FRTB's P&L attribution test

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work based on publication co-authored
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Views expressed herein are my own and not those of ANZ

ANZ

Presentation overview

Context

- Fundamental Review of the Trading Book
  - → where do things stand today?
  - → how did we get here?
  - → where does the P&L attribution test sit within FRTB
- Motivation for our work on the P&L Attribution test

Presentation of our work on the P&L Attribution test

- Assumptions, mathematics, etc.
- Results, implications of those results

Where from here?

- Possible solutions
- Lessons

FRTB has stalled

- Basically radio silence from Basel for the past twelve months
- Changing of the guard within Basel's (renamed) Market Risk Group
- Singapore, Hong Kong, Malaysia, Japan, Europe, USA, Canada, Australia
  → regulators across jurisdictions are aligned in *postponing implementation*
  → …none of them especially keen to put hard deadlines on the table

- "Diminshed hopes" for *any semblance* of a level playing field outcome…
- Baby, bathwater ??? →

"None of us are against good, sound principles, but we must realise the idea of a level playing field is a myth."

Andrew Sheng
Chief adviser to the China Banking Regulatory Commission

So why has FRTB stalled?

Internal Model Approach (IMA)

- P&L Attribution (PLA) test
- Non-Modellable Risk Factor (NMRF) charge
- Expected Shortfall calculation
  - Computationally onerous
  - Reduced vs Full risk factor coverage – unclear how to demonstrate.
- So onerous it effectively dis-incentivises any bank currently on SA to even consider

Standardised Approach (SA)

- Ill-conceived treatment of curvature risk, basis risk
- Computationally onerous, esp. if calculated *daily* (e.g. Curvature calculations)
- …so onerous that Basel has *already* proposed a *Simplified Standardised Approach*
- Will be used as a floor to the IMA charge – but no one is quite sure how…
- Least of its problems is that it's punitively calibrated

And it's partly the *industry's* fault…

How did we get *here*?

- Industry too slow to *really* engage in the formulation process

  → Draft 1: First Basel consultation paper: May 2012

  → Draft 2: Second consultation: October 2013

  → Draft 3: Third consultation: December 2014

  → Draft 4: Instruction for Basel Monitoring: February 2015

  → Draft 5: Quantitative Impact Study: July 2015

  → Draft 6: "Final" release of Market risk standard: January 2016

  … and ***from the beginning*** Basel was upfront in asking for industry to constructively engage.

- *When did you, or your bank, <u>seriously</u> start looking at FRTB?*

- Has the lack of timely, constructive feedback from industry been mistaken by the Basel Committee as tacit endorsement for their proposals?

What is the PLA Test?

- New **desk-level** test to complement Backtesting as part of the framework for use of the **Internal Model Approach** (IMA) for market risk capital

- Monthly test, designed to check how closely the *daily* P&L calculated by the front-office tracks the *daily* P&L calculated by Risk

- More broadly ties back to the question of how representative Risk's projected P&L distribution might be of the actual P&L distribution
  → Is the IMA loss metric (VaR, ES) appropriate to set adequate capital?

- ?? Tangential aim of making credible the threat of pushing Pillar 1 capital to a Standardised basis when internal models perform poorly (eg., GFC)

There needs to be some sort of "punishing" process assocated with having poor Internal Models.

Member of Basel's MRG, meeting in Ottawa, 10th October 2017
(from ISDA's minutes of the meeting)

PLA test - Definition

- Monthly check of two ratios, MS and VV, against prescribed thresholds:

$$MS: \quad \rho_{MS} = \left|\frac{m_E}{s_H}\right| \leq 10\%$$

$$VV: \quad \rho_{VV} = \frac{s^2{}_E}{s^2{}_H} \leq 20\%$$

$E = (R - H) =$ Unexplained (Error) P&L

$R =$ Risk-theoretical P&L

$H =$ Hypothetical P&L

- Month is a Fail if *either* ratio exceeds its threshold

- **4th Failed month** in a rolling 12-month window is a FAIL of the PLA test

MS = Mean/Standard deviation *VV = Variance/Variance*

Consequences of failing the PLA test

- Desk loses accreditation to use IMA, and must revert to using SA.
- No "Ifs" or "Buts": the result is mathematical and *unequivocal*
- No "traffic light" escalation, or any chance to remediate (cf. backtesting)
- No decision or engagement required from the prudential regulator
- No consideration of the tens of millions of dollars the bank might have spent pursuing IMA accreditation, and the cottage industries that have been built up within banks to support it
- **This should have been an obvious warning sign that the PLA test had not been properly thought through by Basel regulators.**

