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Research on the Origin of the Minimum PD Grades Number Requirement for Basel II Models

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Introduction

1. Basel II allows banks to estimate prudential ratios using mathematical models.
2. First, banks evaluate PD* as one of the risk parameters.
3. Second, banks need to convert continuous PD to a discrete rating scale.
4. Each rating grade has its own PD range and final PD grade estimates.
5. Further, PD grade estimates (not individual PDs), is used to calculate CARs**.

* PD – Probability of Default of a borrower

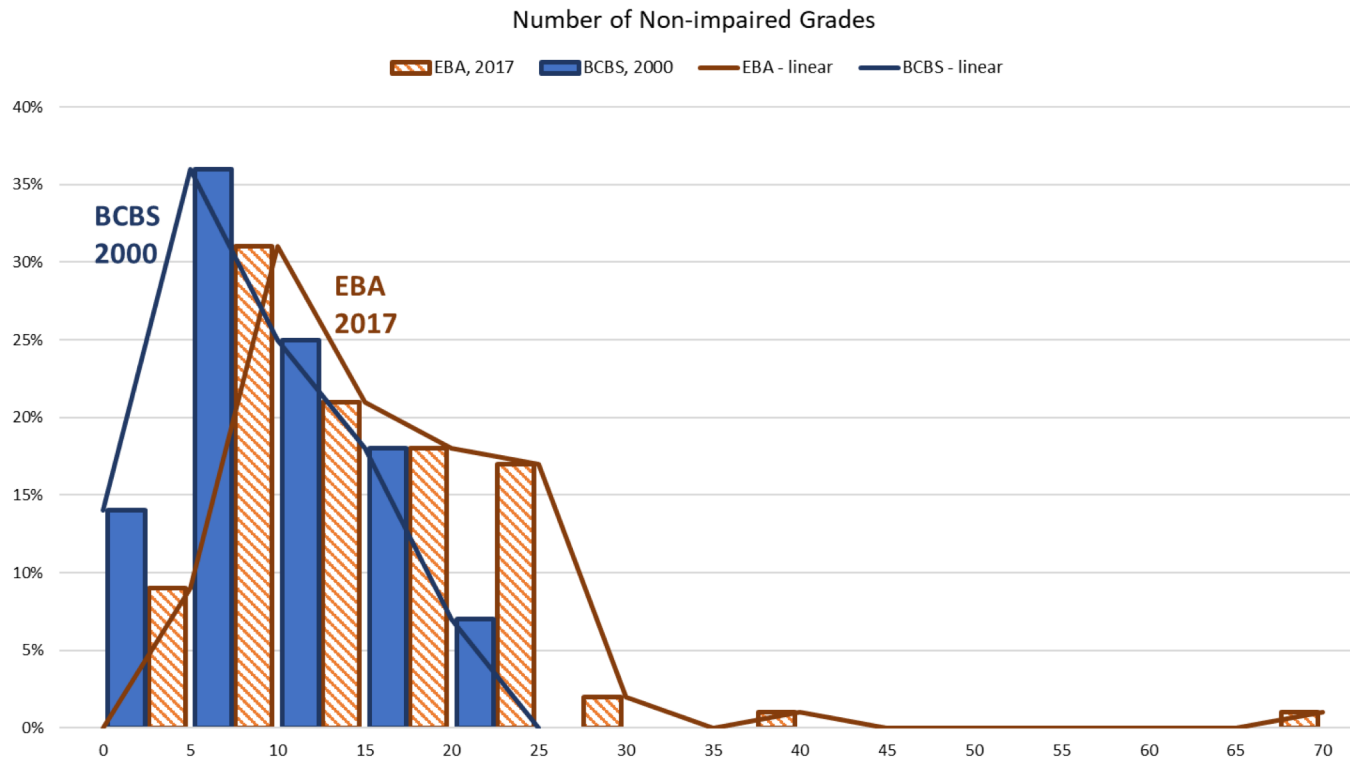
** CAR – Capital Adequacy Ratio

Basel II requirements to the rating scale (par. 403-404, 461)

1. Distribution of exposures across grades with no excessive concentrations;
2. A minimum of 7 borrower grades for non-defaulted borrowers;
3. Estimate the average PD for each rating grade.

