# Interest Rate Shock Model

Alain LeBel

16 February 2017

# What is the *Interest Rate Shock Model*?

> *"The fools are certain and the intelligent full of doubt." — Bertrand Russell*

Start with multi factor model with only two factors, being the benchmark equity index ($B$) and the bond index ($F$ for fixed income):

$$r_t = \alpha + \beta_B r_{B,t} + \beta_F r_{F,t} + \theta_t$$

For every stock, I run a **multilinear regression** using three years of weekly historic data to determine the values of $\alpha$ and the two $\beta$'s. The result is a simple linear model: plug in returns of the two factors to get an estimated return of the stock.

To build a complete *Interest Rate Shock Model*, we use simpler 1-factor models to estimate how yield changes affect the benchmark and bond returns, then plug those estimates into the above equation.

# The factors and the shock parameter

For the benchmark, use the *MSCI AC World* total return index.

For the yield, use the *U.S. 10y Treasury Yield*. When I shock the yield (by increasing it by 100 bp), I actually compute the log return of the latest yield:

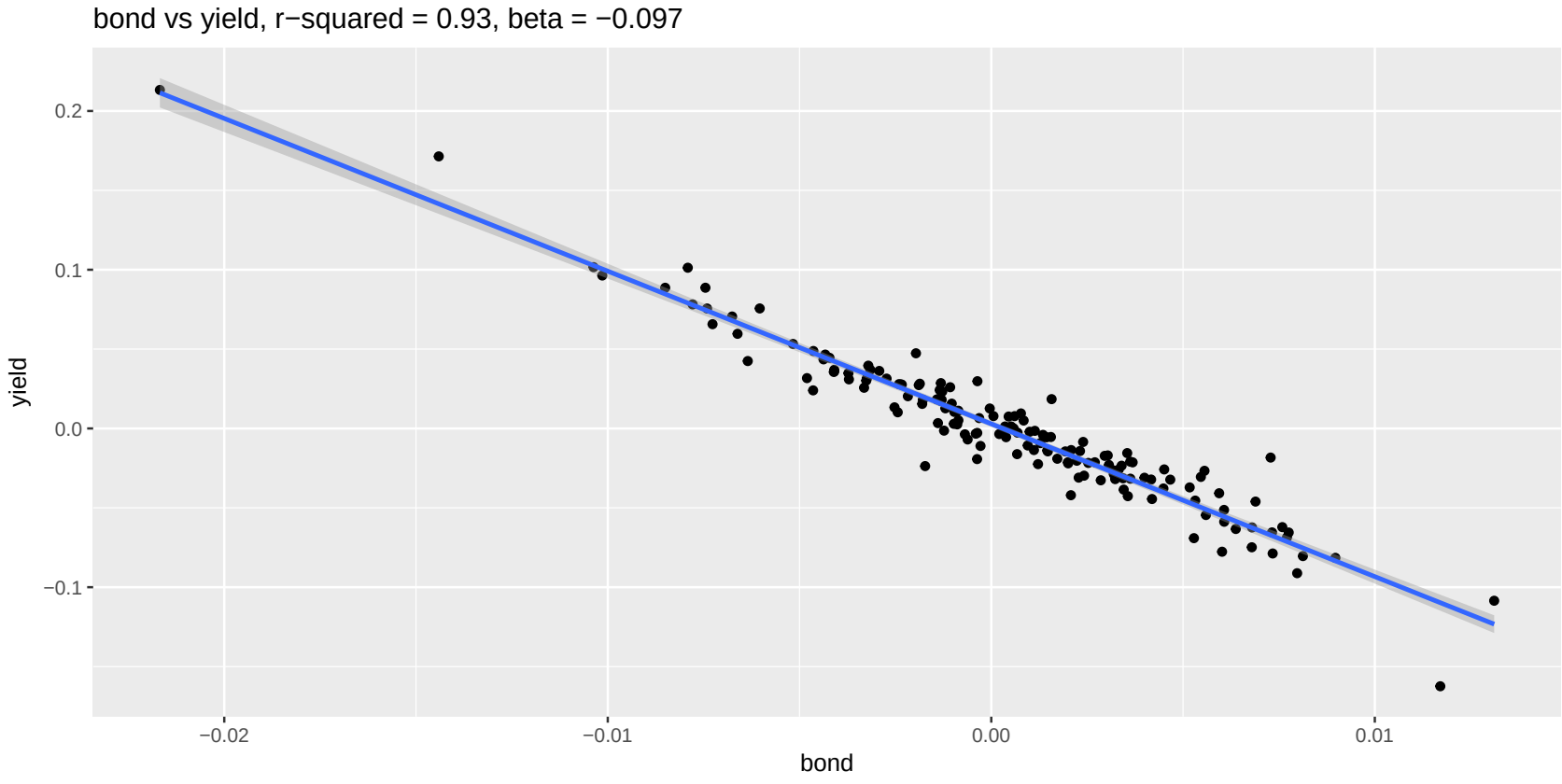
$$log(3.5\%) - log(2.5\%) = 0.337$$

is the "return of the yield" shock. I use this to estimate the shocked returns of the benchmark and bond index.

