

# ARIMA

## SARIMAX Results

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Dep. Variable:          Price    No. Observations:          332
Model:                 ARIMA(3, 1, 3)    Log Likelihood          167.889
Date:                 Tue, 18 Mar 2025    AIC          -321.779
Time:                 12:03:49    BIC          -295.164
Sample:                 02-01-1990    HQIC          -311.163
                                     - 09-01-2017
                                     Covariance Type:          opg
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               coef      std err          z      P>|z|      [0.025      0.975]
-----
ar.L1          0.7383      0.019     39.571      0.000      0.702      0.775
ar.L2          0.7162      0.032     22.286      0.000      0.653      0.779
  ar.L3        -0.9815      0.018    -53.491      0.000     -1.017     -0.946
  ma.L1        -0.7900      0.033    -23.806      0.000     -0.855     -0.725
  ma.L2        -0.7377      0.061    -12.112      0.000     -0.857     -0.618
ma.L3          0.9573      0.038     25.453      0.000      0.884      1.031
sigma2         0.0210      0.001     14.967      0.000      0.018      0.024
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Ljung-Box (L1) (Q):          2.38    Jarque-Bera (JB):          24.38
Prob(Q):          0.12    Prob(JB):          0.00
Heteroskedasticity (H):          2.55    Skew:          0.35
Prob(H) (two-sided):          0.00    Kurtosis:          4.13
=====
```

## SARIMAX Results

|                         |                                  |         |                   |              |        |        |
|-------------------------|----------------------------------|---------|-------------------|--------------|--------|--------|
| =====                   |                                  |         |                   |              |        |        |
| Dep. Variable:          | Price                            |         | No. Observations: | 332          |        |        |
| Model:                  | SARIMAX(0, 1, 0)x(1, 0, [1], 12) |         | Log Likelihood    | 283.314      |        |        |
| Date:                   | Tue, 18 Mar 2025                 |         | AIC               | -556.628     |        |        |
| Time:                   | 12:08:45                         |         | BIC               | -537.617     |        |        |
| Sample:                 | 02-01-1990                       |         | HQIC              | -549.046     |        |        |
|                         |                                  |         |                   | - 09-01-2017 |        |        |
| Covariance Type:        |                                  |         |                   | opg          |        |        |
| =====                   |                                  |         |                   |              |        |        |
|                         | coef                             | std err | z                 | P> z         | [0.025 | 0.975] |
|                         | -----                            |         |                   |              |        |        |
| Population              | 0.1416                           | 0.404   | 0.351             | 0.726        | -0.650 | 0.933  |
| GDP                     | -0.0008                          | 0.003   | -0.249            | 0.804        | -0.007 | 0.005  |
| ar.S.L12                | 0.9851                           | 0.010   | 96.285            | 0.000        | 0.965  | 1.005  |
| ma.S.L12                | -0.7041                          | 0.048   | -14.789           | 0.000        | -0.797 | -0.611 |
| sigma2                  | 0.0099                           | 0.001   | 16.545            | 0.000        | 0.009  | 0.011  |
| =====                   |                                  |         |                   |              |        |        |
| Ljung-Box (L1) (Q):     | 2.01                             |         | Jarque-Bera (JB): | 37.61        |        |        |