See par. 403-404, 461, Basel II, 2006
www.bis.org/publ/bcbs107.pdf

In 2017 European banks use 16 grades in the rating scale on average



BCBS: Range of Practice in Banks' Internal Ratings Systems (www.bis.org/publ/bcbs66.pdf)

EBA Report on IRB modelling practices (20.11.2017), figure 12

1. Banks choose the number of ratings in a scale so that the concentration in one grade does not exceed **25-30%**.
 - See EBA GL on PD, LGD estimation, p. 106

After reviewing the relevant documents on banking regulation, we have not found answers to the questions:

1. Why are the 7 grades the minimum for a PD rating scale?
2. Why should the concentration of $\leq 25\text{-}30\%$ be maintained in each grade?
3. Why are the average (not individual) estimates used for capital assessment?
- 4. Do these requirements provide a more accurate estimate of bank capital?**

Academic literature review

1. PD models' development has a track of more than a decade in academic literature.
 - for Russian banks (Peresetsky, et al., 2004), (Peresetsky, 2012)),
 - for corporate borrowers ((Surzhko, 2014), (Ermolova, Penikas, 2015)),
 - for shipping corporations (Lozinskaia, et al., 2017),
 - for investment projects (Morgunov, 2017).
2. However, none of those deals with prudential requirements on the minimum number of rating (PD) grades (buckets).

The assumption about how do 7 grades come from

1. George A. Miller (Harvard University, 1955):

- *The paper: The Magical Number 7 ± 2 Some Limits on Our Capacity for Processing Information*
- «My problem is that I have been persecuted by an integer. For seven years this number has followed me around, has intruded in my most private data, and has assailed me from the pages of our most public journals».
- 7 units are the working capacity of our brain:
 - 7 musical notes, 7 days per week, 7 grades ...

2. A rating scale was originally created to generate reports and to make bank internal communication easier

- for people it is easier to think in a few discrete (not continuous) values
- No link with an accuracy of capital estimation?

The assumption # 1 about how 25-30% concentration limit had arisen

1. HHI thresholds have arisen in the antitrust regulation.
2. If $HHI < \text{lower bound}$, then perfect competition.
3. If $\text{lower bound} < HHI < \text{upper bound}$, then oligopoly, otherwise, monopoly.

HHI threshold	Antitrust regulation			Internal Rating-Based Approach Validation rule	Financial stability review
	US, 1982-1992	EU, 2004	US, 2010 (– present)	Russia, 2013	Russia, 2018
Lower bound	-	10%	15%	20%	10%
Upper bound	18%	20%	25%	30%	18%
Change in HHI	2%	1,5%	1%	-	-

Reference:

1. 1982-1992: S. Rhoades (1993) «The Herfindahl-Hirschman Index (HHI)»
https://fraser.stlouisfed.org/files/docs/publications/FRB/pages/1990-1994/33101_1990-1994.pdf
2. 2004: European guidelines:
[https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52004XC0205\(02\)&from=EN](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52004XC0205(02)&from=EN)
3. 2010: The US Ministry of Justice:
<https://www.justice.gov/sites/default/files/atr/legacy/2010/08/19/hmg-2010.pdf>
4. 2013: Association of Russian banks
https://arb.ru/banks/analytcs/validatsiya_komitet_arb_po_standartam_bazel_ii_i_upravleniyu_riskami-9752418/
5. 2018: Bank of Russia. Financial stability review (II – III quarters, 2018)
https://www.cbr.ru/Collection/Collection/File/10438/OFS_18-02.pdf

