Default Flow

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Contents

Introduction

A big thank to Geoffrey D. who introduced me to the Rmd function of R for quick reports production. Note that the following is for educational purpose only and is not to our knowledge a model in use in the industry.

Data Description

Description of the Variables

Explained variable:

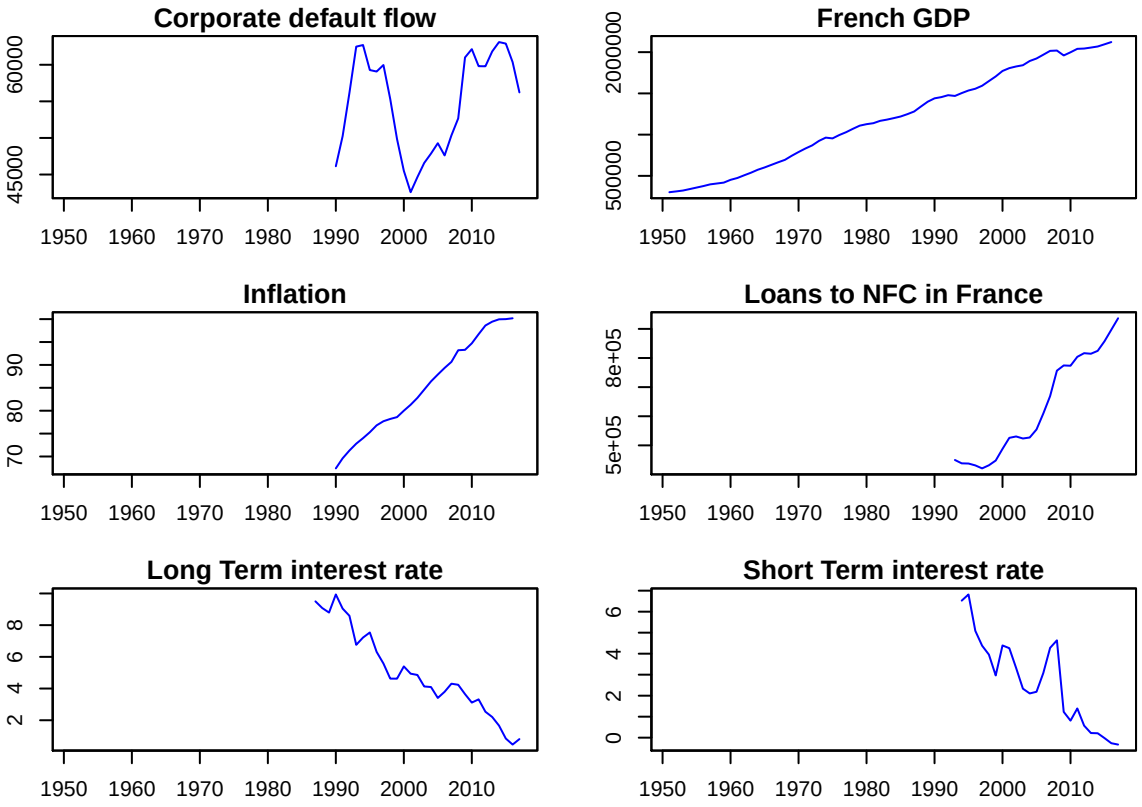
- Number of failed companie in France, taken from Banque de France DIREN.M.FR.DE.DF.03.N.ZZ.TT

Set of potential explanatory variables:

- GDP growth rate in volume (source = INSEE, IdBank = 1690354)
- Inflation rate (source = INSEE, IdBank = 001765178)
- CAC 40 index (source = Yahoo finance)
- Loans to non financial companies in France (source = Banque de France, Id = BSI1.M.FR.N.R.A26.A.1.U6.2240.Z01.E)
- Long Term interest rate (LT IR), OAT 10 years (source = Banque de France, Id = FM.D.FR.EUR.FR2.BB.FR10YT_RR.Y

- Short Term interest rate (ST IR), Euribor 3 month (source = Bundesbank, Id = FM.M.U2.EUR.RT.MM.EURIBOR3MD_
- Spread = LT IR - ST IR

Simple Plots



Compute growth of DF, GDP, ICP and NFCloan

We compute the growth rates of the variables in level.

