Interest Rate Shock Model

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What is the *Interest Rate Shock Model*?

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 α and the two β'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 two factor returns, and plug those estimates into the above equation.

The factors and the shock parameter

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

For the bond, I use the total return of the *Citigroup US Broad Investment-Grade Bond Index* (as does Northfield).

For the yield, I use the *U.S. 10y Treasury Yield*.

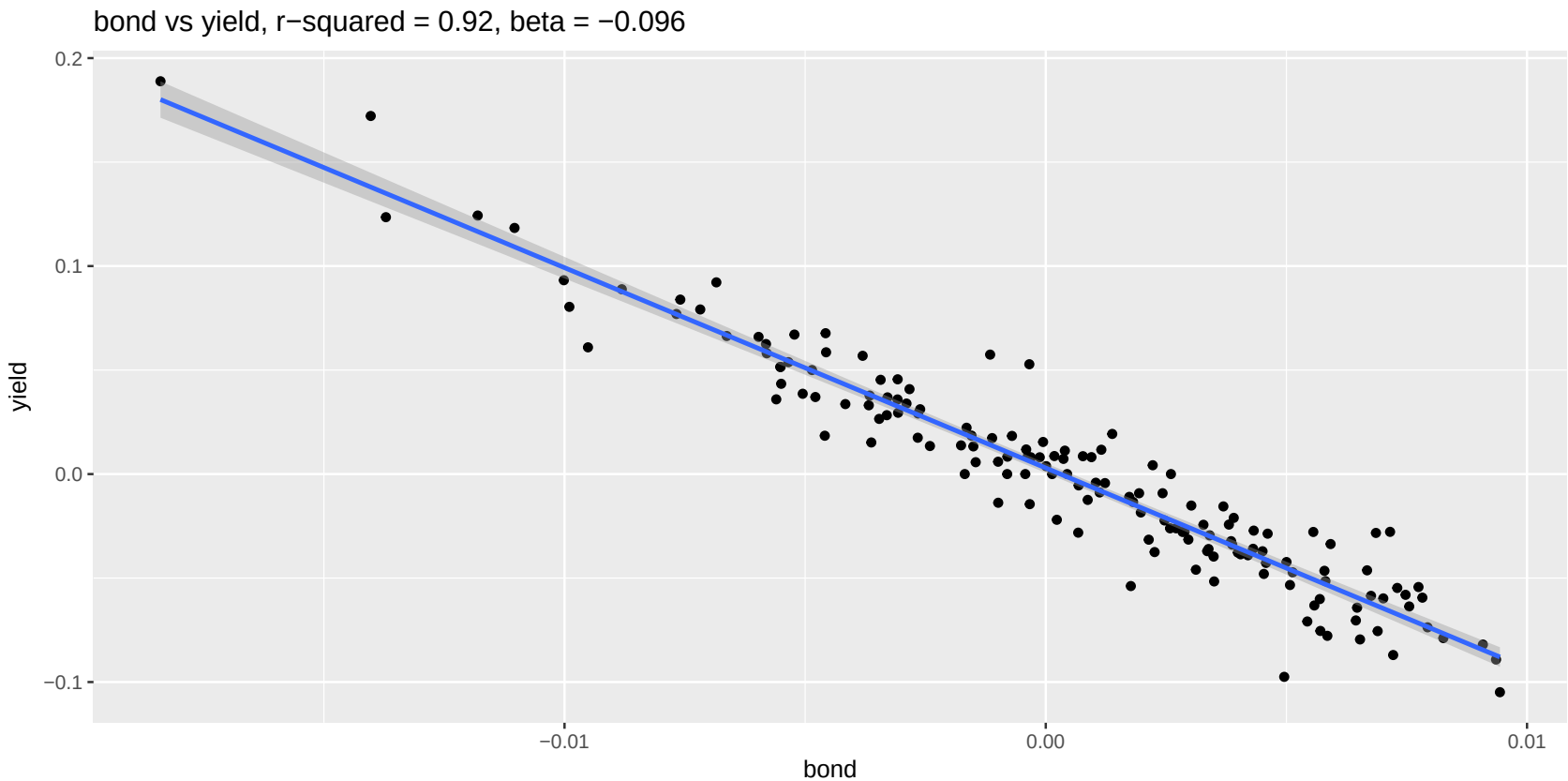
When I shock the yield (by increasing it by 100 bp), I actually compute the log return of the latest yield:

