# Predicting the real economy wih volatility

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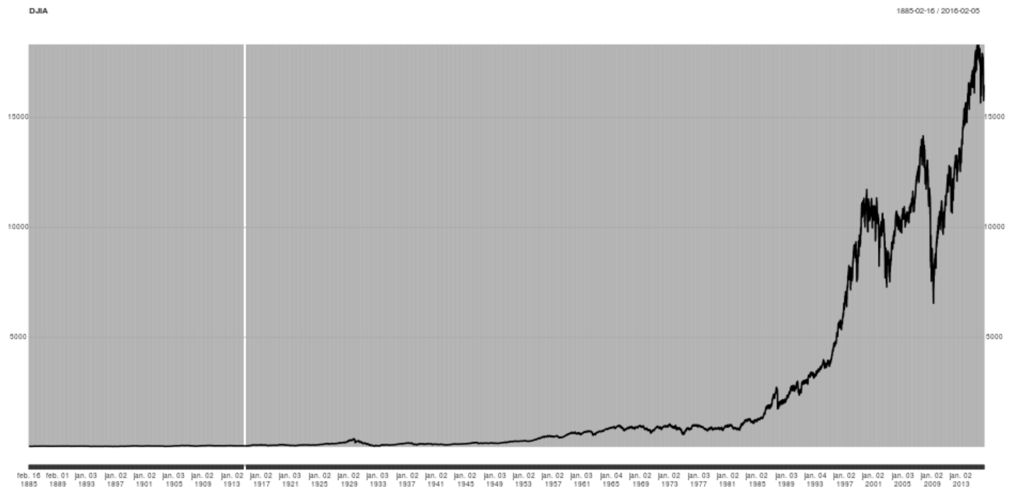
## 1 Predicting real economy variables with asset price volatility

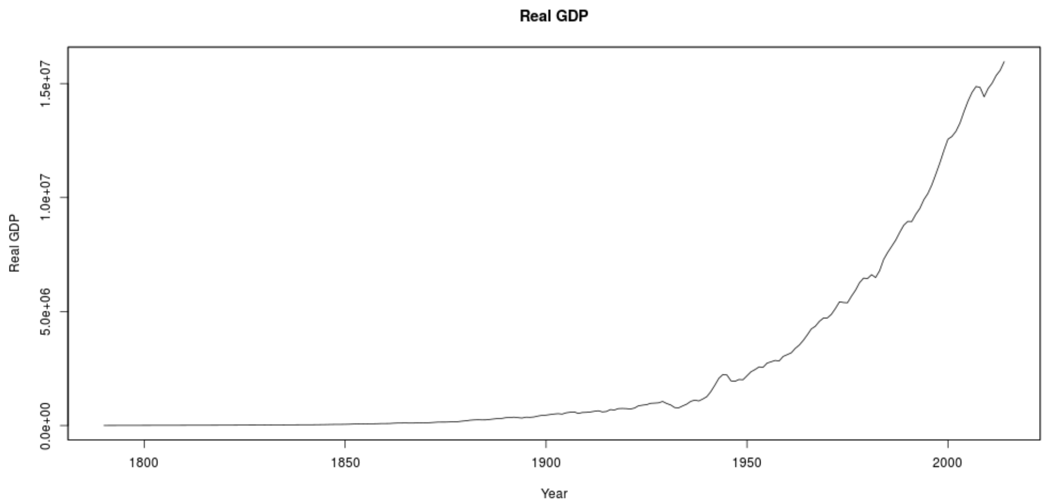
Look at the case of US.

As real variable we use (changes in) GDP. The asset price we consider is the stock market, represented with the DJIA. The use of the DJIA is due to the desire to have as long a time series as possible. At the webpage `https://www.measuringworth.com` you will find daily series of DJIA going back to 1885, as well as annual GDP estimates going back to 1790.

**Figure 1** DJIA and Real GDP

DJIA



let $dGDP$ be the (log) change in GDP, and $\sigma(R_m)$ the annual estimate of stock volatility on the DJIA

We will estimate the relationship

$$dGDP_t = a + b_1 dGDP_{t-1} + b_2 \sigma(R_{m,t-1}) + \varepsilon_t$$

If the change in the stock price volatility predicts the future GDP, the coefficient $b_2$ will be significant. Let us test this

We do so in a VAR context.

Show some of the `R` commands.

