How to Manage a Portfolio of Models

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Credit Risk and Credit Control XVI

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What is Model Risk?

Model Risk – the risk of loss resulting from the use of a model.

A relative risk, to be compared with the risk of not using a model, or of using another model.

Model Risk Management is embedded deeply in many well-written and comprehensive regulations: US Fed SR11-7; ECB TRIM; PRA SS3/18

“Model Risk should be managed like other kinds of risk”

OCC 2011-12a / FR SR11-7

Model Risk Management becomes clearer when we compare Model Risk with other kinds of risk, for example Consumer Credit Risk.

How do we manage models? Like we manage customers?

Overview

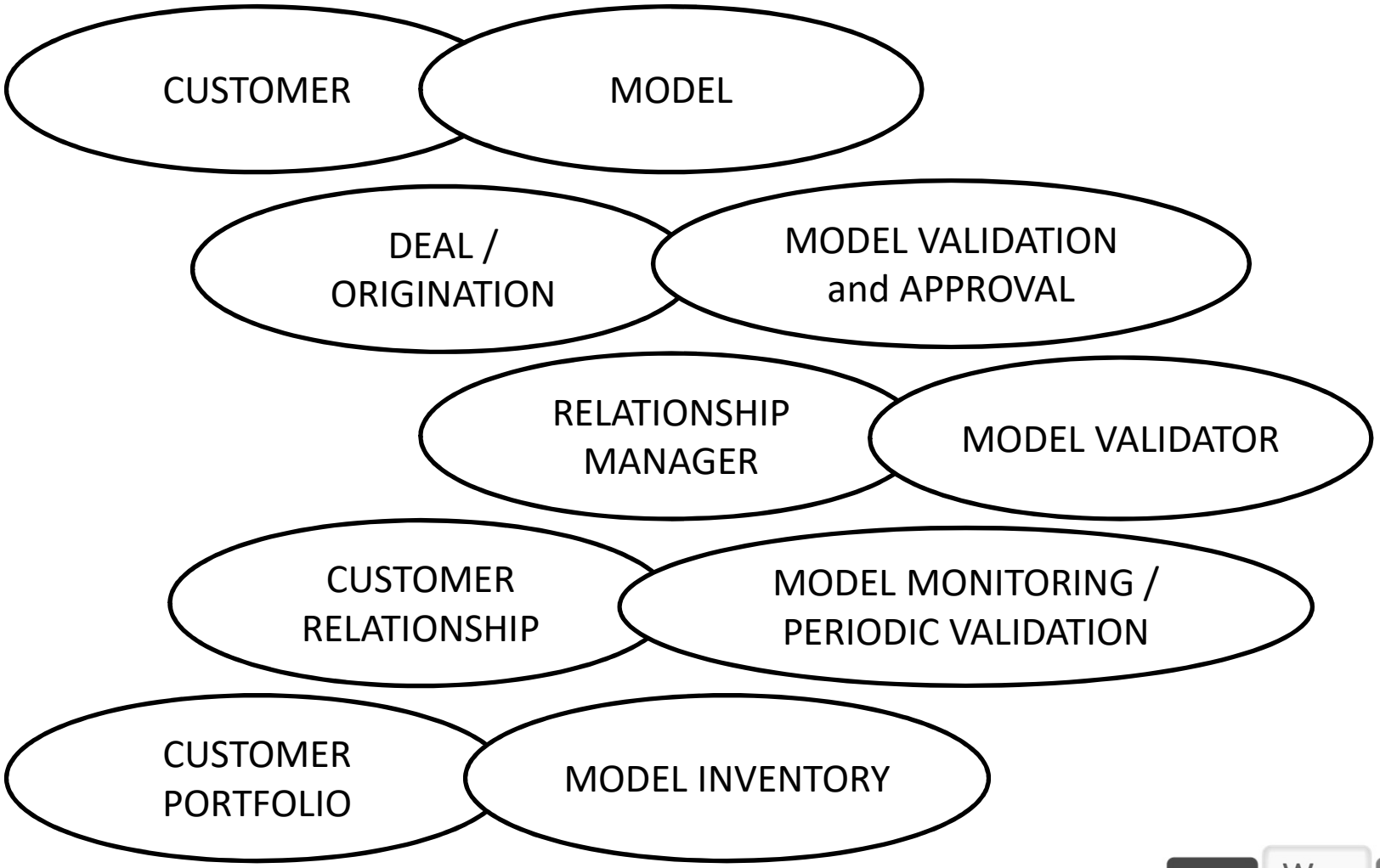
Model Risk and Credit Risk - how far does the analogy stretch?

