CHUONG 11: SAN CHUOI

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# BAT TAP: Data = oil.txt

# Mo hinh: SMS, HOLT-WINTERS

# Call packages for estimating, test

library(foreign); library(car); library(carData)

## Loading required package: carData

library(lmtest);library(zoo)

## Loading required package: zoo

##   
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':  
##   
## as.Date, as.Date.numeric

library(sandwich); library(survival)  
library(AER); library(stargazer)

##   
## Please cite as:

## Hlavac, Marek (2022). stargazer: Well-Formatted Regression and Summary Statistics Tables.

## R package version 5.2.3. https://CRAN.R-project.org/package=stargazer

library(ggplot2)  
library(forecast)

## Registered S3 method overwritten by 'quantmod':  
## method from  
## as.zoo.data.frame zoo

## I.INPUT DATA

data\_oil=read.table("D:/dataR/chuong 11/oil.txt", header=TRUE)  
data\_oil

## year y  
## 1 1996 445.36  
## 2 1997 453.20  
## 3 1998 454.41  
## 4 1999 422.38  
## 5 2000 456.04  
## 6 2001 440.39  
## 7 2002 425.19  
## 8 2003 486.21  
## 9 2004 500.43  
## 10 2005 521.28  
## 11 2006 508.95  
## 12 2007 488.89  
## 13 2008 509.87  
## 14 2009 456.72  
## 15 2010 473.82  
## 16 2011 525.95  
## 17 2012 549.83  
## 18 2013 542.34

names(data\_oil)

## [1] "year" "y"

year=data\_oil$year  
year

## [1] 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010  
## [16] 2011 2012 2013

oil=data\_oil$y  
oil

## [1] 445.36 453.20 454.41 422.38 456.04 440.39 425.19 486.21 500.43 521.28  
## [11] 508.95 488.89 509.87 456.72 473.82 525.95 549.83 542.34

oil=ts(oil,start=1996, frequency=1)  
oil

## Time Series:  
## Start = 1996   
## End = 2013   
## Frequency = 1   
## [1] 445.36 453.20 454.41 422.38 456.04 440.39 425.19 486.21 500.43 521.28  
## [11] 508.95 488.89 509.87 456.72 473.82 525.95 549.83 542.34

## SAN MU GIAN GIAN DON - SINGLE EXPONENTIAL SMOOTHING - MOT THAM SO

# plot(oil)  
# Từ khóa san chuỗi: ses = Simple Exponential Smoothing  
oilses=ses(oil,h=5)  
summary(oilses)

##   
## Forecast method: Simple exponential smoothing  
##   
## Model Information:  
## Simple exponential smoothing   
##   
## Call:  
## ses(y = oil, h = 5)   
##   
## Smoothing parameters:  
## alpha = 0.8339   
##   
## Initial states:  
## l = 446.5649   
##   
## sigma: 29.8295  
##   
## AIC AICc BIC   
## 178.1445 179.8588 180.8156   
##   
## Error measures:  
## ME RMSE MAE MPE MAPE MASE ACF1  
## Training set 6.403552 28.12351 22.25903 1.097903 4.61071 0.9256448 -0.03380699  
##   
## Forecasts:  
## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 2014 542.6795 504.4515 580.9076 484.2148 601.1443  
## 2015 542.6795 492.9048 592.4543 466.5556 618.8035  
## 2016 542.6795 483.5723 601.7868 452.2827 633.0763  
## 2017 542.6795 475.5244 609.8347 439.9746 645.3845  
## 2018 542.6795 468.3427 617.0163 428.9912 656.3679

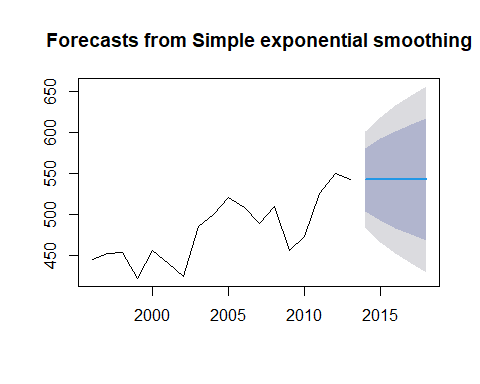
# chú ý: ses chỉ tính sau mẫu, ở sau h=5 giá trị.   
oilses

## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 2014 542.6795 504.4515 580.9076 484.2148 601.1443  
## 2015 542.6795 492.9048 592.4543 466.5556 618.8035  
## 2016 542.6795 483.5723 601.7868 452.2827 633.0763  
## 2017 542.6795 475.5244 609.8347 439.9746 645.3845  
## 2018 542.6795 468.3427 617.0163 428.9912 656.3679

# tính giá trị oil trong mẫu  
oilsesmu=fitted(oilses)  
oilsesmu

## Time Series:  
## Start = 1996   
## End = 2013   
## Frequency = 1   
## [1] 446.5649 445.5602 451.9308 453.9981 427.6329 451.3206 442.2059 428.0169  
## [9] 476.5421 496.4614 517.1568 510.3134 492.4492 506.9758 465.0692 472.3662  
## [17] 517.0479 544.3838

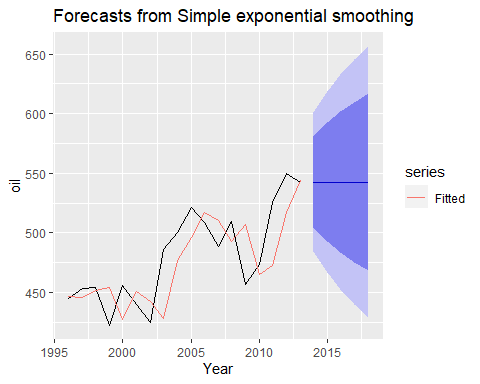
plot(oilses)



round(accuracy(oilses,1.96))

## ME RMSE MAE MPE MAPE MASE ACF1  
## Training set 6 28 22 1 5 1 0  
## Test set -541 541 541 -27588 27588 22 NA

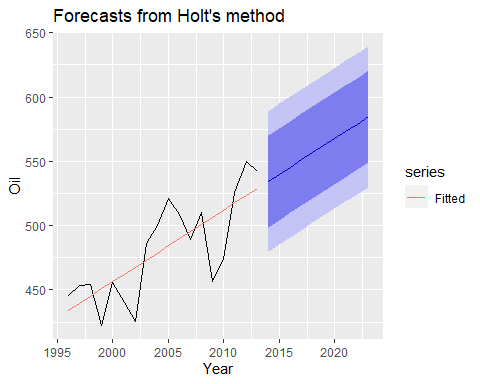
autoplot(oilses)+  
 autolayer(fitted(oilses),series="Fitted")+   
 ylab("oil")+xlab("Year")

 ## HOLT-WINTRES SAN CHUOI CO XU THE, KHONG CO YEU TO THOI VU - HAI THAM SO

oilhw1=holt(oil)  
summary(oilhw1)

##   
## Forecast method: Holt's method  
##   
## Model Information:  
## Holt's method   
##   
## Call:  
## holt(y = oil)   
##   
## Smoothing parameters:  
## alpha = 1e-04   
## beta = 1e-04   
##   
## Initial states:  
## l = 428.483   
## b = 5.5757   
##   
## sigma: 27.8702  
##   
## AIC AICc BIC   
## 177.2951 182.2951 181.7469   
##   
## Error measures:  
## ME RMSE MAE MPE MAPE MASE  
## Training set -0.2711669 24.57917 20.53694 -0.3257339 4.338246 0.8540311  
## ACF1  
## Training set 0.3429167  
##   
## Forecasts:  
## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 2014 534.4099 498.6929 570.1270 479.7854 589.0344  
## 2015 539.9851 504.2680 575.7021 485.3606 594.6096  
## 2016 545.5602 509.8431 581.2772 490.9357 600.1847  
## 2017 551.1353 515.4183 586.8524 496.5108 605.7598  
## 2018 556.7104 520.9934 592.4275 502.0859 611.3350  
## 2019 562.2856 526.5685 598.0026 507.6610 616.9101  
## 2020 567.8607 532.1436 603.5778 513.2361 622.4853  
## 2021 573.4358 537.7187 609.1529 518.8112 628.0604  
## 2022 579.0110 543.2938 614.7281 524.3863 633.6356  
## 2023 584.5861 548.8689 620.3032 529.9614 639.2107

autoplot(oilhw1)+  
 autolayer(fitted(oilhw1),series="Fitted")+  
 ylab("Oil")+ xlab("Year")



## HOLT-WINTRES SAN CHUOI CO XU THE, CO YEU TO THOI VU - BA THAM SO

ch12bt20=read.table("D:/dataR/chuong 11/ch12bt20.txt",header=TRUE)  
  
