Useful findings

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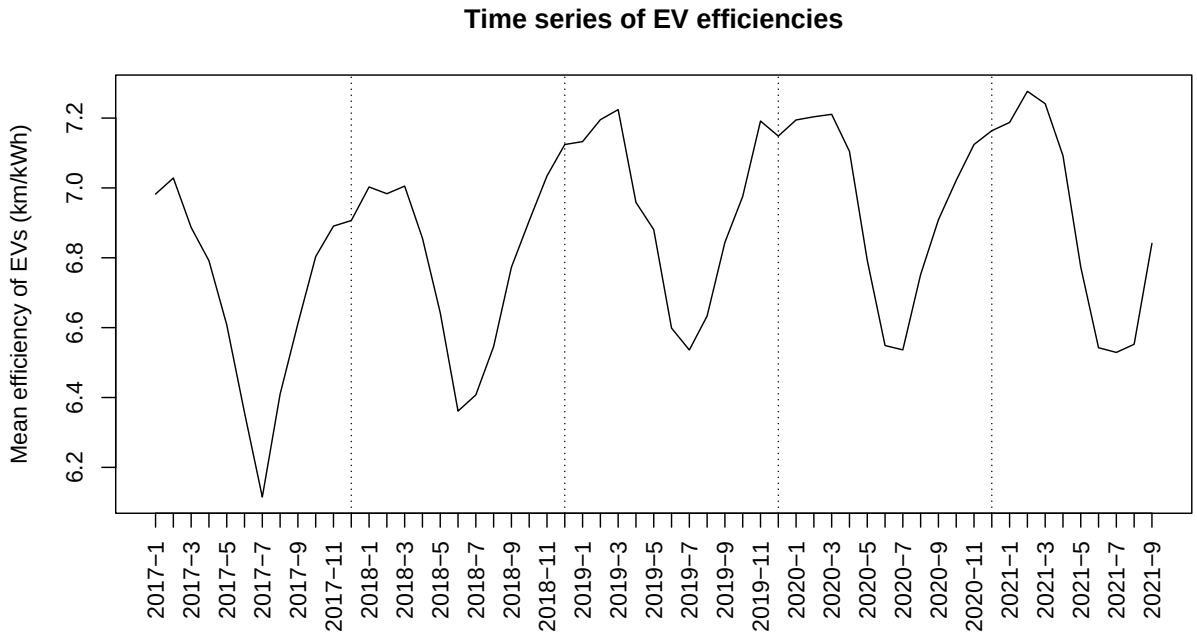
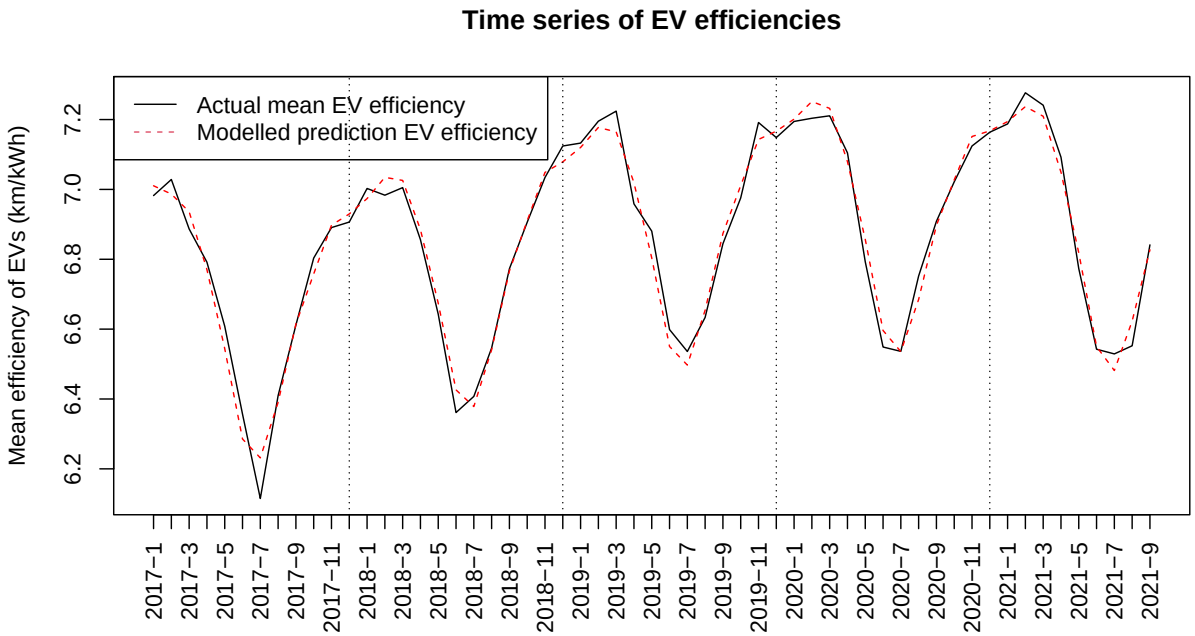


