

Pro-cyclicality of Capital and Portfolio Segmentation in the IRB framework: An application to Mortgage Portfolios.

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FEDERAL RESERVE BANK OF PHILADELPHIA

- “[c]redit risk is the primary component of RWAs and the dominant source of overall RWA variations at the bank level, accounting for 77% of the dispersion” (BCBS 2013, 7).
- “[r]ating systems should be designed in such a way that assignments to rating categories generally remain stable over time and throughout business cycles. Migration from one category to another should generally be due to idiosyncratic or industry-specific changes rather than due to business cycles” (BCBS 2016, p. 7).



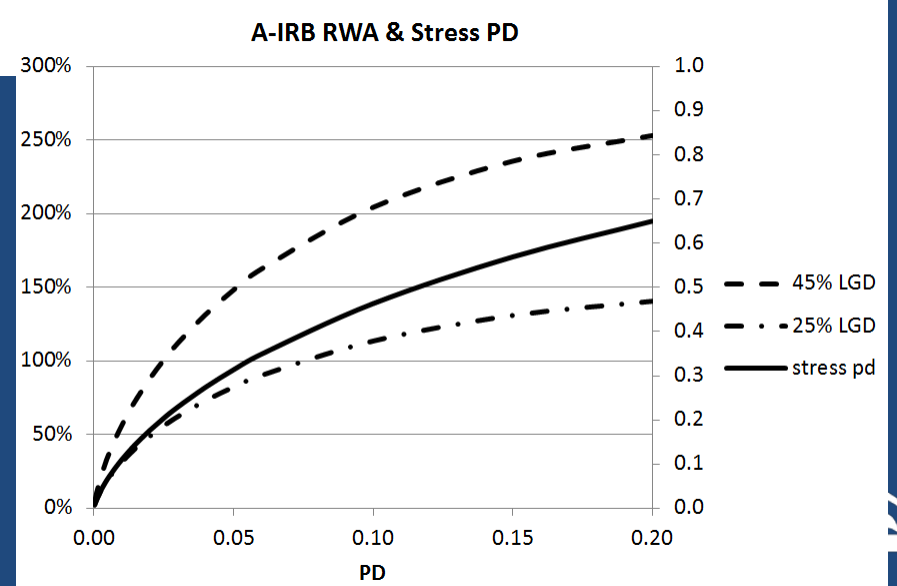
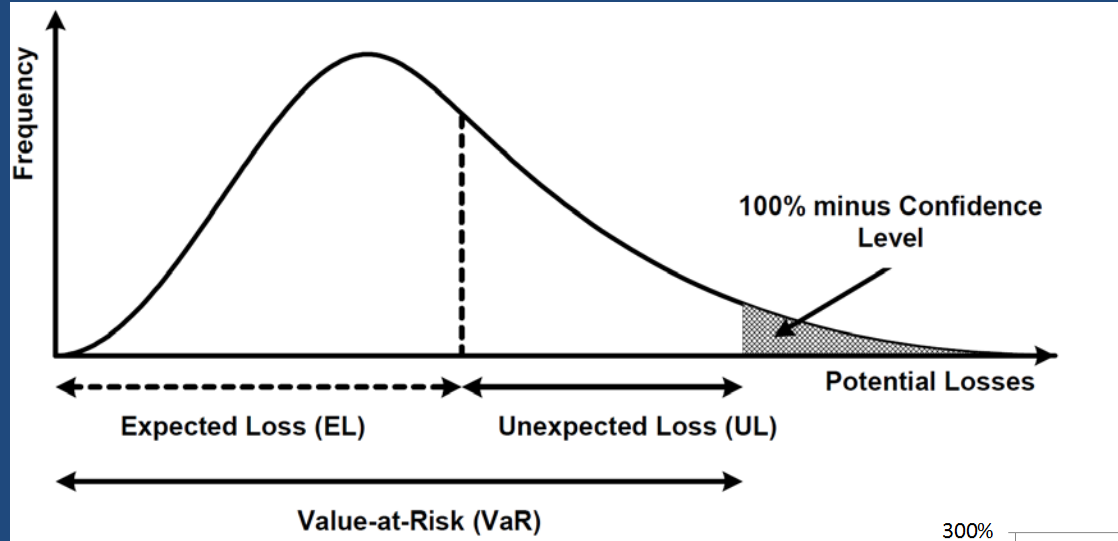
- A clear understanding of the fundamental restrictions implied by these principle-based requirements may simplify and accelerate the design of rating systems with the desired properties and can facilitate discussions around regulatory compliance.
- Point in time accuracy of ranking systems may have to be weighted against the potentially binding goal of creating risk-ranking systems that remain stable over the business cycle.