Background to our work

Motivation

- ANZ's own preliminary results indicated high failure rates
- Portfolios which had *low* P&L volatility had the *highest* failure rates
  → started to sniff a rat with the *mathematical definition* of the PLA test
- Partly motivated by a casual suggestion from a regulator that "*with big enough desks, any noise should just diversify away – so what's the issue?*"

Optics

- The *optics* of having an author outside the industry was important.
- PLA test is academic, ivory-tower regulation.
  Perhaps a critique from within the *same tower* would be more effective?

Mathematical assumptions for ANZ's analysis

- Assume that for an individual instrument on day i, both H_i and E_i are random normal variables, with a *relative* variance of σ^2

$$H_i \sim N(0,1) \qquad E_i = (H_i - R_i) \sim N(0, \sigma^2)$$

- Assume that across all n distinct instruments in the desk,

  H_i's are correlated γ_H , E_i's are correlated γ_E (both γ_H, γ_E constant)

- Therefore for the desk of n distinct instruments on day i,

$$H_{n,i} \sim N(0, q_H) \qquad E_{n,i} \sim N(0, \sigma^2 . q_E) \qquad q_* = n + \gamma_*(n^2 - n)$$

Maths (cont'd)

$$m_{E_n} = \frac{1}{21}\sum_{i=1}^{21} E_{n,i} \qquad s^2{}_{E_n} = \frac{1}{20}\sum_{i=1}^{21}\left(E_{n,i} - m_{E_n}\right)^2$$

$$m_{E_n} \sim N\left(0, \frac{\sigma^2 . q_E}{21}\right) \qquad s^2{}_{E_n} \sim \chi^2_{20} \cdot \frac{\sigma^2 . q_E}{20}$$

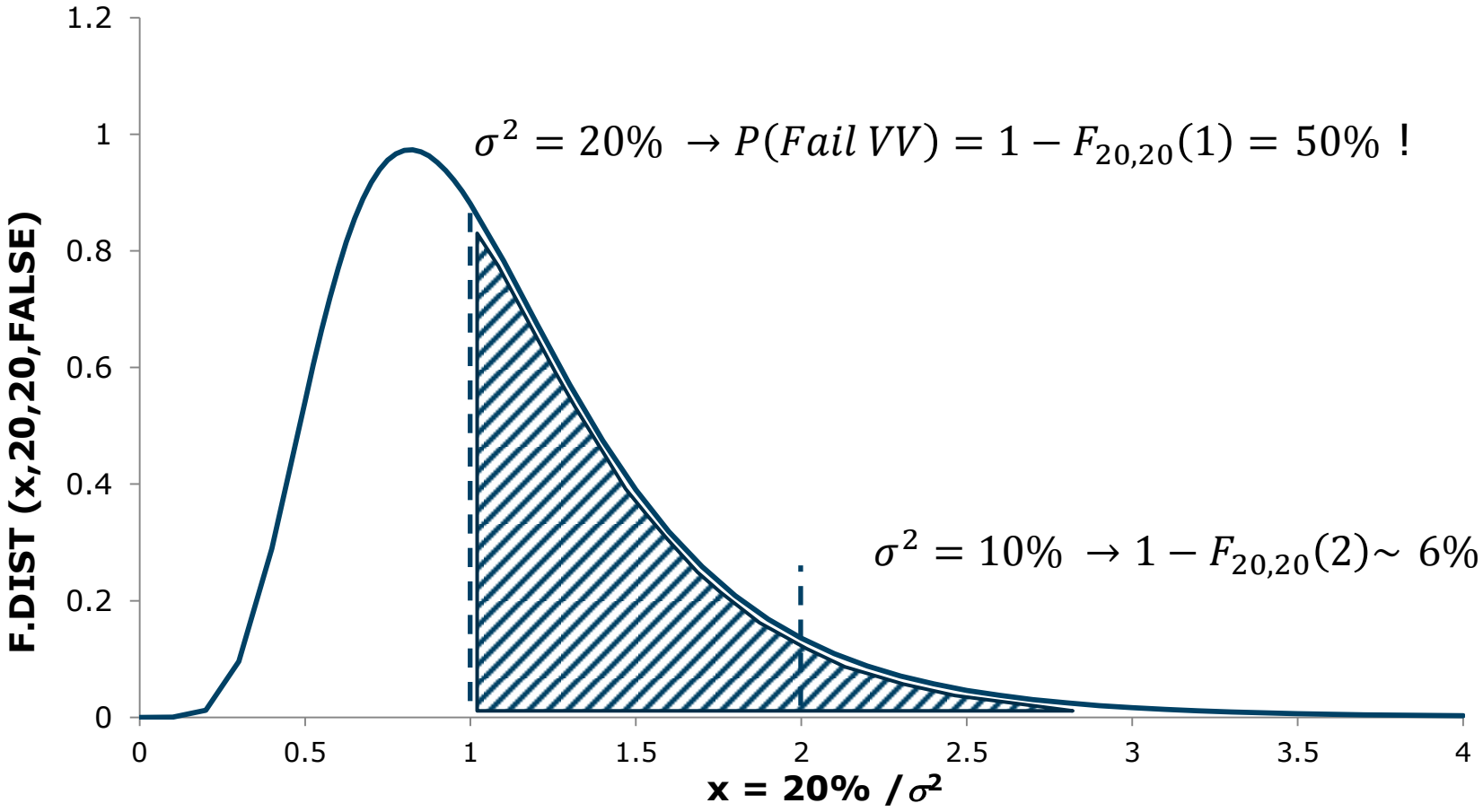
$$\sqrt{\frac{21}{\sigma^2} . \frac{q_H}{q_E}} . \rho_{MS} \sim t_{20} \qquad \frac{1}{\sigma^2} . \frac{q_H}{q_E} . \rho_{VV} \sim F_{20,20}$$