Subset the time series

Starting from 1994 we have a data set with all column values available, we might want to subset our data frame from 1994 onwards.

```
##                DF           GDP        ICP      NFCloan      LTIR
## 1951          NaN  3.021090e+05        NaN          NaN       NaN
## 1952          NaN  3.017569e-02        NaN          NaN       NaN
## 1953          NaN  3.343325e-02        NaN          NaN       NaN
## 1954          NaN  5.279678e-02        NaN          NaN       NaN
## 1955          NaN  5.045921e-02        NaN          NaN       NaN
## 1956          NaN  4.755209e-02        NaN          NaN       NaN
## 1957          NaN  5.231644e-02        NaN          NaN       NaN
## 1958          NaN  2.612373e-02        NaN          NaN       NaN
## 1959          NaN  2.595699e-02        NaN          NaN       NaN
## 1960          NaN  7.395934e-02        NaN          NaN       NaN
## 1961          NaN  4.735565e-02        NaN          NaN       NaN
```

```
## 1962           NaN  6.400396e-02         NaN          NaN       NaN
## 1963           NaN  5.853025e-02         NaN          NaN       NaN
## 1964           NaN  6.233159e-02         NaN          NaN       NaN
## 1965           NaN  4.614094e-02         NaN          NaN       NaN
## 1966           NaN  4.976200e-02         NaN          NaN       NaN
## 1967           NaN  4.687420e-02         NaN          NaN       NaN
## 1968           NaN  4.292925e-02         NaN          NaN       NaN
## 1969           NaN  6.645559e-02         NaN          NaN       NaN
## 1970           NaN  5.769102e-02         NaN          NaN       NaN
## 1971           NaN  5.074446e-02         NaN          NaN       NaN
## 1972           NaN  4.344280e-02         NaN          NaN       NaN
## 1973           NaN  5.935870e-02         NaN          NaN       NaN
## 1974           NaN  4.114772e-02         NaN          NaN       NaN
## 1975           NaN -9.898645e-03         NaN          NaN       NaN
## 1976           NaN  4.135817e-02         NaN          NaN       NaN
## 1977           NaN  3.336224e-02         NaN          NaN       NaN
## 1978           NaN  3.826555e-02         NaN          NaN       NaN
## 1979           NaN  3.436793e-02         NaN          NaN       NaN
## 1980           NaN  1.563360e-02         NaN          NaN       NaN
## 1981           NaN  1.066253e-02         NaN          NaN       NaN
## 1982           NaN  2.447144e-02         NaN          NaN       NaN
## 1983           NaN  1.240709e-02         NaN          NaN       NaN
## 1984           NaN  1.501578e-02         NaN          NaN       NaN
## 1985           NaN  1.597316e-02         NaN          NaN       NaN
## 1986           NaN  2.297229e-02         NaN          NaN       NaN
## 1987           NaN  2.512565e-02         NaN          NaN 9.5008607
## 1988           NaN  4.519980e-02         NaN          NaN 9.0814341
## 1989           NaN  4.171630e-02         NaN          NaN 8.7948361
## 1990           NaN  2.831500e-02         NaN          NaN 9.9372800
## 1991  0.0818866216  1.028419e-02 0.031609195          NaN 9.0454800
## 1992  0.1053552350  1.574485e-02 0.023842917          