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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DA6213  Exercise #6  Name: Emily Bates  Aussies tend to drink a lot of beer. You have been commissioned by XXXX Beer Company in Brisbane, Australia (yes, it is real and pronounced four-ex and it’s not bad). You need to forecast beer consumption for the next 48 time periods. They have 476 data points for you to use in your Unobserved Components Model (UCM) time series model. The data appears at the end of this exercise. Here are your questions:   1. What is the adjusted R square for your model? Does that look like a pretty decent fit? Paste the table form the output as well.   The adjusted R-square for the model is 0.84471. This looks like a pretty good fit.   | **Fit Statistics Based on Residuals** | | | --- | --- | | **Mean Squared Error** | 174.12651 | | **Root Mean Squared Error** | 13.19570 | | **Mean Absolute Percentage Error** | 7.46402 | | **Maximum Percent Error** | 20.09402 | | **R-Square** | 0.84635 | | **Adjusted R-Square** | 0.84471 | | **Random Walk R-Square** | 0.54918 | | **Amemiya's Adjusted R-Square** | 0.84241 | | **Number of non-missing residuals used for computing the fit statistics = 474** | |      1. Tell me which of the modeling components – irregular, level, slope and period are statistically significant – that is, you have found those components in the data. Paste the output table that shows this here as well.   Irregular, Level, and Cycle are statistically significant.   | **Significance Analysis of Components (Based on the Final State)** | | | | | --- | --- | --- | --- | | **Component** | **DF** | **Chi-Square** | **Pr > ChiSq** | | **Irregular** | 1 | 14.81 | 0.0001 | | **Level** | 1 | 1821.73 | <.0001 | | **Slope** | 1 | 1.00 | 0.3184 | | **Cycle** | 2 | 170.81 | <.0001 |      1. Forecast the next 48 time periods of the data and put the forecasted data table below.        1. Plot out the data and forecast data and paste that plot below. Does it look like it did a good job of forecasting?   This plot does look like it did a good job forecasting.    **Additional Plots:**      **SAS Code:**  data temp;  input mytime beer;  datalines;  1 93.2  2 96  3 95.2  4 77.1  5 70.9  6 64.8  7 70.1  8 77.3  9 79.5  10 100.6  11 100.7  12 107.1  13 95.9  14 82.8  15 83.3  16 80  17 80.4  18 67.5  19 75.7  20 71.1  21 89.3  22 101.1  23 105.2  24 114.1  25 96.3  26 84.4  27 91.2  28 81.9  29 80.5  30 70.4  31 74.8  32 75.9  33 86.3  34 98.7  35 100.9  36 113.8  37 89.8  38 84.4  39 87.2  40 85.6  41 72  42 69.2  43 77.5  44 78.1  45 94.3  46 97.7  47 100.2  48 116.4  49 97.1  50 93  51 96  52 80.5  53 76.1  54 69.9  55 73.6  56 92.6  57 94.2  58 93.5  59 108.5  60 109.4  61 105.1  62 92.5  63 97.1  64 81.4  65 79.1  66 72.1  67 78.7  68 87.1  69 91.4  70 109.9  71 116.3  72 113  73 100  74 84.8  75 94.3  76 87.1  77 90.3  78 72.4  79 84.9  80 92.7  81 92.2  82 114.9  83 112.5  84 118.3  85 106  86 91.2  87 96.6  88 96.3  89 88.2  90 70.2  91 86.5  92 88.2  93 102.8  94 119.1  95 119.2  96 125.1  97 106.1  98 102.1  99 105.2  100 101  101 84.3  102 87.5  103 92.7  104 94.4  105 113  106 113.9  107 122.9  108 132.7  109 106.9  110 96.6  111 127.3  112 98.2  113 100.2  114 89.4  115 95.3  116 104.2  117 106.4  118 116.2  119 135.9  120 134  121 104.6  122 107.1  123 123.5  124 98.8  125 98.6  126 90.6  127 89.1  128 105.2  129 114  130 122.1  131 138  132 142.2  133 116.4  134 112.6  135 123.8  136 103.6  137 113.9  138 98.6  139 95  140 116  141 113.9  142 127.5  143 131.4  144 145.9  145 131.5  146 131  147 130.5  148 118.9  149 114.3  150 85.7  151 