How do we quantify the model risk of individual models?

Models: individuals or a portfolio?

How do we quantify model portfolio risk?

Credit Risk and Model Risk



Credit Risk and Model Risk

The analogy gives a new perspective and prompts interesting questions,

Can we tolerate a certain level of model failure ?

Can we validate some models almost automatically ?

By focussing only on one method (eg logistic regression approaches to scorecarding) do we create systemic model risk?

The analogy indicates best practice.

Model management, inventory and control – is it as good as our customer processes and the management of customer data?

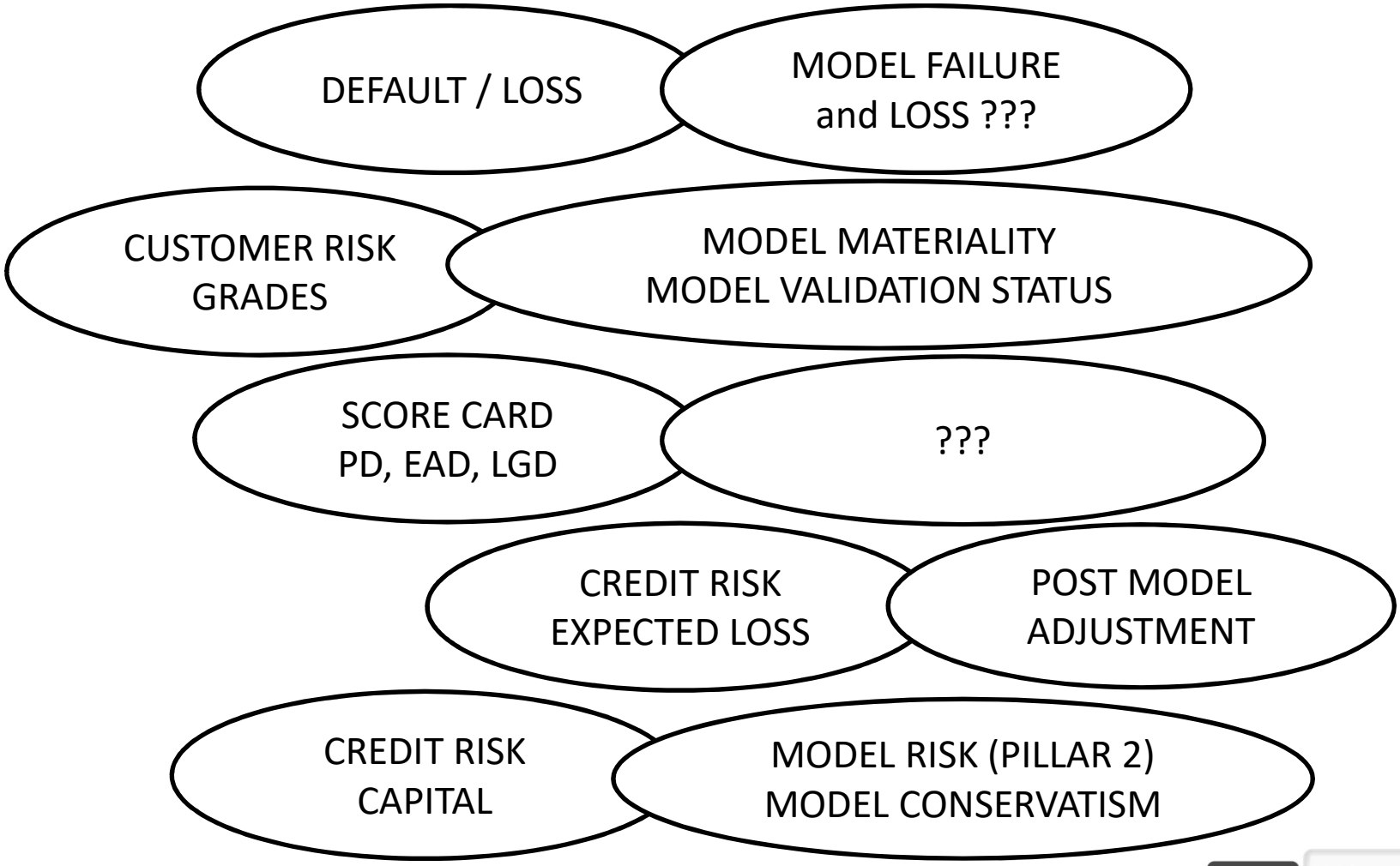
How effectively do we grade models into levels of model risk? Do we treat them differently according to grade?

