Avantage Reply

FRTB Implementation: Stock Take in the Eurozone and the UK

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Agenda

1. Implementing FRTB
   - Overview of the open issues that hinder implementation

2. PnL attribution
   - P-values are an effective solution

By 2019 banks must implement FRTB

What:

- Implementation
  - IT systems
  - Policies and procedures
- Model validation and internal audit review
- For IMA - model approval by regulators

Impact:

- Capital impact
- Implementation cost
- Target operating model
  - Recurring costs
  - Organisational impacts

Requirements:

- FRTB is more risk sensitive and granular, therefore it requires more detail
- Many outstanding questions (over 100 FAQs)

Elements on which our interactions with banks have mostly focused:

High focus

Focus

Some outstanding issues for implementation

Trading book / banking book boundary

- Definition of the trading desk
- No order of interpretation of boundary requirements

Standardised approach

- Definition of a risk factor
- Adjustments for positive gamma

Internal model approach

- Definition of a risk factor
- Interaction of trading desk definition with other rules
- Non-modellable risk factors

Disclosure requirements & SREP

- Too much detail required at granular level, particularly for standardised rules calculations.
- But less of a focus for the moment

When will the fog clear ?

While the fog remains

Waiting for full certainty is not an option

Banks must start the implementation under uncertainty:

1. Some requirements are clear:
   - Data models can be reviewed to ensure all relevant information is captured
   - 10 year history of risk factors can be built
   - Operating model around new products can be reviewed

2. Familiarize themselves with the rules:
   - Participate in quantitative impact studies
   - Build prototypes
   - Engage with all stakeholders

3. Make informed assumptions

The FRTB control framework around internal models

Backtesting – test the PnL distribution of the risk model

Two confidence intervals:
- 97.5%
- 99%

Two daily PnLs to test:
- Actual PnL
- Hypotethical PnL

PnL attribution – test the risk factor coverage of the risk model

Two types of PnL are used:
- Hypothetical PnL (HPL)
- Risk Theoretical PnL (RTPL)

Two tests to apply:
- Mean test
- Variance ratio test

The industry found that the tests do not work well even when the risk factor coverage is adequate. For example, the test don't work with very well hedged portfolios since the standard deviations of the portfolios PnL tends to zero.

Industry proposed better alignment of the definitions of RTPL and HPL and has also defined new test statistics, ExVol and the Coverage Ratio. However, **these tests may be difficult to calibrate and are in fact simplified variants of P–value tests.**

PnL attribution tests under FRTB

BCBS requires banks to test the correlation between RTPL and HPL by desk:

- Hypothetical PnL (HPL) – based on the **full set of risk factors** the desk uses for risk management
- Risk Theoretical PnL (RTPL) – based on risk factors the **bank's risk engine uses**

Mean test	Variance ratio test
$\left\lvert \frac{Mean(RTPL - HPL)}{\sigma_{HPL}} \right\rvert < 10\%$	$\frac{\sigma^2_{(RTPL - HPL)}}{\sigma^2_{HPL}} < 20\%$

This would seem reasonable, but HPL can differ from RTPL for a number of reasons in addition to model approximations:

- For well hedged portfolios σ will be close to zero while the numerators of these ratios can still be non-zero
- Alignment of front office and risk data (NY close vs. London for example)
- Valuation adjustments
- NMRFs will lead to PnL attribution test failure
- Specific risk: impractical to source actual returns for non-material single names

Industry proposals

Industry proposals to improve the BCBS text cover both:

- Improve alignment of RTPL and HPL definitions
- Using alternative metrics

Alternative 1

$$\frac{\sigma^2_{RTPL} - \sigma^2_{HPL}}{Max[\sigma^2_{HPL}, Z]} < T$$

Alternative 2

$$\frac{\sigma^2_{(RTPL-HPL)}}{Max[\sigma^2_{HPL}, \sigma^2_{RTPL}]} < T$$

Alternative 3

$$ExVol = Stdev(z(t)) - 1$$

$$where \quad z(t) = HPNL(t) / sigma(t)$$

Alternative 4

$$CR = \frac{ES_{75\%}(1-\ day\ HPL)}{ES_{75\%}(1-\ day\ RTPL)}$$

What is the right question ?