Student t-distn

Fisher's F-distn

Fisher's F-distribution is the problem here

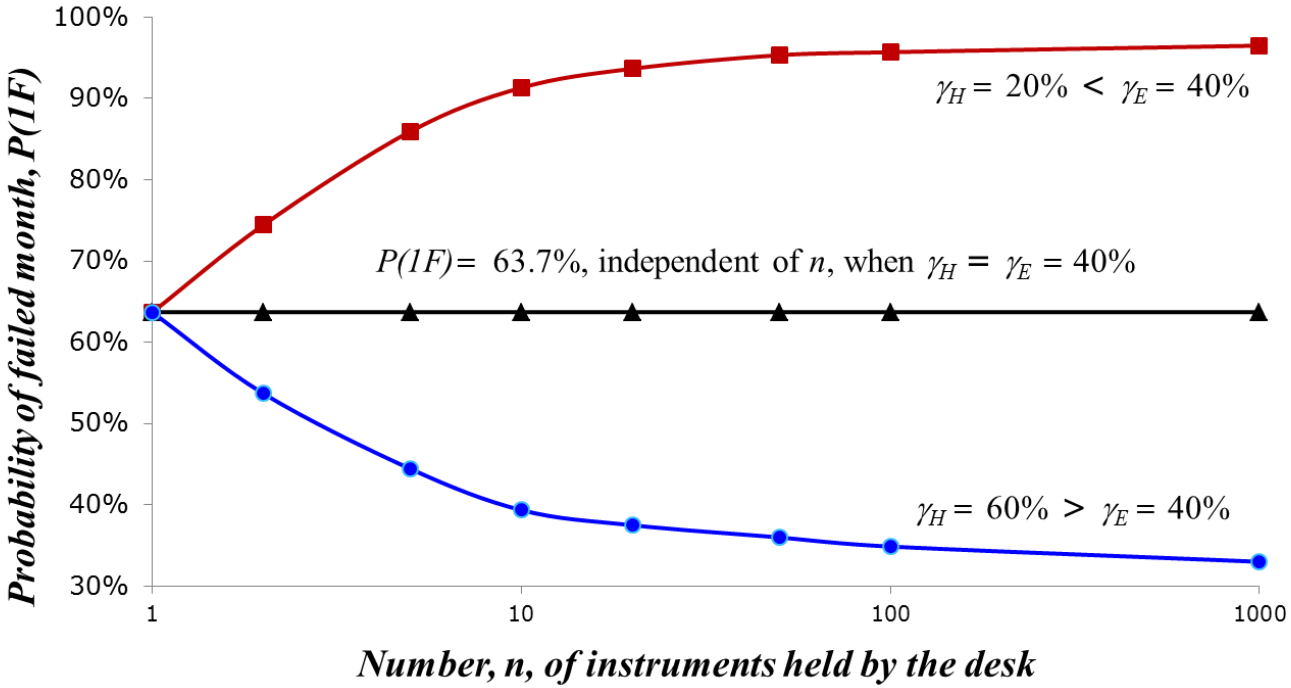
$$P(Fail\ VV) = P(\rho_{VV} > 20\%) = 1 - F_{20,20}\left(\frac{20\%}{\sigma^2}\right)$$