NaN 8.5892430
## 1993  0.1010984174 -6.164294e-03 0.020604396          NaN 6.7579283
## 1994  0.0035103063  2.291638e-02 0.016216216 -0.026501133 7.2177200
## 1995 -0.0576914155  2.042497e-02 0.017264276 -0.001362834 7.5369758
## 1996 -0.0034264837  1.369002e-02 0.019531250 -0.014832312 6.3125896
## 1997  0.0148832685  2.283950e-02 0.011583012 -0.024403061 5.5813200
## 1998 -0.0841039269  3.434079e-02 0.006393862  0.024728319 4.6261265
## 1999 -0.1098526269  3.294841e-02 0.005089059  0.036357474 4.6230709
## 2000 -0.0951229114  3.730596e-02 0.017500000  0.081970836 5.3975686
## 2001 -0.0686687552  1.916983e-02 0.015990160  0.071951534 4.9377344
## 2002  0.0461531283  1.106086e-02 0.018115942  0.009066792 4.8573228
## 2003  0.0415262303  8.128699e-03 0.021276596 -0.013286378 4.1312500
## 2004  0.0268085032  2.710887e-02 0.020833333  0.006320838 4.0954269
## 2005  0.0287944349  1.582275e-02 0.017064846  0.049794415 3.4061574
## 2006 -0.0351503631  2.319852e-02 0.016118200  0.089945888 3.7945196
## 2007  0.0542628088  2.307019e-02 0.014559894  0.089348415 4.3044136
## 2008  0.0442062727  1.949141e-03 0.027357580  0.115421104 4.2368978
## 2009  0.1365142904 -3.030478e-02 0.000857541  0.023101742 3.6484418
## 2010  0.0182874080  1.927764e-02 0.014993137 -0.001330146 3.1136889
## 2011 -0.0388860325  2.036878e-02 0.020680385  0.038071225 3.3169506
## 2012 -0.0002773566  1.823599e-03 0.019267823  0.015362606 2.5359141
## 2013  0.0328264855  5.729400e-03 0.008446456 -0.002380333 2.2051736
## 2014  0.0202684410  6.325944e-03 0.005102041  0.011973731 1.6605882
## 2015 -0.0032926904  1.258149e-02 0.000400000  0.038346803 0.8455480
```

```
## 2016 -0.0419311640  1.283317e-02 0.001896397  0.044036295 0.4640234
## 2017 -0.0736006270           NaN         NaN  0.042244990 0.8095622
##             STIR
## 1951         NaN
## 1952         NaN
## 1953         NaN
## 1954         NaN
## 1955         NaN
## 1956         NaN
## 1957         NaN
## 1958         NaN
## 1959         NaN
## 1960         NaN
## 1961         NaN
## 1962         NaN
## 1963         NaN
## 1964         NaN
## 1965         NaN
## 1966         NaN
## 1967         NaN
## 1968         NaN
## 1969         NaN
## 1970         NaN
## 1971         NaN
## 1972         NaN
## 1973         NaN
## 1974         NaN
## 1975         NaN
## 1976         NaN
## 1977         NaN
## 1978         NaN
## 1979         NaN
## 1980         NaN
## 1981         NaN
## 1982         NaN
## 1983         NaN
## 1984         NaN
## 1985         NaN
## 1986         NaN
## 1987         NaN
## 1988         NaN
## 1989         NaN
## 1990         NaN
## 1991         NaN
## 1992         NaN
## 1993         NaN
## 1994  6.52500000
## 1995  6.82000000
## 1996  5.08833333
## 1997  4.38083333
## 1998  3.95500000
## 1999  2.96350000
## 2000  4.39176667
## 2001  4.26178333
```

```
## 2002  3.31859167
## 2003  2.33346667
## 2004  2.10633333
## 2005  2.18468333
## 2006  3.07922500
## 2007  4.27760833
## 2008  4.63423333
## 2009  1.22835833
## 2010  0.81095833
## 2011  1.39060000
## 2012  0.57318333
## 2013  0.22066667
## 2014  0.20993333
## 2015 -0.01936667
## 2016 -0.26369167
## 2017 -0.32905000
```