$$log(3.39\%) - log(2.39\%) = 0.3495$$

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

How yield affect bond index returns

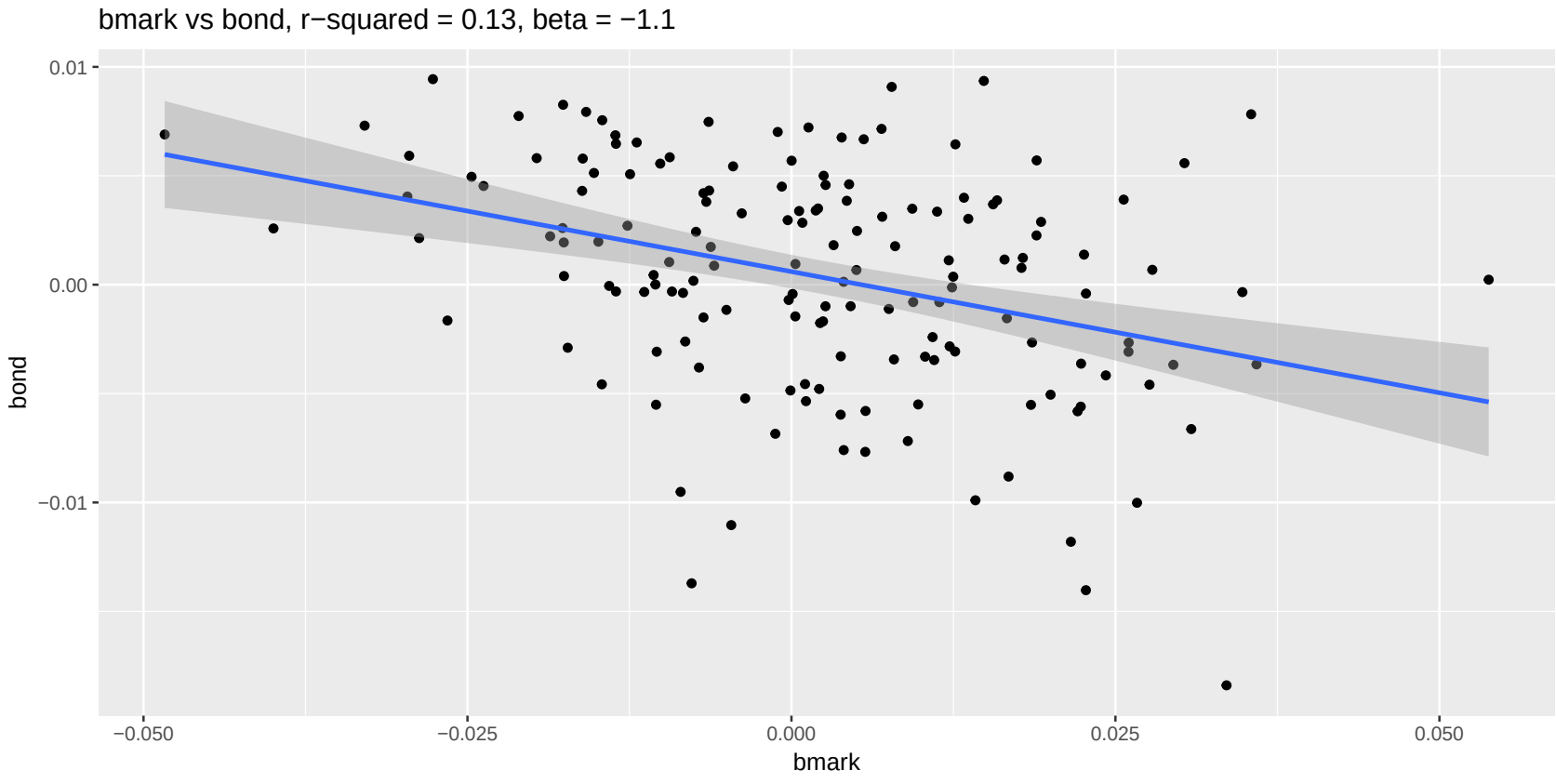
Returns of the yield are highly correlated to bonds: saying "The (return of the) yield goes up x%" is almost the same as saying "The bond index goes down $-0.096x$%":



