

Relatório de Análise de Séries Temporais

```
##  
## Attaching package: 'zoo'  
##  
## The following objects are masked from 'package:base':  
##  
##     as.Date, as.Date.numeric  
##  
## This is forecast 5.6  
##  
## locfit 1.5-9.1    2013-03-22  
## Loading required package: nlme  
##  
## Attaching package: 'nlme'  
##  
## The following object is masked from 'package:forecast':  
##  
##     getResponse  
##  
## This is mgcv 1.8-3. For overview type 'help("mgcv-package")'.
```

Este relatório tem como objecto de análise

Dados originais:

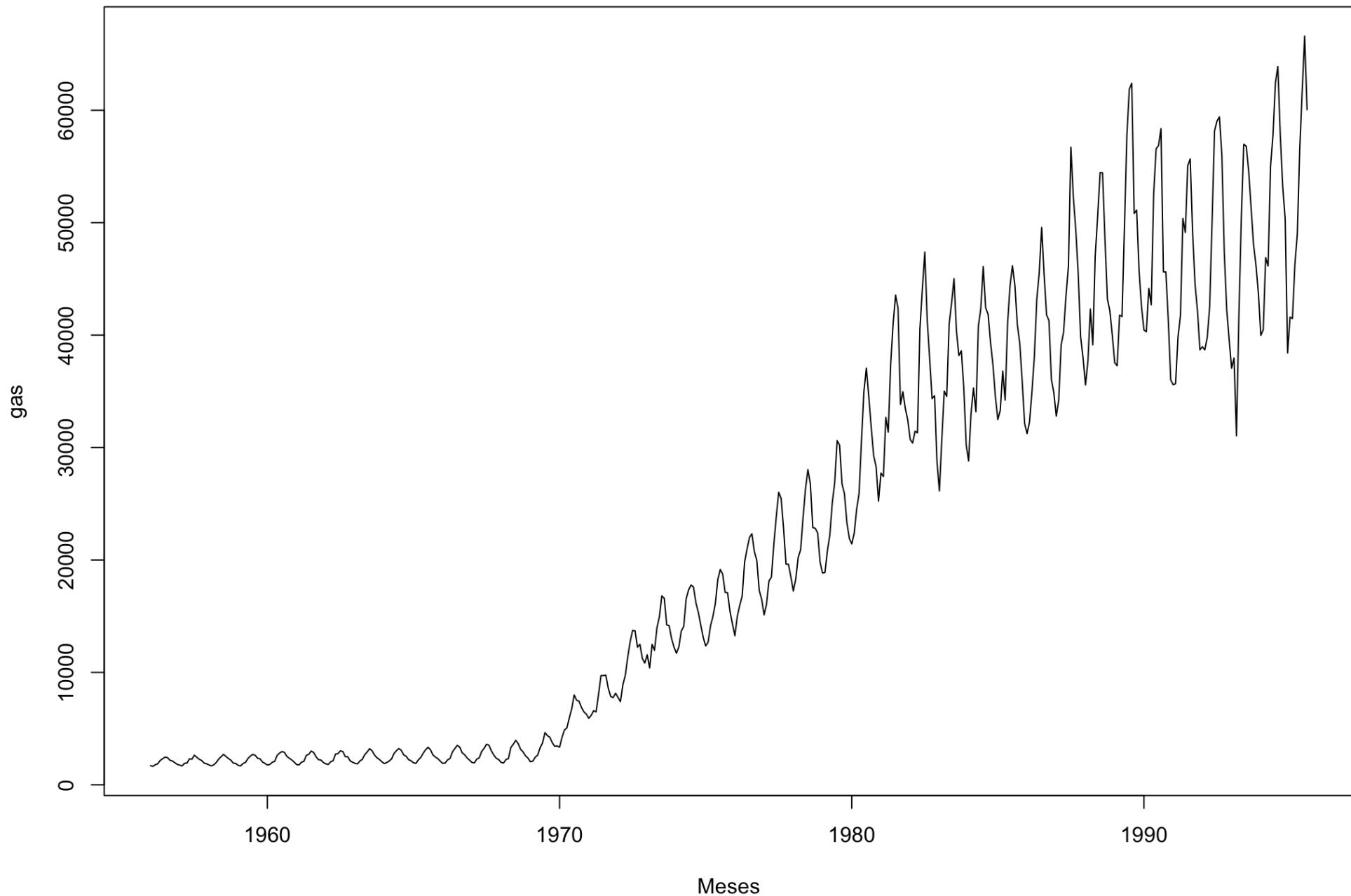
```
##      Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct   Nov  
## 1956 1709 1646 1794 1878 2173 2321 2468 2416 2184 2121 1962  
## 1957 1751 1688 1920 1941 2311 2279 2638 2448 2279 2163 1941  
## 1958 1773 1688 1783 1984 2290 2511 2712 2522 2342 2195 1931  
## 1959 1730 1688 1899 1994 2342 2553 2712 2627 2363 2311 2026  
## 1960 1762 1815 2005 2089 2617 2828 2965 2891 2532 2363 2216  
## 1961 1804 1773 2015 2089 2627 2712 3007 2880 2490 2237 2205
```



```
## 1956 1825
## 1957 1878
## 1958 1910
## 1959 1910
## 1960 2026
## 1961 1984
## 1962 2015
## 1963 2057
## 1964 2142
## 1965 2110
## 1966 2205
## 1967 2247
## 1968 2384
## 1969 3461
## 1970 6288
## 1971 8154
## 1972 10829
## 1973 12253
## 1974 13116
## 1975 14312
## 1976 16498
## 1977 18488
## 1978 19795
## 1979 21930
## 1980 25248
## 1981 32445
## 1982 28729
## 1983 30234
## 1984 34514
## 1985 32142
## 1986 34879
## 1987 37958
## 1988 39995
## 1989 42528
## 1990 36016
```

```
## 1991 38698  
## 1992 39606  
## 1993 43736  
## 1994 38410  
## 1995
```

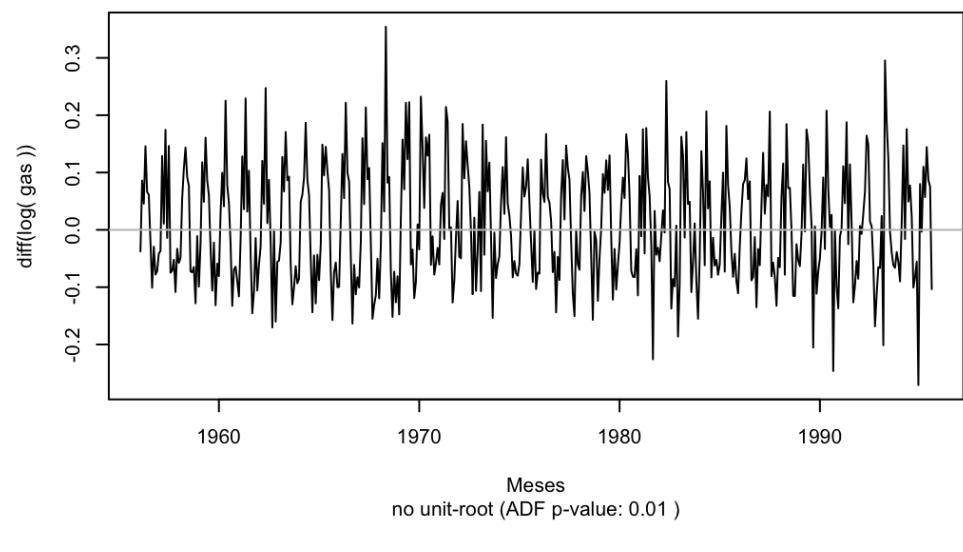
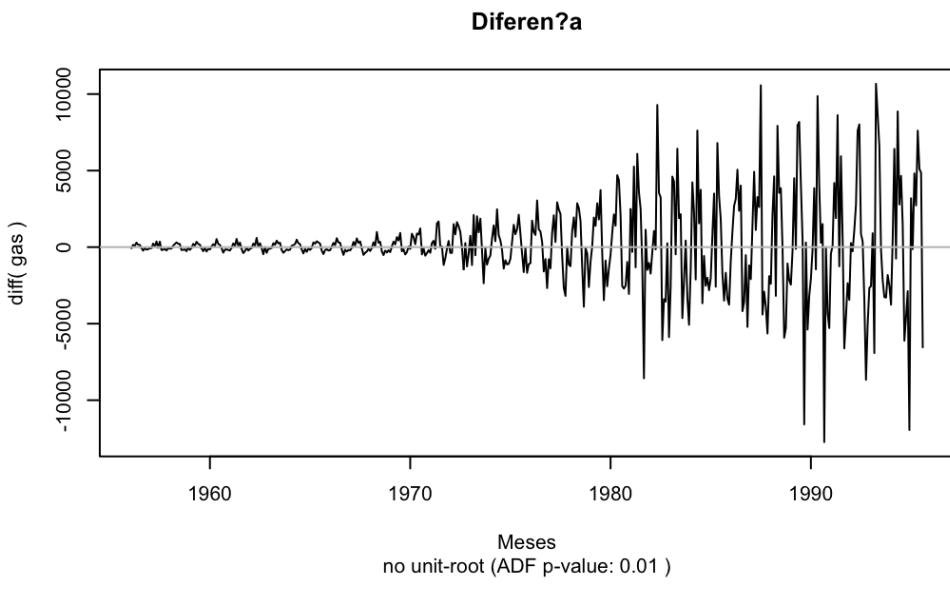
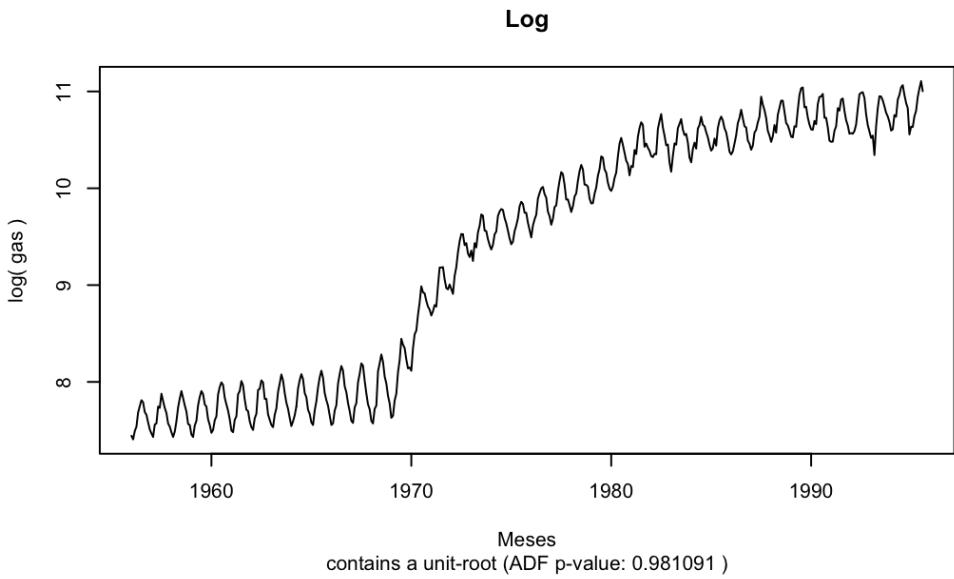
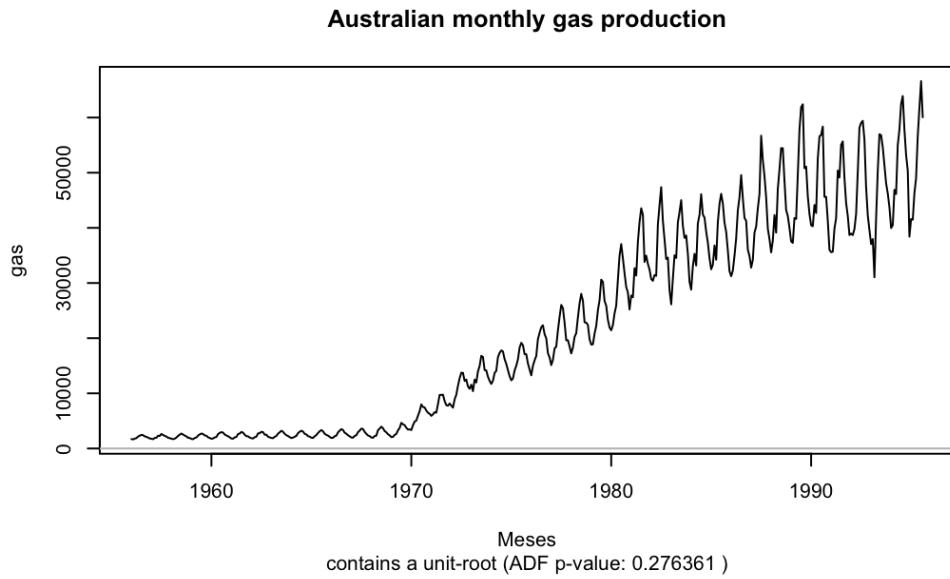
Australian monthly gas production

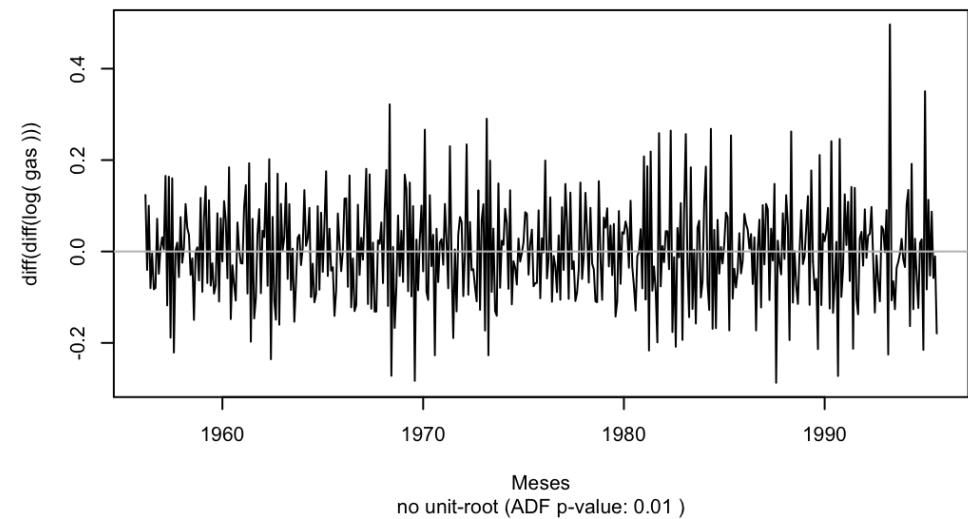
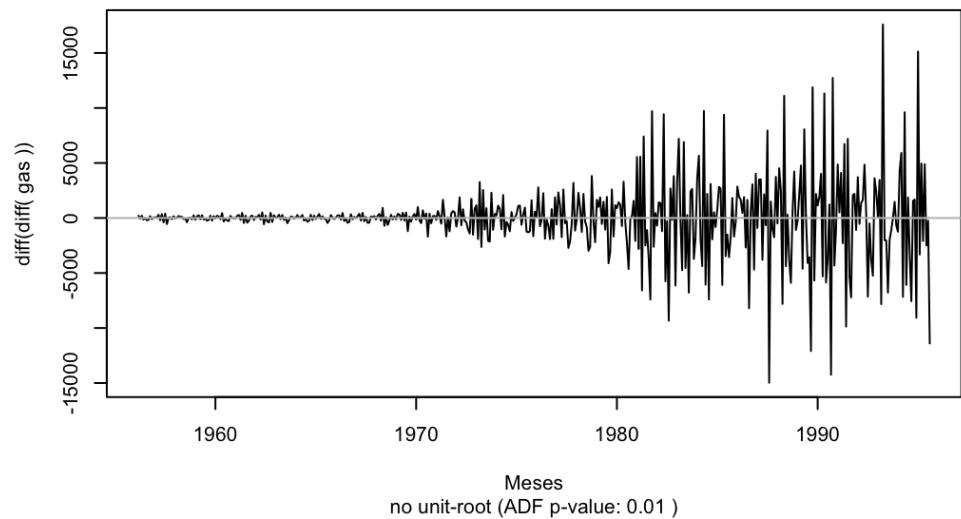


```

## Warning: p-value smaller than printed p-value

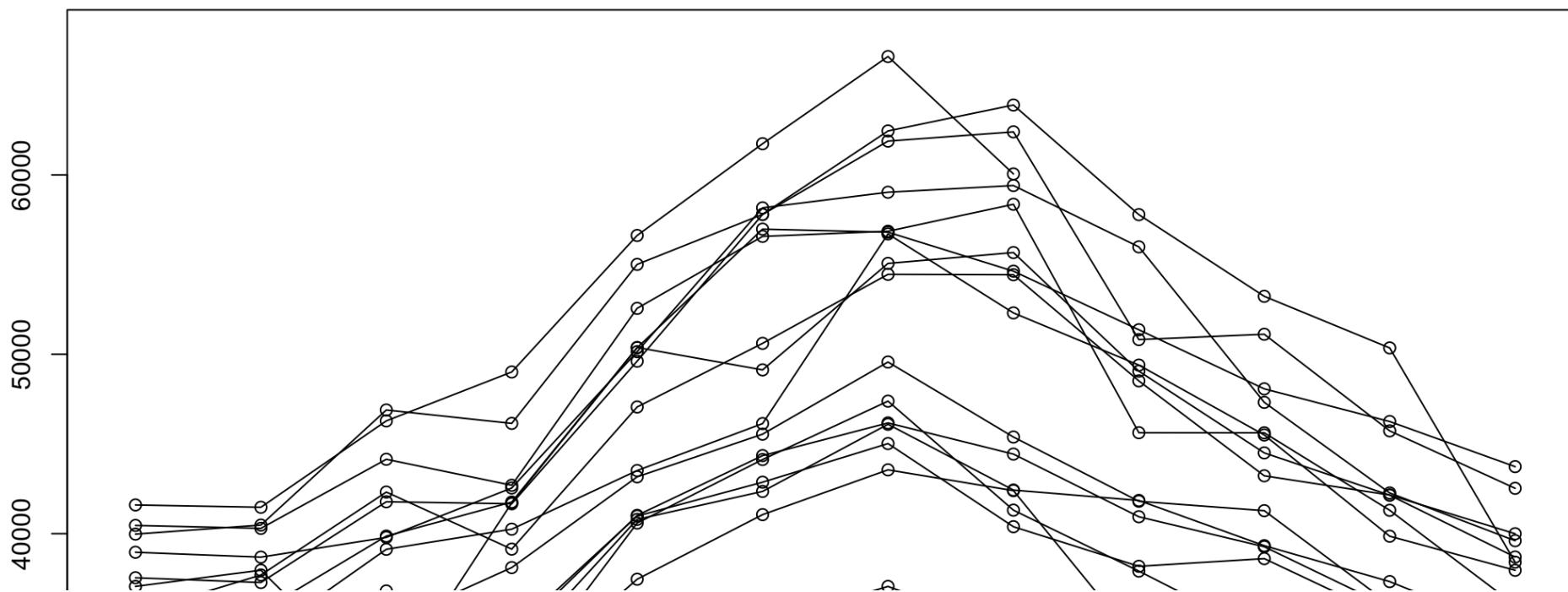
```