We believe that:

The model must generate a probability distribution for PnL (RTPL) which is consistent with the hypothetical PnL (HPL) we are observing

The PnL attribution tests as prescribed are too severe because they require contemporaneous correlation between RTPL and HPL which is not necessary. However, backtesting a couple of 1-day VaR percentiles is not sufficient to ensure adequate modelling, especially given the divergence under FRTB between 1-day VaR and the capital model.

Using **P-values** would ensure the probability distribution is adequate

- FRTB already requires firms to compute these and make them available to regulators
- In time, we believe, they will be seen as the most direct, reliable and comprehensive test that the model generates an adequate representation of the 1-day PnL distribution.

Using **stress testing** would ensure capital adequacy

- Neither the existing tests nor P-values can ensure capital adequacy

P-values explained (1 of 2)

The ideas is to transform the observed PnL outcomes – which follow an unknown distribution – into a new measure which follows a uniform distribution. From these normally distributed random variables can be constructed so that the usual statistical tests can be applied to it.

The process requires 2 steps

1. Assign a probability (p_i) to each PnL outcome based on the rank of the the model generated scenario it is closest to
2. Test:
   a. directly that the p-values (p_i) follow a uniform distribution, or
   b. convert the p-values to a normally distributed variable, using $q_i=N^{-1}(p_i)$ and conduct normality tests

1. Assign a probability (p_i)

$$p_i = prob(x < pl_i / model\_scenarios)$$

For example, consider a historical simulation based on 250 scenarios:

$$p_i = \frac{rank(pl_i)}{250} = percentilerank(pl_i)$$

Where *rank(pl_i)* is the rank of the scenario closest to pl_i (the most negative scenario is 1 and the most positive is 250)

Sources:
P-Values comes from probtiles (probability of a quantile), advocated for backtesting regulatory models by Crnkovic and Drachman (1996) and Diebold and Gunther (1998). But the idea of so-called probtiles goes back to at least Rosenblatt (1952).
The industry already proposed P-values (referred to as PiT) in a March 2013 response to the May 2012 FRTB proposals (BCBS219).

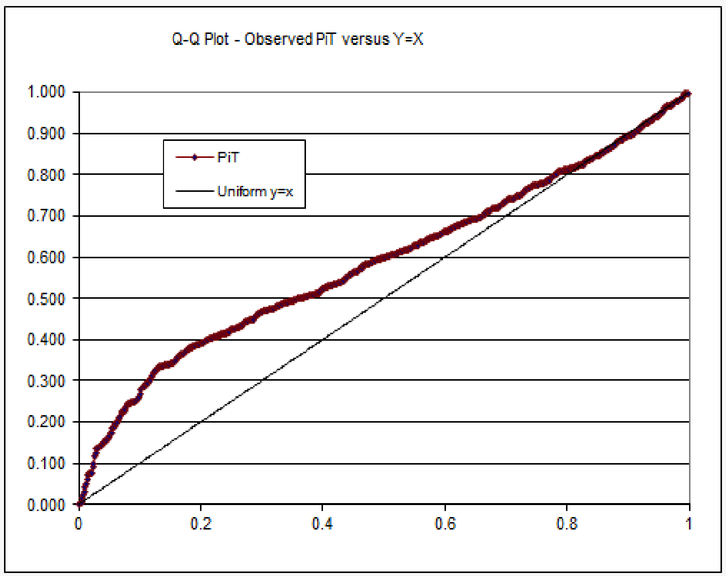
P-values explained (2 of 2)

1. Assign a probability (p_i)

$$p_i = prob(x < pl_i \,/\, model\_scenarios)$$

By definition the p_i values are uniformly distributed U(0,1) since they define a cumulative density function.

2. Test the distribution of p_i is Uniform



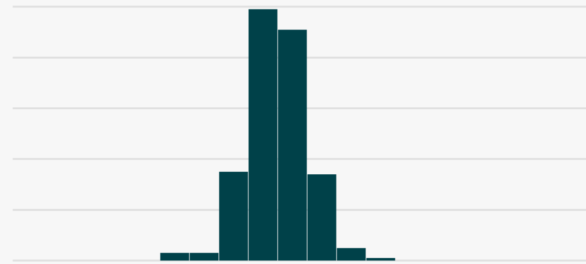
A range of tests exist to test the distribution p_i.