| Prob(Q):                | 0.16                             |         | Prob(JB):         | 0.00         |        |        |
| Heteroskedasticity (H): | 1.92                             |         | Skew:             | 0.34         |        |        |
| Prob(H) (two-sided):    | 0.00                             |         | Kurtosis:         | 4.51         |        |        |
| =====                   |                                  |         |                   |              |        |        |

# VAR

## Summary of Regression Results

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Model: VAR

Method: OLS

Date: Tue, 18, Mar, 2025

Time: 12:41:27

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No. of Equations: 5.00000 BIC: 10.2367

Nobs: 319.000 HQIC: 7.89716

Log likelihood: -2944.70 FPE: 585.192

AIC: 6.34164 Det(Omega\_mle): 228.533

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## Results for equation Price

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|                   | coefficient | std. error | t-stat | prob  |
|-------------------|-------------|------------|--------|-------|
| const             | 0.225682    | 0.126220   | 1.788  | 0.074 |
| L1.Price          | 0.925193    | 0.060485   | 15.296 | 0.000 |
| L1.Renewable      | 0.000540    | 0.000375   | 1.442  | 0.149 |
| L1.Petroleum      | -0.000086   | 0.001026   | -0.084 | 0.933 |
| L1.Electric       | -0.000304   | 0.000148   | -2.057 | 0.040 |
| L1.Transportation | 0.290517    | 0.136445   | 2.129  | 0.033 |
| L2.Price          | 0.097464    | 0.082734   | 1.178  | 0.239 |
| L2.Renewable      | 0.000300    | 0.000399   | 0.753  | 0.451 |
| L2.Petroleum      | 0.000404    | 0.001162   | 0.348  | 0.728 |
| L2.Electric       | 0.000294    | 0.000175   | 1.679  | 0.093 |
| L2.Transportation | -0.038013   | 0.130562   | -0.291 | 0.771 |
| L3.Price          | -0.064266   | 0.083209   | -0.772 | 0.440 |
| L3.Renewable      | -0.000590   | 0.000401   | -1.471 | 0.141 |
| L3.Petroleum      | -0.002450   | 0.001161   | -2.109 | 0.035 |
| L3.Electric       | 0.000101    | 0.000179   | 0.568  | 0.570 |
| L3.Transportation | -0.459098   | 0.136485   | -3.364 | 0.001 |
| L4.Price          | -0.042677   | 0.082992   | -0.514 | 0.607 |
| L4.Renewable      | -0.000700   | 0.000408   | -1.715 | 0.086 |

|                    |           |          |        |       |
|--------------------|-----------|----------|--------|-------|
| L4.Petroleum       | 0.002850  | 0.001171 | 2.434  | 0.015 |
| L4.Electric        | -0.000305 | 0.000175 | -1.747 | 0.081 |
| L4.Transportation  | -0.313427 | 0.138914 | -2.256 | 0.024 |
| L5.Price           | 0.014948  | 0.081162 | 0.184  | 0.854 |
| L5.Renewable       | 0.000329  | 0.000404 | 0.815  | 0.415 |
| L5.Petroleum       | 0.001139  | 0.001176 | 0.968  | 0.333 |
| L5.Electric        | -0.000141 | 0.000176 | -0.803 | 0.422 |
| L5.Transportation  | 0.498999  | 0.140490 | 3.552  | 0.000 |
| L6.Price           | 0.005924  | 0.080359 | 0.074  | 0.941 |
| L6.Renewable       | 0.000339  | 0.000402 | 0.841  | 0.400 |
| L6.Petroleum       | 0.001588  | 0.001177 | 1.349  | 0.177 |
| L6.Electric        | 0.000008  | 0.000177 | 0.043  | 0.966 |
| L6.Transportation  | 0.116621  | 0.143654 | 0.812  | 0.417 |
| L7.Price           | 0.099091  | 0.078338 | 1.265  | 0.206 |
| L7.Renewable       | 0.000261  | 0.000407 | 0.641  | 0.522 |
| L7.Petroleum       | -0.001157 | 0.001190 | -0.972 | 0.331 |
| L7.Electric        | 0.000445  | 0.000174 | 2.560  | 0.010 |
| L7.Transportation  | -0.168111 | 0.143237 | -1.174 | 0.241 |
| L8.Price           | 0.013512  | 0.078162 | 0.173  | 0.863 |
| L8.Renewable       | -0.000126 | 0.000403 | -0.313 | 0.754 |
| L8.Petroleum       | -0.001231 | 0.001196 | -1.030 | 0.303 |
| L8.Electric        | -0.000268 | 0.000174 | -1.539 | 0.124 |
| L8.Transportation  | 0.214594  | 0.143379 | 1.497  | 0.134 |
| L9.Price           | -0.204655 | 0.078666 | -2.602 | 0.009 |