This is the full sequence of commands

```
outdir <- "../../results/2015_02_us_annual/"
library(xts)
library(vars)
library(quantmod)

source ("~/data/2016/measuringworth/read_gdp.R")
                                         # RealGDP is a zooreg(annual)
dGDP <- diff(log(RealGDP))
names(dGDP) <- "dGDP"

source ("~/data/2016/measuringworth/read_dja.R")
Rm <- dailyReturn(DJIA)

sigmaRm <- period.apply(Rm,
                        INDEX=endpoints(Rm,on="years"),
                        FUN=sd)
sigmaRm <- zooreg(coredata(sigmaRm),
                  frequency=1,
                  start=1885)
names(sigmaRm) <- "sigmaRm"

data <- merge(dGDP,
              sigmaRm,
              all=FALSE)
head(data)

reg <- VAR(data)
summary(reg)
causality(reg, cause="sigmaRm")
reg.irf <- irf(reg,
               response="dGDP",
               impulse="sigmaRm")
filename <- paste0(outdir,
                   "irf_impulse_sigmaRm_response_dGDP.png")
png(file=filename, width=1000, height=500)
plot(reg.irf)
dev.off()
```

And here is some of the output

The data

```
> source ("~/data/2016/measuringworth/read_gdp.R")
[1] "/home/bernt/data/2016/measuringworth/USGDP_1790-2015.csv"
> head(RealGDP)
1790 1791 1792 1793 1794 1795
```

```
4351 4612 4952 5345 6052 6436
>                                         # RealGDP is a zooreg(annual)
> dGDP <- diff(log(RealGDP))
> names(dGDP) <- "dGDP"
> head(dGDP)
      1791       1792       1793       1794       1795       1796
0.05825590 0.07112993 0.07637001 0.12422725 0.06151843 0.03120473
>
> source ("~/data/2016/measuringworth/read_dja.R")
> head(DJIA)
1885-02-16 1885-02-17 1885-02-18 1885-02-19 1885-02-20 1885-02-21
   30.9226    31.3365    31.4744    31.6765    31.4252    31.8933
> Rm <- dailyReturn(DJIA)
```

This is the final data we will work with

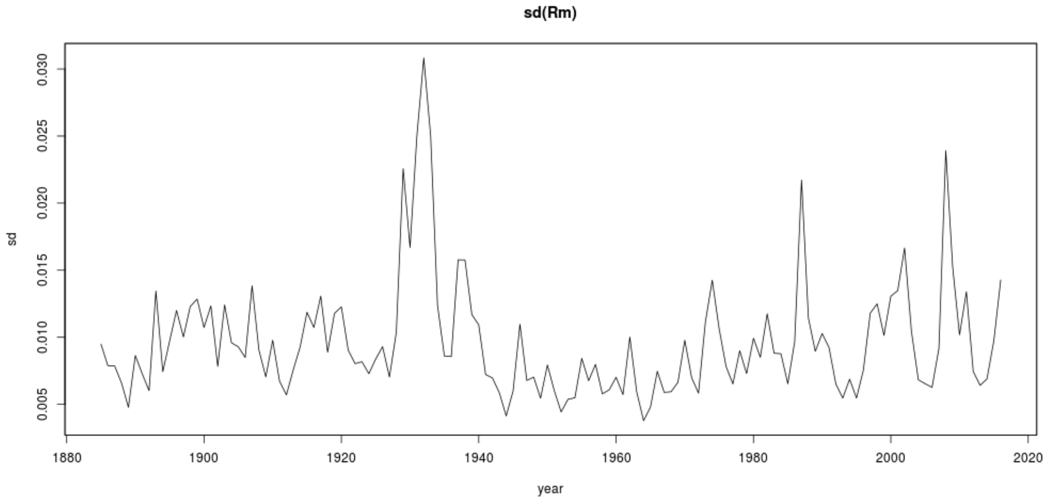
```
> data <- merge(dGDP,sigmaRm,all=FALSE)
> data <- merge(dGDP,
+               sigmaRm,
+               all=FALSE)
> head(data)
            dGDP     sigmaRm
1885 0.003455458 0.009483220
1886 0.078195630 0.007888869
1887 0.070125639 0.007855014
1888 0.055903941 0.006576621
1889 0.028330104 0.004775508
1890 0.092714255 0.008637905
```