- The BCBS has established a framework for the calculation of regulatory capital that considers two possible alternatives: the A-IRB approach, which allows banks to use their own internal models, subject to regulatory approval; and the **standardized approach**, which relies primarily on supervisory guidance.
- This paper investigates the potential sources of pro-cyclicality in the advanced internal ratings-based (A-IRB) Basel framework and identifies the fundamental assumptions required by a quantification credit risk framework that is stable over the economic cycle.



IRB Framework.



- the A-IRB for retail exposures consists of four steps.
 - The first step considers the categorization of a bank's exposures into different asset classes.
 - The second step considers the segmentation of retail exposures into homogeneous segments according to risk characteristics.
 - In the third and fourth steps, the bank quantifies risk (PD, LGD, EAD)
 - and calculates the RWAs at the segment and portfolio levels.
- The standardized approach assigns pre-determined risk weights to different segments of a mortgage portfolio specifically defined by.



Table 1: Standardized Approach – Risk Weights Across Segments

International Standardized Approach

<i>LTV ratio (in percent)</i>	<i>Category 1 loans</i>	<i>Category 2 loans</i>
Less than 40%	25%	70%
Greater or equal to 40% and less than 60%	30%	70%
Greater or equal to 60% and less than 80%	35%	90%
Greater or equal to 80% and less than 90%	45%	120%
Greater or equal to 90% and less than 100%	55%	120%
Greater or equal to 100%	75%	120%

In the standardized approach, the LTV of a loan is defined as the ratio of the loan amount at the current time over the loan’s appraisal value at the time of loan origination.



The A-IRB Parameters as Potential Source of Pro-cyclicality

- I argue that the assignment of risk parameters to homogeneous segments is not a source of pro-cyclicality because of how these parameters are defined in the rule.
- The rule defines PD as “the bank’s empirically based best estimate of the long-run average of one-year default rates for the exposures in the segment, capturing the average default experience for exposures in the segment over a mix of economic conditions (including economic downturn conditions) sufficient to provide a reasonable estimate of the average one-year default rate over the economic cycle for the segment.
- LGD, is defined in the rule as “an estimate of the economic loss that would be incurred on an exposure, relative to the exposure’s EAD ... during economic downturn conditions.”



A-IRB Segmentation as a Potential Source of Pro-cyclicality

Two types of risk drivers:

- Those that are not fundamentally affected by the business cycle, which we call acyclical;
- Those that are susceptible to business cycle variability, which we call cyclical.

The argument is that a segmentation structure that generates stable risk weights over the economic cycle should be derived from a set of acyclical risk drivers.