Probability that *month* is a fail

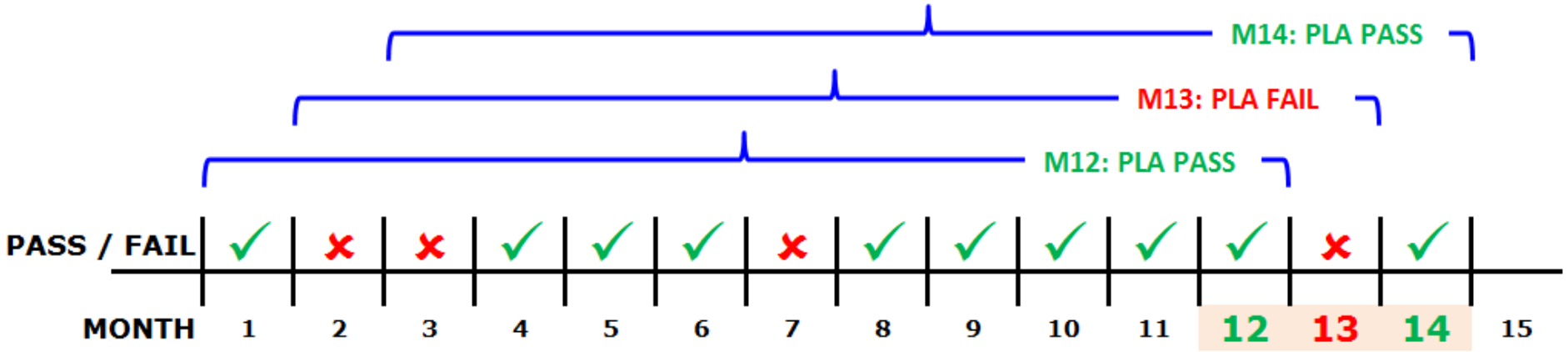
$\rho_{VV} = \sigma^2$	$P(Fail\ VV)$	$P(Fail\ MS)$	$P(1F)$ *(month is a fail)*
30%	81.4%	41.3%	87.8%
28%	77.1%	39.7%	84.7%
26%	71.9%	37.9%	80.8%
24%	65.6%	36.1%	76.1%
22%	58.3%	34.0%	70.5%
20%	50.0%	31.8%	63.7%
18%	40.8%	29.3%	56.0%
16%	31.1%	26.5%	47.4%
14%	21.6%	23.5%	38.3%
12%	13.1%	20.1%	29.3%
10%	6.5%	16.3%	21.0%
8%	2.3%	12.1%	13.8%
6%	0.5%	7.6%	8.0%
4%	0.0%	3.3%	3.3%
2%	0.0%	0.4%	0.4%

Relaxing the assumptions around correlation



γ_E = 40%		Number of instruments in desk					
		n =2	*n* =5	*n* =10	*n* =20	*n* =50	*n* =100
γ_H	0%	84.2%	99.0%	100.0%	100.0%	100.0%	100.0%
	20%	73.7%	86.2%	91.6%	93.5%	95.2%	95.5%
	40%	64.5%	63.8%	63.7%	63.9%	63.6%	63.4%
	60%	53.1%	44.3%	39.8%	37.8%	36.3%	35.3%
	80%	45.7%	30.5%	25.9%	23.3%	21.9%	21.2%
	100%	38.3%	22.6%	17.7%	15.9%	14.0%	13.9%