How yield affect benchmark returns

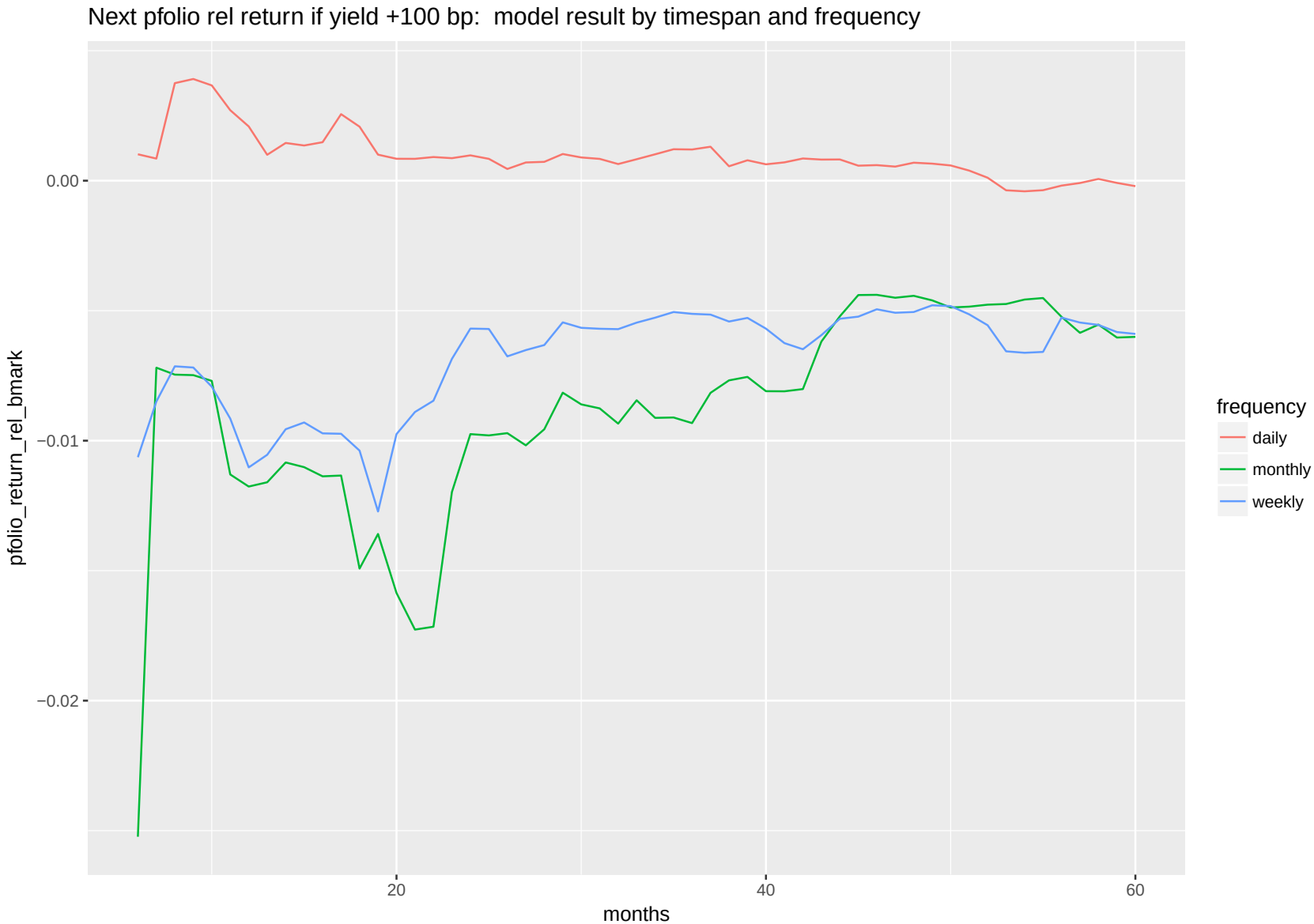
TO DO: Add George Box quote "All models are wrong but some are useful"

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



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 = 3.13%.
- benchmark estimated return = 3.73%.
- Therefore, we estimate PCGLUF would underperform by -0.61% in this scenario.

Similarly, PCGPEN estimated return is 2.14%, or -1.6% relative the MSCI AC World Total Return Index.

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:
   - GICS Sectors
   - Regions (or countries)
   - All currencies
   - Oil prices
   - The usual quant signals such as size, Value/Growth, etc.