Basic Descriptive Statistics

```
##  Date           DF                   GDP                  ICP
##  Min.   :1994   Min.   :-0.109853   Min.   :-0.030305   Min.   :0.00040
##  1st Qu.:2000   1st Qu.:-0.040409   1st Qu.: 0.009595   1st Qu.:0.00742
##  Median :2005   Median : 0.003510   Median : 0.019170   Median :0.01612
##  Mean   :2005   Mean   :-0.003059   Mean   : 0.015766   Mean   :0.01376
##  3rd Qu.:2010   3rd Qu.: 0.030810   3rd Qu.: 0.022993   3rd Qu.:0.01869
##  Max.   :2016   Max.   : 0.136514   Max.   : 0.037306   Max.   :0.02736
##  NFCloan             LTIR            STIR
##  Min.   :-0.026501   Min.   :0.464   Min.   :-0.2637
##  1st Qu.:-0.001346   1st Qu.:3.215   1st Qu.: 1.0197
##  Median : 0.023102   Median :4.131   Median : 2.9635
##  Mean   : 0.028770   Mean   :4.037   Mean   : 2.8031
##  3rd Qu.: 0.046915   3rd Qu.:4.898   3rd Qu.: 4.3292
##  Max.   : 0.115421   Max.   :7.537   Max.   : 6.8200
```

Stationarity tests

We perform stationarity tests on the variables, note the issue with inflation.

```
## [1] "DF"
## [1] "your series is stationary at the 90% critical value"
## [1] "GDP"
## [1] "your series is stationary at the 90% critical value"
## [1] "ICP"
## [1] "your series is not stationary at the 90% critical value"
## [1] "NFCloan"
## [1] "your series is stationary at the 90% critical value"
## [1] "LTIR"
## [1] "your series is stationary at the 90% critical value"
## [1] "STIR"
## [1] "your series is stationary at the 90% critical value"
```

Default Flows models

Simple autoregressive linear regression model

We start with a simple linear regression model with two macroeconomic variables: GDP growth rate and inflation, all variables are to be read as growth rates.

$$DF_t = \alpha + \alpha_1 GDP_t + \alpha_2 \pi_{t-1}$$

```
##
## Call:
## lm(formula = DF ~ GDP + ICP1, data = timeseries)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.061077 -0.022394 -0.004935  0.020134  0.075145
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.01219    0.02538   0.480 0.636588
## GDP         -2.74333    0.63293  -4.334 0.000357 ***
## ICP1         1.87497    1.27218   1.474 0.156903
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03719 on 19 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.6324, Adjusted R-squared:  0.5937
## F-statistic: 16.34 on 2 and 19 DF,  p-value: 7.434e-05
```

We also add an autoregressive component, which then "capture" some of the coefficient significance.