PLA FAIL is FOUR failed months in a ROLLING YEAR



- Probability of surviving *next month* ("survival probability") :

$$P(A \mid B_{<4})$$

A = Probability that next month both the MS and VV ratios PASS

$B_{<4}$ = Probability that prior twelve months has *less than 4* failed months

$$P(\mathrm{A} \mid B_{<4}) = \frac{1}{P(B_{<4})} . \left[P(B_0) + P(B_1) + P(B_2) + P\left(B_{3,1F}\right) + P(1P) . P\left(B_{3,1P}\right)\right]$$

Probabilities of failing the PLA test

$\rho_{VV} = \sigma^2$	*P (Fail PLA) before 1 year*	*P (Fail PLA) within subsequent…*			
		1 year	2 years	3 years	4 years
30%	100%	100%	100%	100%	100%
28%	100%	100%	100%	100%	100%
26%	100%	100%	100%	100%	100%
24%	100%	100%	100%	100%	100%
22%	99.8%	99.9%	100%	100%	100%
20%	99.3%	99.8%	100%	100%	100%
18%	97.0%	99.2%	100%	100%	100%
16%	89.9%	97.0%	100%	100%	100%
14%	73.7%	90.1%	99.0%	99.9%	100%
12%	48.6%	73.4%	92.9%	98.1%	99.5%
10%	23.1%	45.9%	70.7%	84.1%	91.4%
8%	7.2%	18.6%	33.7%	46.0%	56.0%
6%	1.19%	3.77%	7.40%	10.90%	14.26%
4%	0.049%	0.178%	0.355%	0.532%	0.709%
2%	0.000014%	0.000054%	0.000108%	0.000162%	0.000216%

Getting on the horse is *hard*

Falling off the horse is *easy*

Multiple desks

- Report published by the ECB on 29 September 2017
- A **third** of surveyed banks estimate having ***more than* 50** trading desks !

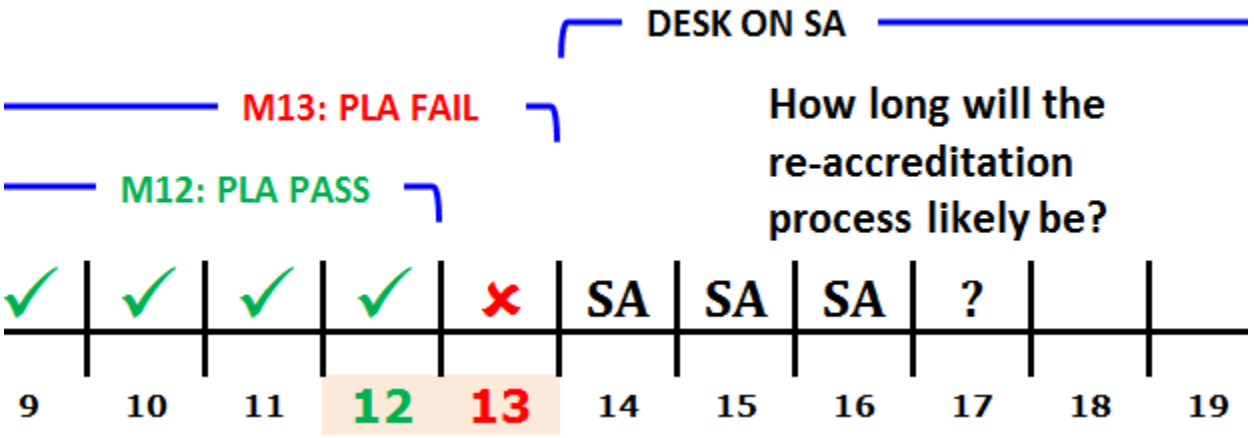
Results

- The currently estimated number of FRTB trading desks (TDs) per bank varies strongly from <10 to >100:

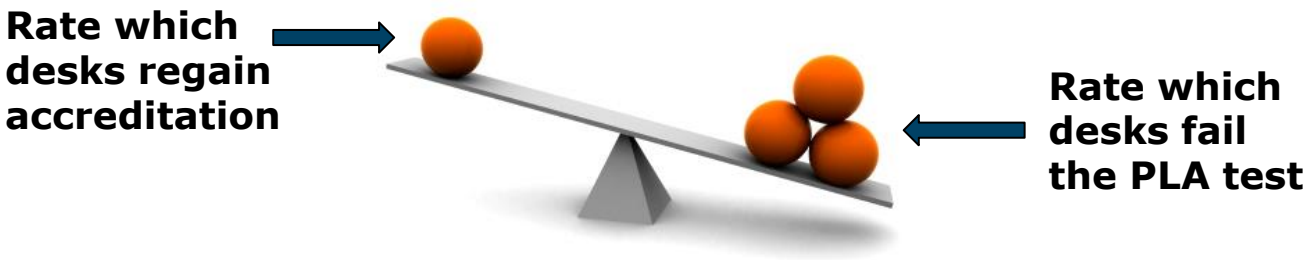
# of desks	% of banks
≤10	32%
≤30	32%
≤50	0%
≤70	23%
≤90	5%
>90	9%

- 39% of the banks planning to apply for IMA approval envisage including all desks in their internal model; the remainder envisage an IMA approval for just a subset of trading desks.

Expected steady-state proportion of desks on IMA



- Depends on how long *realistically* for the process of remediation and *then* becoming re-accredited by the regulator to use IMA…



Steady state solution

- Assume that remediation + re-accreditation from regulator takes ***k***-months
- Equate *prior* to *posterior* probabilities, to get steady-state IMA desk proportion

$$\pi_{IMA} = \pi_{IMA}.P(A \mid B_{<4}) + \pi_{SA,k}$$

Proportion of desks on IMA *next* month = Proportion of desks on IMA and which pass PLA *this* month + Proportion of desks on SA which failed PLA k-months ago but which will become reaccredited *next* month

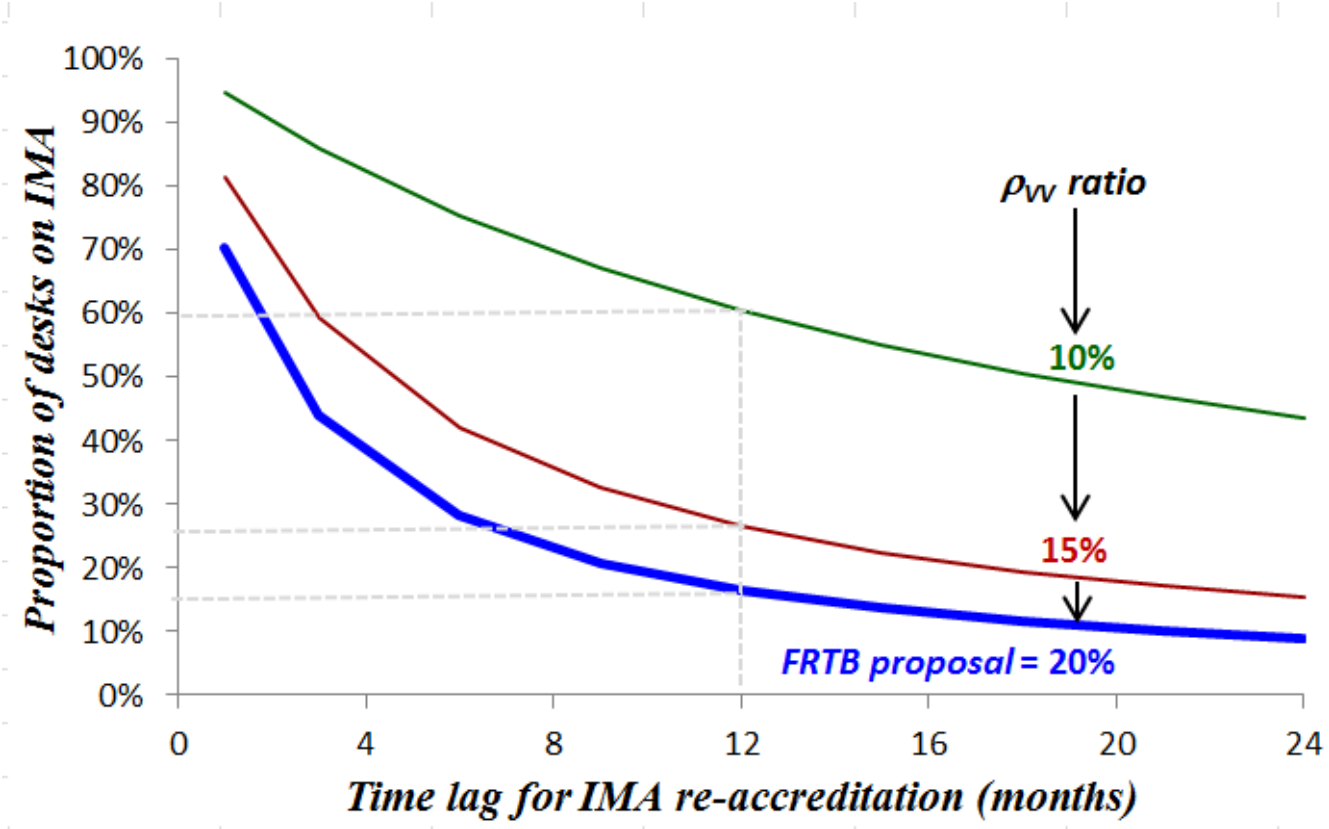
$$\pi_{SA,2} = \pi_{SA,1}$$
$$\vdots$$
$$\pi_{SA,k} = \pi_{SA,k-1}$$