They can be converted to normally distributed variables using $q_i = N^{-1}(p_i)$ and Normality tests applied.

However a simple plot of the ordered p_i values provides a useful visual test of uniformity.
This can be formalized into a test based on Zumbach (2007) which measures the closeness of the plot p_i to the y=x line, by measuring the weighted area between p_i and the y=x line

$$d_p = 2(t+1)\int_0^{0.5} \left(CDF_{emp}(z) - z\right)\left|2z - 1\right|^t dz$$

Illustrating P-values (1 of 5)



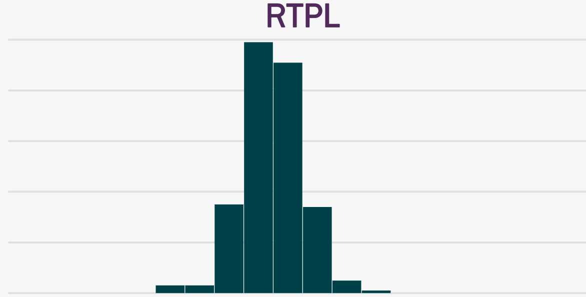
Assumed RTPL – used to derive risk scenarios and compute ES (or VaR) ssign a probability (p_i)

We need to confirm that the PnL distribution (i.e. the scenarios) employed adequately describes the distribution of alternative variants of PnL:

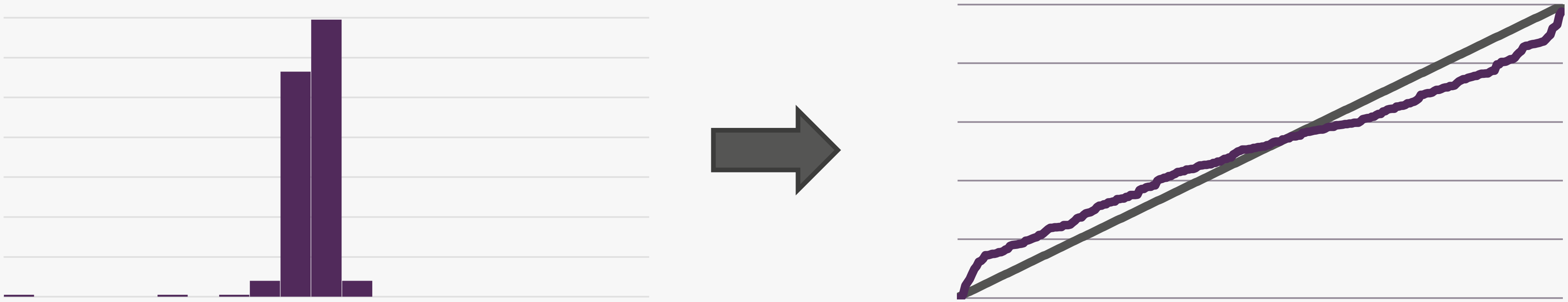
- Desk PnL – daily economic PnL based on the marking to market of the books and records of the bank
- Actual PnL (FRTB) – desk PnL excluding fees and commissions
- Clean PnL (BIPRU) – desk PnL excluding non-risky items (e.g. fees, commissions) but includes xVA and intra-day
- Hypothetical PnL – clean PnL that would have occurred if the portfolio remained unchanged. Excludes intraday trading P/L and bid/ask spreads (FRTB)

For capital purposes it is matching the distribution that matters, not correlation in a time series sense.