The assumption # 2 about how 25-30% concentration limit had arisen

1. The Vasicek model* does not take into account concentration risk.
2. The BCBS introduced a rule to ensure that the concentration risk does not arise.
3. However, this requirement does not provide capital accuracy, because
4. BCBS showed that **HHI = 1.56%** leads to VaR undervaluation by 13-21%.
 - *BCBS. Studies on credit risk concentration (WP 15, 2006, p.10, footnote 8)*
 - www.bis.org/publ/bcbs_wp15.pdf

* The Vasicek model is the base model for capital estimation

The assumption about how PD averaging per grade comes from

1. The first consultative Basel II (1999) implements the granularity adjustment.
2. The adjustment was calculated based on average PD per grade.
3. To simplify, the BCBS introduces average PDs per grade in both granularity adjustment and capital estimation.
4. The granularity adjustment has not been adopted in the official Basel II (2004).
5. However, the rule of averaging PDs was saved.

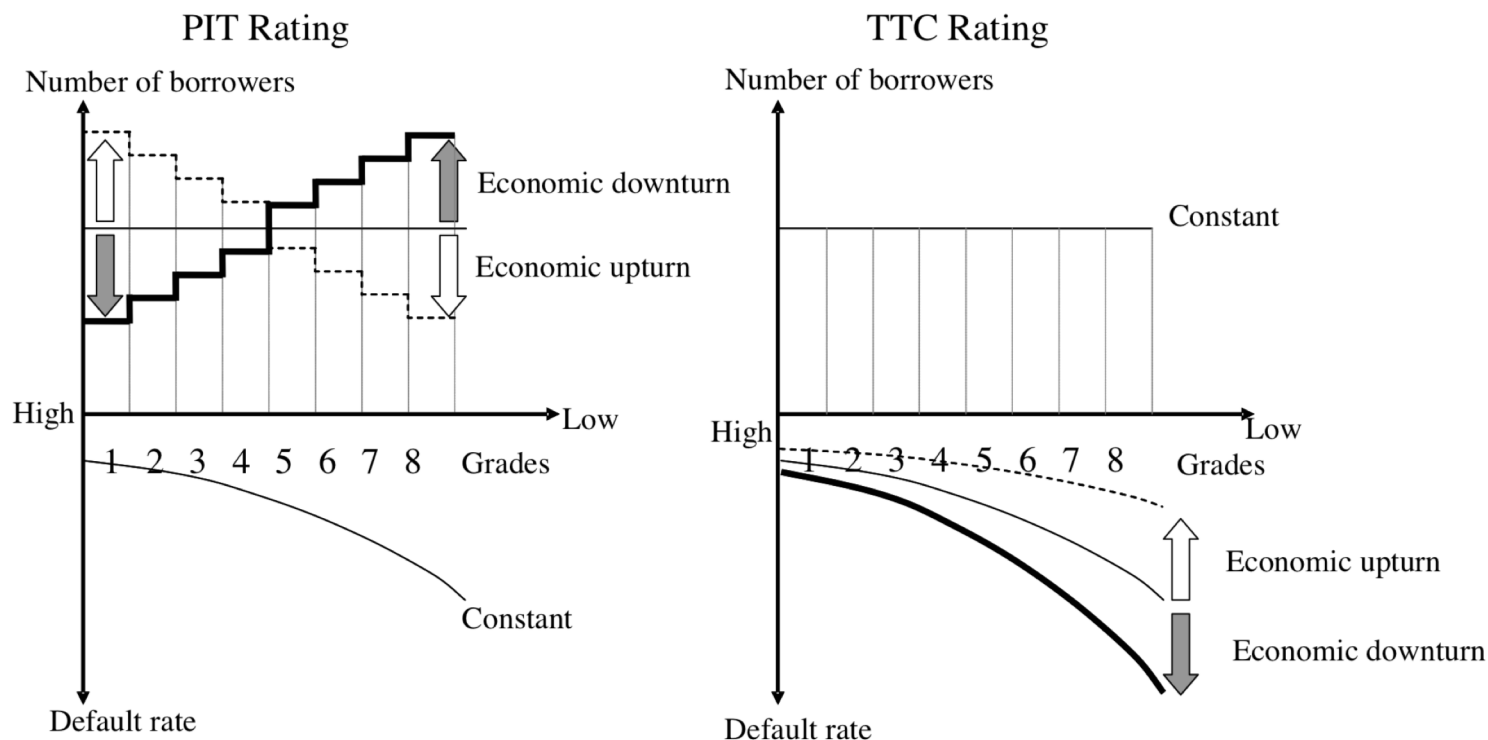
Methodology

1. To generate loan portfolios that differ by its risk parameters distribution:
 - Probability of Default (Uniform, Normal, Concentrated, Correlated with LGD)
 - Loss given default (Uniform, U-shaped, Concentrated)
 - Exposure At Default (Uniform, Normal, Concentrated)
2. To generate several rating scales with 1 to 30 grades.
3. To estimate capital required in each case.
4. To make conclusion whether three requirements (averaging, no excessive concentration and 7 grades) have impact on accuracy of capital estimation.

The idea of no concentration in the grades comes from PIT and TTC

1. There is no concentration over the cycle (TTC), but there is for point-in-time.

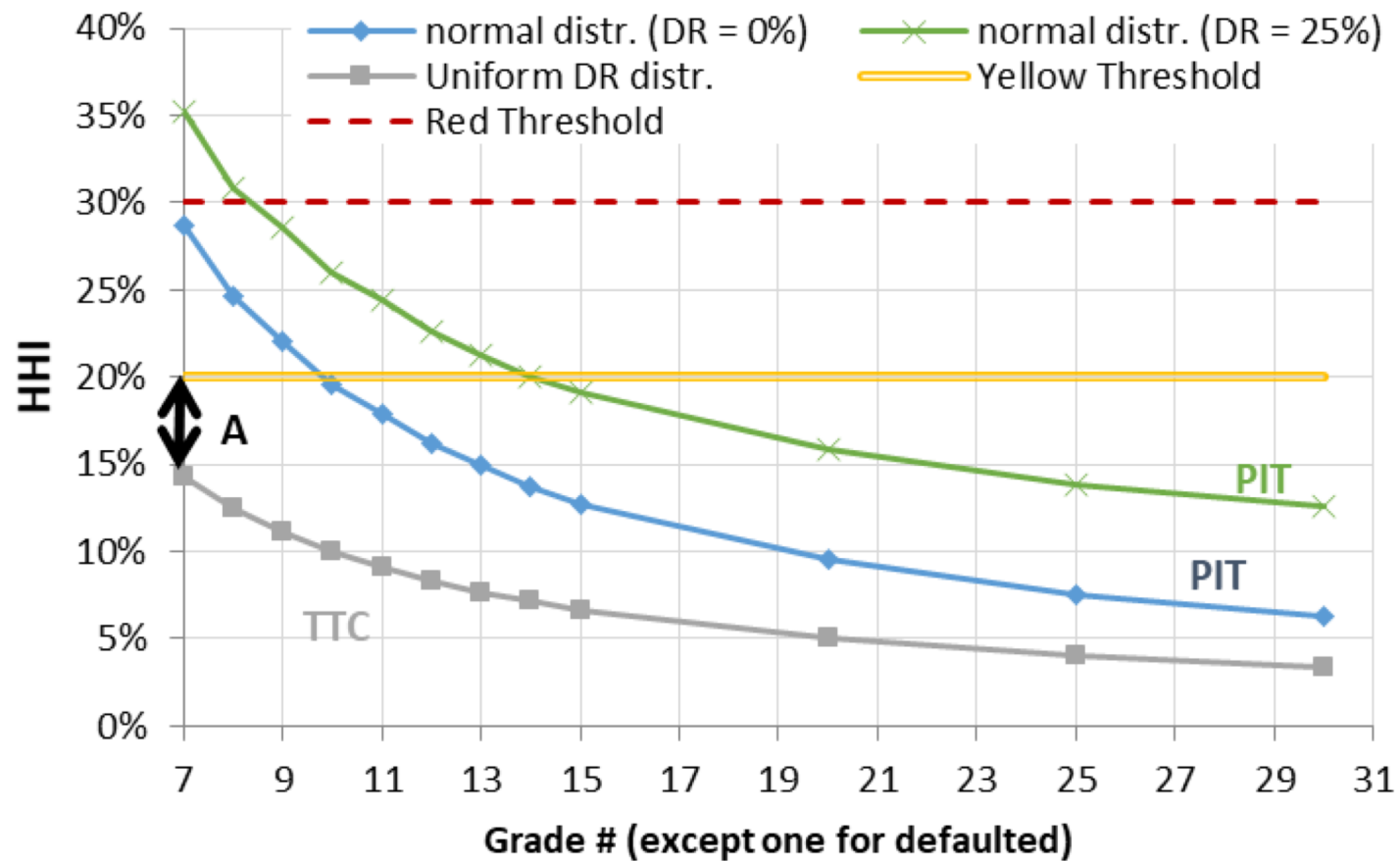
Chart 5: Point-In-Time (PIT) and Through-The-Cycle (TTC) Ratings