What's our Model Risk Appetite statement?

Over the last decade, Model Risk Management has earned the status of an independent professional risk discipline.

Look out for Model Risk Managers International Association (MRMIA) on LinkedIn

Credit Risk and Model Risk



Quantifying Model Specification Risk

What If…? How different would we have made the model if things were different?

…the missing values were filled in by another method?

…our choice of factor went the other way?

…our backcast of default rates was perturbed?

…an expert-set parameter was chosen differently?

…there is (more or less) correlation between two model components?

…a different kind of model was used?

…we aimed to meet the conditions of a different stress scenario?

Leads to sensitivity analysis and to the quantification of sensitivities.

Specification Risk as a Data Shift Problem

Sensitivity analysis – if the data changes and we rebuild the model, how does the new model compare with the old?

The data shift problem is an active area of deep mathematical research.

One recognised way to measure data and model shift is by Kullback Leibler divergence

$$D(p,q) = \int p \ \ln \frac{p}{q} \ \ dx$$

Here the data shift problem seeks to constrain the model shift by the data shift divergence

$$D(m, m+\delta m) \leq C D(d, d+\delta d)$$

General results and simplifications are possible for regression modelling, but even that is hard going.

Data shift in practice

In practice, we use the divergence as a metric to rank the "what-if" scenarios:

1. Take the divergence of the data shift implied by the scenario.

2. Decide which shifts have large enough divergence to be worth investigating further

3. Investigate in rough descending order of divergence

We're interested in a material change in model performance caused by the model shift, which depends on the objective of the model.

$E_p(h)$ measures the expected outcome of an objective h from a population p

$E_p(PD)$ would be a predicted portfolio default rate, for example.

To decide what shift is "large enough" to investigate, we need to relate the change in $E_p(h)$ to the shift in p .

Data shift in practice

To compare a shifted population, p, with a base population q, Pinsker's inequality gives

