
547 SBC                             -0.899
548 Hannan-Quinn -0.952
549 (log) FPE                      -0.987
550
551 **By both AIC and SBC, the ARMA models are better fits for both variables
552
553 ***ARMA/ARIMA Models***
554 *CPI -> ARMA(1,1)
555 *Trade Balance -> ARMA(4,0)
556 *Unemployment -> ARMA(2,2)
557
558 *****Time to run the Models*****
559 *CPI
560 BOXJENK(CONST,AR=1,MA=1,DEFINE=CPIARIMA) MEDCPI * 2018:12 CPIARIMARESIDS
561
562 Box-Jenkins - Estimation by LS Gauss-Newton
563 Convergence in      8 Iterations. Final criterion was  0.0000029 <=  0.0000100
564
565 Dependent Variable MEDCPI
566 Monthly Data From 2000:02 To 2018:12
567 Usable Observations                      227
568 Degrees of Freedom                      224
569 Centered R^2                          0.4235969
570 R-Bar^2                              0.4184504
571 Uncentered R^2                        0.9362755
572 Mean of Dependent Variable            2.3905273386
573 Std Error of Dependent Variable      0.8446621140
574 Standard Error of Estimate           0.6441342377
575 Sum of Squared Residuals             92.939597218
576 Log Likelihood                       -220.7435
577 Durbin-Watson Statistic                1.9318
578 Q(36-2)                             47.5901
579 Significance Level of Q              0.0608983
580
581      Variable                      Coeff      Std Error      T-Stat      Signif
582 *****
583 1.  CONSTANT                      2.346913254    0.237028676      9.90139    0.00000000
584 2.  AR{1}                        0.935031402    0.029773606     31.40471    0.00000000
585 3.  MA{1}                       -0.643773794    0.066726713     -9.64792    0.00000000
586
587 *Trade Balance
588 BOXJENK(CONST,AR=4,DEFINE=TRADEBALARIMA) TRADEBAL * 2018:12 TRADEBALARIMARESIDS
589
590 Box-Jenkins - Estimation by LS Gauss-Newton
591 Convergence in      4 Iterations. Final criterion was  0.0000003 <=  0.0000100
592
593 Dependent Variable TRADEBAL

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594 Monthly Data From 2000:05 To 2018:12
595 Usable Observations                224
596 Degrees of Freedom                219
597 Centered R^2                      0.9090278
598 R-Bar^2                          0.9073662
599 Uncentered R^2                    0.9954549
600 Mean of Dependent Variable        -44732.20089
601 Std Error of Dependent Variable   10281.12382
602 Standard Error of Estimate        3129.14292
603 Sum of Squared Residuals          2144346255.2
604 Regression F(4,219)               547.0820
605 Significance Level of F            0.0000000
606 Log Likelihood                    -2118.1811
607 Durbin-Watson Statistic           1.9981
608 Q(36-4)                          39.8788
609 Significance Level of Q            0.1596666
610
611      Variable                      Coeff      Std Error      T-Stat      Signif
612 *****
613 1.  CONSTANT                      -47288.01004    4773.82218    -9.90569    0.00000000
614 2.  AR{1}                        0.67706        0.06566     10.31232    0.00000000
615 3.  AR{2}                        0.21387        0.07736      2.76465    0.00618408
616 4.  AR{3}                        0.31934        0.07749      4.12101    0.00005351
617 5.  AR{4}                       -0.25581        0.06540     -3.91145    0.00012241
618
619 *Unemployment
620 BOXJENK(CONST,AR=2,MA=2,DEFINE=UNEMPARIMA) UNEMP * 2018:12 UNEMPARIMARESIDS
621
622 Box-Jenkins - Estimation by LS Gauss-Newton
623 Convergence in    10 Iterations. Final criterion was  0.0000073 <=  0.0000100
624
625 Dependent Variable UNEMP
626 Monthly Data From 2000:03 To 2018:12
627 Usable Observations                226
628 Degrees of Freedom                221
629 Centered R^2                      0.9933917
630 R-Bar^2                          0.9932721
631 Uncentered R^2                    0.9994698
632 Mean of Dependent Variable         6.0146017699
633 Std Error of Dependent Variable    1.7804142017
634 Standard Error of Estimate         0.1460366997
635 Sum of Squared Residuals          4.7132046021
636 Log Likelihood                     116.6488
637 Durbin-Watson Statistic            1.9815
638 Q(36-4)                          54.2568
639 Significance Level of Q            0.0083137
640
641      Variable                      Coeff      Std Error      T-Stat      Signif
642 *****
643 1.  CONSTANT                      5.999809679    0.690949567     8.68343    0.00000000
644 2.  AR{1}                        1.948499883    0.030278462    64.35267    0.00000000
645 3.  AR{2}                       -0.951444750    0.030056811   -31.65488    0.00000000
646 4.  MA{1}                       -0.942680319    0.071989822   -13.09463    0.00000000
647 5.  MA{2}                        0.149624460    0.068721605     2.17726    0.03052049
648
649 **Now Forecasts
650 UFORECAST(FROM=2019:01,TO=2019:12,EQUATION=CPIARIMA,STDERRS=CPIARIMASTD,PRINT)
    CPIARIMAFORE
651
652 Entry      MEDCPI
653 2019:01 2.811150164

```