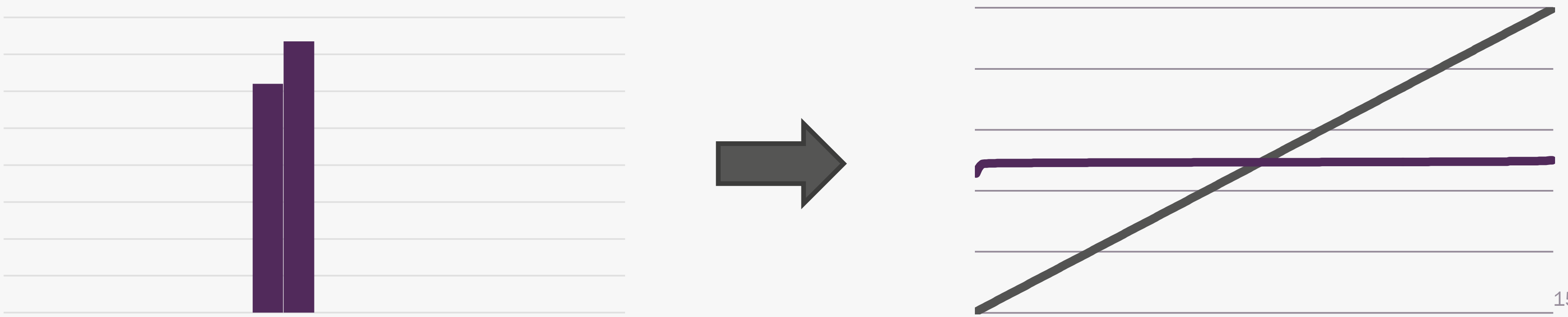
Illustrating P-values (2 of 5)



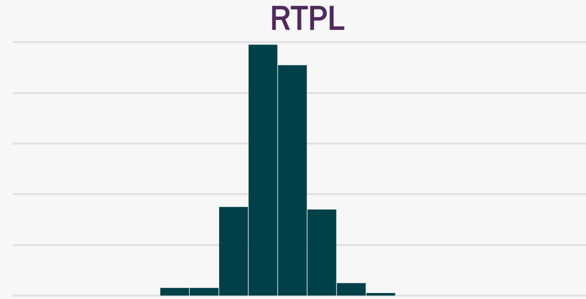
Example 1, HPLC



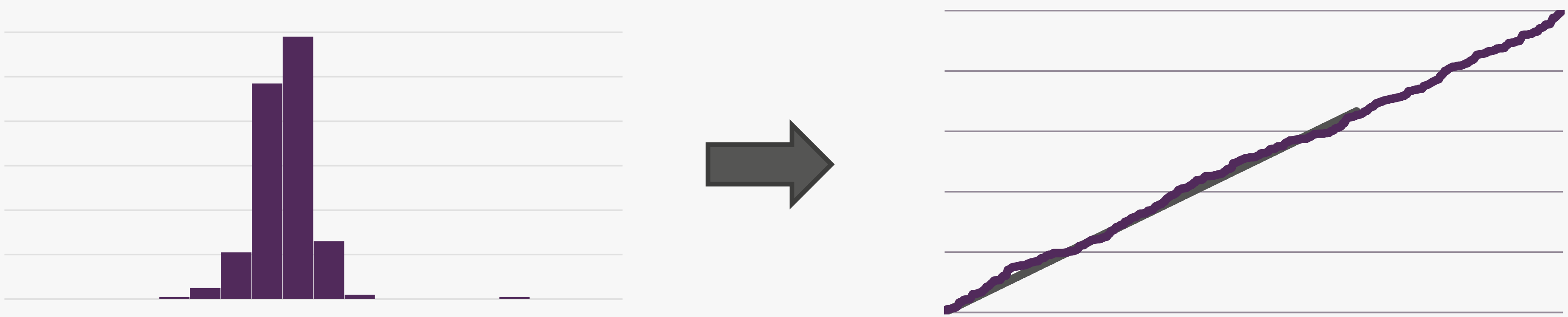
Example 2, HPLCSC



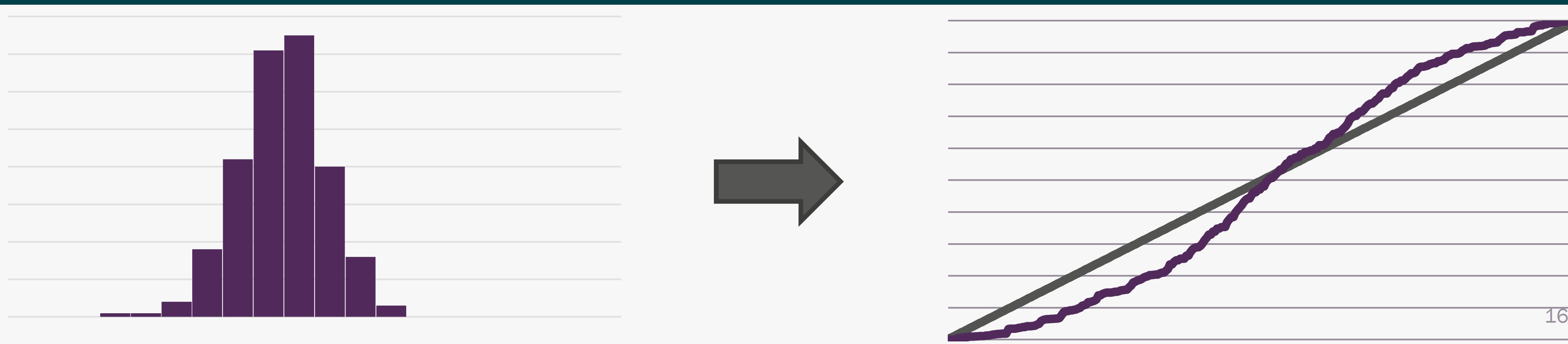
Illustrating P-values (3 of 5)