Análise de Sazonalidade

Gr?fico da Sazonalidade



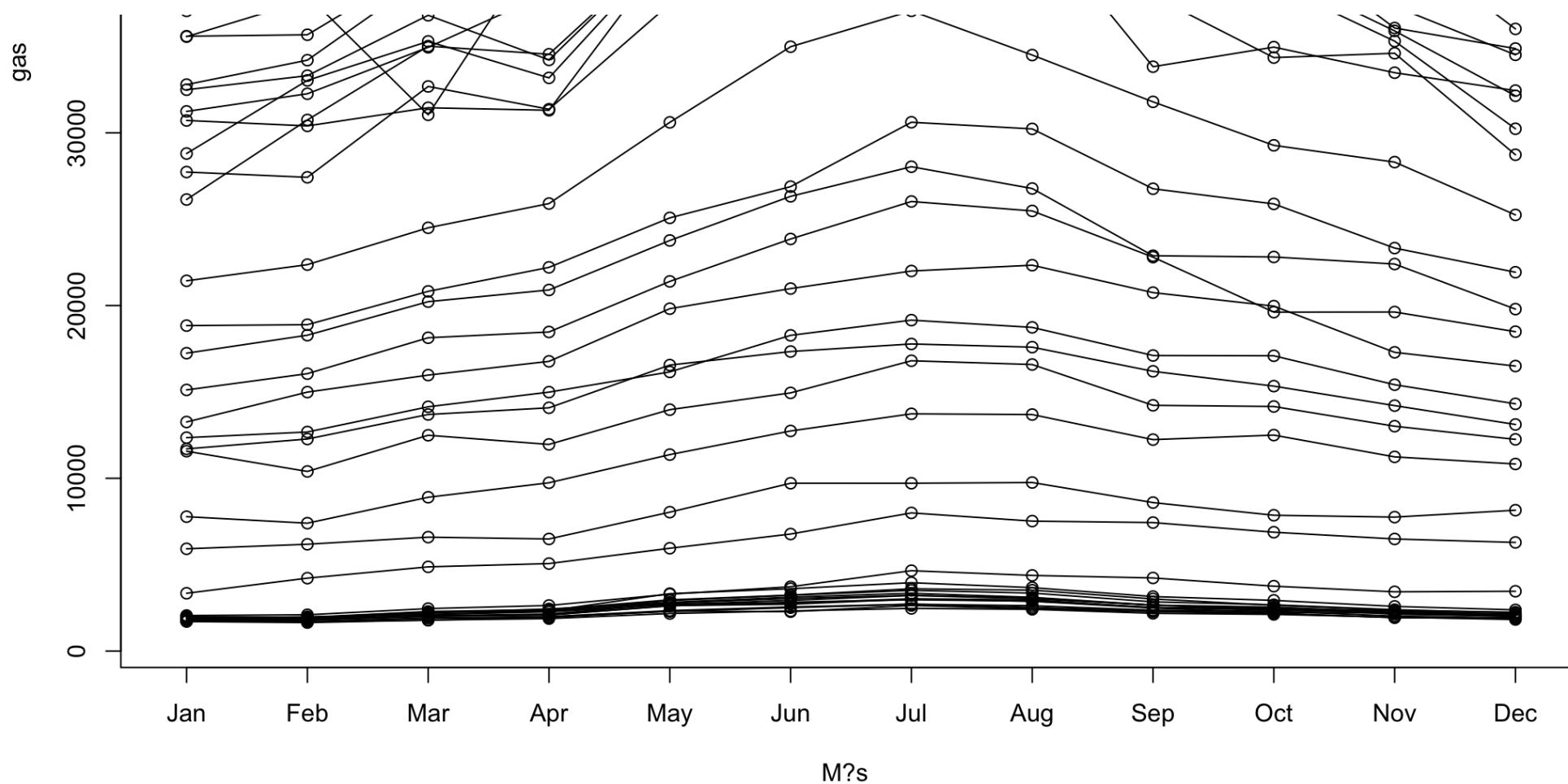
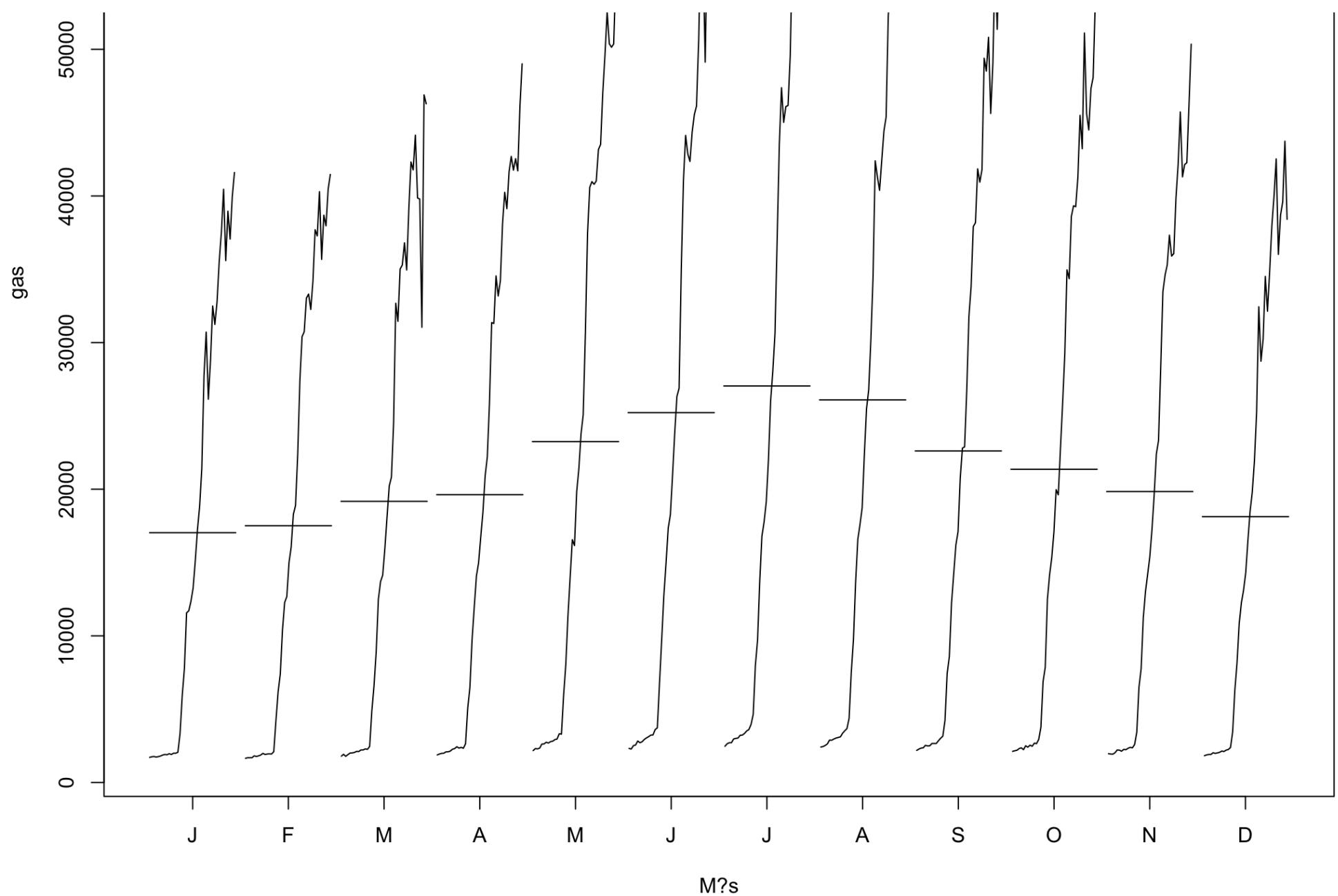


Gráfico de Crescimento Mensal

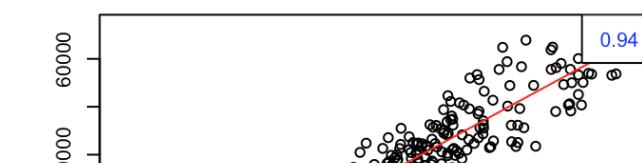
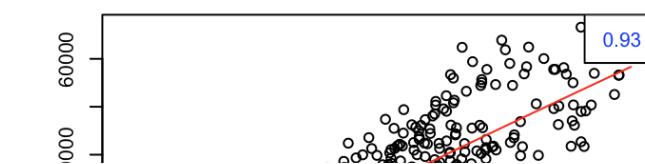
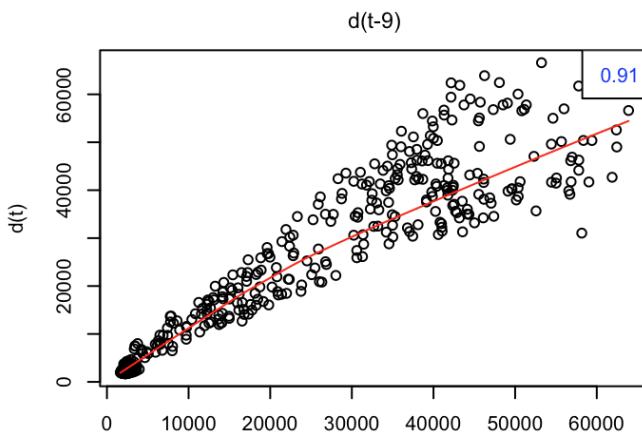
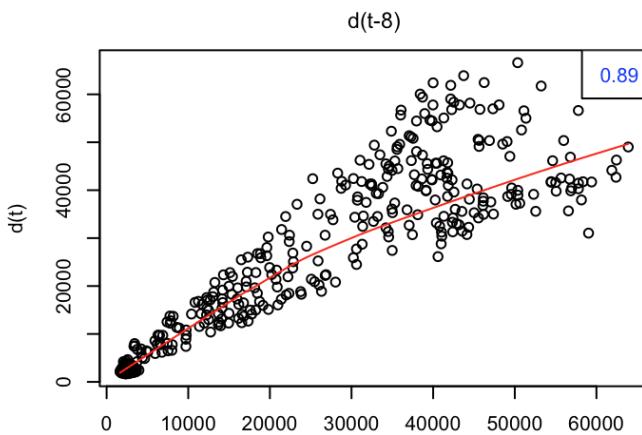
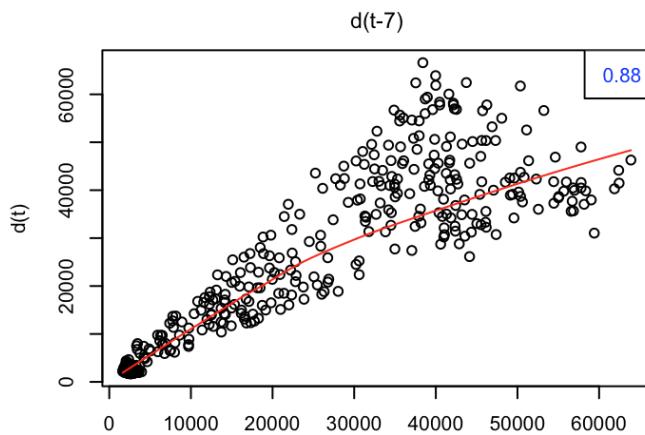
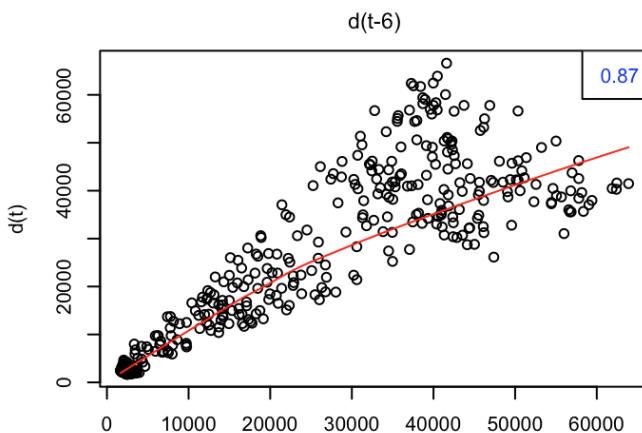
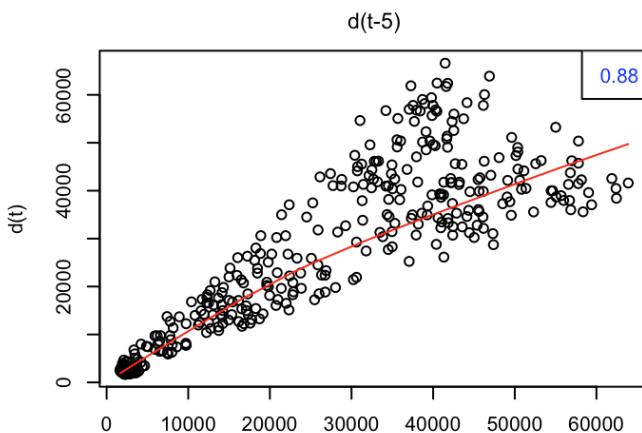
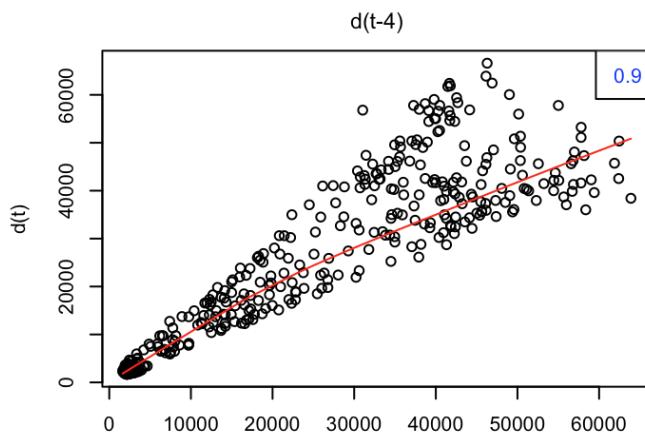
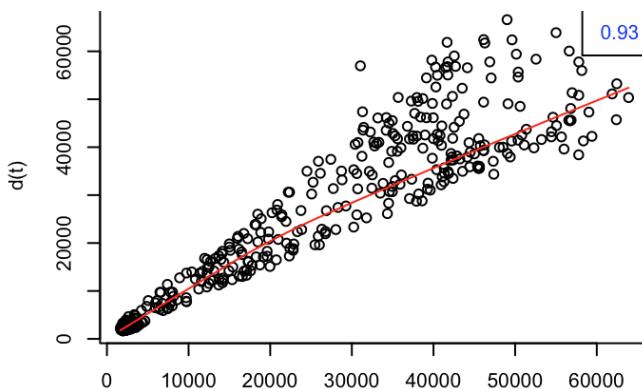
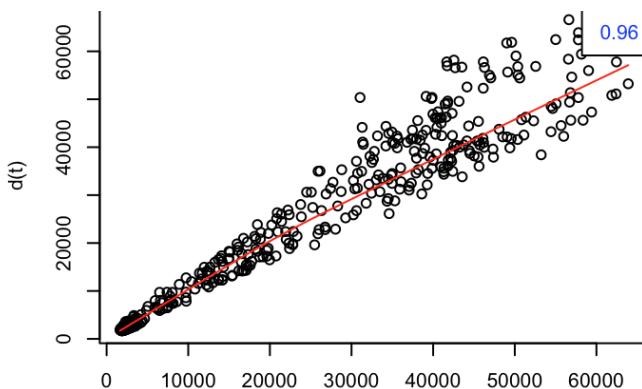
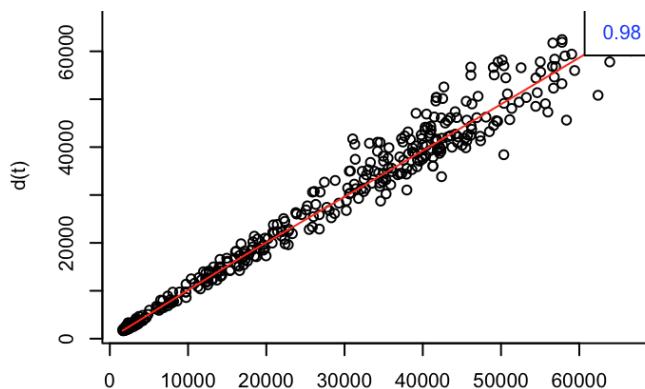


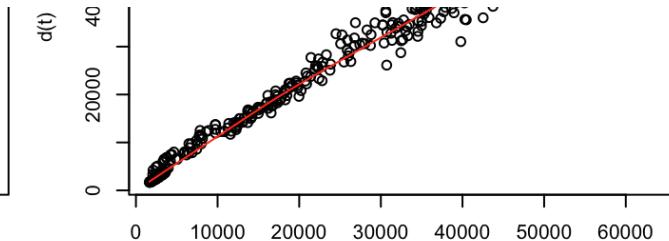
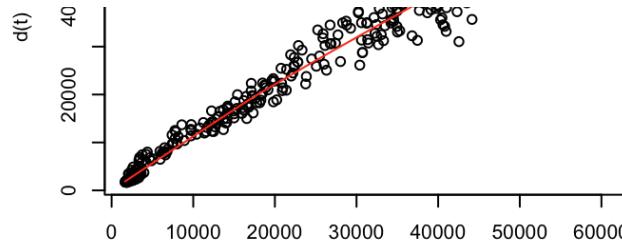
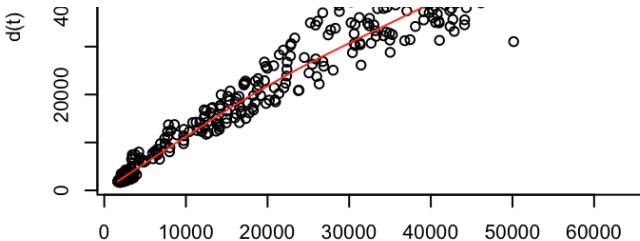
Sazonalidade - Autocorrelações

d(t-1)

d(t-2)