| L9.Renewable       | 0.000333  | 0.000405 | 0.821  | 0.412 |
| L9.Petroleum       | 0.000524  | 0.001186 | 0.442  | 0.659 |
| L9.Electric        | -0.000177 | 0.000175 | -1.014 | 0.311 |
| L9.Transportation  | -0.202984 | 0.152163 | -1.334 | 0.182 |
| L10.Price          | 0.164909  | 0.079487 | 2.075  | 0.038 |
| L10.Renewable      | -0.000557 | 0.000414 | -1.345 | 0.178 |
| L10.Petroleum      | -0.000707 | 0.001193 | -0.593 | 0.553 |
| L10.Electric       | 0.000226  | 0.000176 | 1.282  | 0.200 |
| L10.Transportation | -0.127022 | 0.155710 | -0.816 | 0.415 |
| L11.Price          | -0.029163 | 0.080259 | -0.363 | 0.716 |
| L11.Renewable      | -0.000028 | 0.000408 | -0.068 | 0.946 |
| L11.Petroleum      | -0.000978 | 0.001193 | -0.819 | 0.413 |

|                    |           |          |        |       |
|--------------------|-----------|----------|--------|-------|
| L11.Electric       | 0.000325  | 0.000176 | 1.846  | 0.065 |
| L11.Transportation | -0.007058 | 0.159260 | -0.044 | 0.965 |
| L12.Price          | 0.229552  | 0.079400 | 2.891  | 0.004 |
| L12.Renewable      | 0.000083  | 0.000407 | 0.203  | 0.839 |
| L12.Petroleum      | 0.000744  | 0.001189 | 0.626  | 0.532 |
| L12.Electric       | -0.000028 | 0.000177 | -0.158 | 0.874 |
| L12.Transportation | -0.047585 | 0.148972 | -0.319 | 0.749 |
| L13.Price          | -0.234575 | 0.059788 | -3.923 | 0.000 |
| L13.Renewable      | -0.000257 | 0.000374 | -0.686 | 0.493 |
| L13.Petroleum      | -0.000718 | 0.001046 | -0.687 | 0.492 |
| L13.Electric       | -0.000218 | 0.000151 | -1.441 | 0.149 |
| L13.Transportation | 0.285518  | 0.156264 | 1.827  | 0.068 |

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Results for equation Renewable

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|                   | coefficient | std. error | t-stat | prob  |
|-------------------|-------------|------------|--------|-------|
| -----             |             |            |        |       |
| const             | -52.237739  | 19.731504  | -2.647 | 0.008 |
| L1.Price          | -6.425447   | 9.455349   | -0.680 | 0.497 |
| L1.Renewable      | 0.509721    | 0.058559   | 8.704  | 0.000 |
| L1.Petroleum      | -0.043218   | 0.160411   | -0.269 | 0.788 |
| L1.Electric       | 0.001147    | 0.023141   | 0.050  | 0.960 |
| L1.Transportation | -20.497467  | 21.329861  | -0.961 | 0.337 |
| L2.Price          | 5.356897    | 12.933480  | 0.414  | 0.679 |
| L2.Renewable      | 0.043658    | 0.062375   | 0.700  | 0.484 |
| L2.Petroleum      | 0.003120    | 0.181643   | 0.017  | 0.986 |
| L2.Electric       | -0.041553   | 0.027338   | -1.520 | 0.129 |
| L2.Transportation | 47.733350   | 20.410276  | 2.339  | 0.019 |
| L3.Price          | -0.887602   | 13.007755  | -0.068 | 0.946 |
| L3.Renewable      | 0.194601    | 0.062673   | 3.105  | 0.002 |
| L3.Petroleum      | -0.138395   | 0.181555   | -0.762 | 0.446 |
| L3.Electric       | 0.008059    | 0.027915   | 0.289  | 0.773 |
| L3.Transportation | -17.085723  | 21.336156  | -0.801 | 0.423 |
| L4.Price          | 12.861526   | 12.973755  | 0.991  | 0.322 |
| L4.Renewable      | 0.030084    | 0.063795   | 0.472  | 0.637 |

|                    |            |           |        |       |
|--------------------|------------|-----------|--------|-------|
| L4.Petroleum       | -0.136833  | 0.183012  | -0.748 | 0.455 |
| L4.Electric        | 0.021393   | 0.027305  | 0.783  | 0.433 |
| L4.Transportation  | -3.648701  | 21.715966 | -0.168 | 0.867 |
| L5.Price           | -7.344621  | 12.687777 | -0.579 | 0.563 |
| L5.Renewable       | 0.066768   | 0.063185  | 1.057  | 0.291 |
| L5.Petroleum       | -0.012893  | 0.183838  | -0.070 | 0.944 |
| L5.Electric        | 0.032933   | 0.027535  | 1.196  | 0.232 |
| L5.Transportation  | -4.180775  | 21.962294 | -0.190 | 0.849 |
| L6.Price           | -4.584956  | 12.562194 | -0.365 | 0.715 |
| L6.Renewable       | -0.138596  | 0.062920  | -2.203 | 0.028 |
| L6.Petroleum       | 0.239414   | 0.184020  | 1.301  | 0.193 |