Subject to $\pi_{IMA} + \sum_i^k \pi_{SA,i} = 1$

$$\rightarrow \quad \pi_{IMA} = \frac{1}{1 + k\left(1 - P(A \mid B_{<4})\right)}$$

Steady-state proportion of desks on IMA

- Is having *more than half* of desks on IMA, at any time, optimistic ?



What can be done to help?

- Relative variance of unexplained P&L compared with Hypothetical P&L needs to be a *low single digit percentage* (say σ^2<5%), for all desks.
  → that*, by itself*, will be a fairly tough ask for most desks to achieve

- *Average* correlation of Hypo P&L between instruments should be consistently greater than *average* correlation of Unexplained P&L
  → May (?) be possible to orchestrate, over reasonable periods of time (?)
  → increased Hypo P&L correlation → *increased chance* Backtesting failures

- Need a short turn-around time for re-accreditation, subsequent to failure.
  → Probably naïve to think this would be less than 6 months. Or even 12?
  → Do regulators *really* want to be at the middle of that merry-go-round?

Can the PLA test be salvaged ?

- If it *has* to be a *monthly* test, then ANZ's view is that there is no chance. One month (~21 days) of data is just not enough

  → underlying distributions just too broad

  → too much noise in such small sample size

- ISDA still trying. Results of their "beauty contest" show no clear preference for an alternative

- ISDA proposing *further 2 years*, beyond the implementation date, for parallel testing of PLA test

Proposals	Count of 1st preference	Count of 2nd preference	Count of 3rd preference
Normalised BCBS metrics	5	5	4
Spearman Correlation Test plus Kolmogorov-Smirnov Test	**9**	**7**	5
Symmetrical Variance Ratio	7	**7**	**8**
Ratio of Expected Shortfall	3	2	6
Ratio of Expected Shortfall + Symmetrical Variance Ratio	2	2	2
Direct Volatility Test	1	6	2
Tail Correlation	3	1	2
Stressed PLA	1	1	1
Total	31	31	30

"[Is] it possible the industry proposals result in replacing one bad test with another bad test?"

Member of Basel's MRG, meeting in Ottawa, 10th October 2017

What is the behaviour that PLA seeks to encourage?

- The underlying concern of regulators is really with *model validation.* How can that be addressed *without* something like the PLA test?

  My personal answer:

  → in *much more sensible ways,* starting with Pillar 2

- Risk that regulators are encouraging banks to take their eye *off* the ball? Three 'spinning plates' to juggle at the core of the FRTB :
  - → PLA test
  - → Non-Modellable Risk Factor charge
  - → Backtesting

- Which of the three above *most directly* pertains to the assessment and allocation of prudential levels of loss absorbing capital?

Conclusions

- PLA test is fundamentally flawed. Implementation will be difficult
- One of the intractable problems with FRTB as currently drafted
- The lack of focussed engagement from the industry over the past four years has been totally lamentable.
- Lesson here is that you can't wait for the "final" version to be on the table *and only then* swing into action to have a closer look.

QUESTIONS