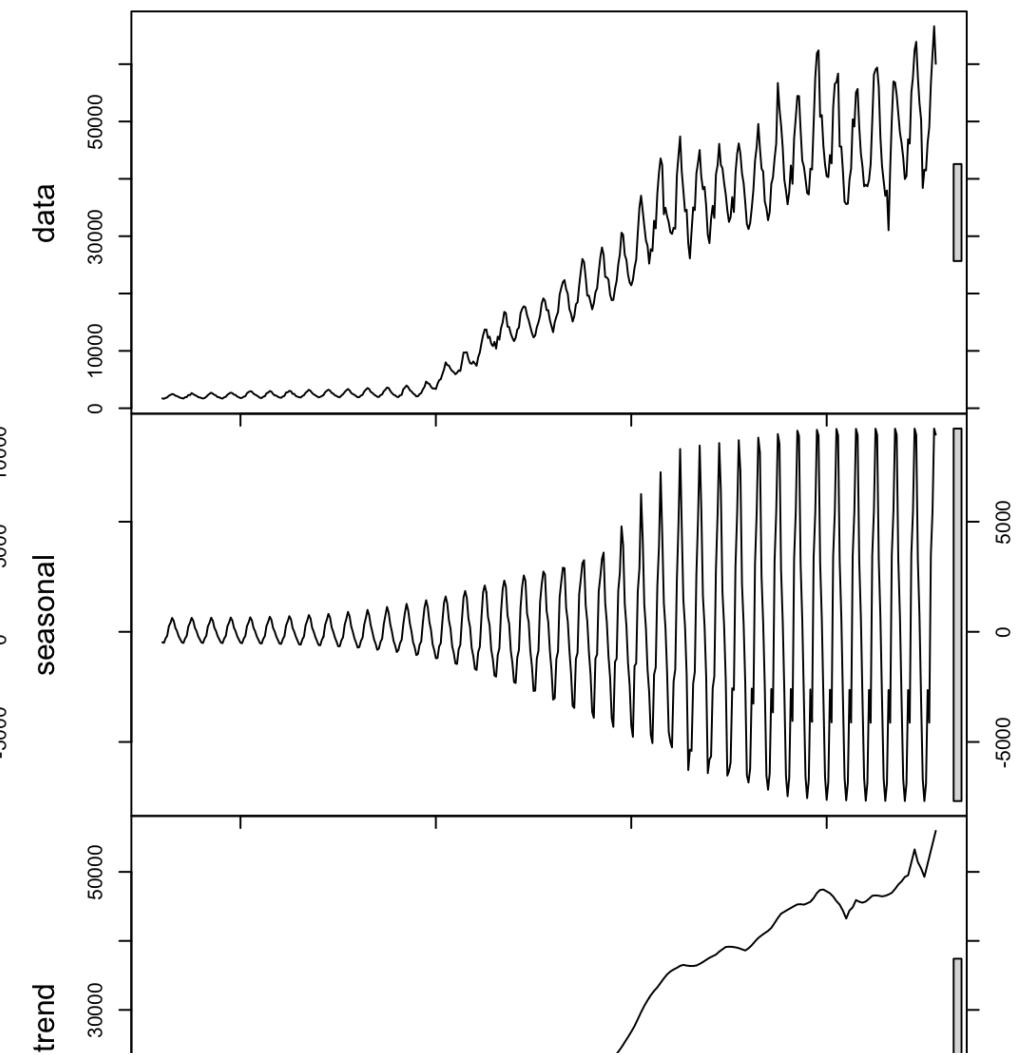
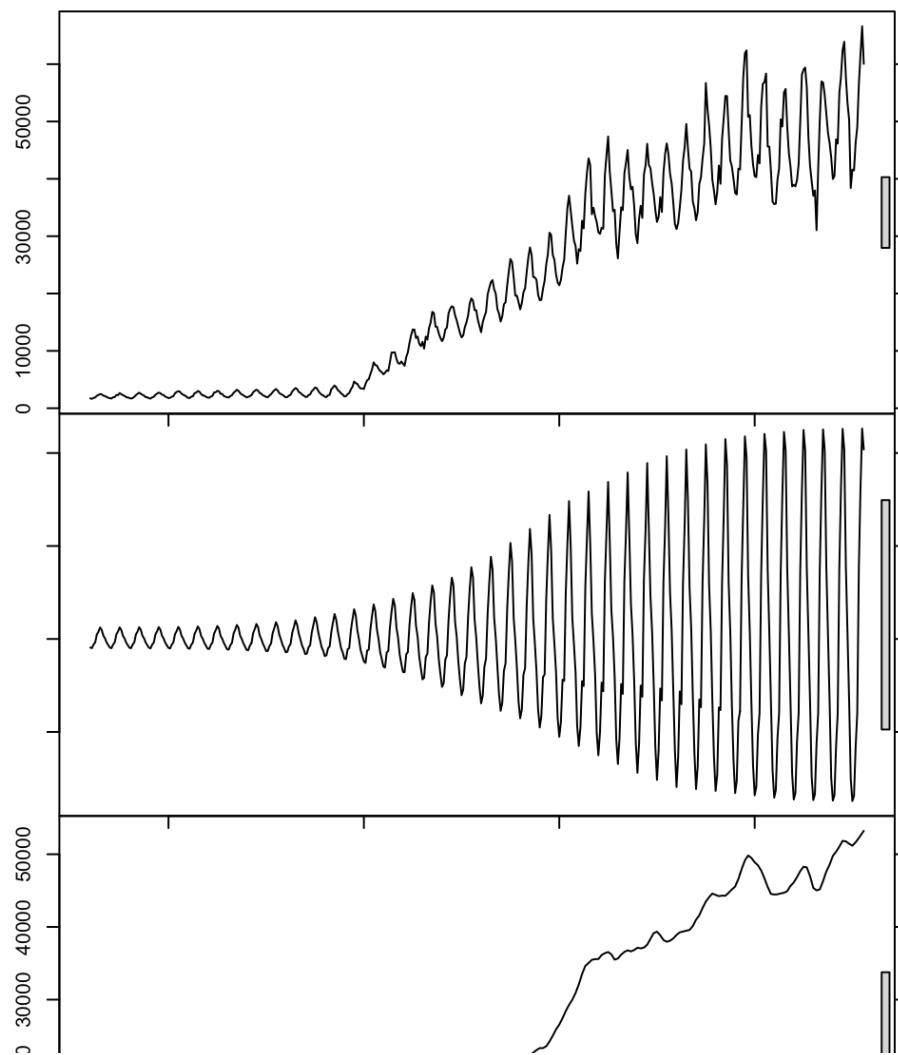
d(t-3)

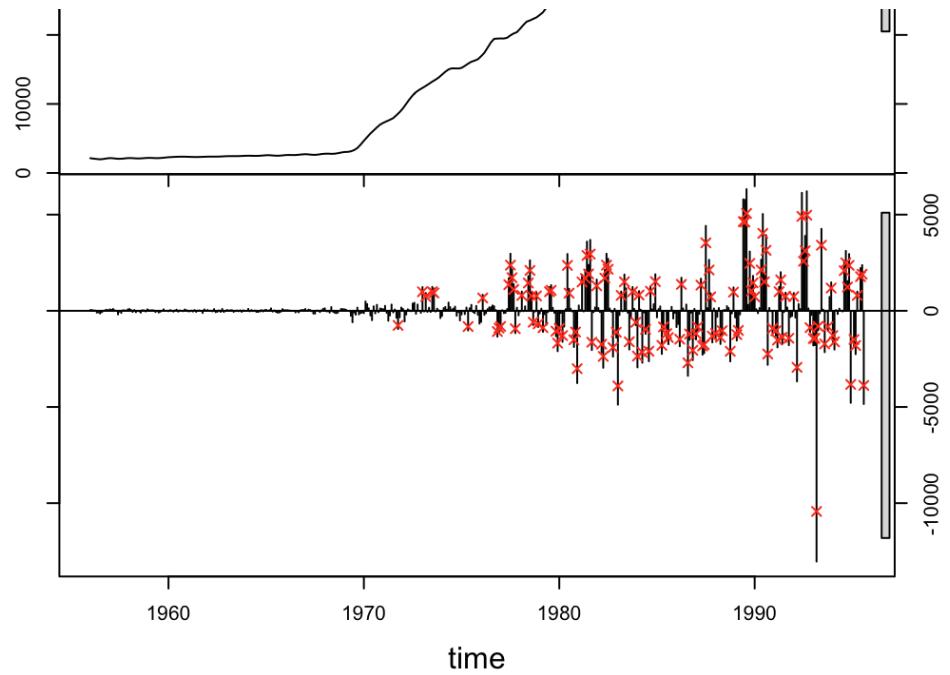
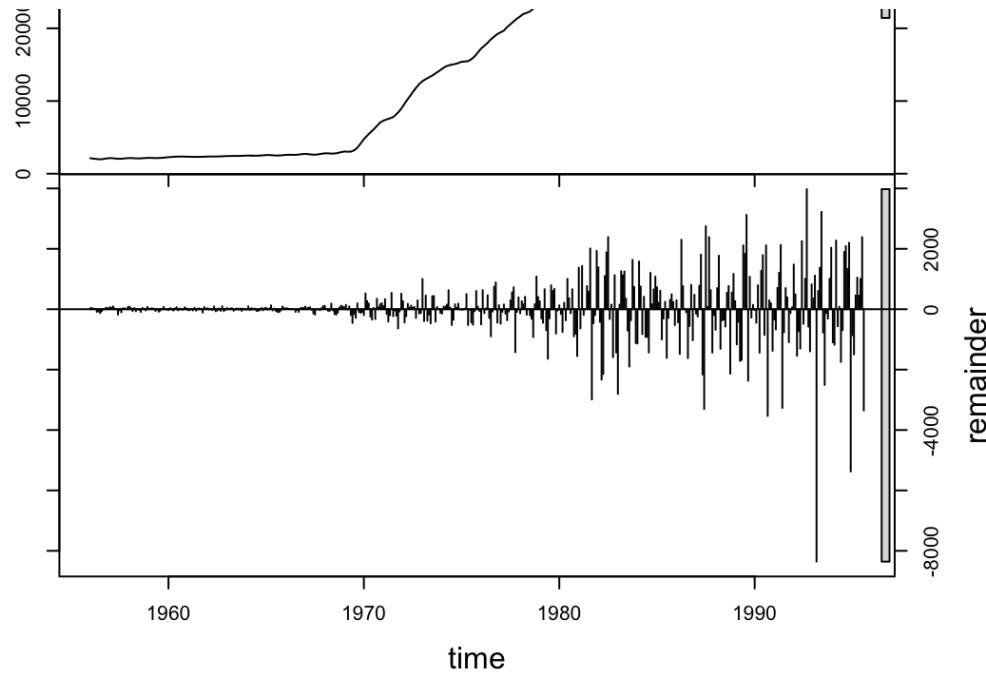




Seasonal Decomposition of Time Series by Loess

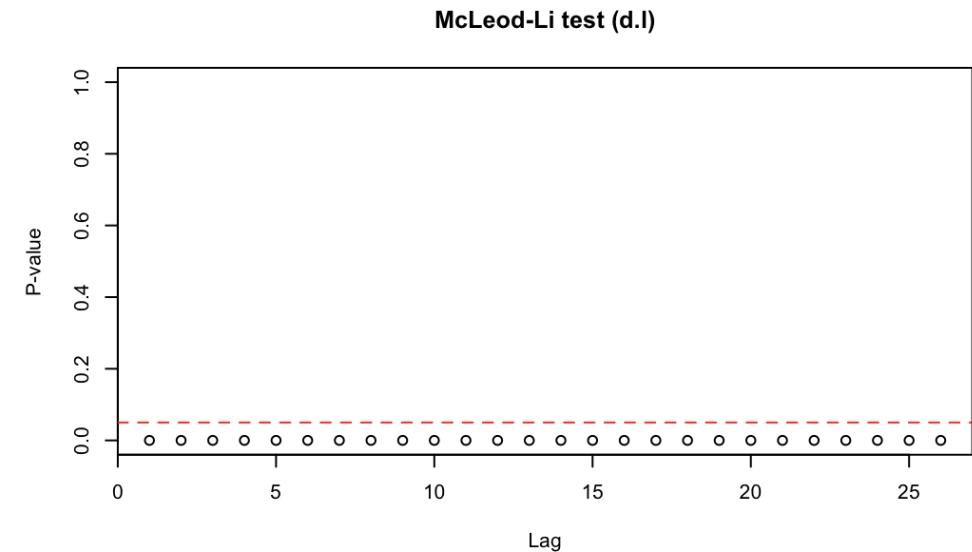
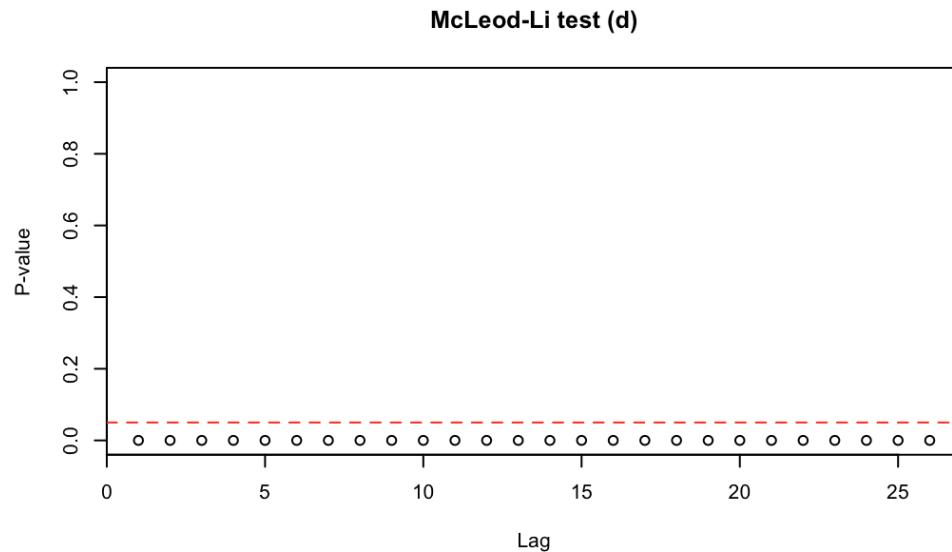
Decompos??o por Loess (Normal / Robusta)



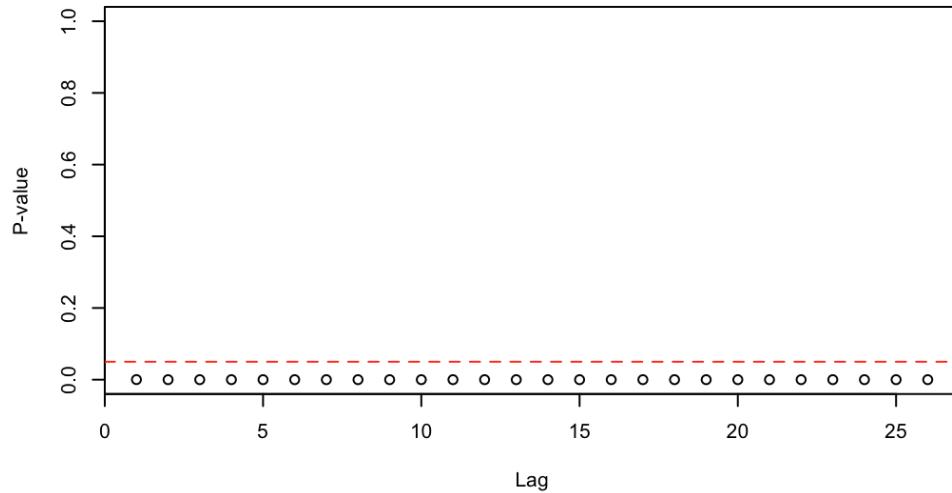


Outros testes

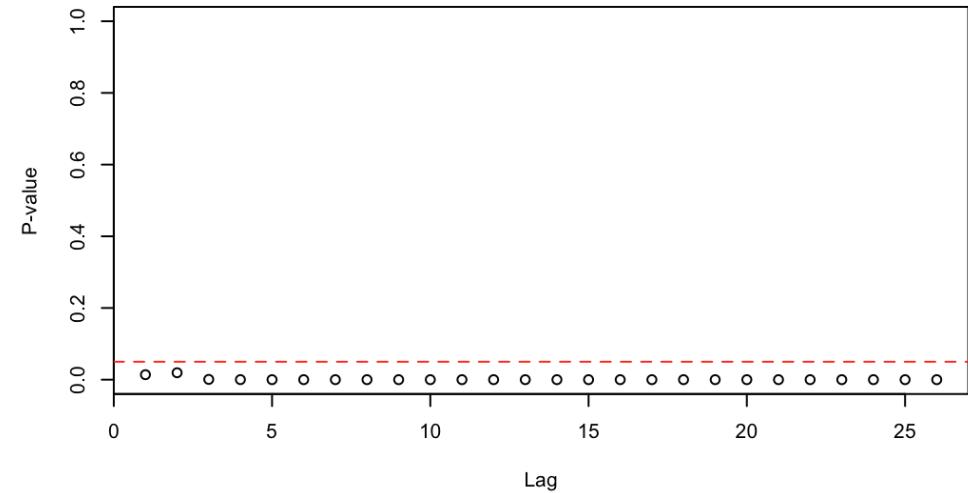
McLeod-Li test for conditional heteroscedascity (ARCH)



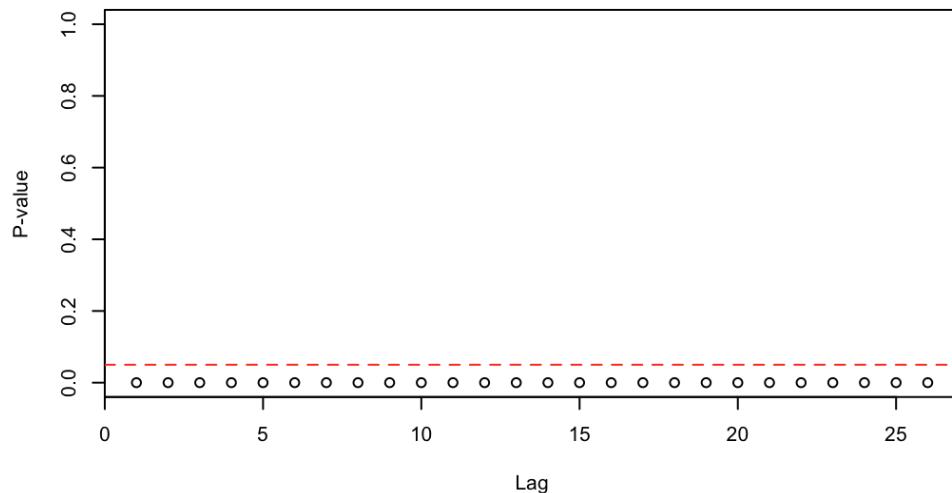
McLeod-Li test (d.d)



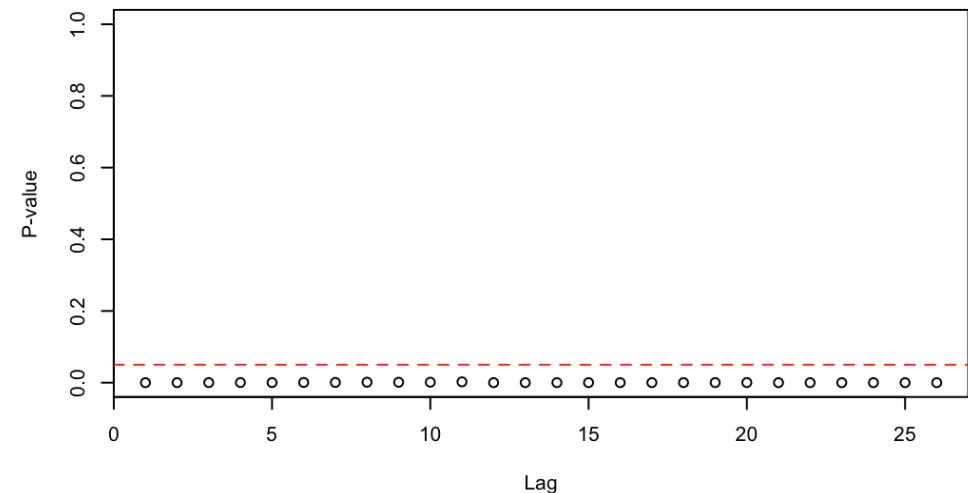
McLeod-Li test (d.dl)



McLeod-Li test (d.dd)



McLeod-Li test (d.ddl)