GDP=ch12bt20$GDP  
GDP=ts(GDP, start=c(1970,1), frequency=4)

# GDP  
GDPAD= hw(GDP,seasonal="additive")  
summary(GDPAD)

##   
## Forecast method: Holt-Winters' additive method  
##   
## Model Information:  
## Holt-Winters' additive method   
##   
## Call:  
## hw(y = GDP, seasonal = "additive")   
##   
## Smoothing parameters:  
## alpha = 0.9999   
## beta = 0.2796   
## gamma = 1e-04   
##   
## Initial states:  
## l = 2863.6881   
## b = 23.8571   
## s = -2.3876 0.5949 1.7513 0.0414  
##   
## sigma: 37.4677  
##   
## AIC AICc BIC   
## 1041.351 1043.658 1063.647   
##   
## Error measures:  
## ME RMSE MAE MPE MAPE MASE  
## Training set -0.7461287 35.72402 27.06421 -0.01268386 0.736728 0.2345349  
## ACF1  
## Training set 0.1267068  
##   
## Forecasts:  
## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 1992 Q1 4875.927 4827.910 4923.944 4802.492 4949.362  
## 1992 Q2 4883.137 4805.161 4961.113 4763.883 5002.391  
## 1992 Q3 4887.481 4779.384 4995.578 4722.161 5052.801  
## 1992 Q4 4889.990 4750.418 5029.562 4676.534 5103.447  
## 1993 Q1 4897.917 4725.210 5070.624 4633.785 5162.050  
## 1993 Q2 4905.127 4697.556 5112.698 4587.675 5222.580  
## 1993 Q3 4909.471 4665.307 5153.635 4536.055 5282.888  
## 1993 Q4 4911.980 4629.528 5194.432 4480.008 5343.953

seasonal\_ad = decompose(GDP, "additive")  
print('Hệ số thời vụ mô hình cộng')