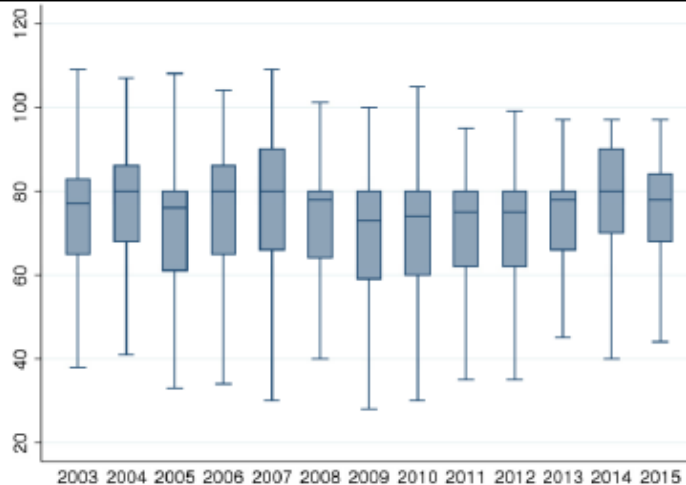
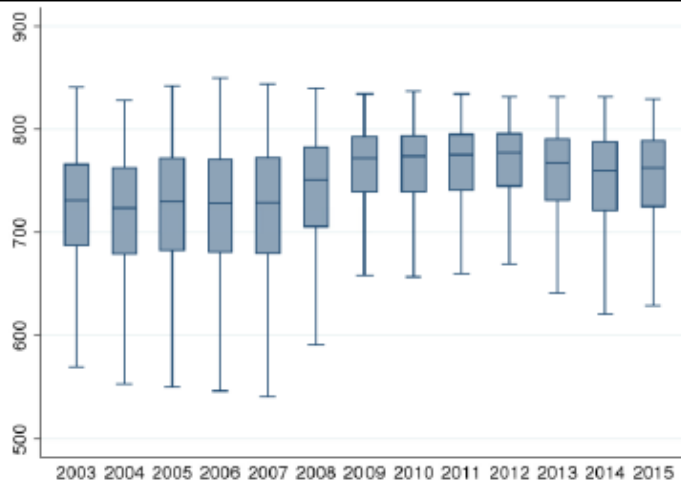
An Application to Mortgage Portfolios

The Data:

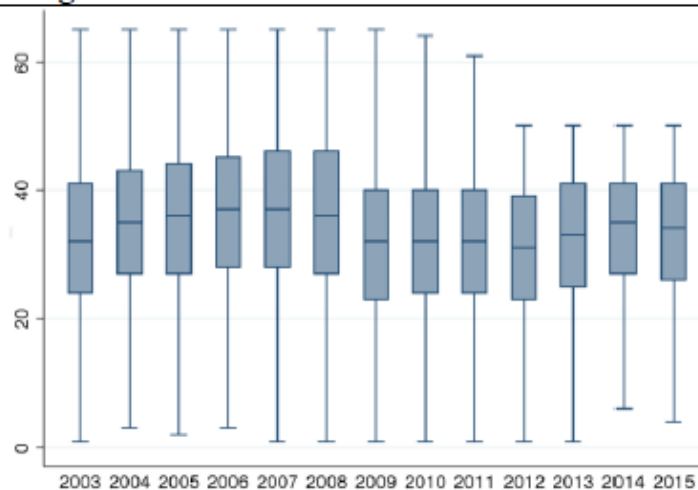
Publicly available mortgage panel dataset of loans originated between 1999 and 2015, including their historical performance information. This dataset is available from Freddie Mac, which is making available loan-level credit performance data on a portion of fully amortizing fixed-rate mortgages that the company purchased or guaranteed.



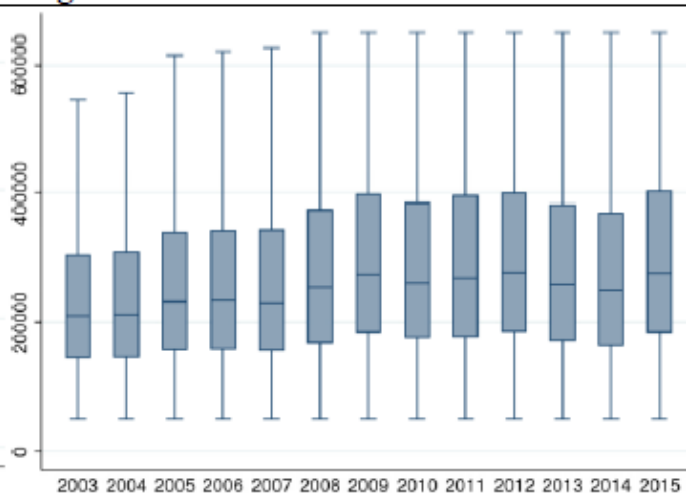
Figure 2: Distribution of Origination Risk Drivers Across Origination Years