Bank of Japan (2005). Advancing Credit Risk Management through Internal Rating Systems

https://www.boj.or.jp/en/research/brp/ron_2005/data/fsk0509a.pdf

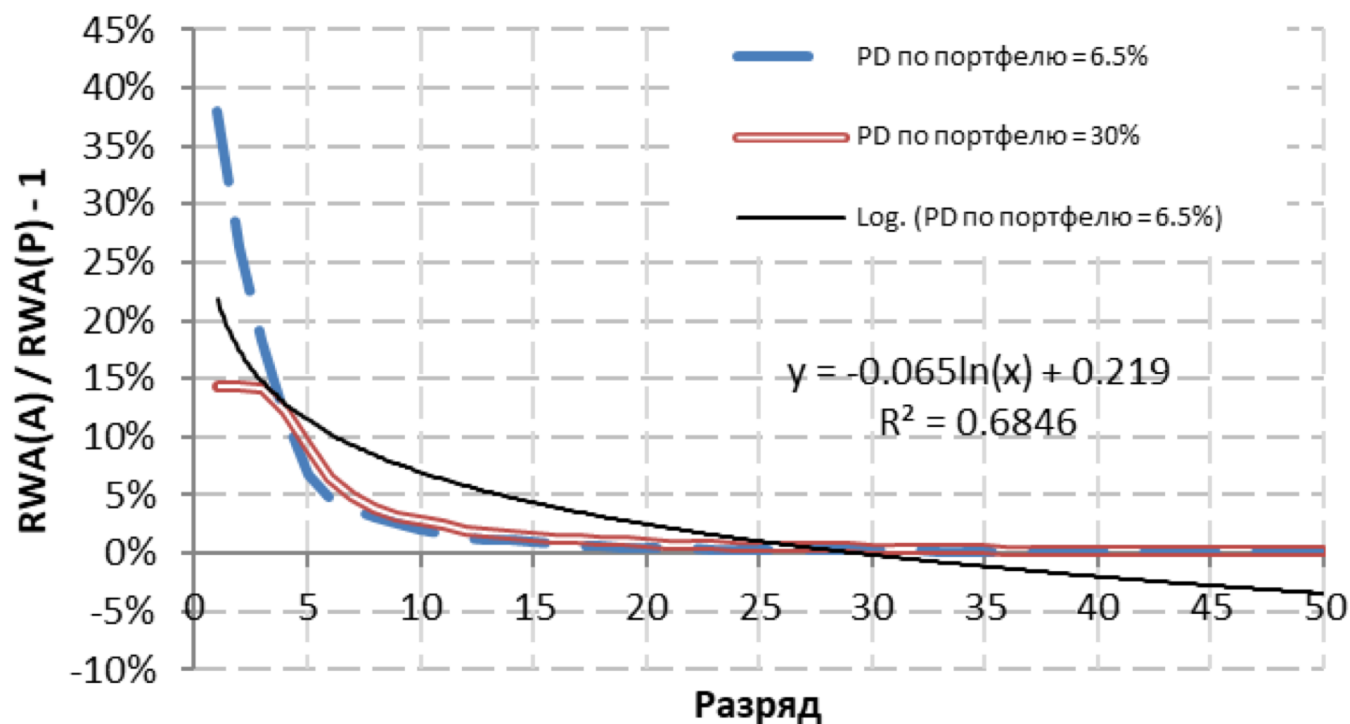
7 grades ensures 15-35% concentration per grade