## [1] "Hệ số thời vụ mô hình cộng"

seasonal\_ad

## $x  
## Qtr1 Qtr2 Qtr3 Qtr4  
## 1970 2872.8 2860.3 2896.6 2873.7  
## 1971 2942.9 2947.4 2966.0 2980.8  
## 1972 3037.3 3089.7 3125.8 3175.5  
## 1973 3253.3 3267.6 3264.3 3289.1  
## 1974 3259.4 3267.6 3239.1 3226.4  
## 1975 3154.0 3190.4 3249.9 3292.5  
## 1976 3356.7 3369.2 3381.0 3416.3  
## 1977 3466.4 3525.0 3574.4 3567.2  
## 1978 3591.8 3707.0 3735.6 3779.6  
## 1979 3780.8 3784.3 3807.5 3814.6  
## 1980 3830.8 3732.6 3733.5 3808.5  
## 1981 3860.5 3844.4 3864.5 3803.1  
## 1982 3756.1 3771.1 3754.4 3759.6  
## 1983 3783.5 3886.5 3944.4 4012.1  
## 1984 4089.5 4144.0 4166.4 4194.2  
## 1985 4221.8 4254.8 4309.0 4333.5  
## 1986 4390.5 4387.7 4412.6 4427.1  
## 1987 4460.0 4515.3 4559.3 4625.5  
## 1988 4655.3 4704.8 4734.5 4779.7  
## 1989 4809.8 4832.4 4845.6 4859.7  
## 1990 4880.8 4900.3 4903.3 4855.1  
## 1991 4824.0 4840.7 4862.7 4868.0  
##   
## $seasonal  
## Qtr1 Qtr2 Qtr3 Qtr4  
## 1970 -0.853869 2.124702 1.396726 -2.667560  
## 1971 -0.853869 2.124702 1.396726 -2.667560  
## 1972 -0.853869 2.124702 1.396726 -2.667560  
## 1973 -0.853869 2.124702 1.396726 -2.667560  
## 1974 -0.853869 2.124702 1.396726 -2.667560  
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## 1985 -0.853869 2.124702 1.396726 -2.667560  
## 1986 -0.853869 2.124702 1.396726 -2.667560  
## 1987 -0.853869 2.124702 1.396726 -2.667560  
## 1988 -0.853869 2.124702 1.396726 -2.667560  
## 1989 -0.853869 2.124702 1.396726 -2.667560  
## 1990 -0.853869 2.124702 1.396726 -2.667560  
## 1991 -0.853869 2.124702 1.396726 -2.667560  
##   
## $trend  
## Qtr1 Qtr2 Qtr3 Qtr4  
## 1970 NA NA 2884.612 2904.262  
## 1971 2923.825 2945.887 2971.075 3000.663  
## 1972 3038.425 3082.737 3134.075 3183.313  
## 1973 3222.862 3254.375 3269.338 3270.100  
## 1974 3266.950 3255.962 3234.950 3212.125  
## 1975 3203.825 3213.438 3247.037 3294.725  
## 1976 3333.463 3365.325 3394.513 3427.700  
## 1977 3471.350 3514.387 3548.925 3587.350  
## 1978 3630.250 3676.950 3727.125 3760.413  
## 1979 3779.062 3792.425 3803.050 3802.838  
## 1980 3787.125 3777.113 3780.062 3797.750  
## 1981 3828.100 3843.800 3830.075 3807.863  
## 1982 3784.938 3765.737 3763.725 3781.575  
## 1983 3819.750 3875.062 3944.875 4015.312  
## 1984 4075.250 4125.762 4165.062 4195.450  
## 1985 4227.125 4262.362 4300.863 4338.562  
## 1986 4368.125 4392.775 4413.163 4437.800  
## 1987 4472.088 4515.225 4564.438 4612.538  
## 1988 4658.125 4699.300 4737.888 4773.150  
## 1989 4802.988 4826.875 4845.750 4863.113  
## 1990 4878.812 4885.450 4877.775 4863.225  
## 1991 4850.700 4847.238 NA NA  
##   
## $random  
## Qtr1 Qtr2 Qtr3 Qtr4  
## 1970 NA NA 10.59077381 -27.89494048  
## 1971 19.92886905 -0.61220238 -6.47172619 -17.19494048  
## 1972 -0.27113095 4.83779762 -9.67172619 -5.14494048  
## 1973 31.29136905 11.10029762 -6.43422619 21.66755952  
## 1974 -6.69613095 9.51279762 2.75327381 16.94255952  
## 1975 -48.97113095 -25.16220238 1.46577381 0.44255952  
## 1976 24.09136905 1.75029762 -14.90922619 -8.73244048  
## 1977 -4.09613095 8.48779762 24.07827381 -17.48244048  
## 1978 -37.59613095 27.92529762 7.07827381 21.85505952  
## 1979 2.59136905 -10.24970238 3.05327381 14.43005952  
## 1980 44.52886905 -46.63720238 -47.95922619 13.41755952  
## 1981 33.25386905 -1.52470238 33.02827381 -2.09494048  
## 1982 -27.98363095 3.23779762 -10.72172619 -19.30744048  
## 1983 -35.39613095 9.31279762 -1.87172619 -0.54494048  
## 1984 15.10386905 16.11279762 -0.05922619 1.41755952  
## 1985 -4.47113095 -9.68720238 6.74077381 -2.39494048  
## 1986 23.22886905 -7.19970238 -1.95922619 -8.03244048  
## 1987 -11.23363095 -2.04970238 -6.53422619 15.63005952  
## 1988 -1.97113095 3.37529762 -4.78422619 9.21755952  
## 1989 7.66636905 3.40029762 -1.54672619 -0.74494048  
## 1990 2.84136905 12.72529762 24.12827381 -5.45744048  
## 1991 -25.84613095 -8.66220238 NA NA  
##   
## $figure  
## [1] -0.853869 2.124702 1.396726 -2.667560  
##   
## $type  
## [1] "additive"  
##   
## attr(,"class")  
## [1] "decomposed.ts"

GDPMUL= hw(GDP,seasonal="multiplicative")  
summary(GDPMUL)