Projeções

Space-State Model (ETS)

```
## ETS(M,Md,M)
##
## Call:
##   ets(y = d)
##
##   Smoothing parameters:
##     alpha = 0.6534
##     beta  = 0.0282
##     gamma = 1e-04
##     phi   = 0.98
##
##   Initial states:
##     l = 2085.0093
##     b = 0.9965
##     s=0.8476 0.919 1.004 1.072 1.206 1.264
##                  1.176 1.093 0.9198 0.8936 0.8085 0.7973
##
##   sigma: 0.0486
##
##   AIC AICC  BIC
## 8991 8992 9062
##
## Training set error measures:
##      ME RMSE    MAE    MPE  MAPE    MASE    ACF1
## Training set 10.56 1454 791.2 0.1444 3.536 0.4582 -0.1029
```

```
##
## Forecast method: ETS(M,Md,M)
##
## Model Information:
## ETS(M,Md,M)
##
## Call:
##   ets(y = d)
```

```

##  

## Smoothing parameters:  

##   alpha = 0.6534  

##   beta  = 0.0282  

##   gamma = 1e-04  

##   phi   = 0.98  

##  

## Initial states:  

##   l = 2085.0093  

##   b = 0.9965  

##   s=0.8476 0.919 1.004 1.072 1.206 1.264  

##                 1.176 1.093 0.9198 0.8936 0.8085 0.7973  

##  

## sigma: 0.0486  

##  

## AIC AICc  BIC  

## 8991 8992 9062  

##  

## Error measures:  

##      ME RMSE    MAE    MPE   MAPE    MASE    ACF1  

## Training set 10.56 1454 791.2 0.1444 3.536 0.4241 -0.1029  

##  

## Forecasts:  

##      Point Forecast Lo 80  Hi 80 Lo 95  Hi 95  

## Sep 1995      54570 51156 58071 49448 59848  

## Oct 1995      51150 47429 55205 45518 57321  

## Nov 1995      46882 42881 51189 40957 53604  

## Dec 1995      43284 39065 47884 37177 50360  

## Jan 1996      40760 36370 45591 34150 48307  

## Feb 1996      41378 36436 46638 34310 49795  

## Mar 1996      45775 40040 52019 37476 55789  

## Apr 1996      47167 40795 54149 37740 58404  

## May 1996      56089 48044 65011 44369 70324  

## Jun 1996      60426 51219 70641 46955 76977  

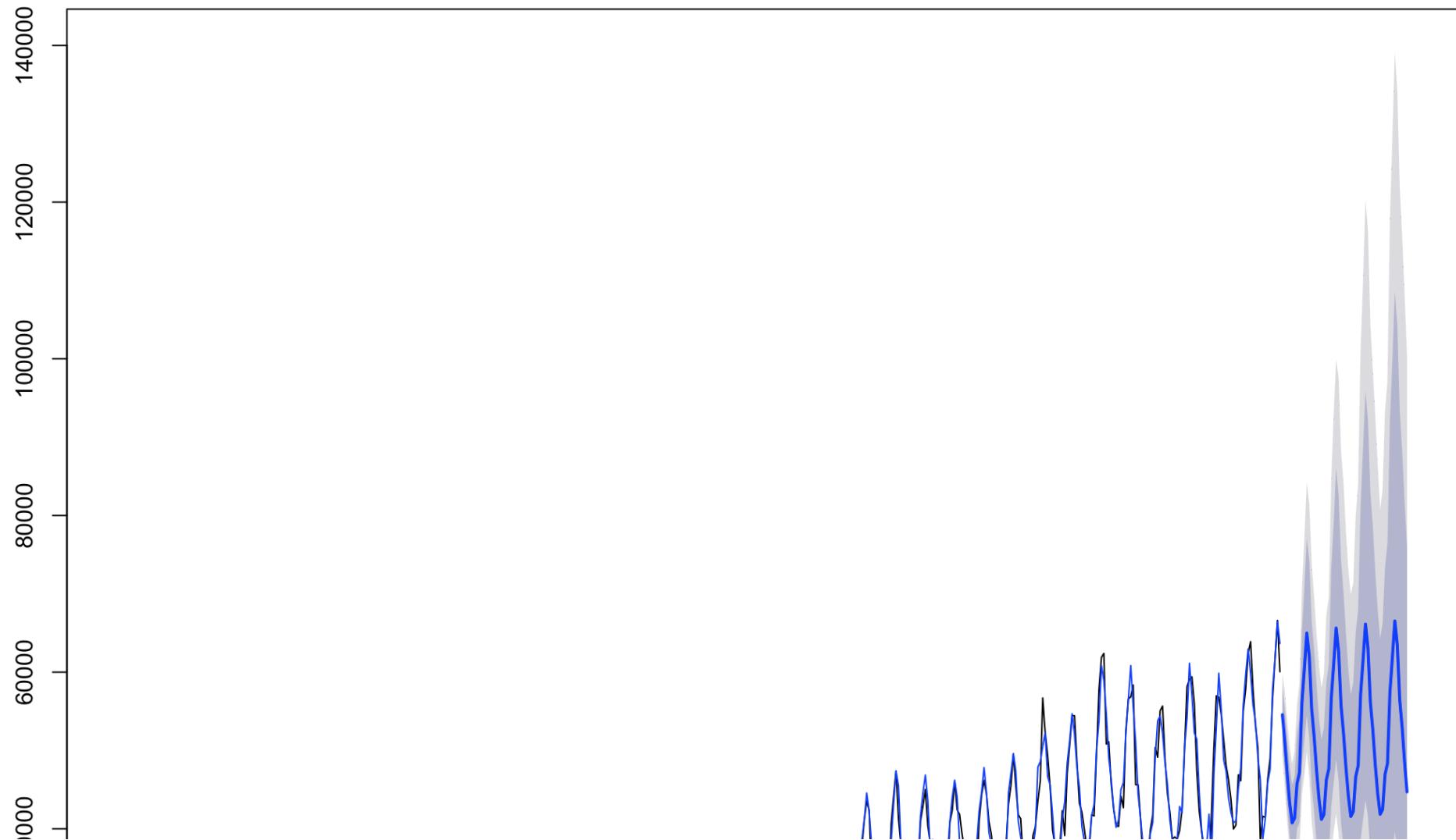
## Jul 1996      64992 54501 77065 49918 84178

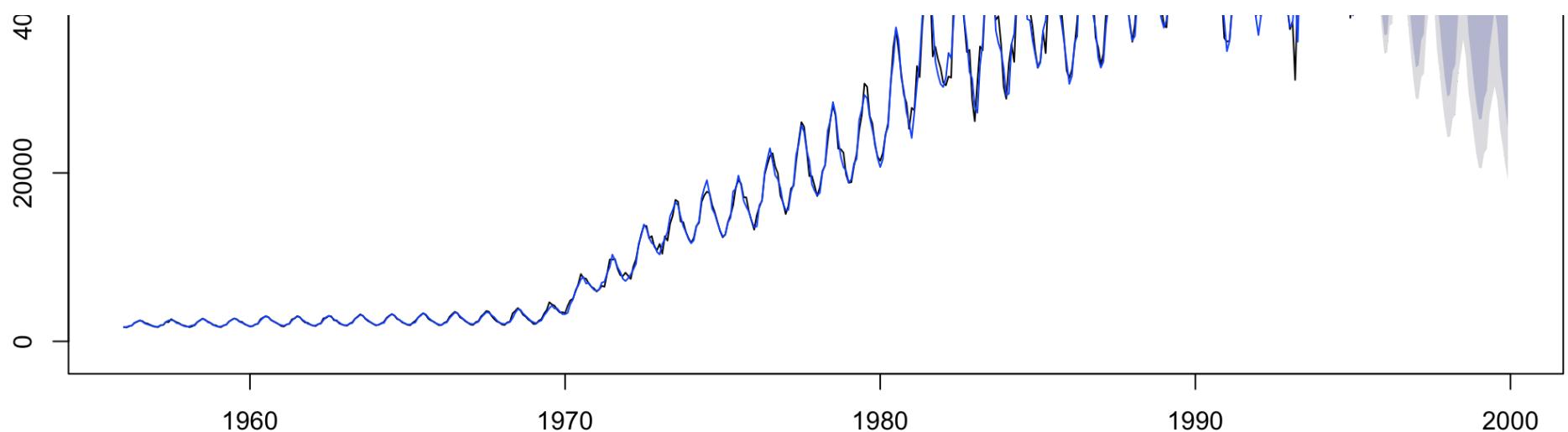
```

## Aug 1996	62055	51572	74263	46777	81427
## Sep 1996	55226	45398	66424	40966	73628
## Oct 1996	51753	42164	62817	37778	69495
## Nov 1996	47424	38180	58248	34539	64603
## Dec 1996	43774	34991	54001	31158	60809
## Jan 1997	41212	32516	51393	28770	57959
## Feb 1997	41827	32785	52910	28843	59708
## Mar 1997	46263	35788	58653	31345	67299
## Apr 1997	47659	36479	61044	31801	69497
## May 1997	56663	42878	73173	36967	84472
## Jun 1997	61032	45883	79002	39719	92763
## Jul 1997	65630	48865	86051	41920	99942
## Aug 1997	62652	46201	82514	39389	97556
## Sep 1997	55747	40728	74206	34649	88116
## Oct 1997	52232	37725	70198	31990	84104
## Nov 1997	47853	34300	64807	28850	77836
## Dec 1997	44163	31250	60204	26229	72960
## Jan 1998	41571	29043	57124	24270	69895
## Feb 1998	42184	29367	58647	24317	71341
## Mar 1998	46649	32107	65126	26455	79908
## Apr 1998	48049	32904	67929	26967	83869
## May 1998	57117	38525	81132	31445	100968
## Jun 1998	61511	41221	88531	33720	109726
## Jul 1998	66135	43698	95866	35887	120245
## Aug 1998	63125	41586	92187	33784	116235
## Sep 1998	56159	36657	82905	29554	104336
## Oct 1998	52610	33790	78596	27401	98317
## Nov 1998	48193	30856	72741	24566	92553
## Dec 1998	44470	28229	67856	22246	86357
## Jan 1999	41854	26322	64236	20605	80634
## Feb 1999	42466	26420	66210	20548	83296
## Mar 1999	46954	28893	73360	22406	93313
## Apr 1999	48358	29769	76481	22838	97186
## May 1999	57476	34713	92123	27068	117618
## Jun 1999	61890	37101	99699	28777	128067

```
## Jul 1999      66535 39590 108604 30358 139132
## Aug 1999      63499 37263 104245 28583 134033
## Sep 1999      56485 32880  93378 25298 121756
## Oct 1999      52909 30494  88167 23330 115450
## Nov 1999      48461 27884  81526 21021 107953
## Dec 1999      44713 25395  75952 19290 100175
```

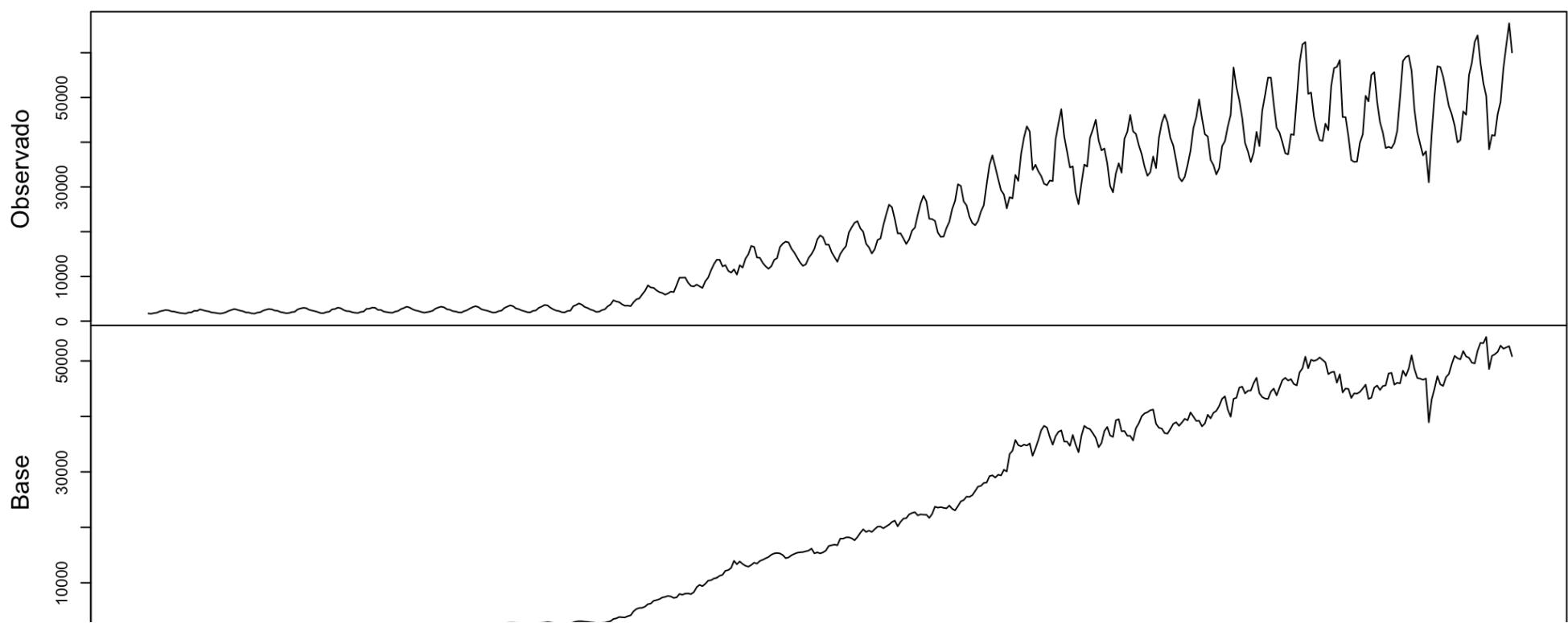
Australian monthly gas production - Previs?o ETS

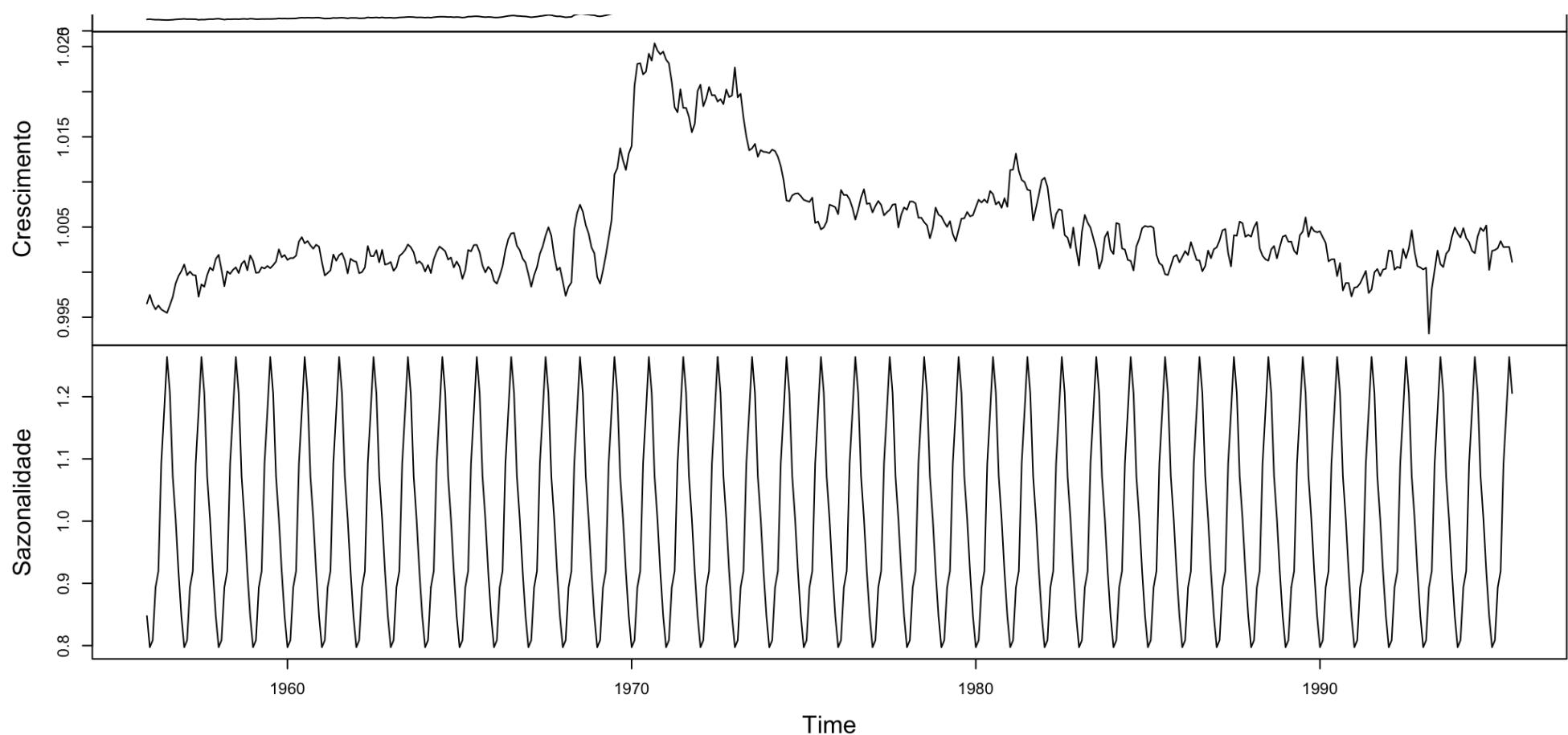




Modelo: ETS(M,Md,M)