A - probable +5% add-on for imperfect TTC

7 grades reduce the risk underestimation until 5%
20 grades are sufficient to avoid risk underestimation

Влияние уровня дефолтов на оценку RWA при усреднении PD

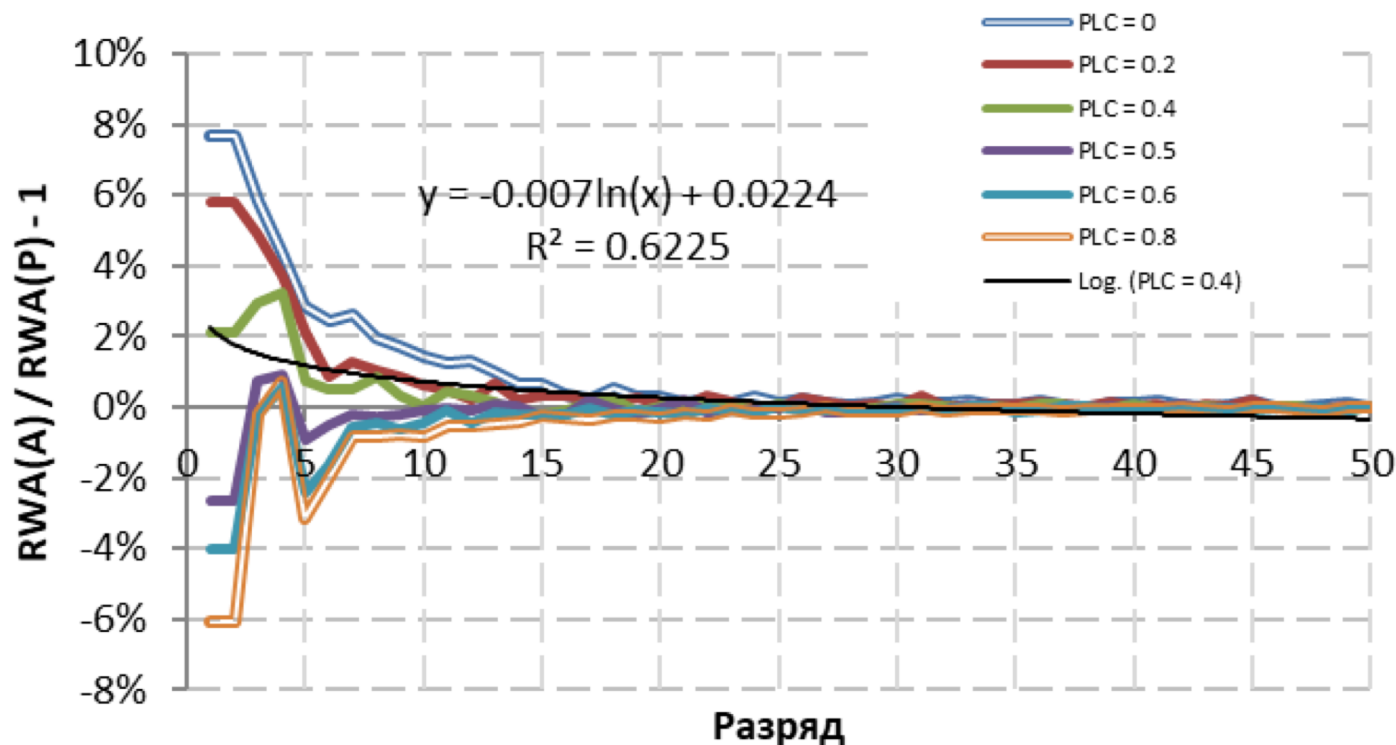


RWA(P) – point estimate (based on PD individual)