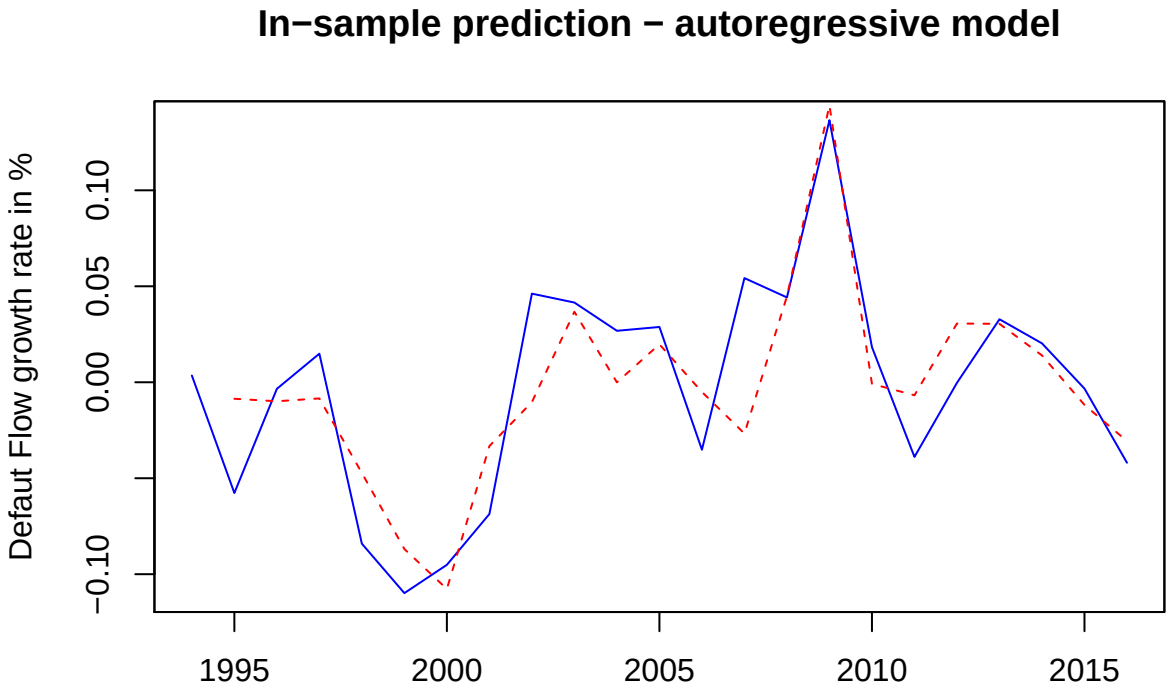
$$DF_t = \alpha + \beta_1 DF_{t-1} + \beta_2 GDP_t + \beta_3 \pi_{t-1}$$

```
##
## Call:
## lm(formula = DF ~ DF1 + GDP + ICP1, data = timeseries)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.049084 -0.028323  0.003609  0.011688  0.081004
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.001699   0.023791  -0.071  0.94384
## DF1          0.309136   0.136242   2.269  0.03580 *
## GDP         -2.250440   0.613180  -3.670  0.00175 **
## ICP1         2.341602   1.170764   2.000  0.06081 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0337 on 18 degrees of freedom
##   (1 observation deleted due to missingness)
## Multiple R-squared:  0.7141, Adjusted R-squared:  0.6665
```

```
## F-statistic: 14.99 on 3 and 18 DF,  p-value: 3.87e-05
```

```
##
##  Durbin-Watson test
##
## data:  DF ~ DF1 + GDP + ICP1
## DW = 2.3549, p-value = 0.7027
## alternative hypothesis: true autocorrelation is greater than 0
```