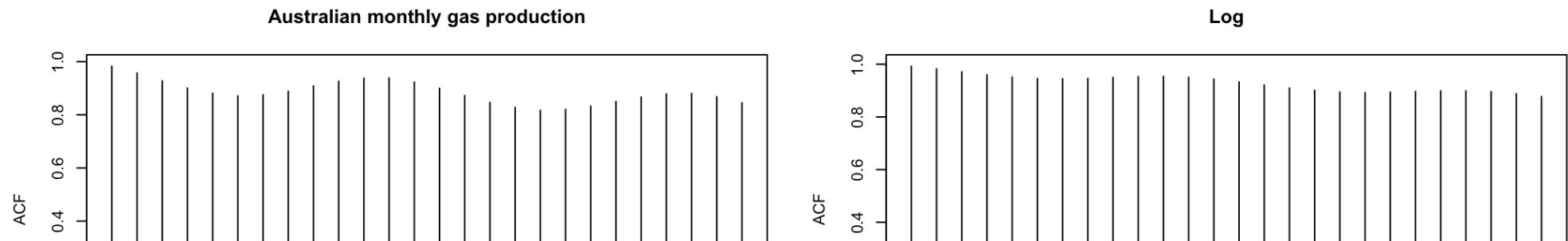
Decomposi??o

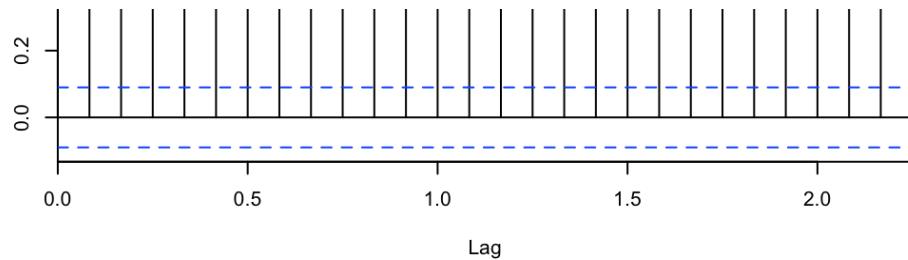




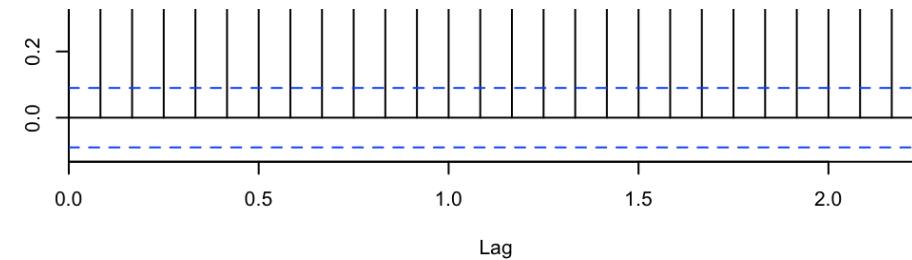
Arima - Pr? an?lise

Arima - Autocorrelation

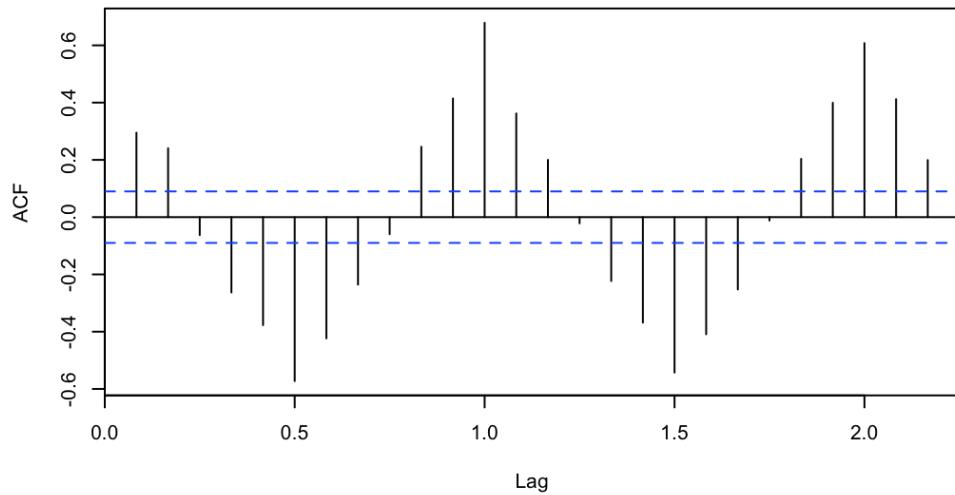




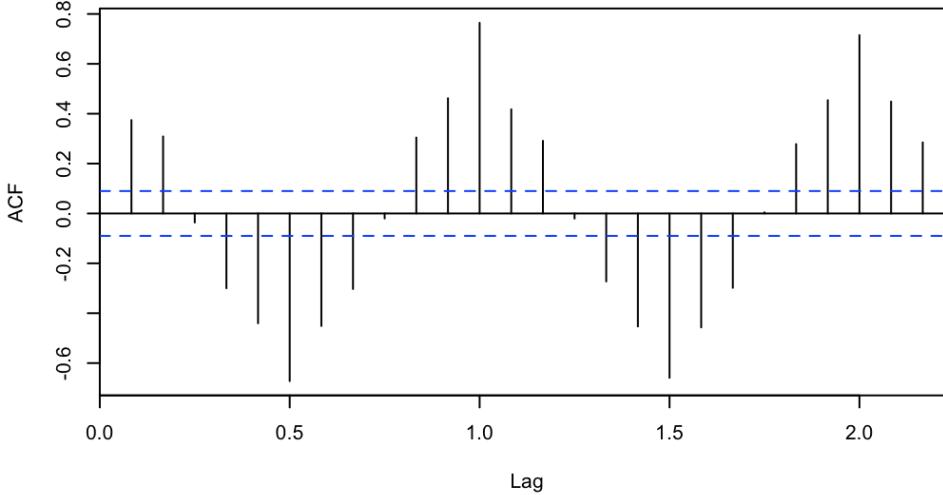
Diferen?a



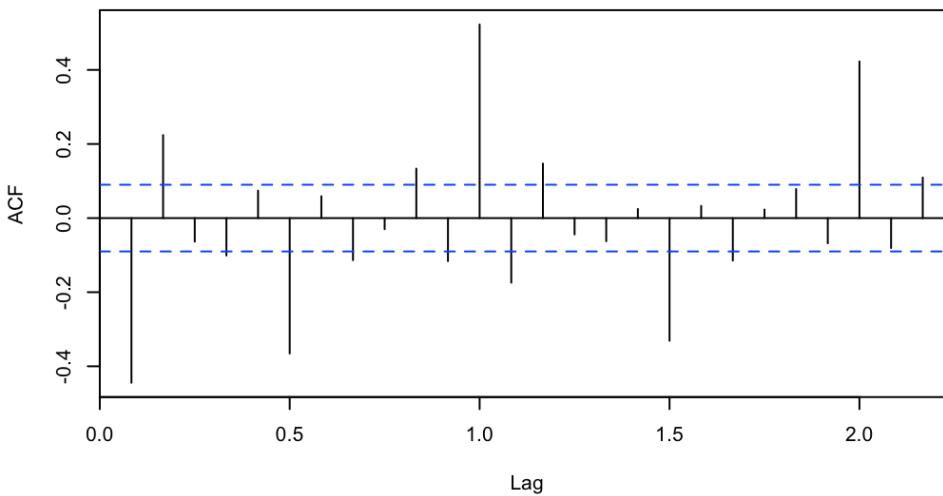
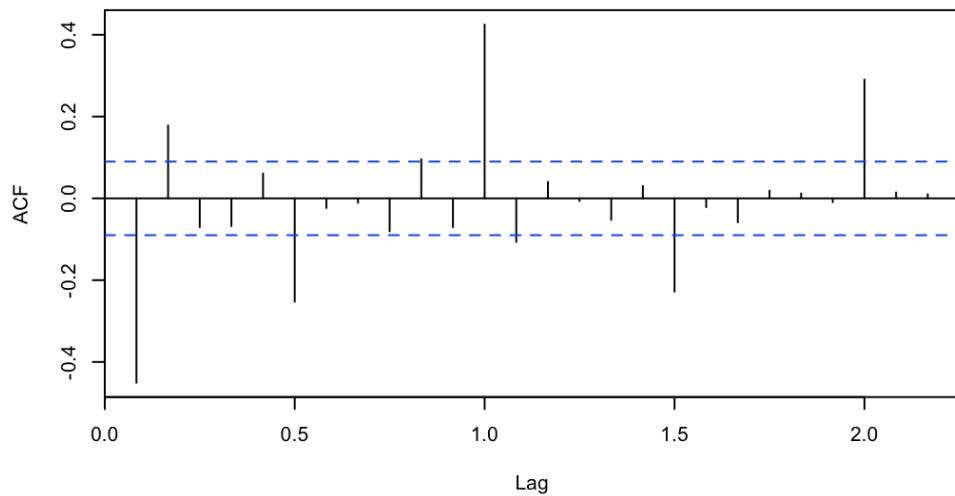
Diferen?a dos Logs



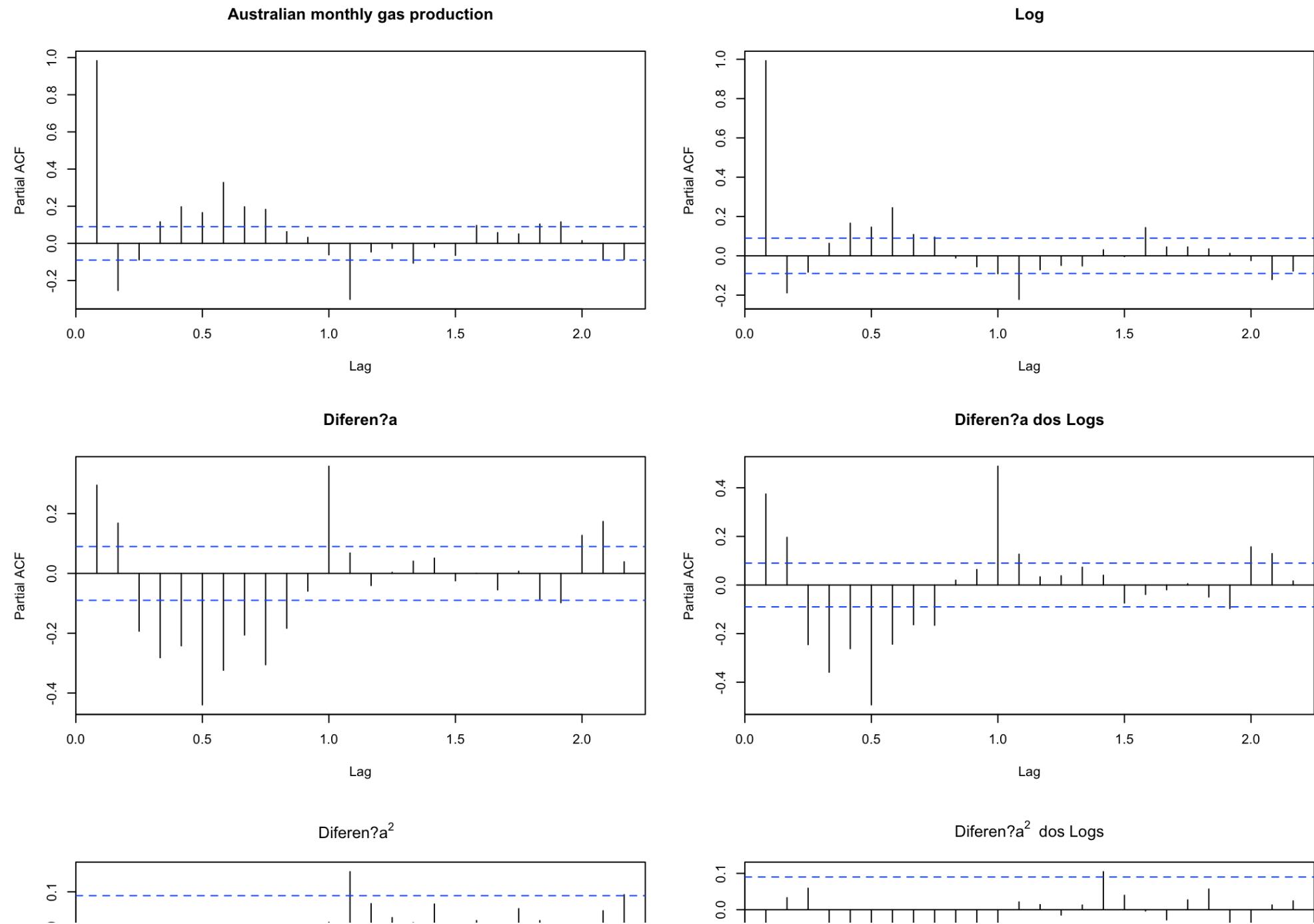
Diferen?a²

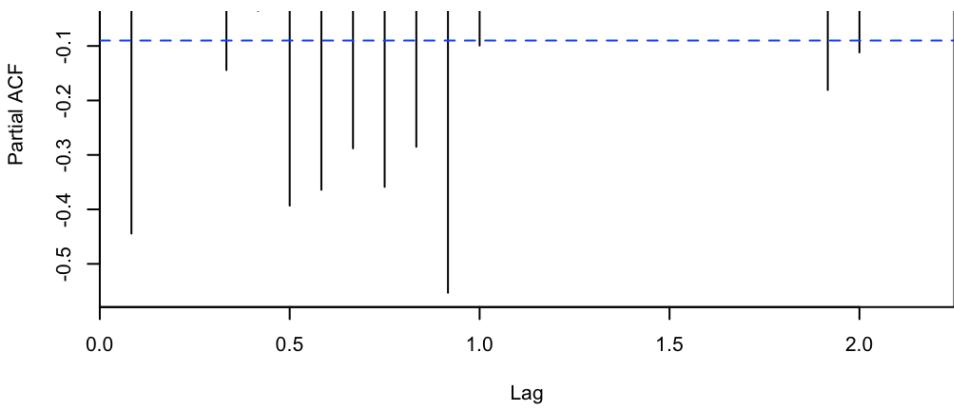
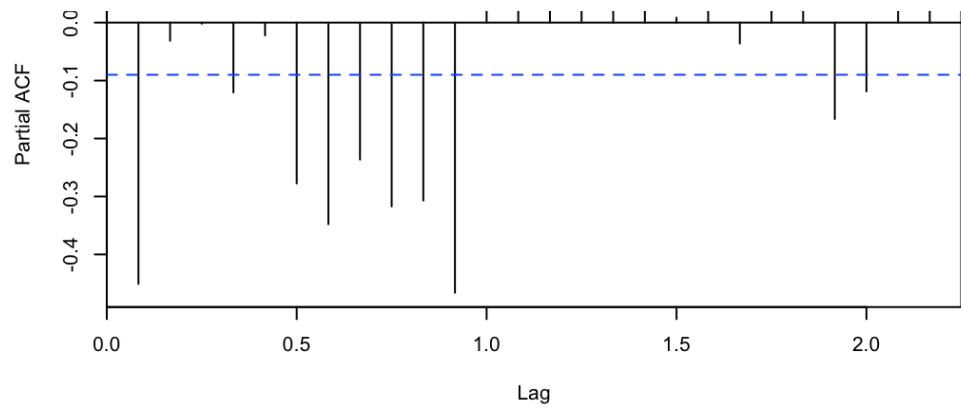


Diferen?a² dos Logs



Arima - Partial Autocorrelation





Arima - Proje??o

```

## 
##  ARIMA(2,1,2)(1,0,1)[12] with drift      : Inf
##  ARIMA(0,1,0) with drift      : 8882
##  ARIMA(1,1,0)(1,0,0)[12] with drift      : 8506
##  ARIMA(0,1,1)(0,0,1)[12] with drift      : 8695
##  ARIMA(1,1,0) with drift      : 8841
##  ARIMA(1,1,0)(2,0,0)[12] with drift      : 8456
##  ARIMA(1,1,0)(2,0,1)[12] with drift      : Inf
##  ARIMA(0,1,0)(2,0,0)[12] with drift      : 8523
##  ARIMA(2,1,0)(2,0,0)[12] with drift      : 8450
##  ARIMA(2,1,1)(2,0,0)[12] with drift      : 8422
##  ARIMA(3,1,2)(2,0,0)[12] with drift      : Inf
##  ARIMA(2,1,1)(2,0,0)[12]      : 8420
##  ARIMA(2,1,1)(1,0,0)[12]      : 8467
##  ARIMA(2,1,1)(2,0,1)[12]      : Inf
##  ARIMA(1,1,1)(2,0,0)[12]      : Inf
##  ARIMA(3,1,1)(2,0,0)[12]      : Inf
##  ARIMA(2,1,0)(2,0,0)[12]      : 8448
##  ARIMA(2,1,2)(2,0,0)[12]      : 8421
##  ARIMA(1,1,0)(2,0,0)[12]      : 8454
##  ARIMA(3,1,2)(2,0,0)[12]      : Inf
## 
##  Best model: ARIMA(2,1,1)(2,0,0)[12]

```

```

## 
## Forecast method: ARIMA(2,1,1)(2,0,0)[12]
## 
## Model Information:
## Series: d
## ARIMA(2,1,1)(2,0,0)[12]
## 
## Coefficients:
##       ar1     ar2     ma1    sar1    sar2
##       0.472   0.219  -0.956   0.554   0.352

```

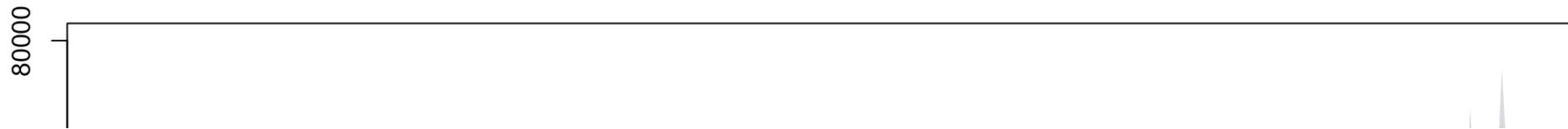
```
## s.e. 0.061 0.058 0.035 0.046 0.046
##
## sigma^2 estimated as 2807497: log likelihood=-4210
## AIC=8431    AICc=8432    BIC=8456
##
## Error measures:
##               ME RMSE    MAE    MPE   MAPE   MASE     ACF1
## Training set 100.8 1674 955.2 0.7066 4.236 0.512 -0.01898
##
## Forecasts:
##               Point Forecast Lo 80 Hi 80 Lo 95 Hi 95
## Sep 1995          57436 55288 59583 54152 60720
## Oct 1995          53216 50801 55632 49522 56911
## Nov 1995          51148 48499 53796 47097 55198
## Dec 1995          43604 40823 46385 39351 47857
## Jan 1996          44065 41190 46941 39668 48463
## Feb 1996          44172 41229 47114 39671 48672
## Mar 1996          49107 46114 52100 44529 53685
## Apr 1996          50357 47324 53389 45718 54995
## May 1996          57701 54636 60766 53013 62389
## Jun 1996          61520 58427 64613 56790 66250
## Jul 1996          65855 62738 68971 61088 70621
## Aug 1996          62737 59599 65875 57938 67536
## Sep 1996          59132 55637 62628 53786 64479
## Oct 1996          55190 51567 58813 49649 60731
## Nov 1996          53029 49288 56771 47308 58751
## Dec 1996          44639 40814 48463 38790 50488
## Jan 1997          46019 42127 49912 40066 51972
## Feb 1997          46033 42085 49981 39995 52071
## Mar 1997          50466 46470 54462 44354 56577
## Apr 1997          52119 48081 56157 45943 58295
## May 1997          58872 54796 62949 52639 65106
## Jun 1997          62792 58681 66903 56505 69079
## Jul 1997          66908 62764 71051 60570 73245
## Aug 1997          62873 58698 67047 56488 69257
```