| L6.Electric        | -0.035072  | 0.027742  | -1.264 | 0.206 |
| L6.Transportation  | -5.207514  | 22.456911 | -0.232 | 0.817 |
| L7.Price           | 4.804560   | 12.246246 | 0.392  | 0.695 |
| L7.Renewable       | 0.052933   | 0.063583  | 0.833  | 0.405 |
| L7.Petroleum       | -0.184374  | 0.186020  | -0.991 | 0.322 |
| L7.Electric        | -0.005663  | 0.027173  | -0.208 | 0.835 |
| L7.Transportation  | 7.585503   | 22.391718 | 0.339  | 0.735 |
| L8.Price           | -29.834316 | 12.218753 | -2.442 | 0.015 |
| L8.Renewable       | -0.101941  | 0.062946  | -1.619 | 0.105 |
| L8.Petroleum       | -0.024979  | 0.186914  | -0.134 | 0.894 |
| L8.Electric        | 0.031579   | 0.027232  | 1.160  | 0.246 |
| L8.Transportation  | 11.064673  | 22.413908 | 0.494  | 0.622 |
| L9.Price           | 21.083235  | 12.297484 | 1.714  | 0.086 |
| L9.Renewable       | 0.185231   | 0.063357  | 2.924  | 0.003 |
| L9.Petroleum       | -0.042640  | 0.185340  | -0.230 | 0.818 |
| L9.Electric        | 0.008630   | 0.027365  | 0.315  | 0.752 |
| L9.Transportation  | 12.974322  | 23.787124 | 0.545  | 0.585 |
| L10.Price          | 2.798414   | 12.425970 | 0.225  | 0.822 |
| L10.Renewable      | 0.042953   | 0.064669  | 0.664  | 0.507 |
| L10.Petroleum      | 0.138850   | 0.186440  | 0.745  | 0.456 |
| L10.Electric       | 0.015859   | 0.027516  | 0.576  | 0.564 |
| L10.Transportation | 9.978936   | 24.341587 | 0.410  | 0.682 |
| L11.Price          | 1.126087   | 12.546661 | 0.090  | 0.928 |
| L11.Renewable      | -0.036145  | 0.063728  | -0.567 | 0.571 |
| L11.Petroleum      | -0.063041  | 0.186522  | -0.338 | 0.735 |

|                    |            |           |        |       |
|--------------------|------------|-----------|--------|-------|
| L11.Electric       | 0.003119   | 0.027546  | 0.113  | 0.910 |
| L11.Transportation | -12.612038 | 24.896586 | -0.507 | 0.612 |
| L12.Price          | 0.732879   | 12.412341 | 0.059  | 0.953 |
| L12.Renewable      | 0.350188   | 0.063695  | 5.498  | 0.000 |
| L12.Petroleum      | -0.085978  | 0.185945  | -0.462 | 0.644 |
| L12.Electric       | 0.050727   | 0.027744  | 1.828  | 0.067 |
| L12.Transportation | -6.542356  | 23.288226 | -0.281 | 0.779 |
| L13.Price          | 9.006685   | 9.346381  | 0.964  | 0.335 |
| L13.Renewable      | -0.285949  | 0.058505  | -4.888 | 0.000 |
| L13.Petroleum      | 0.430269   | 0.163587  | 2.630  | 0.009 |
| L13.Electric       | -0.054966  | 0.023650  | -2.324 | 0.020 |
| L13.Transportation | -26.125621 | 24.428170 | -1.069 | 0.285 |

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Results for equation Petroleum

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|                   | coefficient | std. error | t-stat | prob  |
|-------------------|-------------|------------|--------|-------|
| <hr/>             |             |            |        |       |
| const             | 9.816996    | 7.762763   | 1.265  | 0.206 |
| L1.Price          | -5.641861   | 3.719921   | -1.517 | 0.129 |
| L1.Renewable      | -0.009701   | 0.023038   | -0.421 | 0.674 |
| L1.Petroleum      | 0.591973    | 0.063109   | 9.380  | 0.000 |
| L1.Electric       | -0.002492   | 0.009104   | -0.274 | 0.784 |
| L1.Transportation | -2.644003   | 8.391588   | -0.315 | 0.753 |
| L2.Price          | 0.370938    | 5.088286   | 0.073  | 0.942 |
| L2.Renewable      | 0.016605    | 0.024540   | 0.677  | 0.499 |
| L2.Petroleum      | 0.049570    | 0.071462   | 0.694  | 0.488 |
| L2.Electric       | -0.018852   | 0.010755   | -1.753 | 0.080 |
| L2.Transportation | 11.733981   | 8.029805   | 1.461  | 0.144 |
| L3.Price          | 2.319814    | 5.117507   | 0.453  | 0.650 |
| L3.Renewable      | -0.001702   | 0.024657   | -0.069 | 0.945 |
| L3.Petroleum      | -0.008619   | 0.071427   | -0.121 | 0.904 |
| L3.Electric       | -0.003807   | 0.010982   | -0.347 | 0.729 |
| L3.Transportation | 4.002143    | 8.394065   | 0.477  | 0.634 |
| L4.Price          | -1.541963   | 5.104131   | -0.302 | 0.763 |