RWA(A) – average estimate per grade (based on PD of grade)

7 grades reduce the risk underestimation until 5%
20 grades are sufficient to avoid risk underestimation

Влияние PD-LGD corr на оценку RWA при усреднении PD

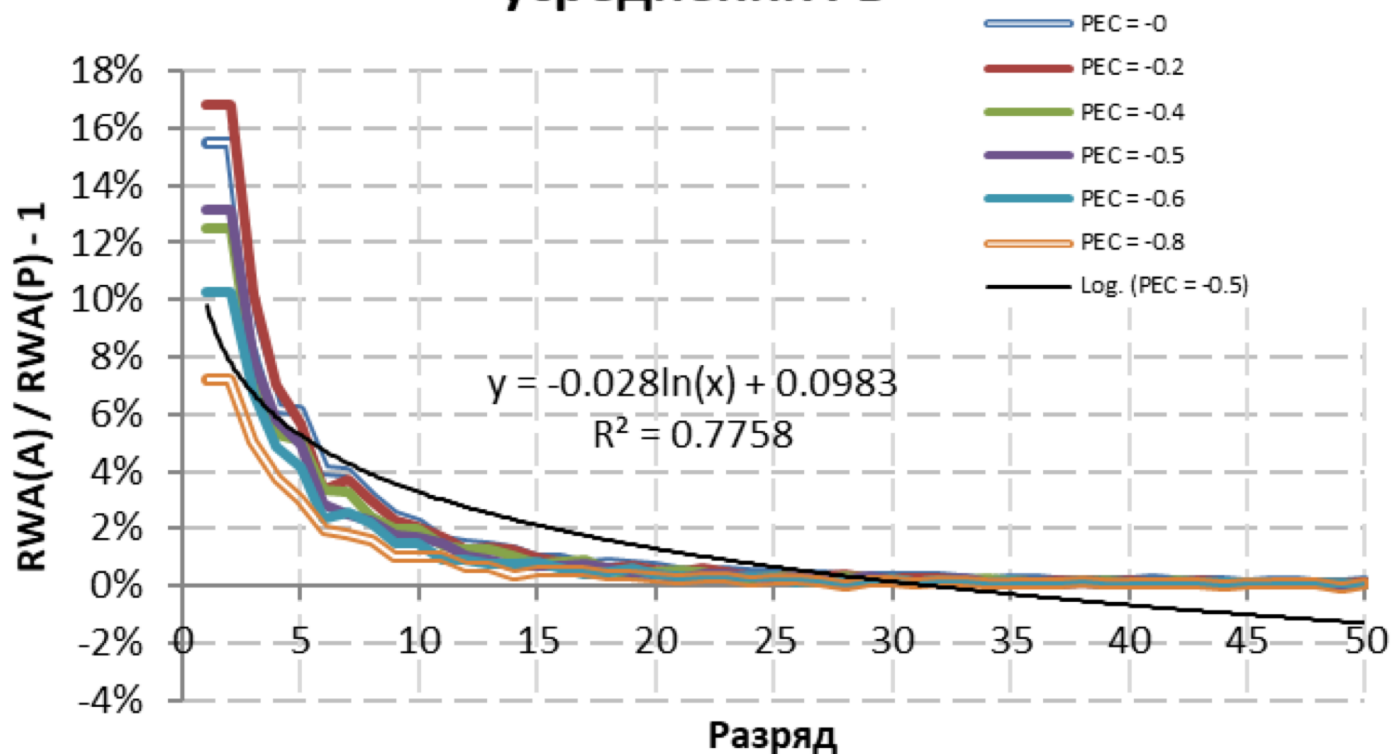


RWA(P) – point estimate (based on PD individual)

RWA(A) – average estimate per grade (based on PD of grade)

7 grades reduce the risk underestimation until 5%
20 grades are sufficient to avoid risk underestimation