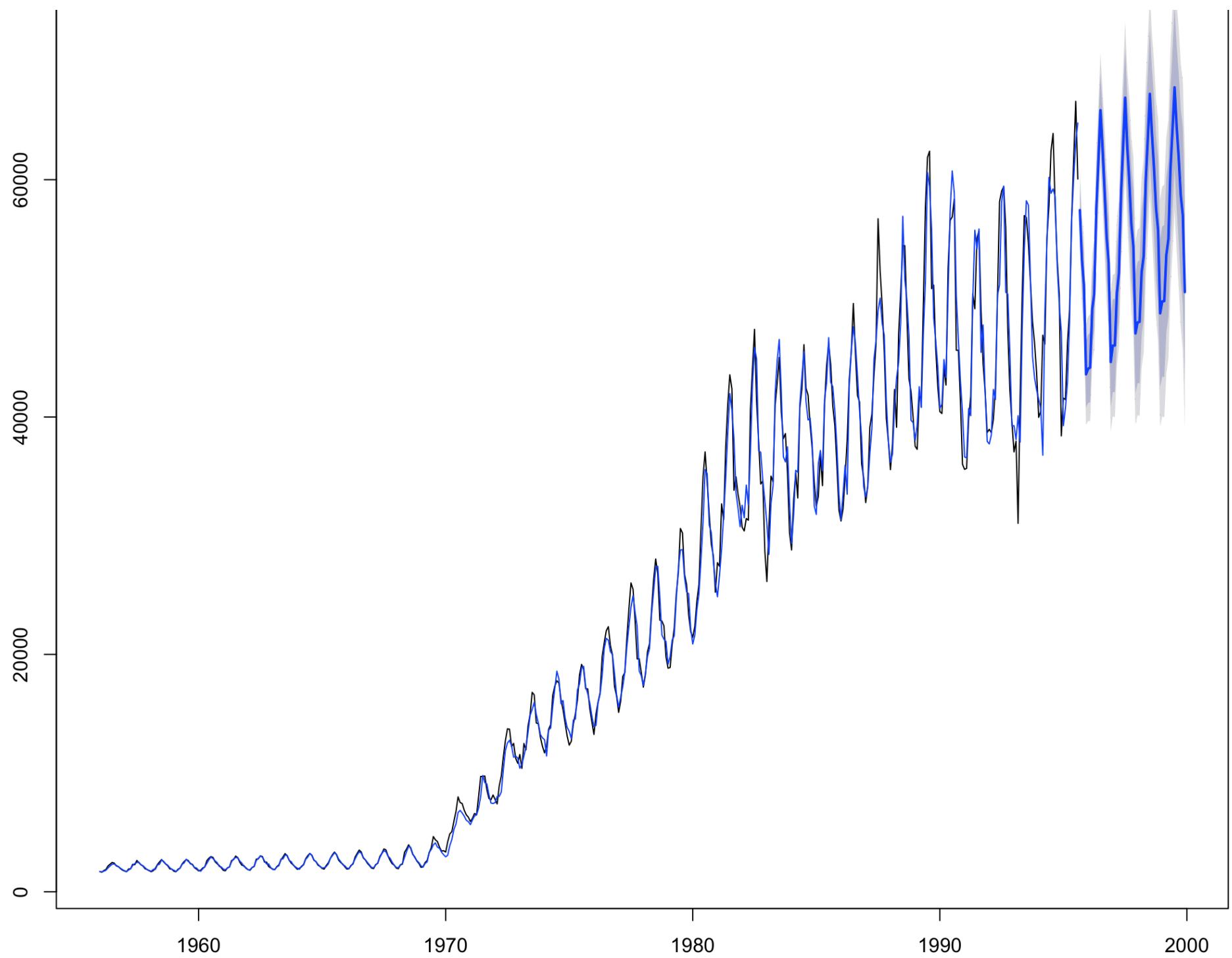
```

## Sep 1997      59952 55359 64545 52927 66977
## Oct 1997      56280 51526 61033 49010 63549
## Nov 1997      54353 49450 59257 46854 61852
## Dec 1997      47044 42031 52057 39377 54711
## Jan 1998      47972 42867 53076 40165 55779
## Feb 1998      48017 42835 53199 40092 55942
## Mar 1998      52213 46964 57462 44185 60241
## Apr 1998      53570 48260 58880 45450 61690
## May 1998      59901 54537 65266 51697 68106
## Jun 1998      63420 58004 68836 55136 71703
## Jul 1998      67229 61764 72694 58871 75587
## Aug 1998      63894 58382 69405 55465 72322
## Sep 1998      61004 55172 66837 52085 69924
## Oct 1998      57579 51600 63558 48435 66724
## Nov 1998      55750 49632 61869 46393 65108
## Dec 1998      48742 42514 54970 39217 58267
## Jan 1999      49742 43420 56065 40072 59413
## Feb 1999      49772 43366 56179 39975 59570
## Mar 1999      53661 47179 60142 43748 63573
## Apr 1999      54995 48444 61546 44976 65014
## May 1999      60885 54269 67501 50767 71003
## Jun 1999      64216 57539 70894 54004 74429
## Jul 1999      67778 61041 74514 57475 78080
## Aug 1999      64507 57714 71301 54117 74897
## Sep 1999      61876 54784 68968 51030 72723
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## Nov 1999      56991 49606 64376 45697 68285
## Dec 1999      50531 43030 58032 39059 62002

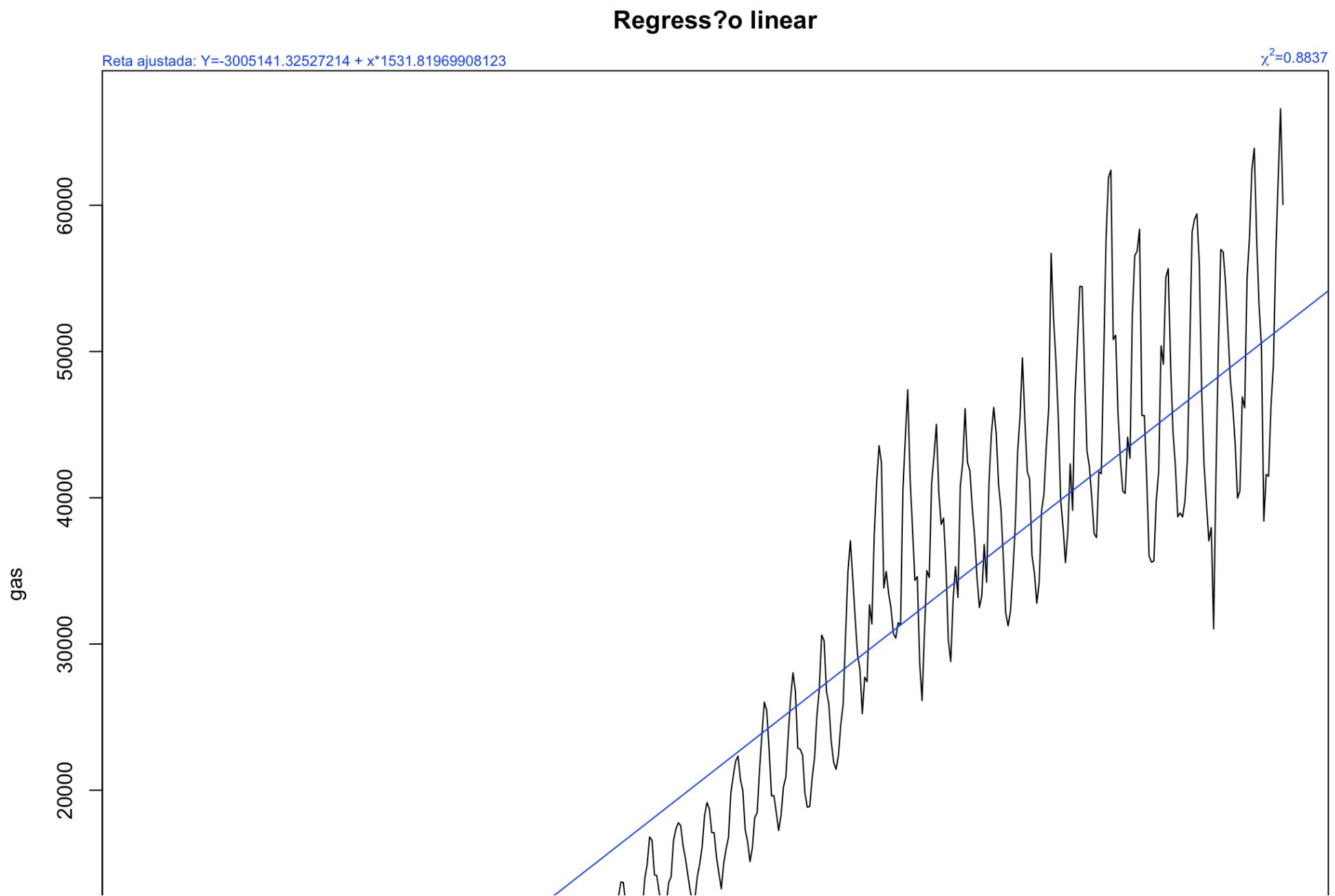
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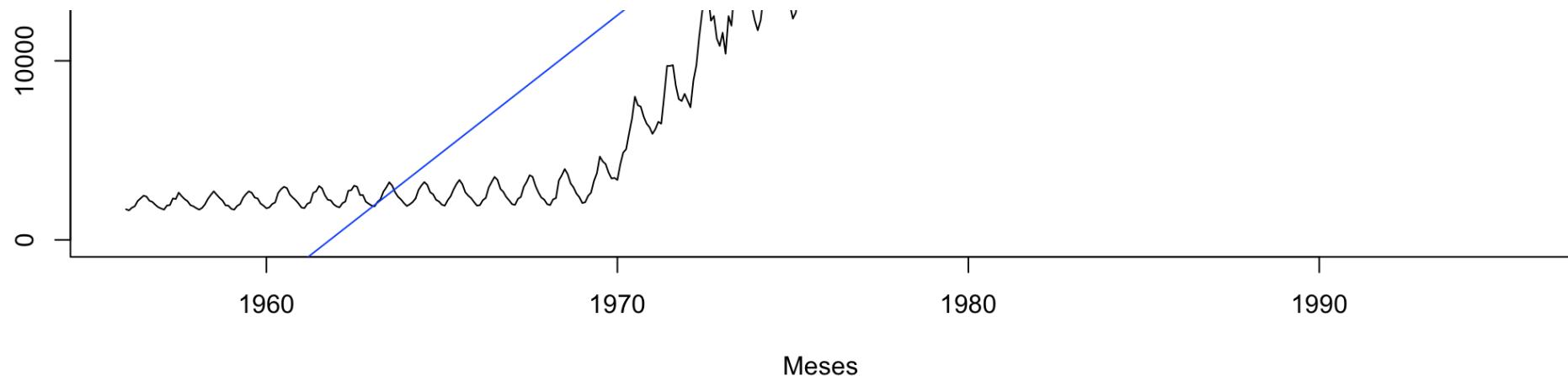
Australian monthly gas production - Previsão ARIMA



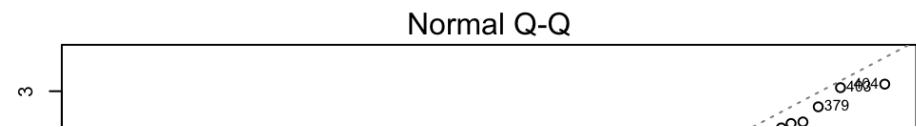
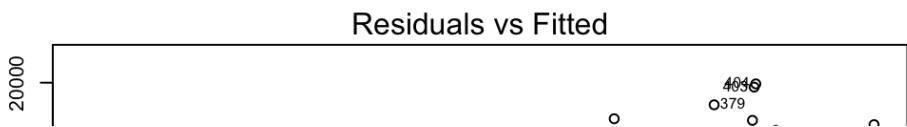


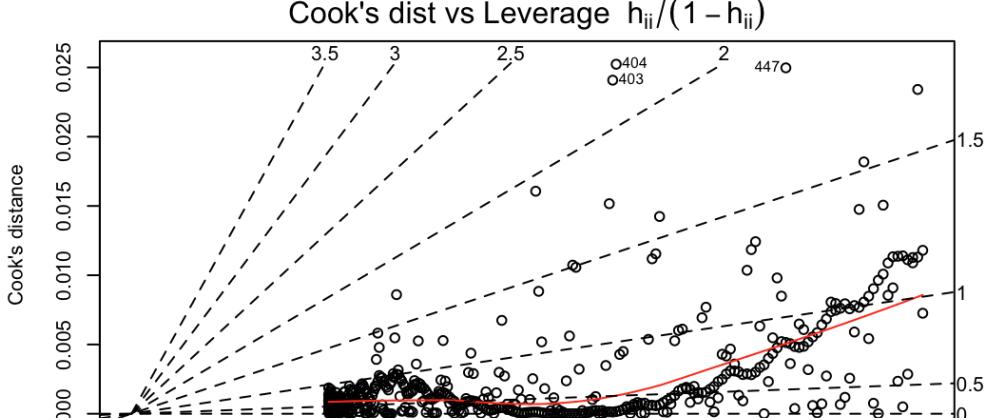
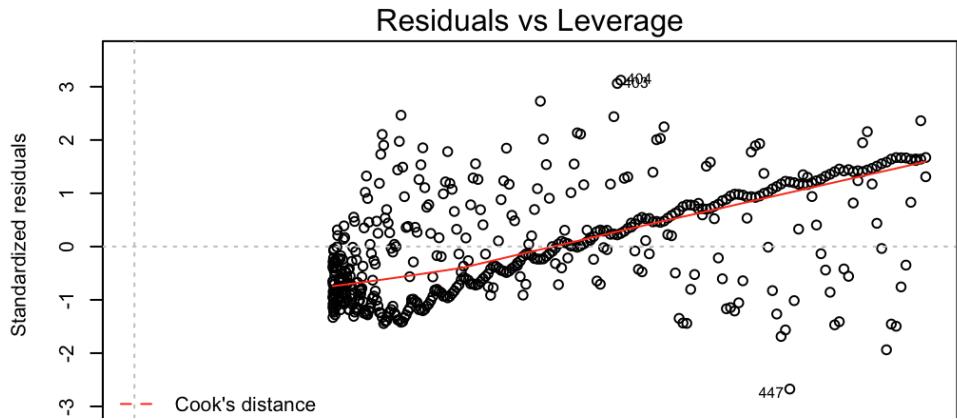
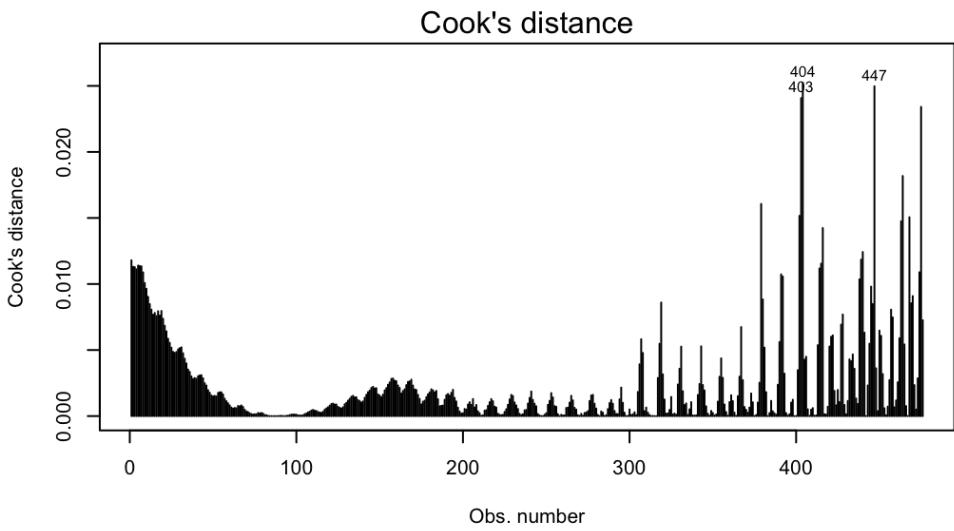
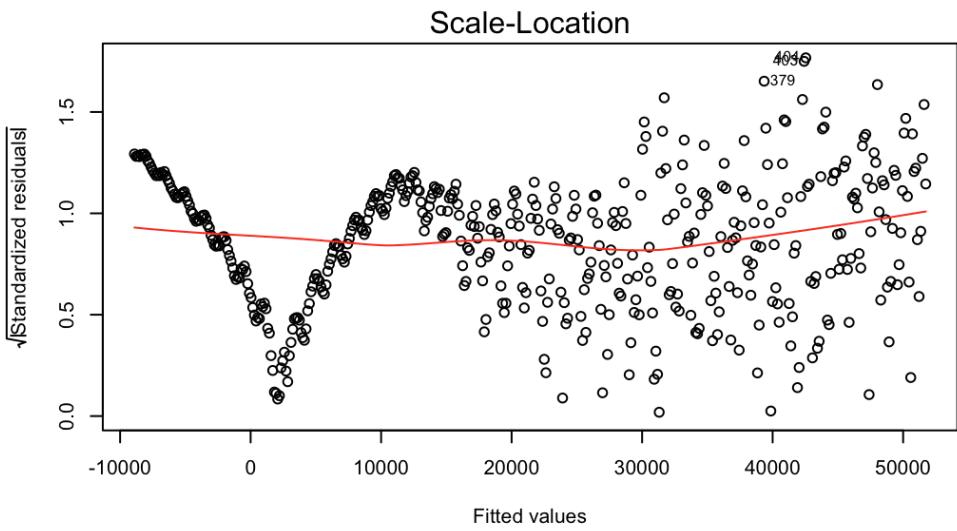
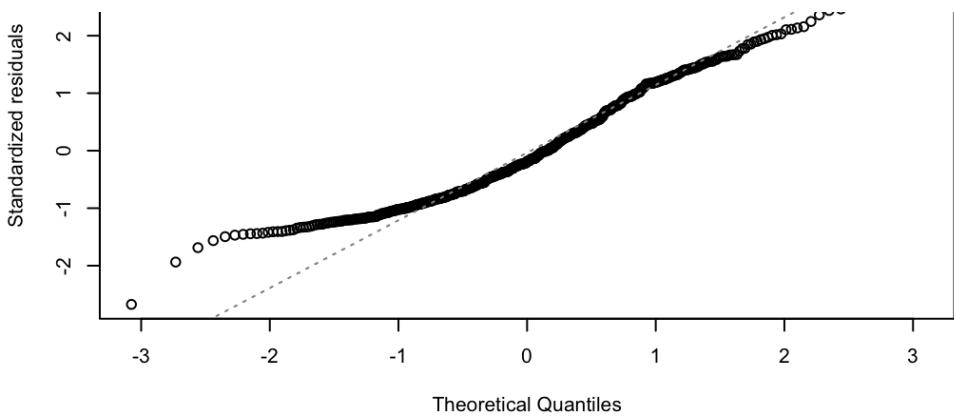
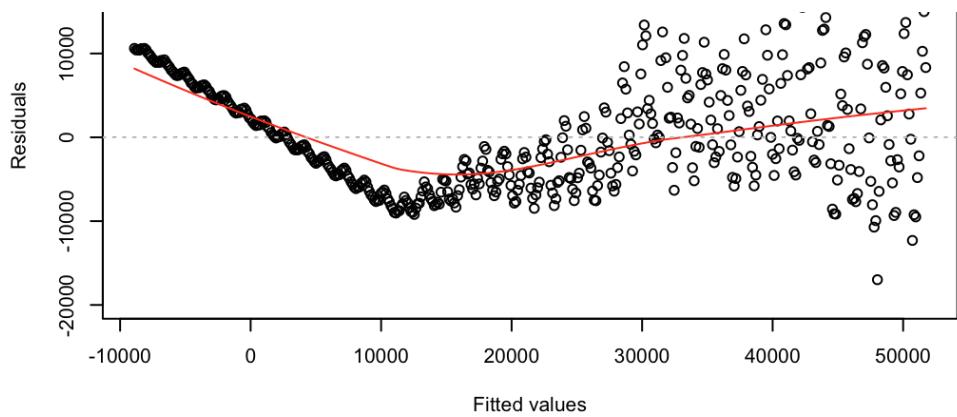
Linear Model

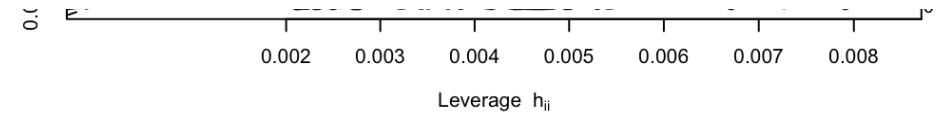
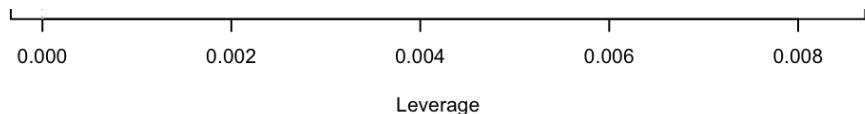