| L4.Renewable      | -0.014064   | 0.025098   | -0.560 | 0.575 |

|                    |           |          |        |       |
|--------------------|-----------|----------|--------|-------|
| L4.Petroleum       | -0.046700 | 0.072000 | -0.649 | 0.517 |
| L4.Electric        | 0.020051  | 0.010742 | 1.867  | 0.062 |
| L4.Transportation  | -1.236722 | 8.543489 | -0.145 | 0.885 |
| L5.Price           | -0.240128 | 4.991622 | -0.048 | 0.962 |
| L5.Renewable       | 0.018704  | 0.024858 | 0.752  | 0.452 |
| L5.Petroleum       | 0.019181  | 0.072325 | 0.265  | 0.791 |
| L5.Electric        | 0.019774  | 0.010833 | 1.825  | 0.068 |
| L5.Transportation  | -2.270713 | 8.640400 | -0.263 | 0.793 |
| L6.Price           | 4.806320  | 4.942215 | 0.973  | 0.331 |
| L6.Renewable       | -0.018401 | 0.024754 | -0.743 | 0.457 |
| L6.Petroleum       | 0.142771  | 0.072397 | 1.972  | 0.049 |
| L6.Electric        | 0.005573  | 0.010914 | 0.511  | 0.610 |
| L6.Transportation  | -6.601260 | 8.834992 | -0.747 | 0.455 |
| L7.Price           | 5.727055  | 4.817915 | 1.189  | 0.235 |
| L7.Renewable       | -0.008707 | 0.025015 | -0.348 | 0.728 |
| L7.Petroleum       | -0.056372 | 0.073184 | -0.770 | 0.441 |
| L7.Electric        | -0.008361 | 0.010690 | -0.782 | 0.434 |
| L7.Transportation  | 0.368903  | 8.809343 | 0.042  | 0.967 |
| L8.Price           | -2.528673 | 4.807099 | -0.526 | 0.599 |
| L8.Renewable       | 0.022117  | 0.024764 | 0.893  | 0.372 |
| L8.Petroleum       | 0.084834  | 0.073536 | 1.154  | 0.249 |
| L8.Electric        | 0.002751  | 0.010714 | 0.257  | 0.797 |
| L8.Transportation  | -5.169737 | 8.818073 | -0.586 | 0.558 |
| L9.Price           | -0.860360 | 4.838073 | -0.178 | 0.859 |
| L9.Renewable       | 0.001616  | 0.024926 | 0.065  | 0.948 |
| L9.Petroleum       | 0.069464  | 0.072916 | 0.953  | 0.341 |
| L9.Electric        | -0.011949 | 0.010766 | -1.110 | 0.267 |
| L9.Transportation  | 18.172876 | 9.358324 | 1.942  | 0.052 |
| L10.Price          | -4.809499 | 4.888622 | -0.984 | 0.325 |
| L10.Renewable      | 0.004784  | 0.025442 | 0.188  | 0.851 |
| L10.Petroleum      | -0.008422 | 0.073349 | -0.115 | 0.909 |
| L10.Electric       | 0.004415  | 0.010825 | 0.408  | 0.683 |
| L10.Transportation | 2.128940  | 9.576460 | 0.222  | 0.824 |
| L11.Price          | -3.011030 | 4.936104 | -0.610 | 0.542 |
| L11.Renewable      | -0.032013 | 0.025072 | -1.277 | 0.202 |
| L11.Petroleum      | 0.068714  | 0.073382 | 0.936  | 0.349 |



|                    |            |          |        |       |
|--------------------|------------|----------|--------|-------|
| L11.Electric       | -0.005819  | 0.010837 | -0.537 | 0.591 |
| L11.Transportation | 0.104965   | 9.794808 | 0.011  | 0.991 |
| L12.Price          | 6.614464   | 4.883260 | 1.355  | 0.176 |
| L12.Renewable      | 0.042650   | 0.025059 | 1.702  | 0.089 |
| L12.Petroleum      | 0.104791   | 0.073154 | 1.432  | 0.152 |
| L12.Electric       | 0.009829   | 0.010915 | 0.901  | 0.368 |
| L12.Transportation | -8.704925  | 9.162048 | -0.950 | 0.342 |
| L13.Price          | -1.595037  | 3.677051 | -0.434 | 0.664 |
| L13.Renewable      | -0.023140  | 0.023017 | -1.005 | 0.315 |
| L13.Petroleum      | -0.150021  | 0.064358 | -2.331 | 0.020 |
| L13.Electric       | -0.005472  | 0.009304 | -0.588 | 0.556 |
| L13.Transportation | -10.747136 | 9.610524 | -1.118 | 0.263 |

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Results for equation Electric

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|                   | coefficient | std. error | t-stat | prob  |
|-------------------|-------------|------------|--------|-------|
| <hr/>             |             |            |        |       |
| const             | 79.927617   | 53.077323  | 1.506  | 0.132 |
| L1.Price          | 35.431964   | 25.434688  | 1.393  | 0.164 |
| L1.Renewable      | -0.281479   | 0.157523   | -1.787 | 0.074 |
| L1.Petroleum      | 0.320560    | 0.431502   | 0.743  | 0.458 |