Origination Credit Score



Origination Combined LTV



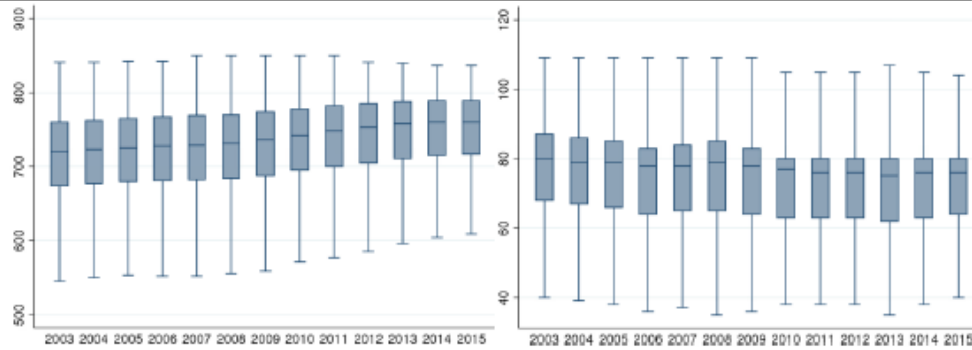
Origination Debt-to-Income

Origination Appraisal Amount

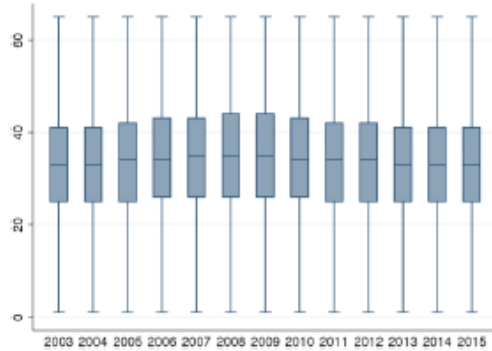
Note: For each origination year, the table presents loan characteristics at origination for that particular year.



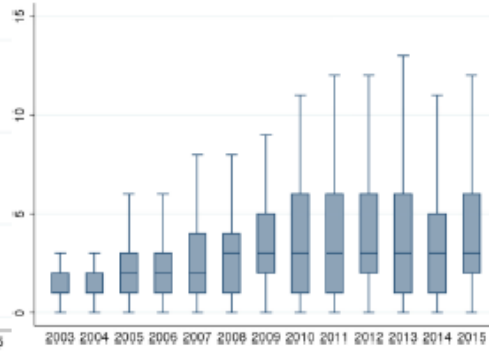
Figure 3: Distribution of Risk Drivers Across Different Cohort Years at Observation Time