```
##
## Call:
## lm(formula = d ~ time(d))
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -16988  -5263  -1184   4830  19858
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -3.01e+06  5.04e+04  -59.6  <2e-16 ***
## time(d)      1.53e+03  2.55e+01    60.0  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 6380 on 474 degrees of freedom
## Multiple R-squared:  0.884, Adjusted R-squared:  0.883
## F-statistic: 3.6e+03 on 1 and 474 DF,  p-value: <2e-16
```



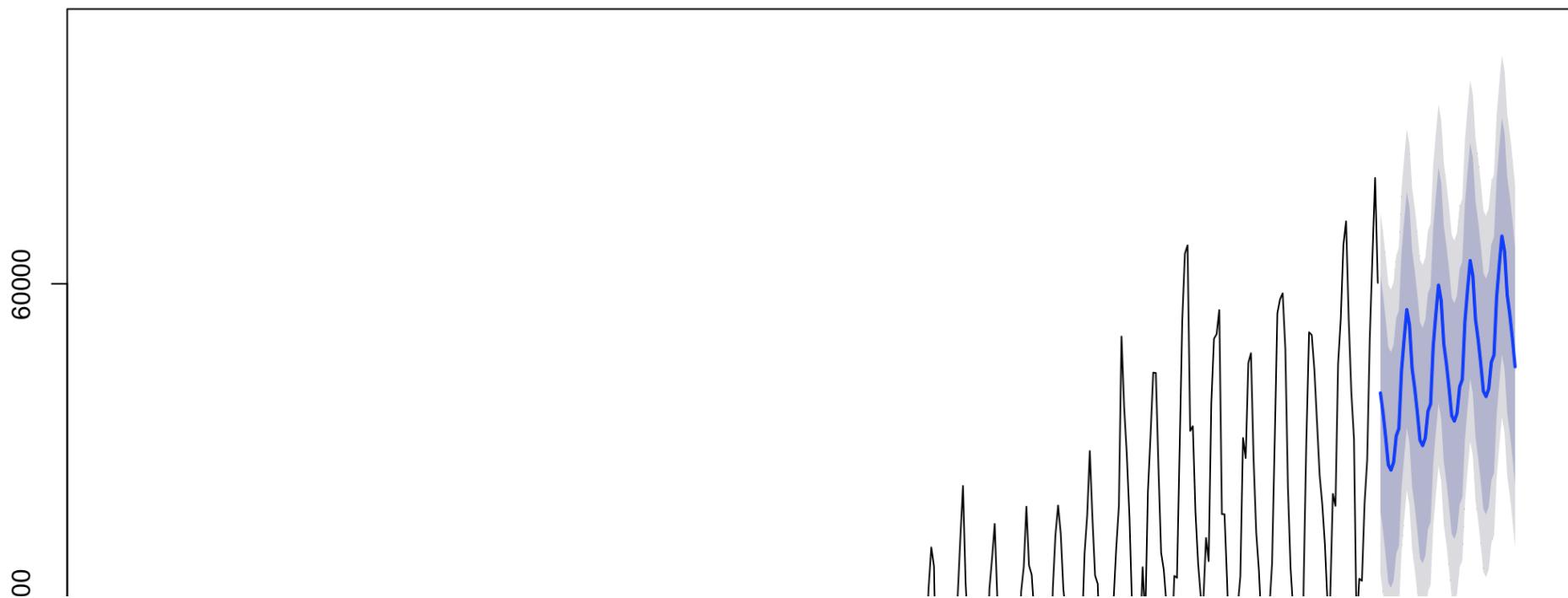


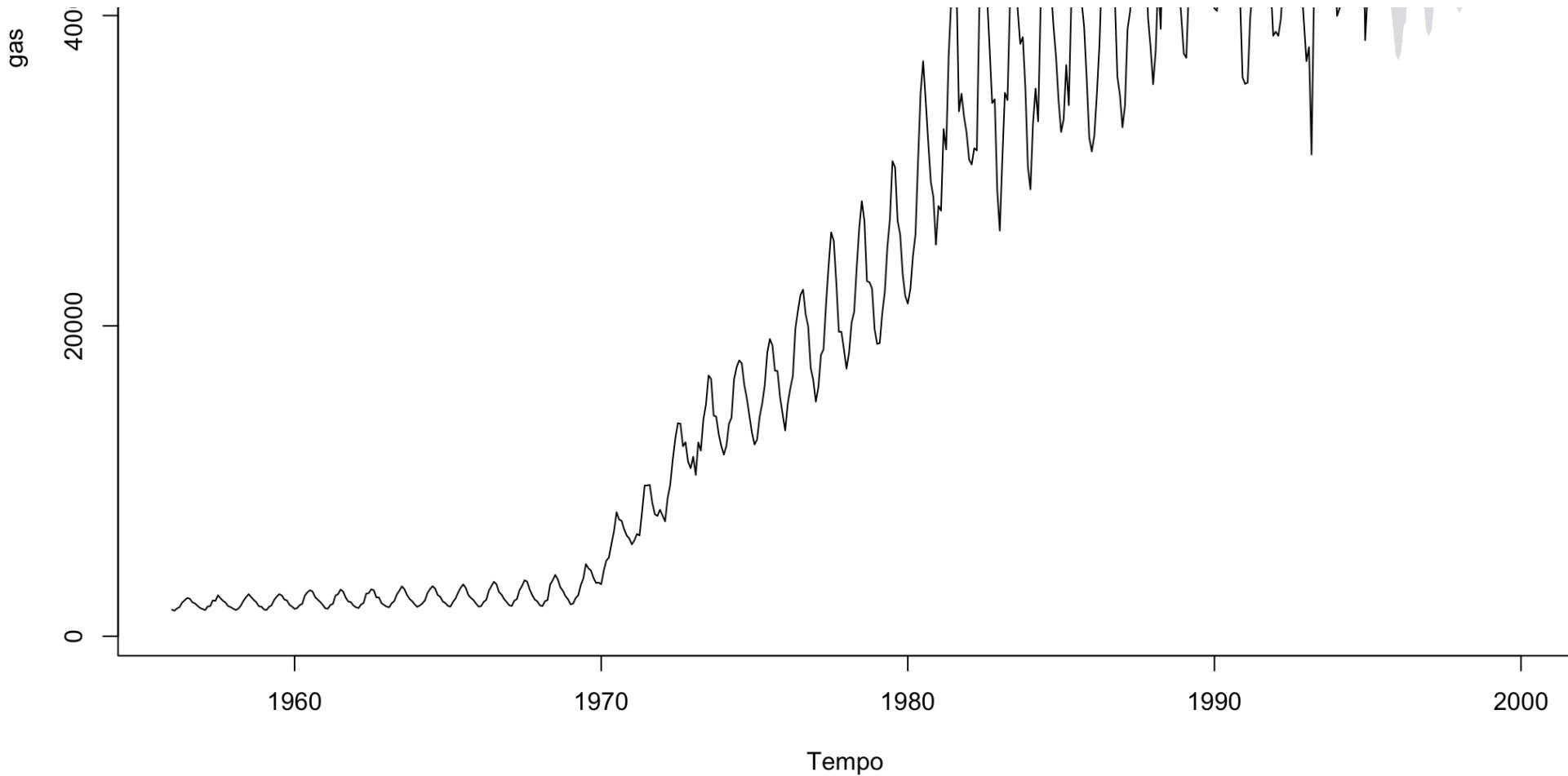


```
## Analysis of Variance Table
##
## Response: d
##           Df  Sum Sq Mean Sq F value Pr(>F)
## time(d)     1 1.46e+11 1.46e+11    3603 <2e-16 ***
## Residuals 474 1.93e+10 4.06e+07
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Trend - Seazonal Linear Model

Régressão linear sazonal





```

## 
## Call:
## lm(formula = formula, data = "d", na.action = na.exclude)
## 
## Residuals:
##    Min     1Q Median     3Q    Max 
## -14888 -4144   -586   3949  15668 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept) -12909.11      994.61  -12.98 < 2e-16 ***
## trend        127.42       1.88    67.77 < 2e-16 ***
## season2      351.28      1260.19    0.28    0.781  
## season3      1885.52     1260.19    1.50    0.135  
## season4      2211.50     1260.20    1.75    0.080  
## season5      5704.76     1260.21    4.53    7.6e-06 ***
## season6      7552.62     1260.22    5.99    4.1e-09 ***
## season7      9243.11     1260.24    7.33    1.0e-12 ***
## season8      8164.92     1260.26    6.48    2.4e-10 ***
## season9      5321.77     1268.25    4.20    3.3e-05 ***
## season10     3946.18     1268.25    3.11    0.002  
## season11     2299.22     1268.26    1.81    0.070  
## season12     456.53      1268.28    0.36    0.719  
## --- 
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 5640 on 463 degrees of freedom
## Multiple R-squared:  0.911, Adjusted R-squared:  0.909 
## F-statistic: 396 on 12 and 463 DF,  p-value: <2e-16

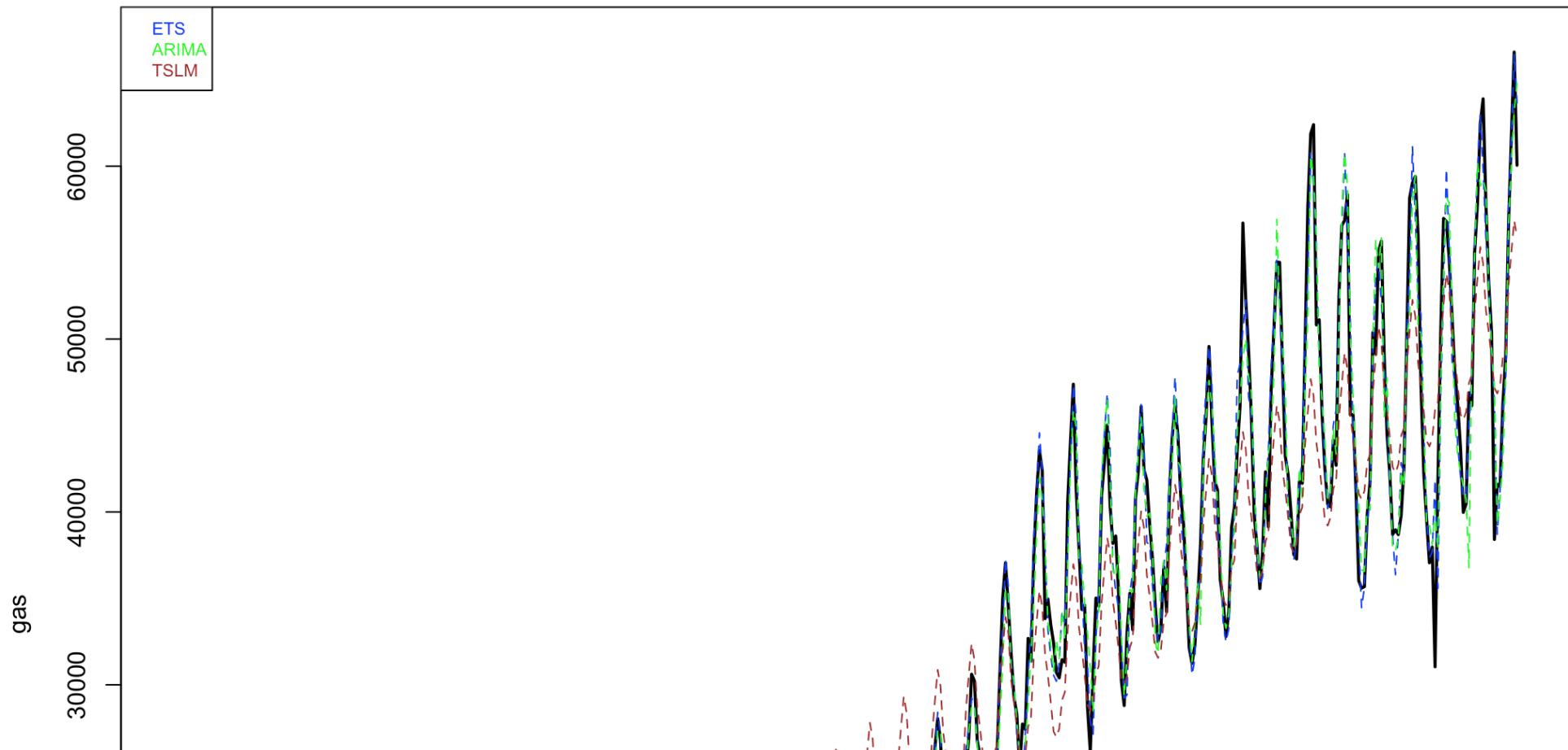
```

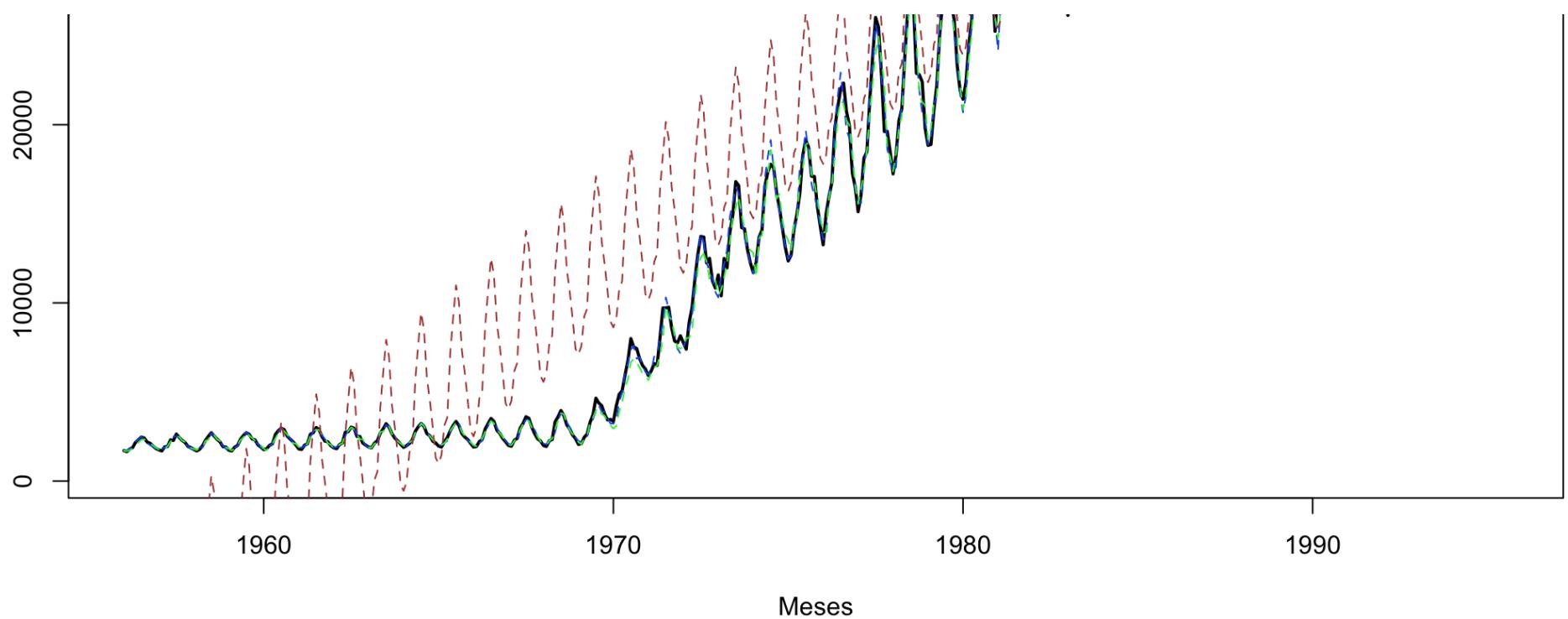
```

## Analysis of Variance Table
##
## Response: d
##          Df  Sum Sq Mean Sq F value Pr(>F)
## trend      1 1.46e+11 1.46e+11  4610.9 <2e-16 ***
## season     11 4.56e+09 4.15e+08     13.1 <2e-16 ***
## Residuals 463 1.47e+10 3.18e+07
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

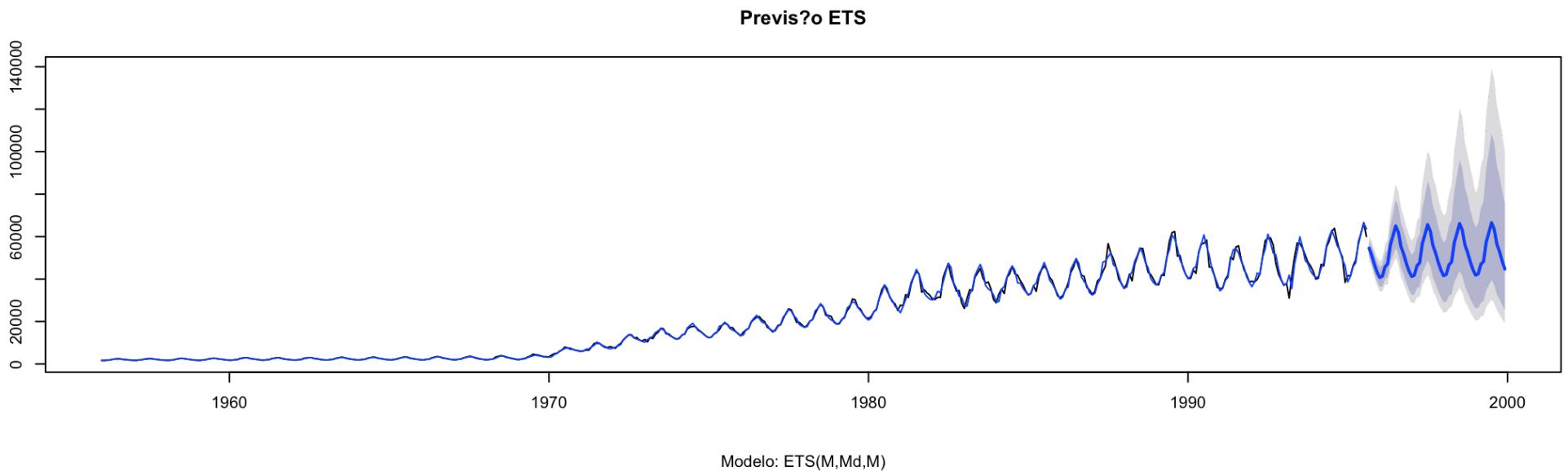
```

ARIMA X ETS X TSLM

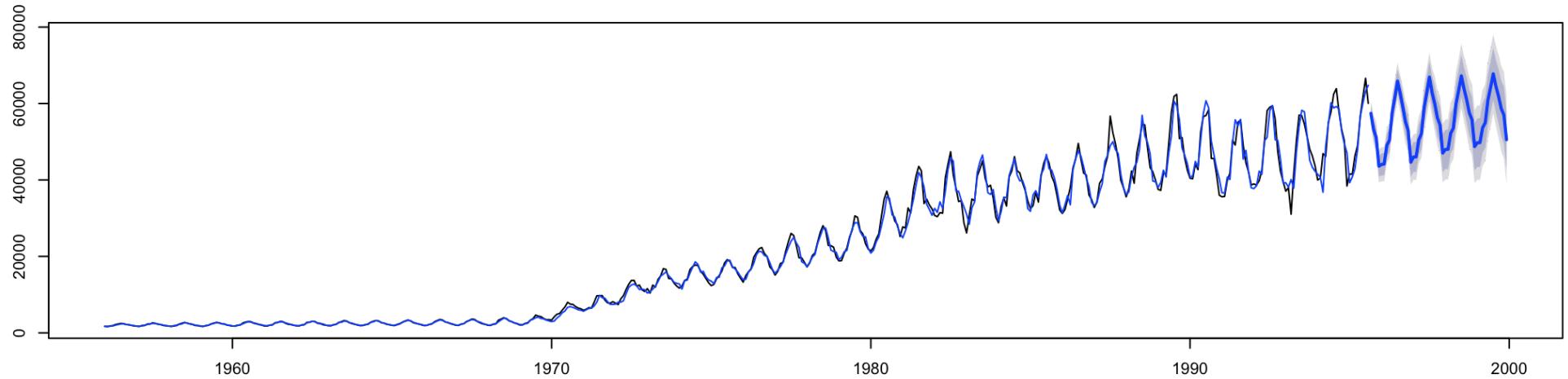




Comparação de Modelos

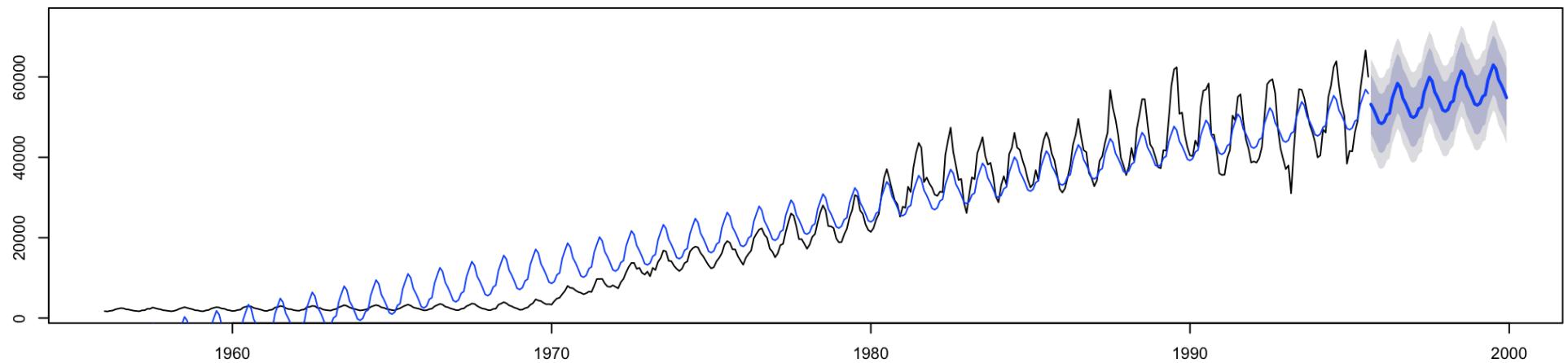


Previs?o Arima

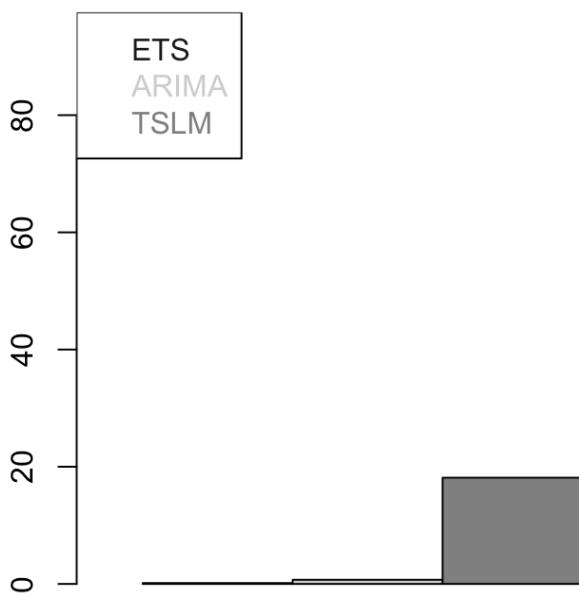
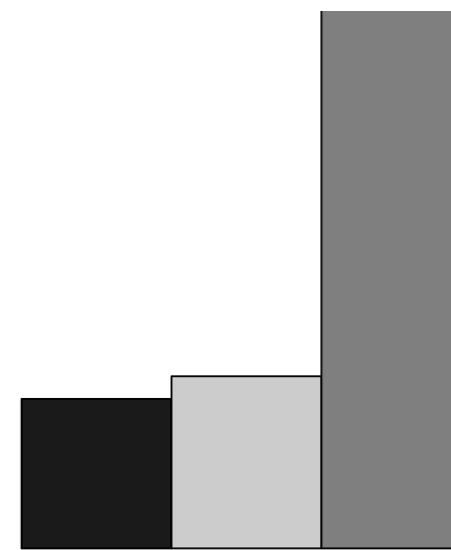
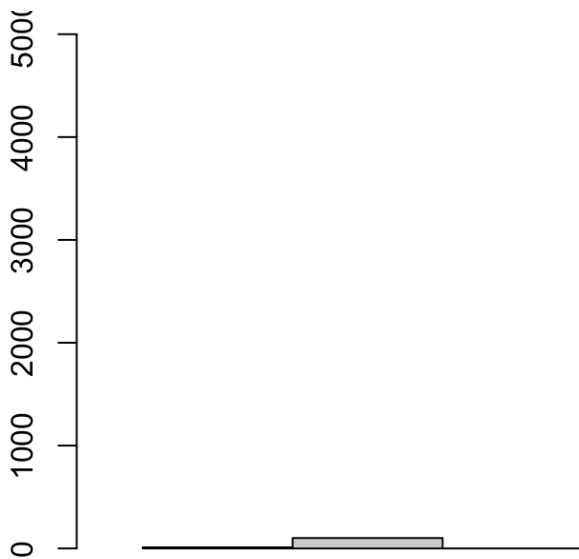