| L1.Electric       | 0.639035    | 0.062249   | 10.266 | 0.000 |
| L1.Transportation | -136.198297 | 57.376869  | -2.374 | 0.018 |
| L2.Price          | -58.074297  | 34.790784  | -1.669 | 0.095 |
| L2.Renewable      | 0.028023    | 0.167788   | 0.167  | 0.867 |
| L2.Petroleum      | -0.226928   | 0.488615   | -0.464 | 0.642 |
| L2.Electric       | -0.100508   | 0.073538   | -1.367 | 0.172 |
| L2.Transportation | 53.038317   | 54.903205  | 0.966  | 0.334 |
| L3.Price          | -44.899077  | 34.990582  | -1.283 | 0.199 |
| L3.Renewable      | -0.010798   | 0.168589   | -0.064 | 0.949 |
| L3.Petroleum      | -0.254749   | 0.488380   | -0.522 | 0.602 |
| L3.Electric       | 0.032131    | 0.075091   | 0.428  | 0.669 |
| L3.Transportation | 76.285398   | 57.393803  | 1.329  | 0.184 |
| L4.Price          | 26.695236   | 34.899124  | 0.765  | 0.444 |
| L4.Renewable      | 0.076617    | 0.171606   | 0.446  | 0.655 |

|                    |            |           |        |       |
|--------------------|------------|-----------|--------|-------|
| L4.Petroleum       | 0.181789   | 0.492298  | 0.369  | 0.712 |
| L4.Electric        | -0.043449  | 0.073450  | -0.592 | 0.554 |
| L4.Transportation  | 14.161485  | 58.415484 | 0.242  | 0.808 |
| L5.Price           | 12.360161  | 34.129850 | 0.362  | 0.717 |
| L5.Renewable       | -0.011532  | 0.169967  | -0.068 | 0.946 |
| L5.Petroleum       | -0.134688  | 0.494519  | -0.272 | 0.785 |
| L5.Electric        | -0.011157  | 0.074070  | -0.151 | 0.880 |
| L5.Transportation  | -85.313125 | 59.078101 | -1.444 | 0.149 |
| L6.Price           | 64.549054  | 33.792034 | 1.910  | 0.056 |
| L6.Renewable       | -0.121823  | 0.169255  | -0.720 | 0.472 |
| L6.Petroleum       | 0.526424   | 0.495011  | 1.063  | 0.288 |
| L6.Electric        | -0.002120  | 0.074626  | -0.028 | 0.977 |
| L6.Transportation  | -5.534935  | 60.408612 | -0.092 | 0.927 |
| L7.Price           | -53.833906 | 32.942141 | -1.634 | 0.102 |
| L7.Renewable       | 0.166950   | 0.171036  | 0.976  | 0.329 |
| L7.Petroleum       | 0.618703   | 0.500390  | 1.236  | 0.216 |
| L7.Electric        | -0.024268  | 0.073095  | -0.332 | 0.740 |
| L7.Transportation  | 63.134512  | 60.233242 | 1.048  | 0.295 |
| L8.Price           | -40.967665 | 32.868186 | -1.246 | 0.213 |
| L8.Renewable       | -0.027141  | 0.169324  | -0.160 | 0.873 |
| L8.Petroleum       | -0.021881  | 0.502796  | -0.044 | 0.965 |
| L8.Electric        | -0.030525  | 0.073255  | -0.417 | 0.677 |
| L8.Transportation  | -18.946602 | 60.292932 | -0.314 | 0.753 |
| L9.Price           | 4.264335   | 33.079968 | 0.129  | 0.897 |
| L9.Renewable       | 0.030235   | 0.170430  | 0.177  | 0.859 |
| L9.Petroleum       | -0.473779  | 0.498560  | -0.950 | 0.342 |
| L9.Electric        | -0.102426  | 0.073612  | -1.391 | 0.164 |
| L9.Transportation  | 0.352637   | 63.986856 | 0.006  | 0.996 |
| L10.Price          | 61.937508  | 33.425595 | 1.853  | 0.064 |
| L10.Renewable      | -0.033366  | 0.173958  | -0.192 | 0.848 |
| L10.Petroleum      | -0.020714  | 0.501518  | -0.041 | 0.967 |
| L10.Electric       | 0.117010   | 0.074017  | 1.581  | 0.114 |
| L10.Transportation | -25.249431 | 65.478349 | -0.386 | 0.700 |
| L11.Price          | -7.499860  | 33.750249 | -0.222 | 0.824 |
| L11.Renewable      | -0.050921  | 0.171426  | -0.297 | 0.766 |
| L11.Petroleum      | -0.051825  | 0.501742  | -0.103 | 0.918 |

|                    |            |           |        |       |
|--------------------|------------|-----------|--------|-------|
| L11.Electric       | 0.034150   | 0.074098  | 0.461  | 0.645 |
| L11.Transportation | -1.526025  | 66.971285 | -0.023 | 0.982 |
| L12.Price          | 45.186611  | 33.388932 | 1.353  | 0.176 |
| L12.Renewable      | 0.335793   | 0.171337  | 1.960  | 0.050 |
| L12.Petroleum      | -0.131977  | 0.500188  | -0.264 | 0.792 |
| L12.Electric       | 0.237943   | 0.074630  | 3.188  | 0.001 |
| L12.Transportation | 74.866406  | 62.644832 | 1.195  | 0.232 |