For the bond, use *Citigroup US Broad Investment-Grade Treasury Bond Index*. It measures "the total rate of return performance for bond markets with a remaining maturity of at least one year" and is "composed of US Treasuries excluding Federal Reserve purchases, inflation-indexed securities and STRIPS" *(?)*. Northfield tends to use Citigroup fixed-income indices, and for this yield I find the correlation to be very good (see next page).

# How yield affects bond index returns

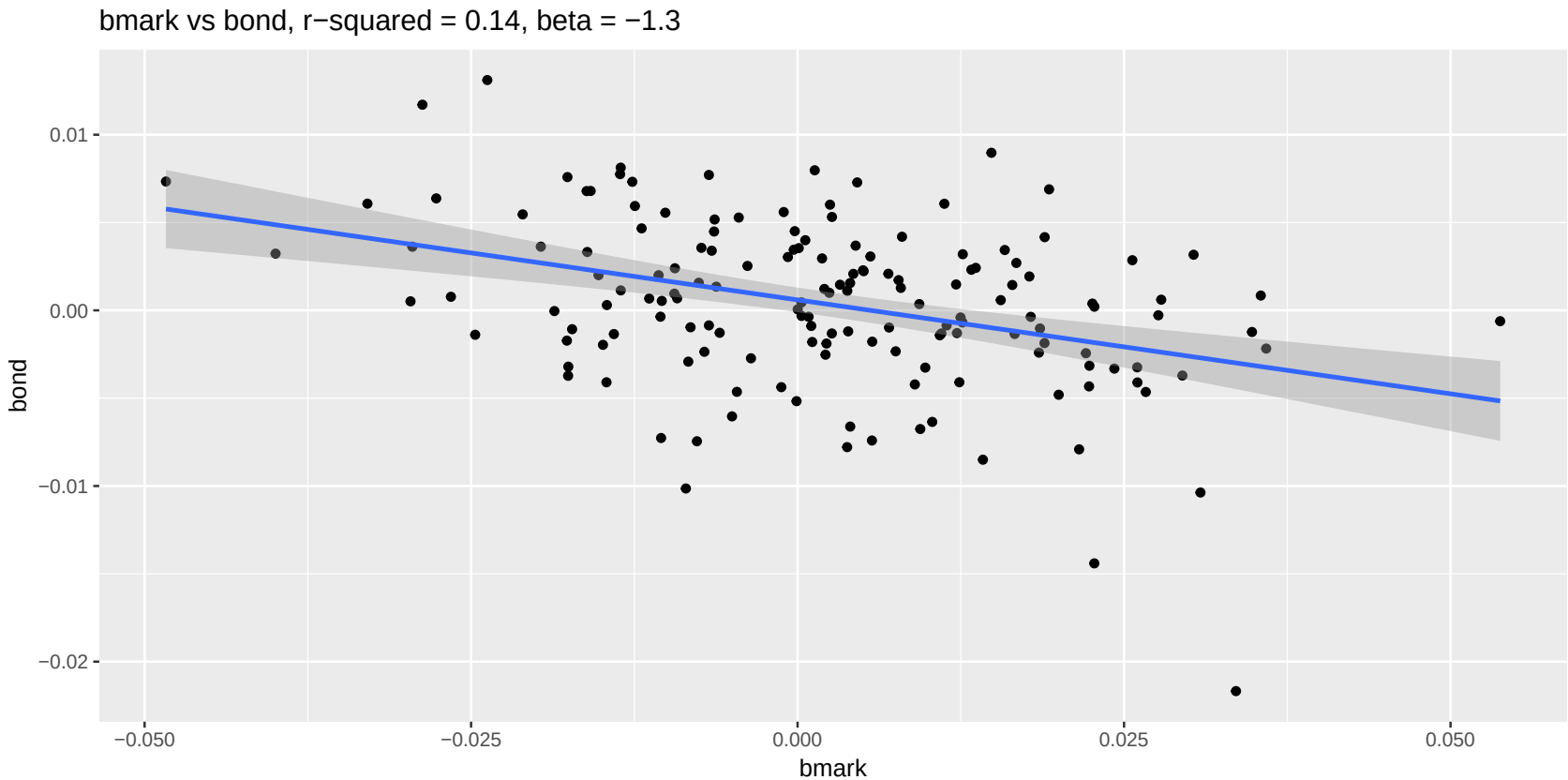
*Returns of the yield* are highly correlated to bonds: saying "The (return of the) yield is $+x\%$" is almost the same as saying "The bond index goes down $-0.097x\%$":