104.6  152 105.1  153 117.3  154 142.5  155 140  156 159.8  157 131.2  158 125.4  159 126.5  160 119.4  161 113.5  162 98.7  163 114.5  164 113.8  165 133.1  166 143.4  167 137.3  168 165.2  169 126.9  170 124  171 135.7  172 130  173 109.4  174 117.8  175 120.3  176 121  177 132.3  178 142.9  179 147.4  180 175.9  181 132.6  182 123.7  183 153.3  184 134  185 119.6  186 116.2  187 118.6  188 130.7  189 129.3  190 144.4  191 163.2  192 179.4  193 128.1  194 138.4  195 152.7  196 120  197 140.5  198 116.2  199 121.4  200 127.8  201 143.6  202 157.6  203 166.2  204 182.3  205 153.1  206 147.6  207 157.7  208 137.2  209 151.5  210 98.7  211 145.8  212 151.7  213 129.4  214 174.1  215 197  216 193.9  217 164.1  218 142.8  219 157.9  220 159.2  221 162.2  222 123.1  223 130  224 150.1  225 169.4  226 179.7  227 182.1  228 194.3  229 161.4  230 169.4  231 168.8  232 158.1  233 158.5  234 135.3  235 149.3  236 143.4  237 142.2  238 188.4  239 166.2  240 199.2  241 182.7  242 145.2  243 182.1  244 158.7  245 141.6  246 132.6  247 139.6  248 147  249 166.6  250 157  251 180.4  252 210.2  253 159.8  254 157.8  255 168.2  256 158.4  257 152  258 142.2  259 137.2  260 152.6  261 166.8  262 165.6  263 198.6  264 201.5  265 170.7  266 164.4  267 179.7  268 157  269 168  270 139.3  271 138.6  272 153.4  273 138.9  274 172.1  275 198.4  276 217.8  277 173.7  278 153.8  279 175.6  280 147.1  281 160.3  282 135.2  283 148.8  284 151  285 148.2  286 182.2  287 189.2  288 183.1  289 170  290 158.4  291 176.1  292 156.2  293 153.2  294 117.9  295 149.8  296 156.6  297 166.7  298 156.8  299 158.6  300 210.8  301 203.6  302 175.2  303 168.7  304 155.9  305 147.3  306 137  307 141.1  308 167.4  309 160.2  310 191.9  311 174.4  312 208.2  313 159.4  314 161.1  315 172.1  316 158.4  317 114.6  318 159.6  319 159.7  320 159.4  321 160.7  322 165.5  323 205  324 205.2  325 141.6  326 148.1  327 184.9  328 132.5  329 137.3  330 135.5  331 121.7  332 166.1  333 146.8  334 162.8  335 186.8  336 185.5  337 151.5  338 158.1  339 143  340 151.2  341 147.6  342 130.7  343 137.5  344 146.1  345 133.6  346 167.9  347 181.9  348 202  349 166.5  350 151.3  351 146.2  352 148.3  353 144.7  354 123.6  355 151.6  356 133.9  357 137.4  358 181.6  359 182  360 190  361 161.2  362 155.5  363 141.9  364 164.6  365 136.2  366 126.8  367 152.5  368 126.6  369 150.1  370 186.3  371 147.5  372 200.4  373 177.2  374 127.4  375 177.1  376 154.4  377 135.2  378 126.4  379 147.3  380 140.6  381 152.3  382 151.2  383 172.2  384 215.3  385 154.1  386 159.3  387 160.4  388 151.9  389 148.4  390 139.6  391 148.2  392 153.5  393 145.1  394 183.7  395 210.5  396 203.3  397 153.3  398 144.3  399 169.6  400 143.7  401 160.1  402 135.6  403 141.8  404 159.9  405 145.7  406 183.5  407 198.2  408 186.8  409 172  410 150.6  411 163.3  412 153.7  413 152.9  414 135.5  415 148.5  416 148.4  417 133.6  418 194.1  419 208.6  420 197.3  421 164.4  422 148.1  423 152  424 144.1  425 155  426 124.5  427 153  428 146  429 138  430 190  431 192  432 192  433 147  434 133  435 163  436 150  437 129  438 131  439 145  440 137  441 138  442 168  443 176  444 188  445 139  446 143  447 150  448 154  449 137  450 129  451 128  452 140  453 143  454 151  455 177  456 184  457 151  458 134  459 164  460 126  461 131  462 125  463 127  464 143  465 143  466 160  467 190  468 182  469 138  470 136  471 152  472 127  473 151  474 130  475 119  476 153  ;  run;  proc ucm data=temp;  id mytime interval = day ;  model beer;  irregular;  level;  slope;  cycle;  Forecast lead = 48 plot=decomp;  run;  **Additional Results:** |
|  |
| **The SAS System** |