| L13.Price          | -43.925136 | 25.141564 | -1.747 | 0.081 |
| L13.Renewable      | 0.041636   | 0.157376  | 0.265  | 0.791 |
| L13.Petroleum      | -0.523285  | 0.440046  | -1.189 | 0.234 |
| L13.Electric       | -0.153702  | 0.063618  | -2.416 | 0.016 |
| L13.Transportation | 47.363081  | 65.711255 | 0.721  | 0.471 |

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Results for equation Transportation

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|                   | coefficient | std. error | t-stat | prob  |
|-------------------|-------------|------------|--------|-------|
| const             | 0.056798    | 0.054328   | 1.045  | 0.296 |
| L1.Price          | 0.042960    | 0.026034   | 1.650  | 0.099 |
| L1.Renewable      | 0.000240    | 0.000161   | 1.491  | 0.136 |
| L1.Petroleum      | 0.000716    | 0.000442   | 1.622  | 0.105 |
| L1.Electric       | -0.000046   | 0.000064   | -0.726 | 0.468 |
| L1.Transportation | 0.595284    | 0.058729   | 10.136 | 0.000 |
| L2.Price          | -0.027104   | 0.035611   | -0.761 | 0.447 |
| L2.Renewable      | -0.000073   | 0.000172   | -0.428 | 0.669 |
| L2.Petroleum      | 0.000068    | 0.000500   | 0.136  | 0.892 |
| L2.Electric       | -0.000010   | 0.000075   | -0.126 | 0.900 |
| L2.Transportation | 0.335981    | 0.056197   | 5.979  | 0.000 |
| L3.Price          | -0.009801   | 0.035815   | -0.274 | 0.784 |
| L3.Renewable      | 0.000067    | 0.000173   | 0.385  | 0.700 |
| L3.Petroleum      | -0.000017   | 0.000500   | -0.033 | 0.973 |
| L3.Electric       | -0.000089   | 0.000077   | -1.152 | 0.249 |
| L3.Transportation | 0.113587    | 0.058747   | 1.934  | 0.053 |
| L4.Price          | -0.005495   | 0.035722   | -0.154 | 0.878 |
| L4.Renewable      | 0.000006    | 0.000176   | 0.034  | 0.973 |

|                    |           |          |        |       |
|--------------------|-----------|----------|--------|-------|
| L4.Petroleum       | 0.000074  | 0.000504 | 0.146  | 0.884 |
| L4.Electric        | 0.000083  | 0.000075 | 1.110  | 0.267 |
| L4.Transportation  | -0.037534 | 0.059792 | -0.628 | 0.530 |
| L5.Price           | -0.022120 | 0.034934 | -0.633 | 0.527 |
| L5.Renewable       | -0.000067 | 0.000174 | -0.386 | 0.699 |
| L5.Petroleum       | -0.000515 | 0.000506 | -1.017 | 0.309 |
| L5.Electric        | 0.000029  | 0.000076 | 0.377  | 0.706 |
| L5.Transportation  | -0.024435 | 0.060471 | -0.404 | 0.686 |
| L6.Price           | -0.006849 | 0.034589 | -0.198 | 0.843 |
| L6.Renewable       | 0.000101  | 0.000173 | 0.584  | 0.559 |
| L6.Petroleum       | -0.000066 | 0.000507 | -0.130 | 0.897 |
| L6.Electric        | 0.000007  | 0.000076 | 0.094  | 0.925 |
| L6.Transportation  | -0.021887 | 0.061833 | -0.354 | 0.723 |
| L7.Price           | 0.039257  | 0.033719 | 1.164  | 0.244 |
| L7.Renewable       | -0.000177 | 0.000175 | -1.011 | 0.312 |
| L7.Petroleum       | -0.000595 | 0.000512 | -1.162 | 0.245 |
| L7.Electric        | -0.000020 | 0.000075 | -0.261 | 0.794 |
| L7.Transportation  | -0.000378 | 0.061653 | -0.006 | 0.995 |
| L8.Price           | -0.050096 | 0.033643 | -1.489 | 0.136 |
| L8.Renewable       | 0.000063  | 0.000173 | 0.363  | 0.717 |
| L8.Petroleum       | 0.000157  | 0.000515 | 0.304  | 0.761 |
| L8.Electric        | 0.000018  | 0.000075 | 0.235  | 0.814 |
| L8.Transportation  | -0.050053 | 0.061714 | -0.811 | 0.417 |
| L9.Price           | 0.027857  | 0.033860 | 0.823  | 0.411 |
| L9.Renewable       | -0.000048 | 0.000174 | -0.273 | 0.785 |
| L9.Petroleum       | 0.000432  | 0.000510 | 0.847  | 0.397 |
| L9.Electric        | -0.000073 | 0.000075 | -0.964 | 0.335 |
| L9.Transportation  | 0.059179  | 0.065495 | 0.904  | 0.366 |
| L10.Price          | 0.017345  | 0.034213 | 0.507  | 0.612 |
| L10.Renewable      | 0.000243  | 0.000178 | 1.367  | 0.172 |
| L10.Petroleum      | 0.000017  | 0.000513 | 0.032  | 0.974 |
| L10.Electric       | 0.000024  | 0.000076 | 0.314  | 0.753 |
| L10.Transportation | -0.025619 | 0.067022 | -0.382 | 0.702 |
| L11.Price          | 0.023116  | 0.034546 | 0.669  | 0.503 |