$$|E_p(h) - E_q(h)| \leq \sqrt{2D(p,q)} \;\; ||h||_\infty$$

A refinement of this, more useful when h has wide variation

$$|E_p(h) - E_q(h)| \leq 2\sqrt{D(p,q)} \;\; ||h||_{\Phi(dq)}$$

Where the exponential Orlicz norm is defined

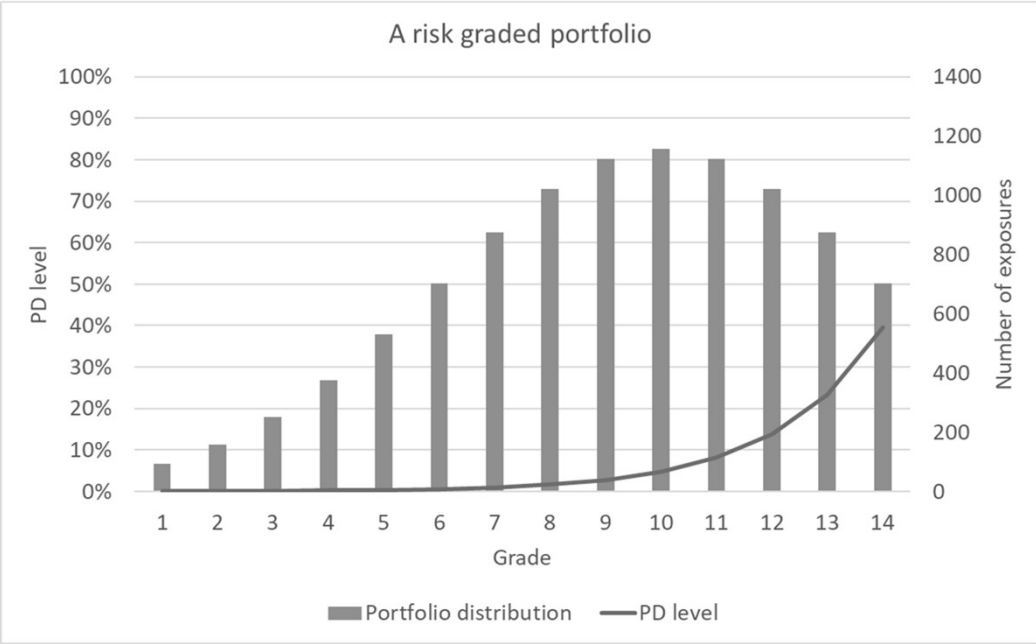
$$||h||_{\Phi(dq)} = \inf\left\{\lambda > 0 : \int \Phi\left(\frac{|h|}{\lambda}\right) \, q \, dx \leq 1\right\}$$

$$\Phi(t) = \exp(t) - t - 1$$

Data shift in practice

Example h = PD and q = distribution among risk grades

The following portfolio and PD grade distribution has a predicted default rate of 8.3% and a sensitivity to population shift that can be scaled using ||PD|| = 0.113.



If we are sensitive to a portfolio PD change of 1.0%, then we can tolerate a population shift up to (1/4)*(0.01/0.113)^2 = 0.002 , measured by KL divergence.

Note that the Pinsker inequality would give 0.001 .

The Model Inventory is a Portfolio

Models are related in many ways:

They can be disjoint: PD on Personal Loans, PD on Mid-Corporate

They can feed one another: Application scorecards feed Origination PD models, RWA feeds pricing models

They can interact strongly: PD and LGD, Significant Increase in Credit Risk selects the PD model to use

They can be used multiple times for different aims: PD used in IRB, stress scenarios, IFRS9 lifetime PD, and SICR.