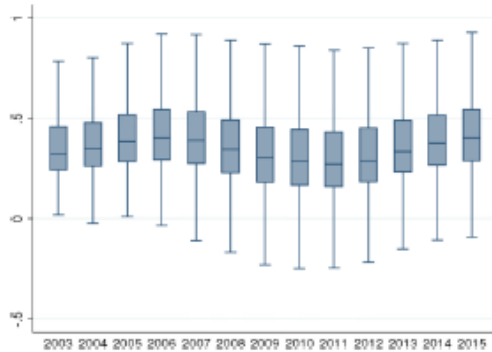
Origination Credit Score



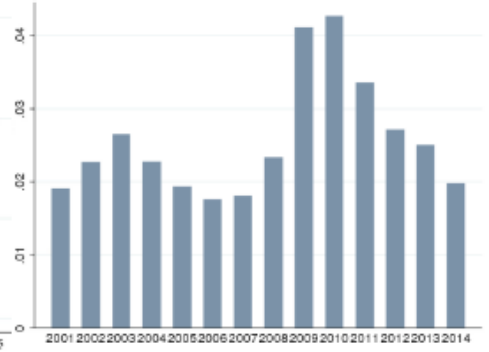
Origination Combined LTV



Origination Debt-to-Income



Loan Age



Equity Ratio

Note: Each cohort represents the sample of active loans in that particular year.

Percentage of Delinquent Accounts



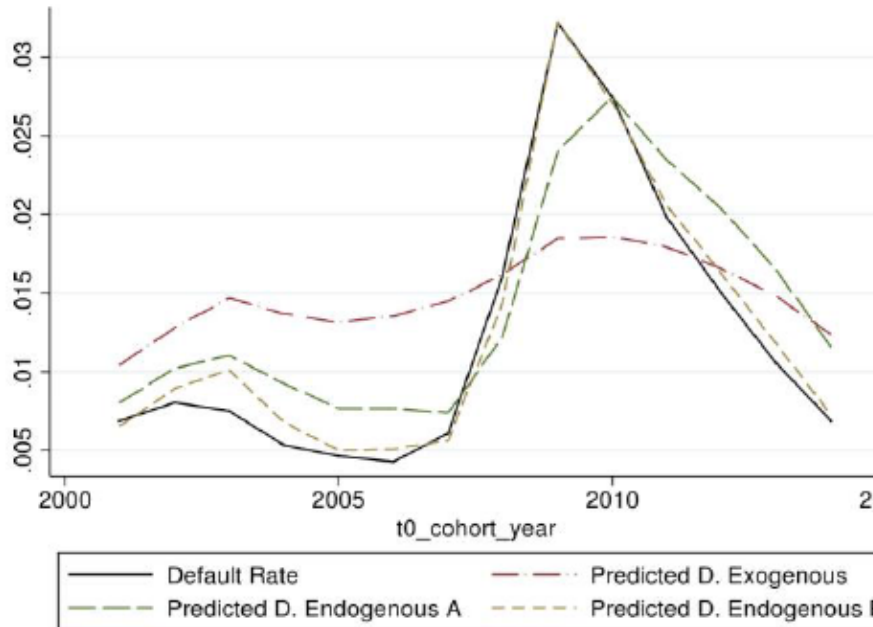
A-IRB Segmentation as a Potential Source of Pro-cyclicality