Modelo: ARIMA(2,1,1)(2,0,0)[12]

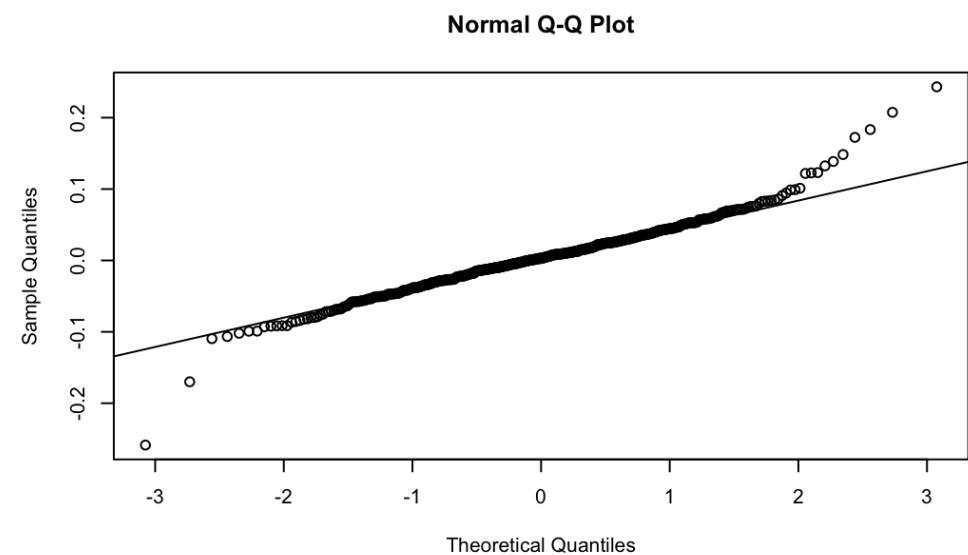
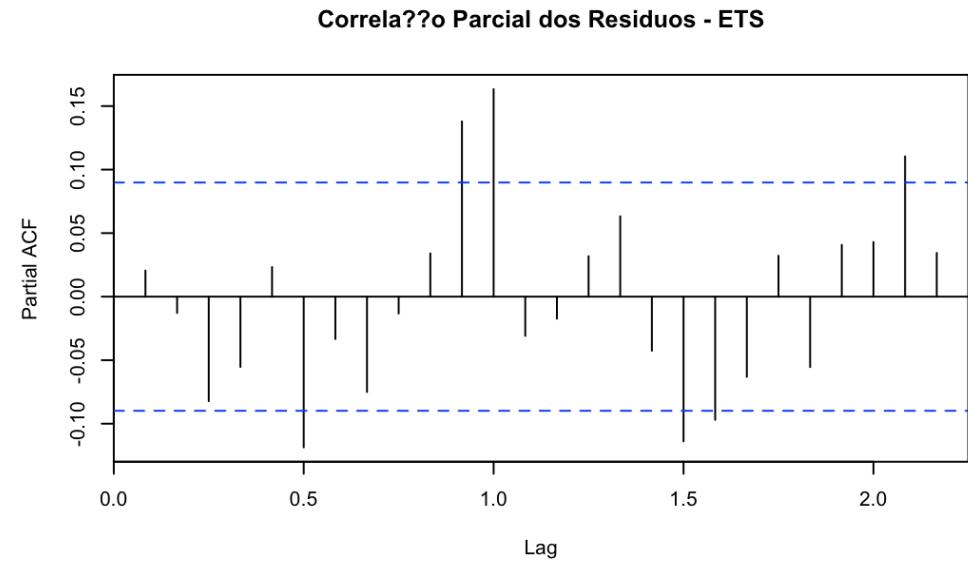
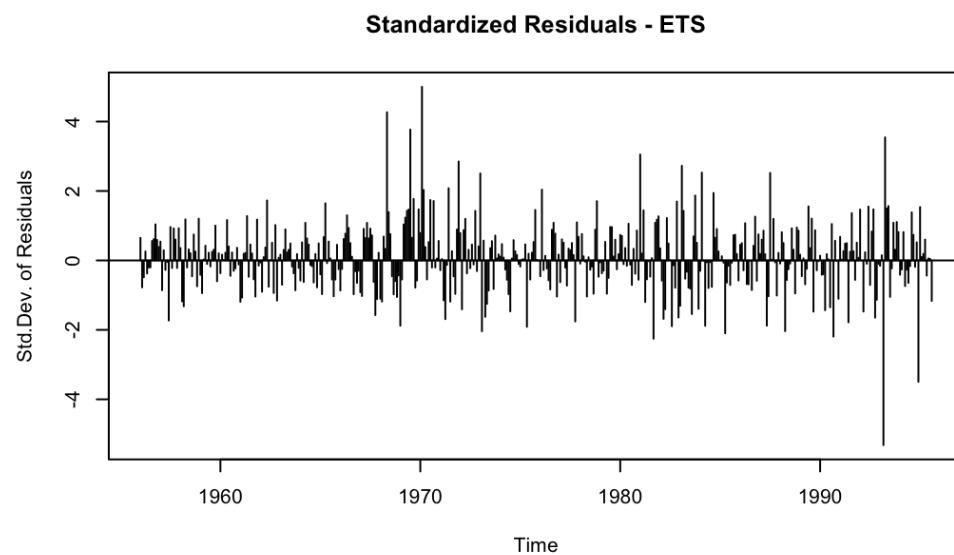
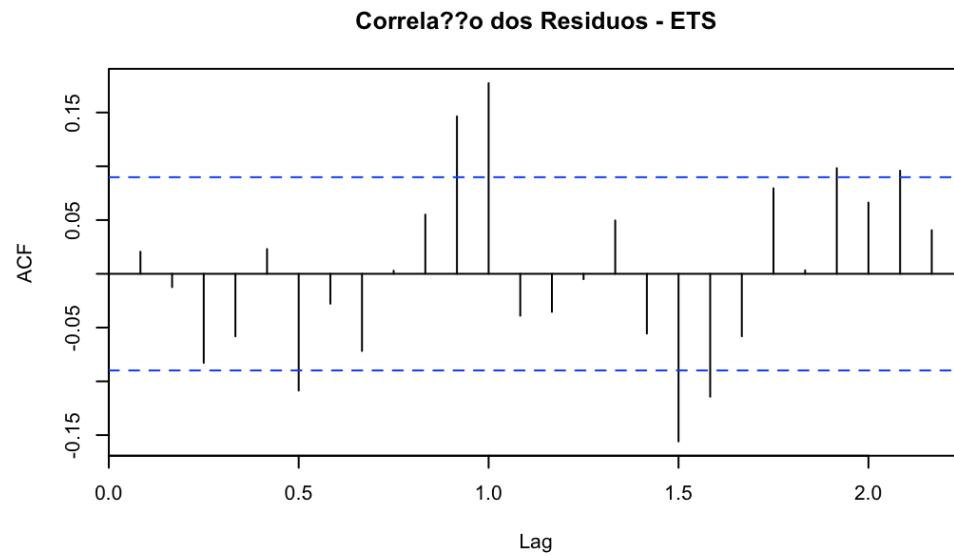
Previs?o TSLM

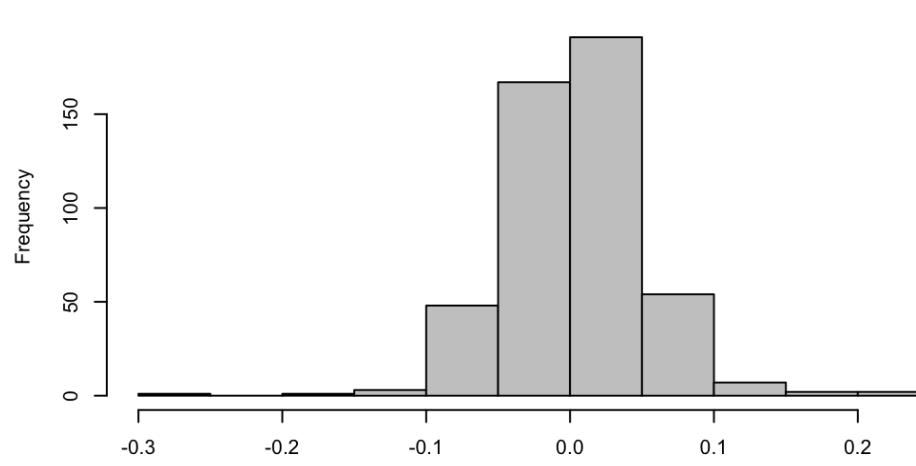
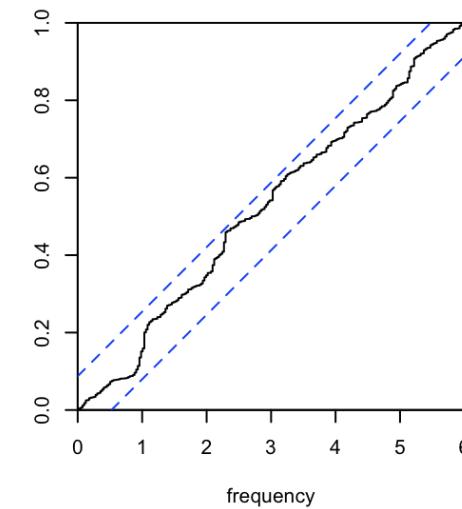


Erros

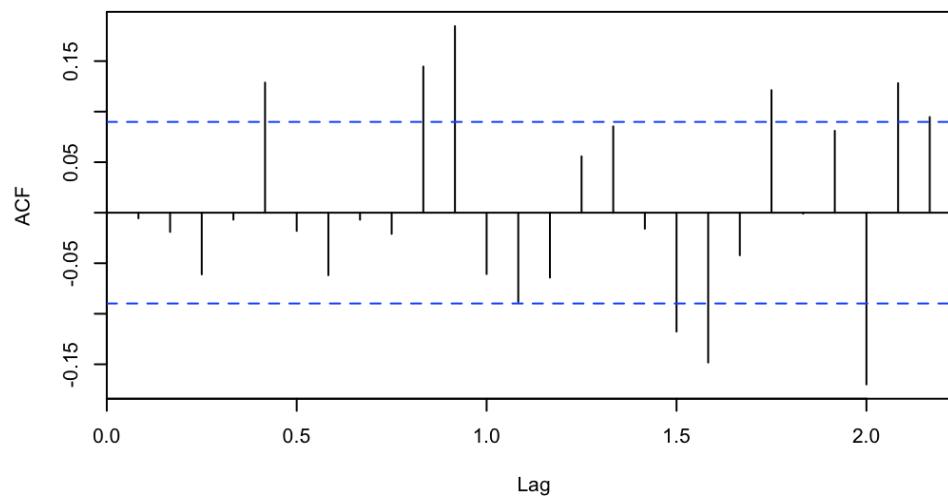
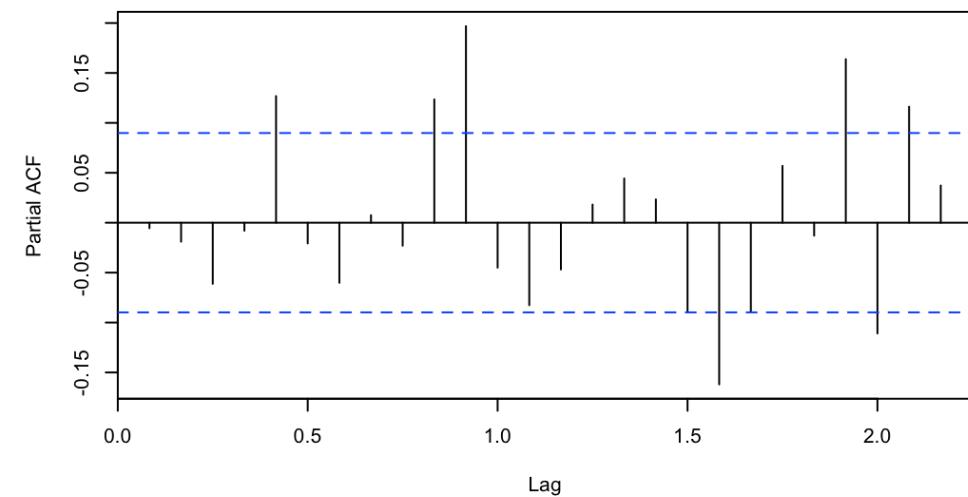


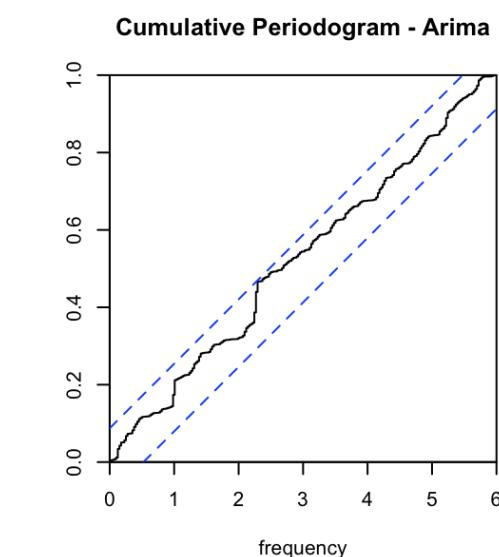
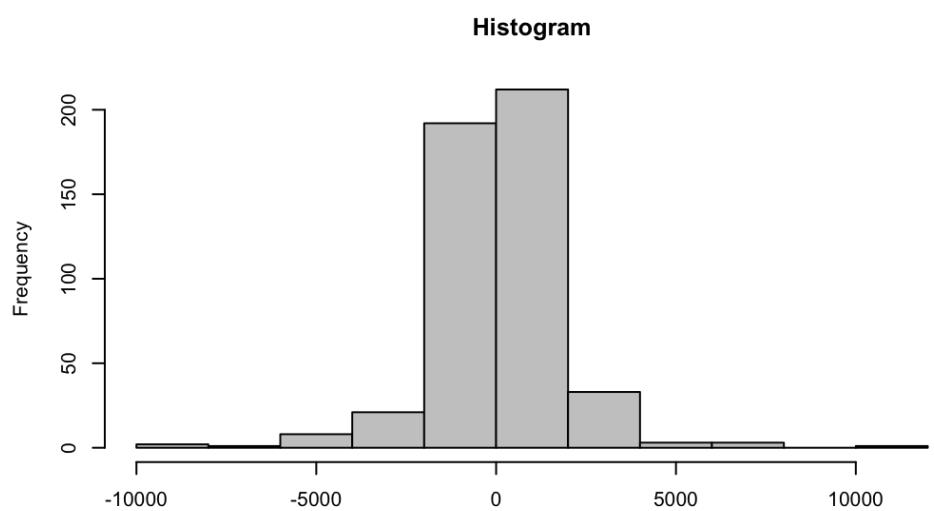
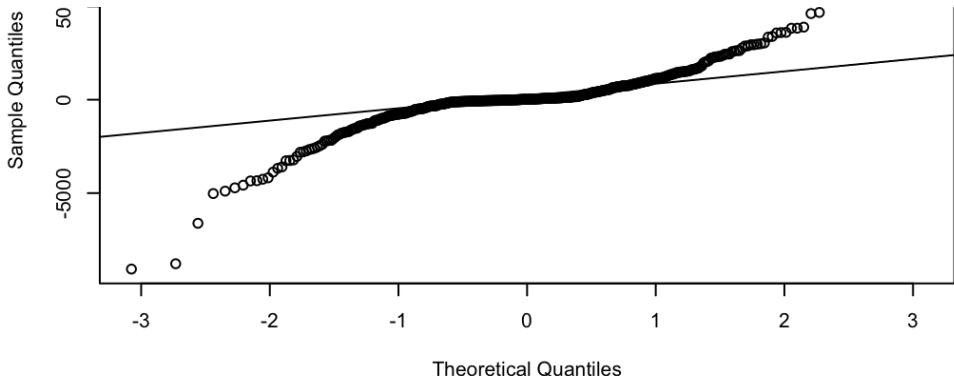
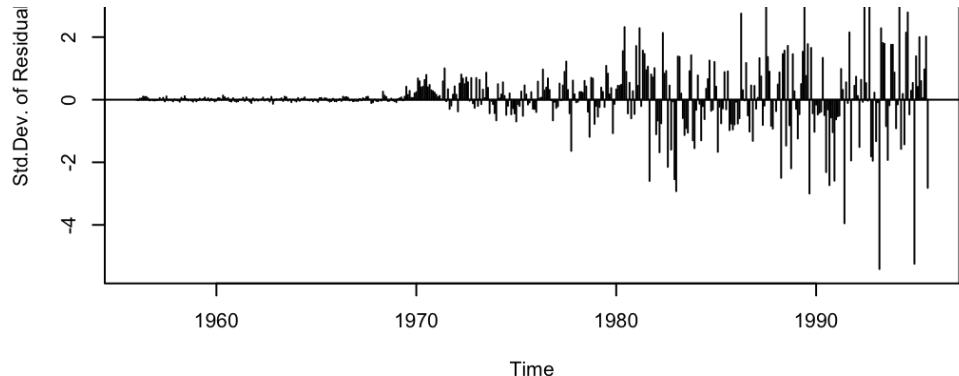
Residuos ETS



Histogram**Cumulative Periodogram - ETS**

Residuos ARIMA

Correla??o dos Residuos - Arima**Correla??o Parcial dos Residuos - Arima****Standardized Residuals - Arima****Normal Q-Q Plot**



Resíduos TSLM