```

654 2019:02 2.780989343
655 2019:03 2.752788028
656 2019:04 2.726418913
657 2019:05 2.701762963
658 2019:06 2.678708875
659 2019:07 2.657152578
660 2019:08 2.636996764
661 2019:09 2.618150446
662 2019:10 2.600528546
663 2019:11 2.584051516
664 2019:12 2.568644975
665
666 UFORECAST (FROM=2019:01,TO=2019:12,EQUATION=TRADEBALARIMA,STDERRS=TRADEBALARIMASTD,PR
INT) TRADEBALARIMAFORE
667
668 Entry      TRADEBAL
669 2019:01 -53916.5177
670 2019:02 -52824.0862
671 2019:03 -54443.7866
672 2019:04 -53406.5773
673 2019:05 -53033.2695
674 2019:06 -53355.3786
675 2019:07 -52748.0721
676 2019:08 -52551.8954
677 2019:09 -52487.5464
678 2019:10 -52125.6881
679 2019:11 -51959.6349
680 2019:12 -51799.4522
681
682 UFORECAST (FROM=2019:01,TO=2019:12,EQUATION=UNEMPARIMA,STDERRS=UNEMPARIMASTD,PRINT)
UNEMPARIMAFORE
683
684 Entry      UNEMP
685 2019:01 3.921101915
686 2019:02 3.960242801
687 2019:03 4.003489444
688 2019:04 4.050515133
689 2019:05 4.100997890
690 2019:06 4.154621192
691 2019:07 4.211074636
692 2019:08 4.270054555
693 2019:09 4.331264588
694 2019:10 4.394416195
695 2019:11 4.459229130
696 2019:12 4.525431862
697
698 *****Forecast comparisons*****
699 **Here are the forecasts**
700 *VARFORE
701 *CPIARIMAFORE
702 *TRADEBALARIMAFORE
703 *UNEMPARIMAFORE
704
705 **Graphing Forecast vs Actual
706 *CPI
707 SET ACTCPI 2019:01 2019:12 = MEDCPI
708 GRAPH (STYLE=LINE,HEADER="CPI Forcast vs Actual Values",KEY=LOLEFT) 3
709 # VARFORE(1)
710 # CPIARIMAFORE
711 # ACTCPI
712

```