| L11.Renewable      | -0.000257 | 0.000175 | -1.464 | 0.143 |
| L11.Petroleum      | 0.000530  | 0.000514 | 1.032  | 0.302 |

|                    |           |          |        |       |
|--------------------|-----------|----------|--------|-------|
| L11.Electric       | -0.000084 | 0.000076 | -1.107 | 0.268 |
| L11.Transportation | -0.212691 | 0.068550 | -3.103 | 0.002 |
| L12.Price          | -0.026896 | 0.034176 | -0.787 | 0.431 |
| L12.Renewable      | 0.000331  | 0.000175 | 1.887  | 0.059 |
| L12.Petroleum      | 0.000143  | 0.000512 | 0.280  | 0.780 |
| L12.Electric       | 0.000144  | 0.000076 | 1.883  | 0.060 |
| L12.Transportation | 0.722906  | 0.064121 | 11.274 | 0.000 |
| L13.Price          | -0.016351 | 0.025734 | -0.635 | 0.525 |
| L13.Renewable      | -0.000258 | 0.000161 | -1.603 | 0.109 |
| L13.Petroleum      | -0.000747 | 0.000450 | -1.659 | 0.097 |
| L13.Electric       | -0.000019 | 0.000065 | -0.297 | 0.766 |
| L13.Transportation | -0.440123 | 0.067260 | -6.544 | 0.000 |

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#### Correlation matrix of residuals

|                | Price     | Renewable | Petroleum | Electric  | Transportation |
|----------------|-----------|-----------|-----------|-----------|----------------|
| Price          | 1.000000  | -0.054557 | -0.053675 | -0.034504 | 0.021661       |
| Renewable      | -0.054557 | 1.000000  | 0.037046  | -0.051544 | 0.050631       |
| Petroleum      | -0.053675 | 0.037046  | 1.000000  | 0.128843  | 0.121257       |
| Electric       | -0.034504 | -0.051544 | 0.128843  | 1.000000  | 0.009865       |
| Transportation | 0.021661  | 0.050631  | 0.121257  | 0.009865  | 1.000000       |

## **Facebook Prophet**

N/A

# Exponential Smoothing

## ExponentialSmoothing Model Results

|                   |                      |                   |                  |
|-------------------|----------------------|-------------------|------------------|
| =====             |                      |                   |                  |
| Dep. Variable:    | Price                | No. Observations: | 332              |
| Model:            | ExponentialSmoothing | SSE               | 3.526            |
| Optimized:        | True                 | AIC               | -1476.901        |
| Trend:            | Additive             | BIC               | -1416.019        |
| Seasonal:         | Additive             | AICC              | -1474.716        |
| Seasonal Periods: | 12                   | Date:             | Tue, 18 Mar 2025 |
| Box-Cox:          | False                | Time:             | 12:39:26         |
|                   | Box-Cox Coeff.:      |                   | None             |
| =====             |                      |                   |                  |

|                    | coeff      | code  | optimized |
|--------------------|------------|-------|-----------|
| -----              |            |       |           |
| smoothing_level    | 0.7986300  | alpha | True      |
| smoothing_trend    | 2.2408e-16 | beta  | True      |
| smoothing_seasonal | 0.2013700  | gamma | True      |
| initial_level      | 7.3508009  | l.0   | True      |
| initial_trend      | 0.0098599  | b.0   | True      |
| initial_seasons.0  | -0.2106641 | s.0   | True      |
| initial_seasons.1  | -0.1397264 | s.1   | True      |
| initial_seasons.2  | -0.1062771 | s.2   | True      |
| initial_seasons.3  | 0.0915257  | s.3   | True      |
| initial_seasons.4  | 0.2977833  | s.4   | True      |
| initial_seasons.5  | 0.3014866  | s.5   | True      |
| initial_seasons.6  | 0.2327778  | s.6   | True      |
| initial_seasons.7  | 0.1799308  | s.7   | True      |
| initial_seasons.8  | 0.1654044  | s.8   | True      |
| initial_seasons.9  | -0.1347590 | s.9   | True      |
| initial_seasons.10 | -0.3130930 | s.10  | True      |
| initial_seasons.11 | -0.3507399 | s.11  | True      |
| -----              |            |       |           |