simple linear model with mean_eff $= t + \ln t + t^2$+month (as factor). negative squared term means can not use for long term efficiency trend as it will got negative but allows it to better fit the seasonal trend

```
##
## Call:
## lm(formula = mean_ef ~ m + I(log(m)) + I(m^2) + factor(month),
##     data = monthly_EV_data)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.116381 -0.028026 -0.003808  0.031606  0.076696
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      6.977e+00  3.700e-02 188.537  < 2e-16 ***
## m                3.423e-02  4.321e-03   7.921 7.21e-10 ***
## I(log(m))       -1.506e-01  3.267e-02  -4.611 3.73e-05 ***
## I(m^2)          -3.637e-04  4.972e-05  -7.315 5.17e-09 ***
## factor(month)2   4.756e-02  3.049e-02   1.560 0.126276
```

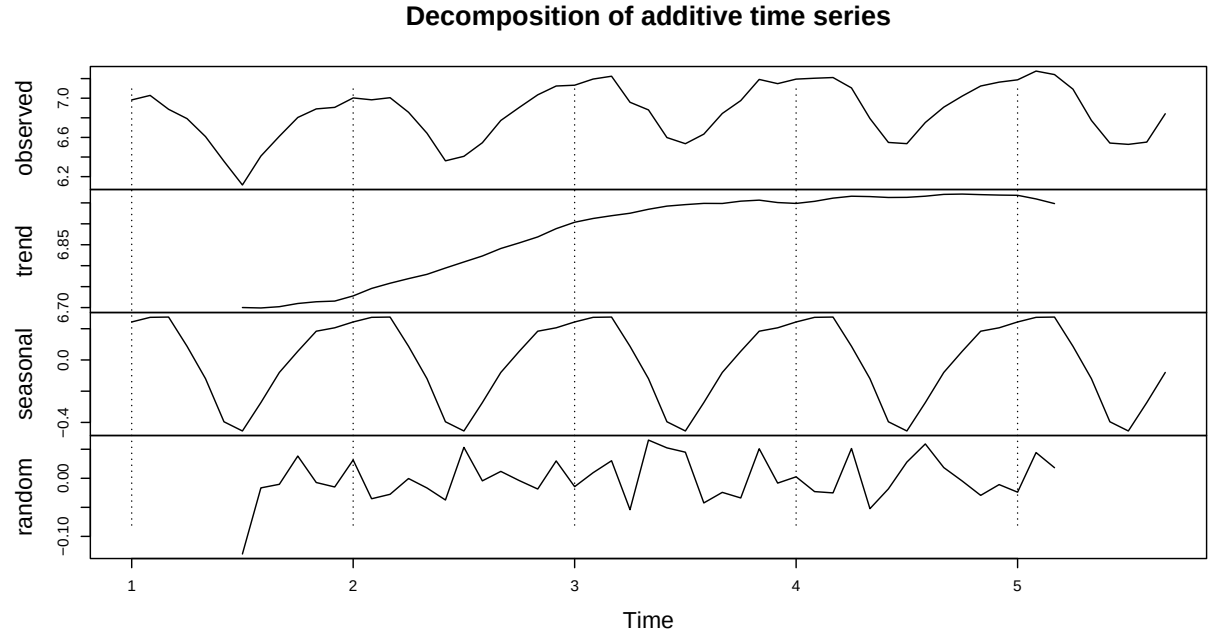
```
## factor(month)3   2.551e-02  3.078e-02   0.829 0.411873
## factor(month)4  -1.286e-01  3.101e-02  -4.146 0.000161 ***
## factor(month)5  -3.523e-01  3.120e-02 -11.290 2.65e-14 ***
## factor(month)6  -6.135e-01  3.135e-02 -19.568  < 2e-16 ***
## factor(month)7  -6.738e-01  3.148e-02 -21.405  < 2e-16 ***
## factor(month)8  -5.235e-01  3.159e-02 -16.570  < 2e-16 ***
## factor(month)9  -3.098e-01  3.170e-02  -9.773 2.22e-12 ***
## factor(month)10 -1.776e-01  3.312e-02  -5.362 3.26e-06 ***
## factor(month)11 -5.042e-02  3.313e-02  -1.522 0.135513
## factor(month)12 -3.090e-02  3.313e-02  -0.933 0.356286
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.04785 on 42 degrees of freedom
## Multiple R-squared:  0.9778, Adjusted R-squared:  0.9704
## F-statistic: 132.2 on 14 and 42 DF,  p-value: < 2.2e-16
```