Prediction



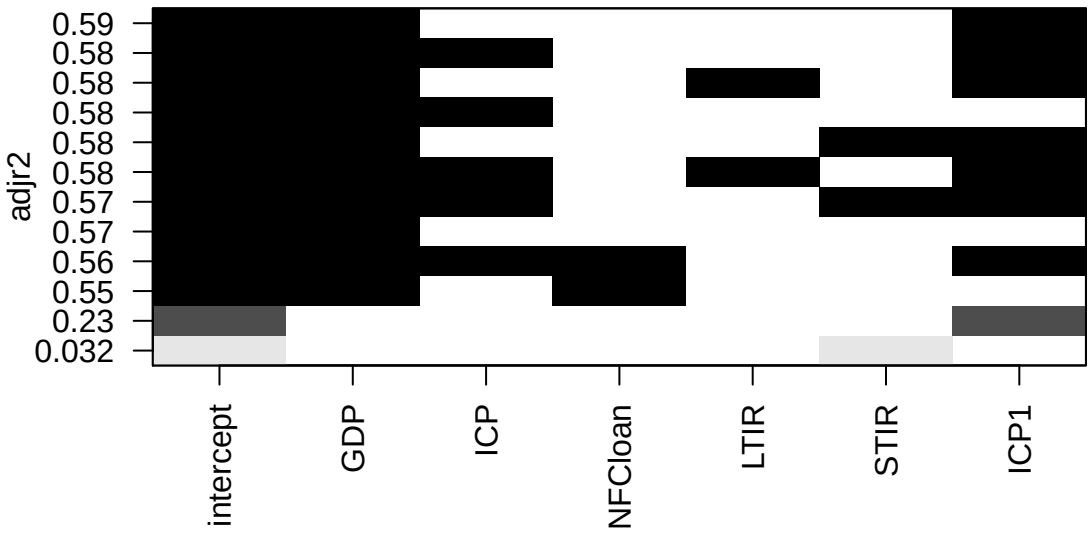
Global Search Algorithm

Search for a model

The R function regsubsets allows to test several models, compare their adjusted R^2. When picking a model, there is a trade-off between the number of explanatory variables used and its explanatory power.

```
## [[1]]
## (Intercept)         GDP
##  0.04526048 -3.14872767
##
## [[2]]
## (Intercept)        ICP1
## -0.06444653  4.27137155
##
## [[3]]
##  (Intercept)         STIR
##  0.018622602 -0.008345178
##
```

```
## [[4]]
## (Intercept)         GDP        ICP1
##  0.01218515 -2.74332579  1.87497386
##
## [[5]]
## (Intercept)         GDP         ICP
##  0.02853273 -3.27566050  1.36896126
##
## [[6]]
## (Intercept)         GDP     NFCloan
##  0.04832655 -3.10413352 -0.12002552
##
## [[7]]
##  (Intercept)          GDP          ICP         ICP1
##  0.009714706 -2.909759828  0.811215277  1.453099601
##
## [[8]]
##  (Intercept)          GDP         LTIR         ICP1
##  0.015573997 -2.465881590 -0.004060094  2.443468726
##
## [[9]]
##  (Intercept)          GDP         STIR         ICP1
##  0.010500058 -2.481986348 -0.003191116  2.298341722
##
## [[10]]
##  (Intercept)          GDP          ICP         LTIR         ICP1
##  0.013479636 -2.587122752  1.137386876 -0.005700736  2.081691043
##
## [[11]]
##  (Intercept)          GDP          ICP         STIR         ICP1
##  0.006236629 -2.598739379  1.148338829 -0.004642317  1.893677490
##
## [[12]]
## (Intercept)         GDP         ICP     NFCloan        ICP1
##  0.01374506 -2.90991253  0.95089154 -0.12140267  1.30367839
```



Prediction

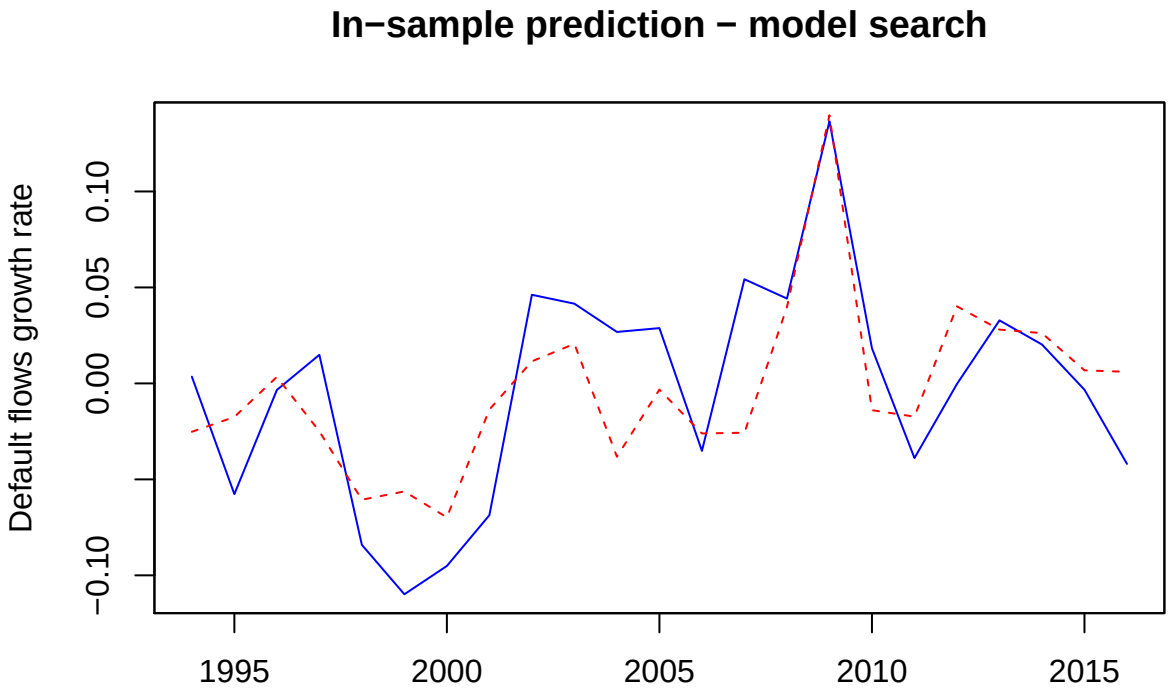
First model, called "search"