Влияние PD-EAD corr на оценку RWA при усреднении PD

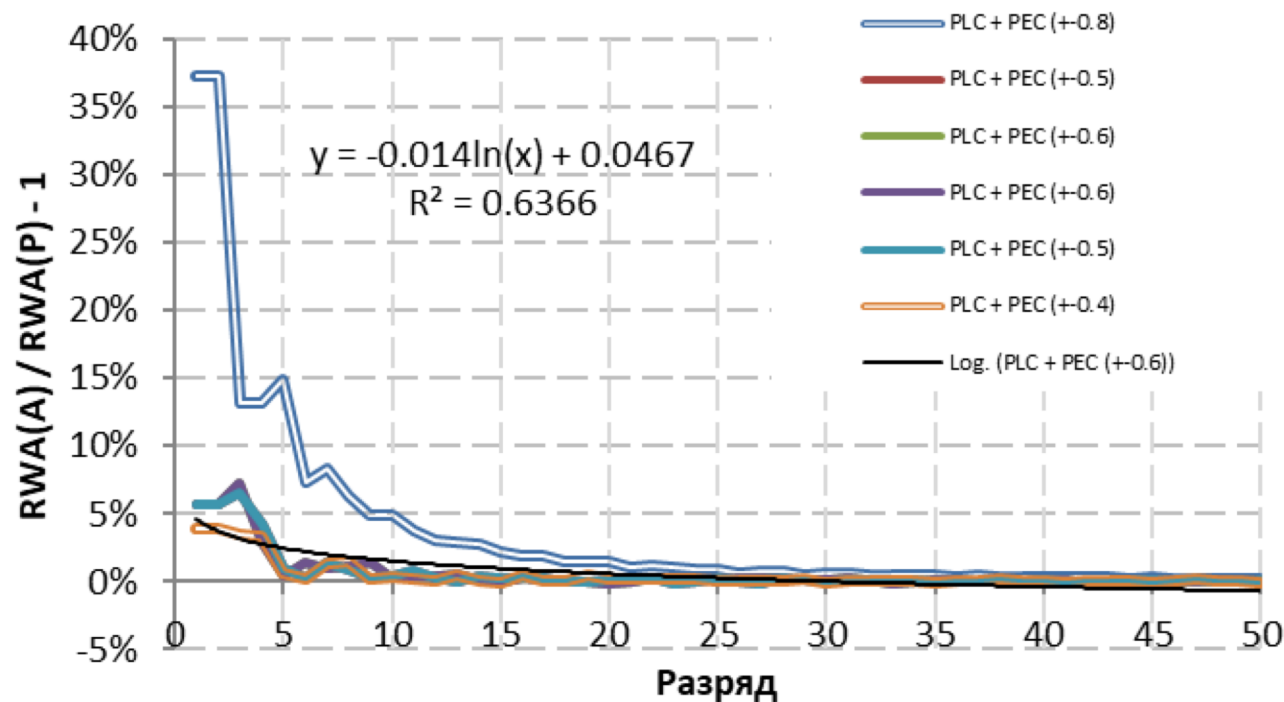


RWA(P) – point estimate (based on PD individual)

RWA(A) – average estimate per grade (based on PD of grade)

7 grades reduce the risk underestimation until 5%
20 grades are sufficient to avoid risk underestimation

**Совместное влияние PD-LGD, PD-EAD corr на
оценку RWA при усреднении PD**



RWA(P) – point estimate (based on PD individual)

RWA(A) – average estimate per grade (based on PD of grade)

Conclusion

1. Since the Vasicek model is non-linear in PD, PD averaging per grade does not lead to underestimation only when the number of grades is more than 20.
2. The requirement of $HHI = 25-30\%$ does not ensure to avoid concentration risk which the Vasicek model is insensitive
 - [requires additional analysis].
3. Using point PD does not require no concentration.
4. HHI threshold should not be fixed. The threshold should depend on the number of grades in the rating scale.

Thank you for your attention!

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