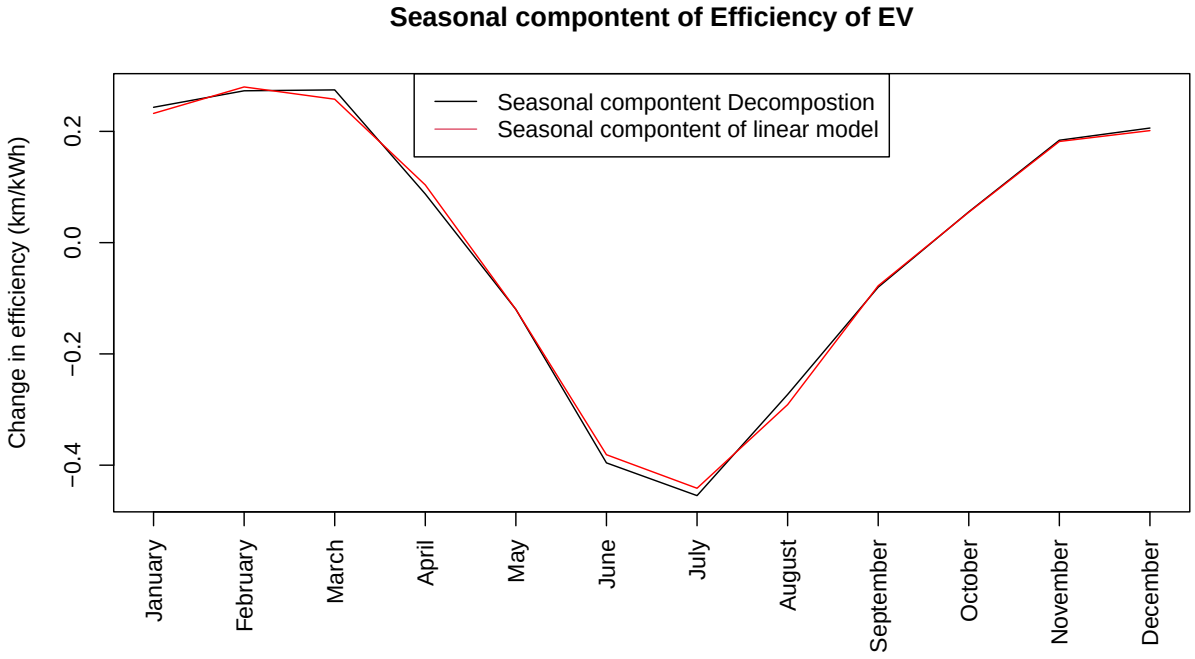



```
## Warning in adf.test(eff_series, alternative = "stationary"): p-value smaller
## than printed p-value
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  eff_series
## Dickey-Fuller = -4.7051, Lag order = 3, p-value = 0.01
## alternative hypothesis: stationary
```

we can reject null hypothesis that data is not-stationary. this makes sense as average efficiency should not have significantly changed in a couple of years. use multiplicative instead of additive as preferable to know estimated extra power use? or should i know total extra power used in season?


Decomposition of additive time series
observed
trend
seasonal
random
6.2
6.6
7.0
6.70
6.85
−0.4
0.0
−0.10
0.00
1
2
3
4
5
Time


Seasonal compontent of Efficiency of EV
Seasonal compontent Decompostion
Seasonal compontent of linear model
Change in efficiency (km/kWh)
−0.4
−0.2
0.0
0.2
January
February
March
April
May
June
July
August
September
October
November
December