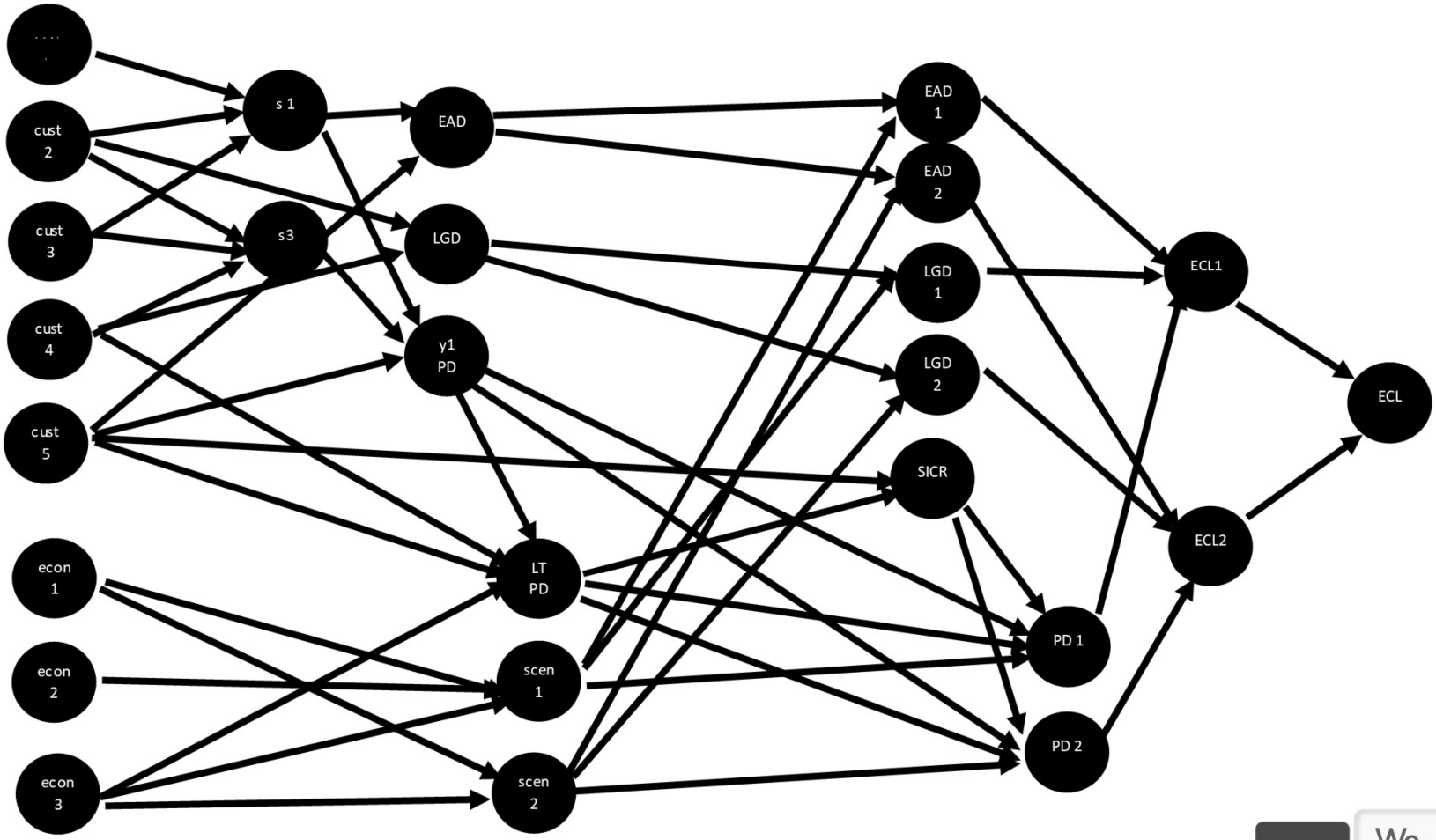
They can have essential or accidental correlations: time-series models of unrelated markets that have common real causes imperfectly captured by common model factors.

One can be an old version of another; or a challenger of another; or be a modelled framework in which other models sit…..