##   
## Forecast method: Holt-Winters' multiplicative method  
##   
## Model Information:  
## Holt-Winters' multiplicative method   
##   
## Call:  
## hw(y = GDP, seasonal = "multiplicative")   
##   
## Smoothing parameters:  
## alpha = 0.9964   
## beta = 0.1353   
## gamma = 0.0036   
##   
## Initial states:  
## l = 2864.0245   
## b = 23.0339   
## s = 0.9994 1.0005 1.0004 0.9997  
##   
## sigma: 0.0104  
##   
## AIC AICc BIC   
## 1051.548 1053.856 1073.844   
##   
## Error measures:  
## ME RMSE MAE MPE MAPE MASE  
## Training set -1.031653 36.03896 27.21955 -0.01981059 0.740881 0.2358811  
## ACF1  
## Training set 0.2492981  
##   
## Forecasts:  
## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 1992 Q1 4880.352 4815.272 4945.431 4780.821 4979.882  
## 1992 Q2 4894.370 4795.921 4992.818 4743.806 5044.934  
## 1992 Q3 4905.491 4776.856 5034.126 4708.761 5102.221  
## 1992 Q4 4911.016 4753.186 5068.846 4669.636 5152.397  
## 1993 Q1 4923.385 4736.032 5110.738 4636.854 5209.916  
## 1993 Q2 4937.432 4720.227 5154.637 4605.246 5269.618  
## 1993 Q3 4948.556 4701.029 5196.084 4569.995 5327.118  
## 1993 Q4 4954.036 4675.812 5232.260 4528.529 5379.542

GDPMUL

## Point Forecast Lo 80 Hi 80 Lo 95 Hi 95  
## 1992 Q1 4880.352 4815.272 4945.431 4780.821 4979.882  
## 1992 Q2 4894.370 4795.921 4992.818 4743.806 5044.934  
## 1992 Q3 4905.491 4776.856 5034.126 4708.761 5102.221  
## 1992 Q4 4911.016 4753.186 5068.846 4669.636 5152.397  
## 1993 Q1 4923.385 4736.032 5110.738 4636.854 5209.916  
## 1993 Q2 4937.432 4720.227 5154.637 4605.246 5269.618  
## 1993 Q3 4948.556 4701.029 5196.084 4569.995 5327.118  
## 1993 Q4 4954.036 4675.812 5232.260 4528.529 5379.542

seasonal\_mu = decompose(GDP, "multiplicative")  
print('Hệ số thời vụ mô hình nhân')