**The UCM Procedure**

| **Input Data Set** | |
| --- | --- |
| **Name** | WORK.TEMP |
| **Time ID Variable** | mytime |

| **Estimation Span Summary** | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Type** | **First Obs** | **Last Obs** | **NObs** | **NMiss** | **Min** | **Max** | **Mean** | **Standard Deviation** |
| **beer** | **Dependent** | 02JAN1960 | 21APR1961 | 476 | 0 | 64.80000 | 217.80000 | 136.39538 | 33.73872 |

| **Forecast Span Summary** | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Type** | **First Obs** | **Last Obs** | **NObs** | **NMiss** | **Min** | **Max** | **Mean** | **Standard Deviation** |
| **beer** | **Dependent** | 02JAN1960 | 21APR1961 | 476 | 0 | 64.80000 | 217.80000 | 136.39538 | 33.73872 |

| **Preliminary Estimates of the Free Parameters** | | |
| --- | --- | --- |
| **Component** | **Parameter** | **Estimate** |
| **Irregular** | **Error Variance** | 5523.62239 |
| **Level** | **Error Variance** | 2071.35840 |
| **Slope** | **Error Variance** | 2071.35840 |
| **Cycle** | **Damping Factor** | 0.90000 |
| **Cycle** | **Period** | 85.33333 |
| **Cycle** | **Error Variance** | 3452.26400 |

| **Likelihood Based Fit Statistics** | |
| --- | --- |
| **Statistic** | **Value** |
| **Diffuse Log Likelihood** | -1901 |
| **Diffuse Part of Log Likelihood** | 71E-16 |
| **Non-Missing Observations Used** | 476 |
| **Estimated Parameters** | 6 |
| **Initialized Diffuse State Elements** | 2 |
| **Normalized Residual Sum of Squares** | 474 |
| **AIC (smaller is better)** | 3813 |
| **BIC (smaller is better)** | 3838 |
| **AICC (smaller is better)** | 3813.2 |
| **HQIC (smaller is better)** | 3822.9 |
| **CAIC (smaller is better)** | 3844 |

|  |
| --- |
| Likelihood Optimization Algorithm Converged in 30 Iterations. |

| **Final Estimates of the Free Parameters** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Component** | **Parameter** | **Estimate** | **Approx Std Error** | **t Value** | **Approx Pr > |t|** |
| **Irregular** | **Error Variance** | 156.43977 | 10.37658 | 15.08 | <.0001 |
| **Level** | **Error Variance** | 8.755126E-7 | 0.0007652 | 0.00 | 0.9991 |
| **Slope** | **Error Variance** | 0.00137 | 0.0008167 | 1.67 | 0.0940 |
| **Cycle** | **Damping Factor** | 0.99995 | 0.00008605 | 11620.4 | <.0001 |
| **Cycle** | **Period** | 11.99231 | 0.01097 | 1093.68 | <.0001 |
| **Cycle** | **Error Variance** | 0.01964 | 0.01953 | 1.01 | 0.3146 |

| **Fit Statistics Based on Residuals** | |
| --- | --- |
| **Mean Squared Error** | 174.12651 |
| **Root Mean Squared Error** | 13.19570 |
| **Mean Absolute Percentage Error** | 7.46402 |
| **Maximum Percent Error** | 20.09402 |
| **R-Square** | 0.84635 |
| **Adjusted R-Square** | 0.84471 |
| **Random Walk R-Square** | 0.54918 |
| **Amemiya's Adjusted R-Square** | 0.84241 |
| **Number of non-missing residuals used for computing the fit statistics = 474** | |

| **Significance Analysis of Components (Based on the Final State)** | | | |
| --- | --- | --- | --- |
| **Component** | **DF** | **Chi-Square** | **Pr > ChiSq** |
| **Irregular** | 1 | 14.81 | 0.0001 |
| **Level** | 1 | 1821.73 | <.0001 |
| **Slope** | 1 | 1.00 | 0.3184 |
| **Cycle** | 2 | 170.81 | <.0001 |

| **Trend Information (Based on the Final State)** | | |
| --- | --- | --- |
| **Name** | **Estimate** | **Standard Error** |
| **Level** | 145.6028229 | 3.4113643 |
| **Slope** | -0.18844186 | 0.1888604 |

| **Summary of Cycles** | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Type** | **Period** | **Frequency** | **Damping Factor** | **Final Amplitude** | **Percent Relative to Level** | **Cycle Variance** | **Error Variance** |
| **Cycle** | **Stationary** | 11.99231 | 0.52393 | 0.99995 | 20.51381 | 14.08888 | 185.17747 | 0.01964 |

| **Outlier Summary** | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Obs** | **mytime** | **Break Type** | **Estimate** | **Standard Error** | **Chi-Square** | **DF** | **Pr > ChiSq** |
| **374** | **09JAN1961** | **Additive Outlier** | -39.07971 | 12.691017 | 9.48 | 1 | 0.0021 |
| **384** | **19JAN1961** | **Additive Outlier** | 37.52904 | 12.692655 | 8.74 | 1 | 0.0031 |
| **325** | **21NOV1960** | **Additive Outlier** | -35.76579 | 12.685803 | 7.95 | 1 | 0.0048 |
| **276** | **03OCT1960** | **Additive Outlier** | 33.46836 | 12.683693 | 6.96 | 1 | 0.0083 |
| **210** | **29JUL1960** | **Additive Outlier** | -33.31916 | 12.683513 | 6.90 | 1 | 0.0086 |