```

713 *TRADEBAL
714 SET ACTTRADEBAL 2019:01 2019:12 = TRADEBAL
715 GRAPH(STYLE=LINE,HEADER="Trade Balance Forecast vs Actual Values",KEY=LOLEFT) 3
716 # VARFORE(2)
717 # TRADEBALARIMAFORE
718 # ACTTRADEBAL
719
720 *UNEMP
721 SET ACTUNEMP 2019:01 2019:12 = UNEMP
722 GRAPH(STYLE=LINE,HEADER="Unemployment Forecast vs Actual Values",KEY=LOLEFT) 3
723 # VARFORE(3)
724 # UNEMPARIMAFORE
725 # ACTUNEMP
726
727 **MSE Values for forecasted CPI values
728 *VAR Model
729 @uforeerrors VARFORE(1) MEDCPI
730
731 Forecast Analysis for VARFORE(1)
732 From 2019:01 to 2019:12
733 Mean Error 0.15723186
734 Mean Absolute Error 0.25291757
735 Root Mean Square Error 0.29704817
736 Mean Square Error 0.088238
737 Theil's U 3.424783
738
739 Mean Pct Error 0.052482
740 Mean Abs Pct Error 0.084518
741 Root Mean Square Pct Error 0.099435
742 Theil's Relative U 3.537379
743
744 *ARMA(1,1) Model
745 @uforeerrors CPIARIMAFORE MEDCPI
746
747 Forecast Analysis for CPIARIMAFORE
748 From 2019:01 to 2019:12
749 Mean Error -0.1764061
750 Mean Absolute Error 0.2283134
751 Root Mean Square Error 0.3113424
752 Mean Square Error 0.096934
753 Theil's U 13.817013
754
755 Mean Pct Error -0.065962
756 Mean Abs Pct Error 0.085553
757 Root Mean Square Pct Error 0.117550
758 Theil's Relative U 14.634395
759
760 **MSE Values for forecasted Trade Balance values
761 *VAR Model
762 @uforeerrors VARFORE(2) TRADEBAL
763
764 Forecast Analysis for VARFORE(2)
765 From 2019:01 to 2019:12
766 Mean Error -5486.4412
767 Mean Absolute Error 5486.4412
768 Root Mean Square Error 6113.6436
769 Mean Square Error 37376637.903928
770 Theil's U 12.807379
771
772 *ARMA(4,0) Model:
773 @uforeerrors TRADEBALARIMAFORE TRADEBAL

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```

774
775 Forecast Analysis for TRADEBALARIMAFOR
776 From 2019:01 to 2019:12
777 Mean Error -6271.4921
778 Mean Absolute Error 6271.4921
779 Root Mean Square Error 6890.5385
780 Mean Square Error 47479520.815101
781 Theil's U 9.545972
782
783 **MSE Values for forecasted Unemployment values
784 *VAR Model
785 @uforeerrors VARFORE(3) UNEMP
786
787 Forecast Analysis for VARFORE(3)
788 From 2019:01 to 2019:12
789 Mean Error 0.51054698
790 Mean Absolute Error 0.52244122
791 Root Mean Square Error 0.58116988
792 Mean Square Error 0.337758
793 Theil's U 12.329425
794
795 Mean Pct Error 0.119656
796 Mean Abs Pct Error 0.122684
797 Root Mean Square Pct Error 0.135235
798 Theil's Relative U 12.585189
799
800 *ARMA(2,2)
801 @uforeerrors UNEMPARIMAFOR UNEMP
802
803 Forecast Analysis for UNEMPARIMAFOR
804 From 2019:01 to 2019:12
805 Mean Error 0.52353661
806 Mean Absolute Error 0.53668629
807 Root Mean Square Error 0.60427244
808 Mean Square Error 0.365145
809 Theil's U 10.865552
810
811 Mean Pct Error 0.121794
812 Mean Abs Pct Error 0.125148
813 Root Mean Square Pct Error 0.139246
814 Theil's Relative U 11.153643
815
816 ***MSE VALUES***
817 *-----
818 *| MODEL\Variable | CPI | TRADEBAL | UNEMP |
819 *-----
820 *| VAR | 0.088238* | 37376637.903928* | 0.337758* |
821 *-----
822 *| ARMA/ARIMA | 0.096934 | 47479520.815101 | 0.365145 |
823 *-----
824
825 *For all variables, VAR had the smaller MSE
826
827 *Based on the graphs and the MSE's of each model, the VAR model was better for CPI
and TRADEBAL
828 *The VAR model is slightly better than ARMA by MSE, but only by about 0.03, and
the graph show they appear very similar
829
830 *The VAR model most likely predicted CPI and TRADEBAL better because UNEMP
exhibits Granger causality on CPI and TRADEBAL,
831 *This means that including UNEMP in the model improved the forecast for CPI and

```

TRADEBAL (Compared to CPI or TRADEBAL alone in the ARMA models)

832 *UNEMP's small difference in MSE between VAR and ARMA is likely due to the lack of
a predictive causality-exhibiting variable for UNEMP in the data