## [1] "Hệ số thời vụ mô hình nhân"

seasonal\_mu

## $x  
## Qtr1 Qtr2 Qtr3 Qtr4  
## 1970 2872.8 2860.3 2896.6 2873.7  
## 1971 2942.9 2947.4 2966.0 2980.8  
## 1972 3037.3 3089.7 3125.8 3175.5  
## 1973 3253.3 3267.6 3264.3 3289.1  
## 1974 3259.4 3267.6 3239.1 3226.4  
## 1975 3154.0 3190.4 3249.9 3292.5  
## 1976 3356.7 3369.2 3381.0 3416.3  
## 1977 3466.4 3525.0 3574.4 3567.2  
## 1978 3591.8 3707.0 3735.6 3779.6  
## 1979 3780.8 3784.3 3807.5 3814.6  
## 1980 3830.8 3732.6 3733.5 3808.5  
## 1981 3860.5 3844.4 3864.5 3803.1  
## 1982 3756.1 3771.1 3754.4 3759.6  
## 1983 3783.5 3886.5 3944.4 4012.1  
## 1984 4089.5 4144.0 4166.4 4194.2  
## 1985 4221.8 4254.8 4309.0 4333.5  
## 1986 4390.5 4387.7 4412.6 4427.1  
## 1987 4460.0 4515.3 4559.3 4625.5  
## 1988 4655.3 4704.8 4734.5 4779.7  
## 1989 4809.8 4832.4 4845.6 4859.7  
## 1990 4880.8 4900.3 4903.3 4855.1  
## 1991 4824.0 4840.7 4862.7 4868.0  
##   
## $seasonal  
## Qtr1 Qtr2 Qtr3 Qtr4  
## 1970 0.9998665 1.0005949 1.0003515 0.9991870  
## 1971 0.9998665 1.0005949 1.0003515 0.9991870  
## 1972 0.9998665 1.0005949 1.0003515 0.9991870  
## 1973 0.9998665 1.0005949 1.0003515 0.9991870  
## 1974 0.9998665 1.0005949 1.0003515 0.9991870  
## 1975 0.9998665 1.0005949 1.0003515 0.9991870  
## 1976 0.9998665 1.0005949 1.0003515 0.9991870  
## 1977 0.9998665 1.0005949 1.0003515 0.9991870  
## 1978 0.9998665 1.0005949 1.0003515 0.9991870  
## 1979 0.9998665 1.0005949 1.0003515 0.9991870  
## 1980 0.9998665 1.0005949 1.0003515 0.9991870  
## 1981 0.9998665 1.0005949 1.0003515 0.9991870  
## 1982 0.9998665 1.0005949 1.0003515 0.9991870  
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## 1986 0.9998665 1.0005949 1.0003515 0.9991870  
## 1987 0.9998665 1.0005949 1.0003515 0.9991870  
## 1988 0.9998665 1.0005949 1.0003515 0.9991870  
## 1989 0.9998665 1.0005949 1.0003515 0.9991870  
## 1990 0.9998665 1.0005949 1.0003515 0.9991870  
## 1991 0.9998665 1.0005949 1.0003515 0.9991870  
##   
## $trend  
## Qtr1 Qtr2 Qtr3 Qtr4  
## 1970 NA NA 2884.612 2904.262  
## 1971 2923.825 2945.887 2971.075 3000.663  
## 1972 3038.425 3082.737 3134.075 3183.313  
## 1973 3222.862 3254.375 3269.338 3270.100  
## 1974 3266.950 3255.962 3234.950 3212.125  
## 1975 3203.825 3213.438 3247.037 3294.725  
## 1976 3333.463 3365.325 3394.513 3427.700  
## 1977 3471.350 3514.387 3548.925 3587.350  
## 1978 3630.250 3676.950 3727.125 3760.413  
## 1979 3779.062 3792.425 3803.050 3802.838  
## 1980 3787.125 3777.113 3780.062 3797.750  
## 1981 3828.100 3843.800 3830.075 3807.863  
## 1982 3784.938 3765.737 3763.725 3781.575  
## 1983 3819.750 3875.062 3944.875 4015.312  
## 1984 4075.250 4125.762 4165.062 4195.450  
## 1985 4227.125 4262.362 4300.863 4338.562  
## 1986 4368.125 4392.775 4413.163 4437.800  
## 1987 4472.088 4515.225 4564.438 4612.538  
## 1988 4658.125 4699.300 4737.888 4773.150  
## 1989 4802.988 4826.875 4845.750 4863.113  
## 1990 4878.812 4885.450 4877.775 4863.225  
## 1991 4850.700 4847.238 NA NA  
##   
## $random  
## Qtr1 Qtr2 Qtr3 Qtr4  
## 1970 NA NA 1.0038028 0.9902817  
## 1971 1.0066583 0.9999186 0.9979411 0.9941889  
## 1972 0.9997632 1.0016626 0.9970092 0.9983574  
## 1973 1.0095790 1.0034668 0.9981083 1.0066286  
## 1974 0.9978222 1.0029775 1.0009310 1.0052614  
## 1975 0.9845797 0.9922406 1.0005299 1.0001378  
## 1976 1.0071054 1.0005562 0.9956693 0.9974851  
## 1977 0.9987073 1.0024234 1.0068243 0.9951921  
## 1978 0.9895405 1.0075731 1.0019217 1.0059203  
## 1979 1.0005933 0.9972643 1.0008183 1.0039092  
## 1980 1.0116675 0.9876277 0.9873350 1.0036466  
## 1981 1.0085983 0.9995614 1.0086335 0.9995619  
## 1982 0.9925135 1.0008286 0.9971719 0.9949978  
## 1983 0.9906421 1.0023553 0.9995282 1.0000129  
## 1984 1.0036307 1.0038232 0.9999696 1.0005155  
## 1985 0.9988736 0.9976322 1.0015400 0.9996458  
## 1986 1.0052565 0.9982508 0.9995212 0.9984006  
## 1987 0.9974303 0.9994220 0.9985234 1.0036262  
## 1988 0.9995269 1.0005751 0.9989339 1.0021870  
## 1989 1.0015521 1.0005494 0.9996176 1.0001114  
## 1990 1.0005409 1.0024433 1.0048797 0.9991416  
## 1991 0.9946284 0.9980575 NA NA  
##   
## $figure  
## [1] 0.9998665 1.0005949 1.0003515 0.9991870  
##   
## $type  
## [1] "multiplicative"  
##   
## attr(,"class")  
## [1] "decomposed.ts"

autoplot(GDP)+  
 autolayer(GDPAD, series="HW additive forecasts", PI=FALSE)+  
 autolayer(GDPMUL, series="HW multiplicative forecasts", PI=FALSE)+  
 xlab("Year")+  
 ylab("GDP of USA")+  
 ggtitle(" FORECAST GDP OF USA BY HOLT-WINTERS")+  
 guides(colour=guide\_legend(title="Forecast"))