# How yield affects benchmark returns

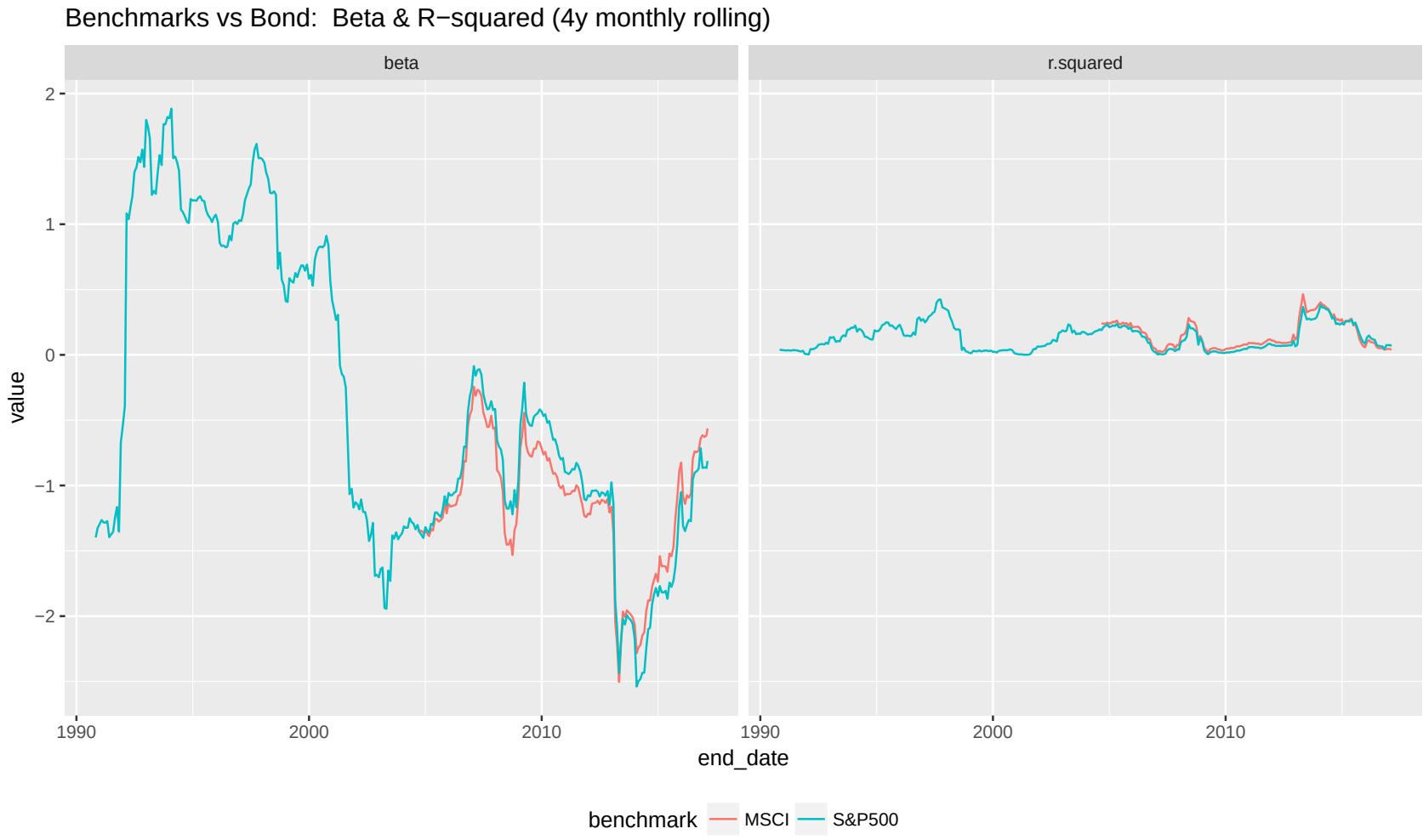
*"All models are wrong but some are useful" — George Box*

*Don't forget correlation:* If the bond changes, then the benchmark will change, too:



# Equities vs fixed income

Disclaimer: benchmarks and bonds now have low correlation *(remember: correlation$^2 = R^2$)* and are inversely related ($\beta < 0$)



# Why 3 years weekly?

We tried all timespans from six months to five years, with daily, weekly and monthly frequencies:

# Now the results:

I computed this model for each stock in the global portfolios (GLUF and Global Pensions). Then I shock the 10Y U.S. Treasury Yield by +100 bps and calculate the estimated return of your portfolio based on latest weights in the database. I find:

- PCGLUF estimated return = 3.34%.
- benchmark estimated return = 4.27%.
- Therefore, we estimate PCGLUF would underperform by -0.94% in this scenario.

Similarly, PCGPEN estimated return is 2.52%, or -1.75% relative the MSCI AC World Total Return Index.

# How the results changed through history

TO DO: Draw a chart of the benchmark and portfolio estimated shocks through history.

# How does this compare to Barra?

I also computed the model over the same timeframe which Barra did for us a couple of months ago (October 2013 to October 2016). I find:

- PCGLUF estimated return is +3.0%, while Barra computed +6.4%
- the benchmark estimated returns +4.2%, while Barra computed +8.0%
- My model says -1.2% underperformance, while Barra say -1.6%

# Why so different from other risk models?

The two main differences with a true risk model (by Northfield, Barra or UBS) are:

1. Most risk models use "exponentially decay weighted" observations. This means history has a half-life, and the model puts more emphasis on recent data than older data.
2. Other risk models have more factors, including:
   - Sectors (GICS or otherwise)
   - Regions or countries
   - Currencies
   - Oil prices
   - The usual quant signals (size, Value/Growth, etc)
   - Some economic signals (IP, Slope of the Term Structure, etc)