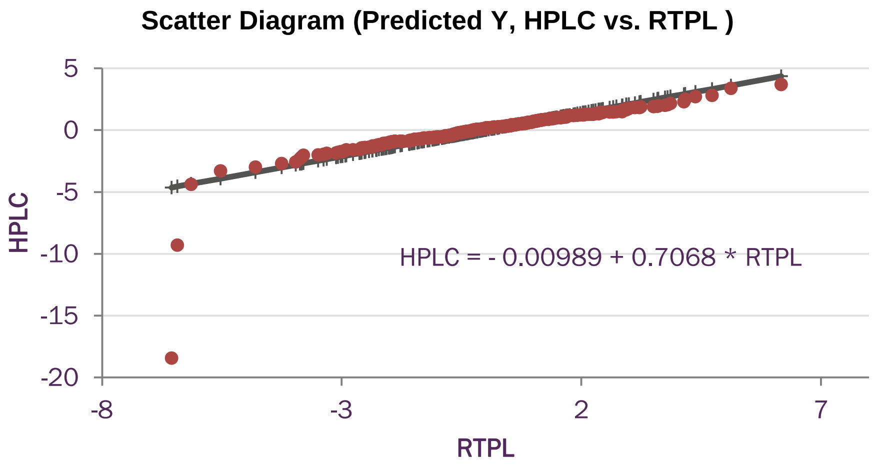
Example 3, HPLF

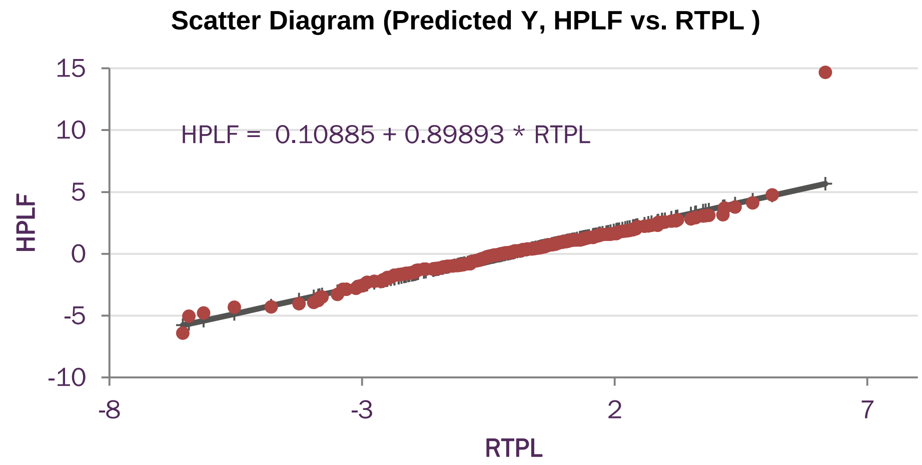


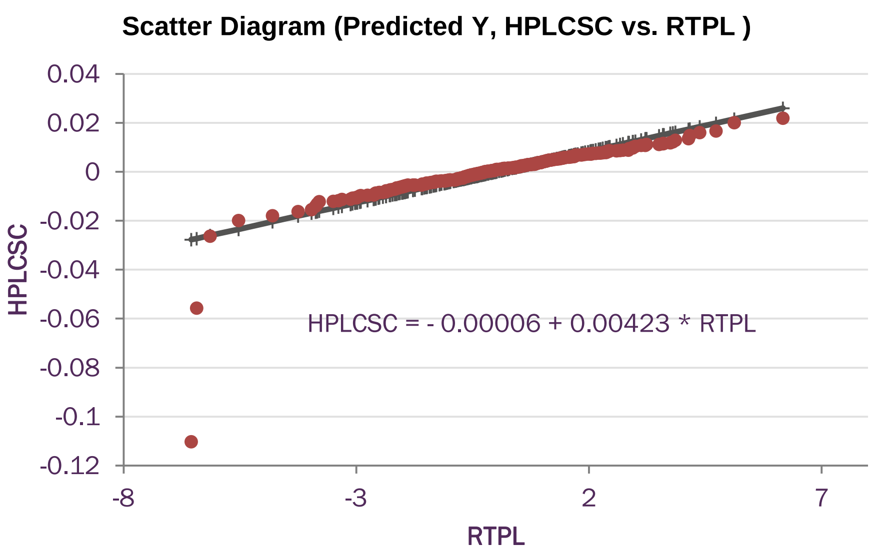
Example 4, HPLH

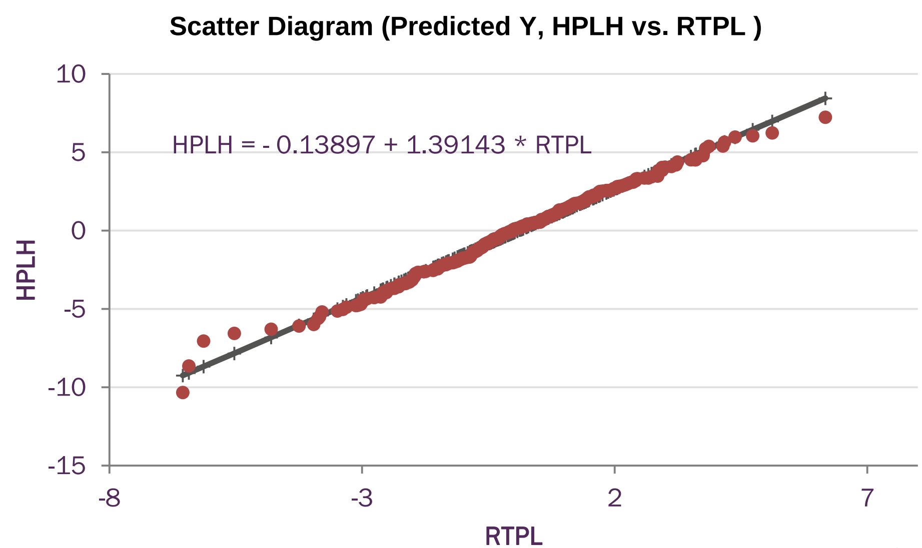


Illustrating P-values (4 of 5)









Illustrating P-values (5 of 5)

	Zumbach	FRTB mean test	FRTB variance ratio test	FRTB variance ratio test with floored denominator	Industry CR	QQ Regression R	Pass (1)	Time series R	Comment
RTPL	0%	0%	0%	0%	1.0	100%	Yes	100%	Control test
HPLF	1%	6%	250%	201%	0.9	95%	Yes	6%	Very good distribution fit even though poor time series correlation
HPLC	6%	0%	226%	185%	0.7	84%	Yes	6%	Apart from two large outliers, distribution of HPLC is generally thinner than RTPL.
HPLCSC	42%	0%	3,914,254%	100%	0.0	84%	No	6%	Would be over-capitalised and the model distributions are very different.
HPLH	-4%	9%	155%	156%	1.5	100%	Yes	3%	Slightly fatter tailed than RTPL but not materially

Pass (1)

- A Monte Carlo can be used to obtain a formal statistical thresholds for Zumbach statistic
- Even without a formal test, the Zumbach statistic clearly rejects HPLCSC, while the statistic accepts that RTPL reasonably represents other PnLs.

The mean and variance ratios reject RTPL in all cases except in the trivial case representing itself

The coverage ratio appears to work better, although it might lead to the rejection of RTPL for HPLC and HPLH which may be unreasonable.

- It is unclear if any formal rejection threshold can be constructed for the coverage ratio as in general its distribution is unknown.
- A GPD approximation may be possible

R statistics cannot differentiate between HPLC and HPLCSC

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