Based on the results above, we can consider the following model:

$$DF_t = \gamma_0 + \gamma_1 GDP_t$$

```
##
## Call:
## lm(formula = DF ~ GDP, data = timeseries)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.055062 -0.024410 -0.005919  0.030378  0.079954
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.04579    0.01205   3.799  0.00105 **
## GDP         -3.09829    0.57722  -5.368 2.53e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0379 on 21 degrees of freedom
## Multiple R-squared:  0.5784, Adjusted R-squared:  0.5583
## F-statistic: 28.81 on 1 and 21 DF,  p-value: 2.529e-05
```

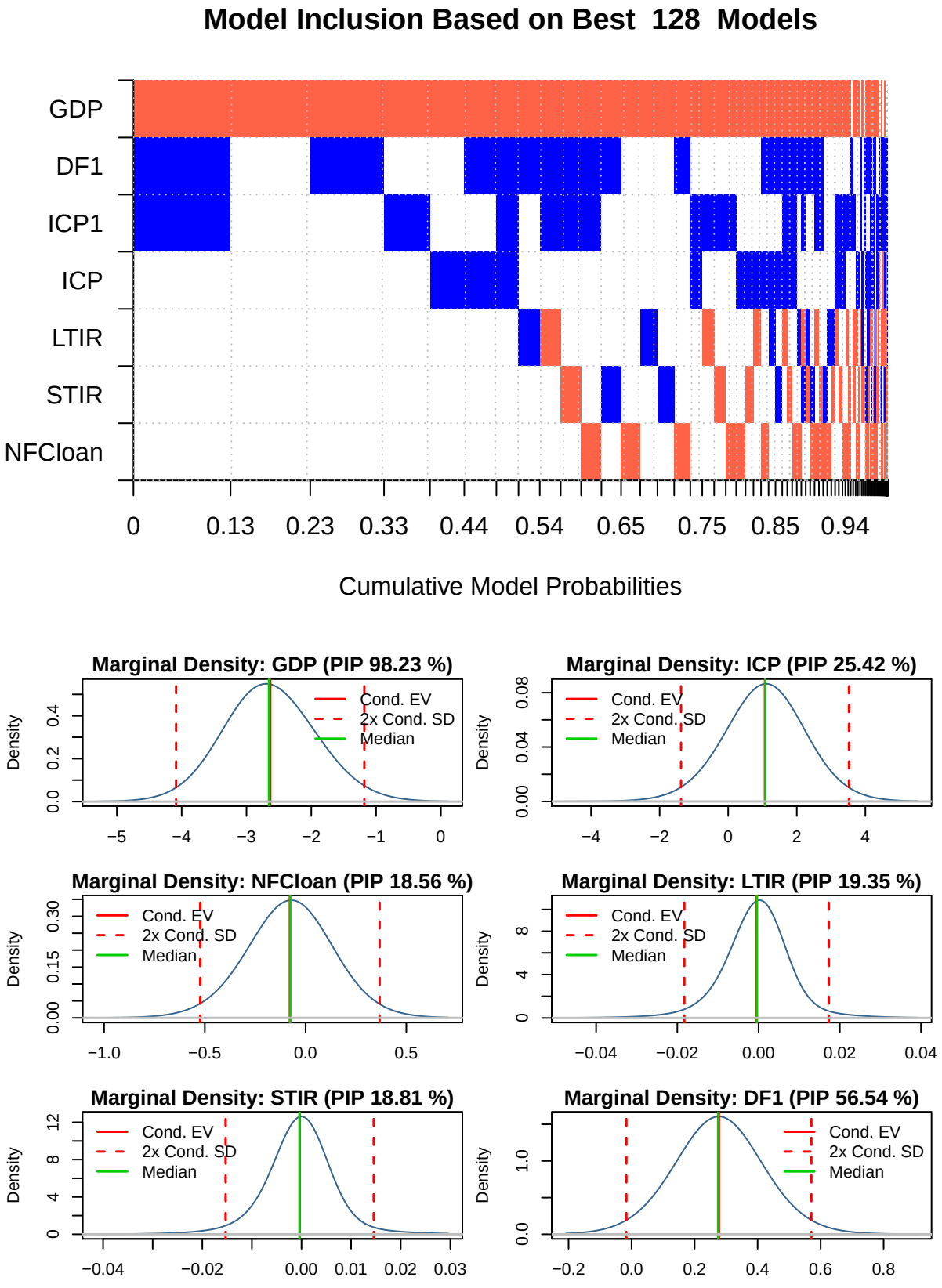
```
##
##  Durbin-Watson test
##
## data:  DF ~ GDP
## DW = 1.6375, p-value = 0.166
## alternative hypothesis: true autocorrelation is greater than 0
```