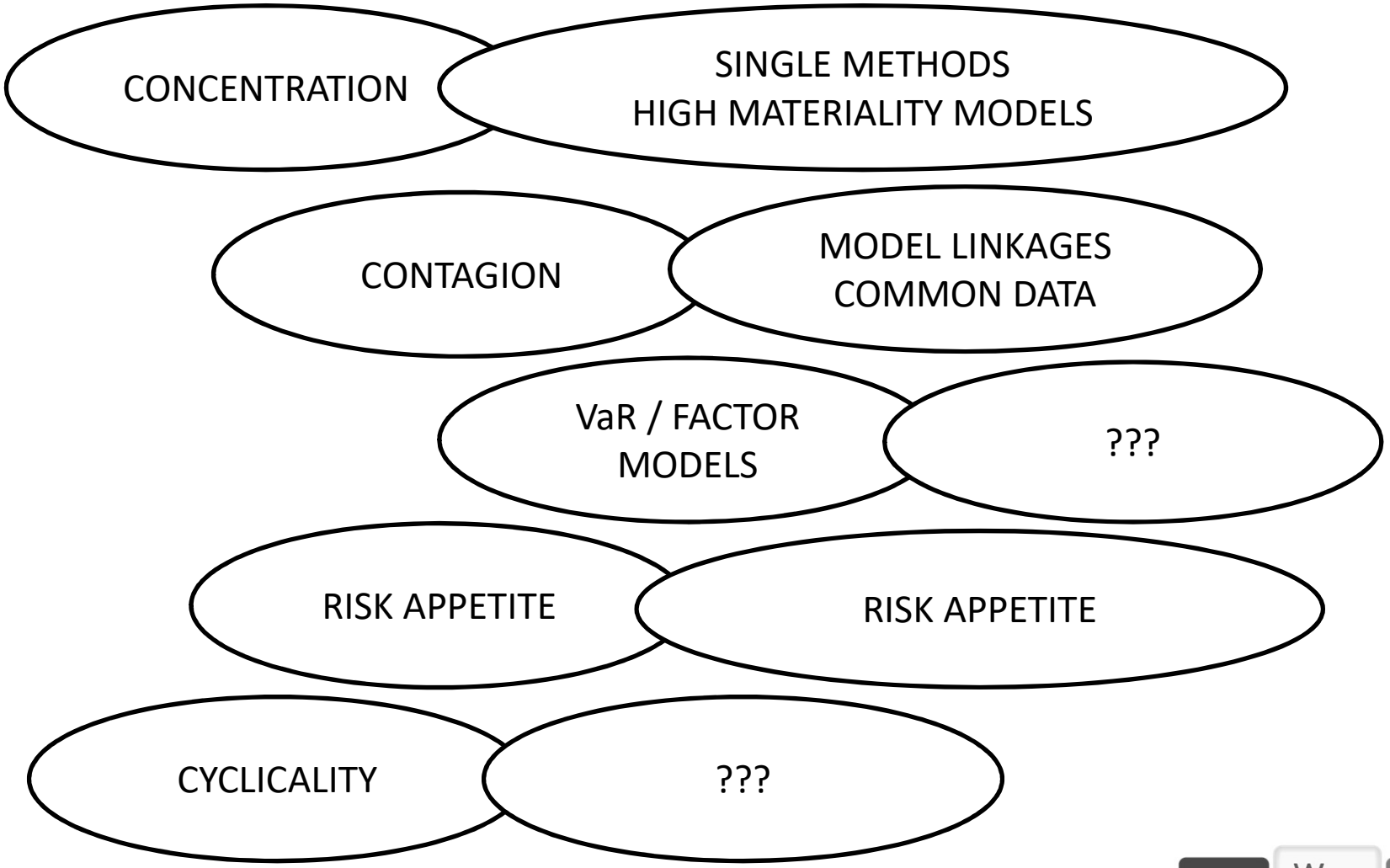
All the models live under a common policy and in a complex regulatory environment

The model inventory is not a list – it's a highly correlated and complex portfolio.

An IFRS9 Credit EL calculation (simplified)



Credit Risk and Model Risk



Conclusions

With the help of strong and intelligent guidance from regulators, Model Risk Management is maturing rapidly into a coherent professional risk discipline.

We gain new insight and practical perspective on Model Risk Management when we compare Model Risk analogously with other kinds of risk, such as Credit Risk.

Compared to Credit Risk, the quantification of Model Risk is still in its infancy:

Individual Models can have their Model Risk quantified by a "what if?" approach to validation, especially making the connection with the data shift problem.

Portfolios of Models have yet to receive any special quantitative treatment – what is Model Risk's VaR?