Plot these, se figure
and then the VAR

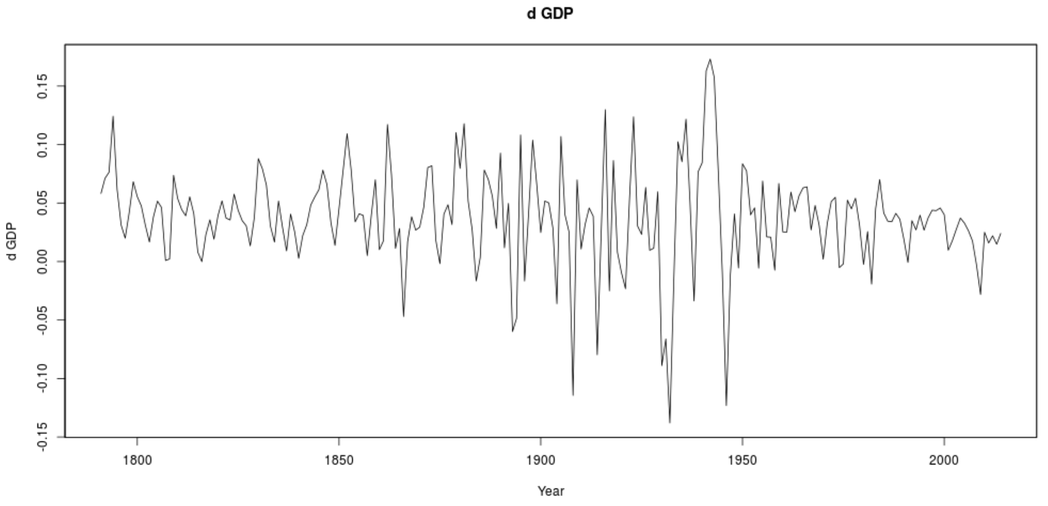
```
> reg <- VAR(data)
> summary(reg)

VAR Estimation Results:
=========================
Endogenous variables: dGDP, sigmaRm
Deterministic variables: const
Sample size: 129
Log Likelihood: 763.632
Roots of the characteristic polynomial:
0.6193 0.1563
Call:
VAR(y = data)


Estimation results for equation dGDP:
=====================================
dGDP = dGDP.l1 + sigmaRm.l1 + const
```

**Figure 2** sigma DJIA and diff Real GDP

annual sd of DJIA daily returns




(log) Changes in GDP



```
           Estimate Std. Error t value Pr(>|t|)
dGDP.l1     0.18996    0.09053   2.098 0.037879 *
sigmaRm.l1 -2.24233    1.02262  -2.193 0.030163 *
const       0.04778    0.01200   3.980 0.000116 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.04745 on 126 degrees of freedom
Multiple R-Squared: 0.1033,Adjusted R-squared: 0.0891
F-statistic:  7.26 on 2 and 126 DF,  p-value: 0.001037


Estimation results for equation sigmaRm:
========================================
sigmaRm = dGDP.l1 + sigmaRm.l1 + const

             Estimate Std. Error t value Pr(>|t|)
dGDP.l1    -0.0064530  0.0066917  -0.964    0.337
sigmaRm.l1  0.5856172  0.0755854   7.748 2.69e-12 ***
const       0.0041828  0.0008873   4.714 6.32e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.003508 on 126 degrees of freedom
Multiple R-Squared: 0.3784,Adjusted R-squared: 0.3685
F-statistic: 38.34 on 2 and 126 DF,  p-value: 9.839e-14



Covariance matrix of residuals:
              dGDP    sigmaRm
dGDP     2.252e-03 -4.215e-05
sigmaRm -4.215e-05  1.230e-05

Correlation matrix of residuals:
           dGDP sigmaRm
dGDP     1.0000 -0.2532
sigmaRm -0.2532  1.0000
```

Causality test

```
> causality(reg, cause="sigmaRm")
$Granger

Granger causality H0: sigmaRm do not Granger-cause dGDP

data:  VAR object reg
```

```
F-Test = 4.8081, df1 = 1, df2 = 252, p-value = 0.02924


$Instant

H0: No instantaneous causality between: sigmaRm and dGDP

data:  VAR object reg
Chi-squared = 7.7737, df = 1, p-value = 0.005301
```

and an impulse response plot

```
> reg.irf <- irf(reg,response="dGDP",impulse="sigmaRm")
> plot(reg.irf)
```