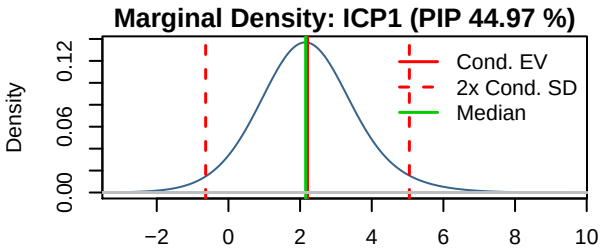


Bayesian Averaging Models

Estimation

```
##                PIP     Post Mean     Post SD Cond.Pos.Sign Idx
## GDP      0.9823395 -2.587063e+00 0.799046918    0.00000000   1
## DF1      0.5653711  1.566621e-01 0.176205955    1.00000000   6
## ICP1     0.4496673  9.925481e-01 1.453988666    1.00000000   7
## ICP      0.2541563  2.727909e-01 0.774183805    0.98958831   2
## LTIR     0.1935281 -9.578161e-05 0.003915341    0.46411715   4
## STIR     0.1881229 -6.921739e-05 0.003241302    0.44829560   5
## NFCloan 0.1855899 -1.441269e-02 0.100514521    0.00410566   3
```


Model Inclusion Based on Best 128 Models
GDP
DF1
ICP1
ICP
LTIR
STIR
NFCloan
0
0.13
0.23
0.33
0.44
0.54
0.65
0.75
0.85
0.94
Cumulative Model Probabilities
Marginal Density: GDP (PIP 98.23 %)
Marginal Density: ICP (PIP 25.42 %)
Marginal Density: NFCloan (PIP 18.56 %)
Marginal Density: LTIR (PIP 19.35 %)
Marginal Density: STIR (PIP 18.81 %)
Marginal Density: DF1 (PIP 56.54 %)
Density
Cond. EV
2x Cond. SD
Median



We can display the "estimated" coefficients:

```
##             GDP       ICP     NFCloan          LTIR          STIR       DF1
## [1,] -2.587063 0.2727909 -0.01441269 -9.578161e-05 -6.921739e-05 0.1566621
##            ICP1 (Intercept)
## [1,] 0.9925481   0.0198773
```

Prediction