Table 2: Relevant Variable Definitions

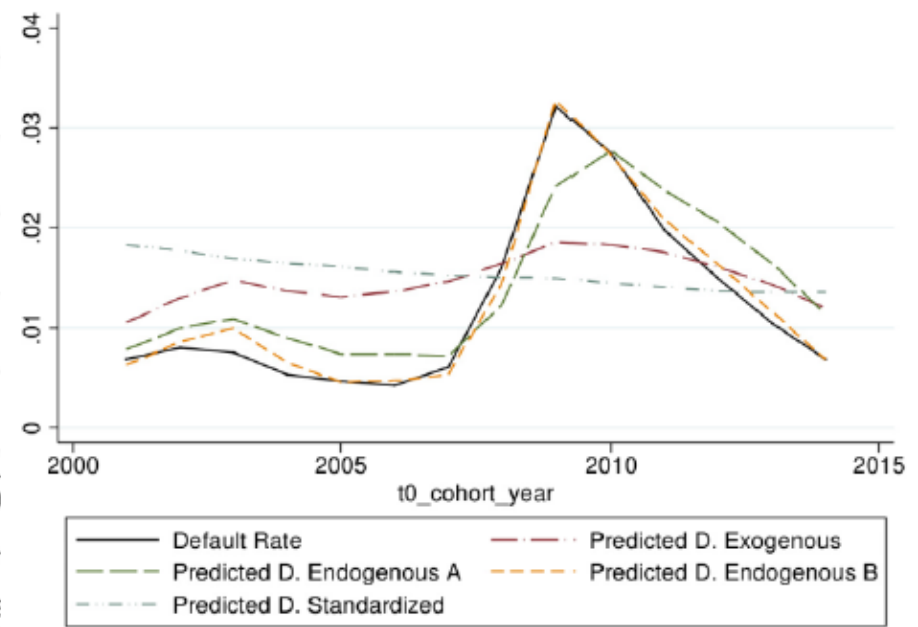
<i>Acyclical variables</i>	
Account age	Categorical controls for account age in years
FICO score	Categorical controls for credit score range at origination for the following ranges: up to 580, 580–620, 620–650, 650–680, 680–720, 720–760, 760–900
Debt-to-income	Categorical controls for debt-to-income at origination for the following ranges: less than 20, 20–30, 30–35, 35–40, 40–45, more than 45
LTV	Categorical controls for LTV at origination for the following ranges: less than 75%, 75–80%, 80–85%, 85–90%, 90–95%, 95–100%, 100–105%, 105–110%, more than 110%
Interest rate spread	Interest rate spread at origination, measured with respect to the 10-year Treasury note ratio
Borrowers	Categorical control for number of borrowers
Purpose	Categorical control for loan purpose
Loan balance	Categorical controls for loan balance range at origination for the following ranges: less than 75K, 75–100K, 100–150K, 150–250K, 250–325K, more than 325K
Occupancy type	Categorical control for occupancy type
First-time buyer	First-time buyer dummy.
Judiciary	Dummy for judiciary state
<i>Cyclical variables – updated account information</i>	
Delinquency history	Specific risk drivers derived from delinquency history
Highest del. in the past 12 months	Highest delinquency history over the past 12 months
Delinquency status	Updated delinquency status at observation time
Equity ratio	Categorical controls for updated equity ratio using appraisal at origination combined with a price index updated history and the updated loan amount
<i>Cyclical variables – macroeconomic risk drivers</i>	
Interest rate spread	Updated interest rate spread, measured with respect to the 10-year treasury Note
House price index change	Updated 12-month home price index change
Unemployment	Updated unemployment rate
Unemployment change	Updated change in unemployment rate



Figure 4: Model Fit Across Model and Segment Specifications



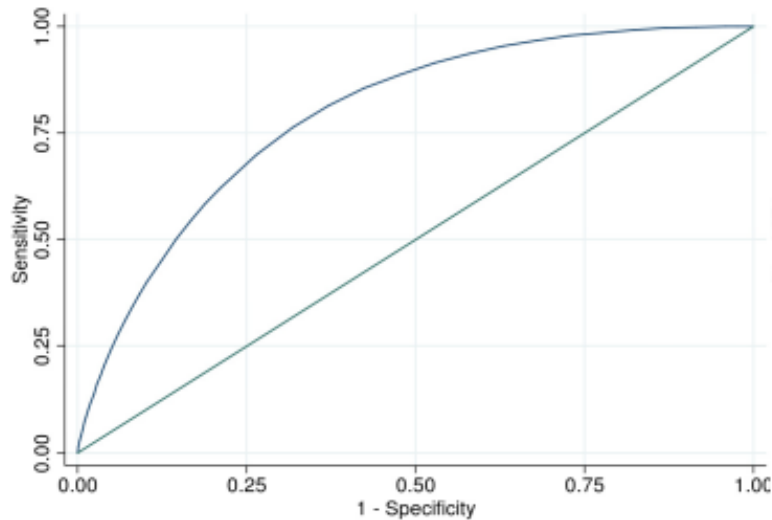
A. Realized PD vs. acyclical and cyclical model specifications.



B. Realized PD vs. predicted PD in the acyclical, cyclical, and standardized segmentation schemes.

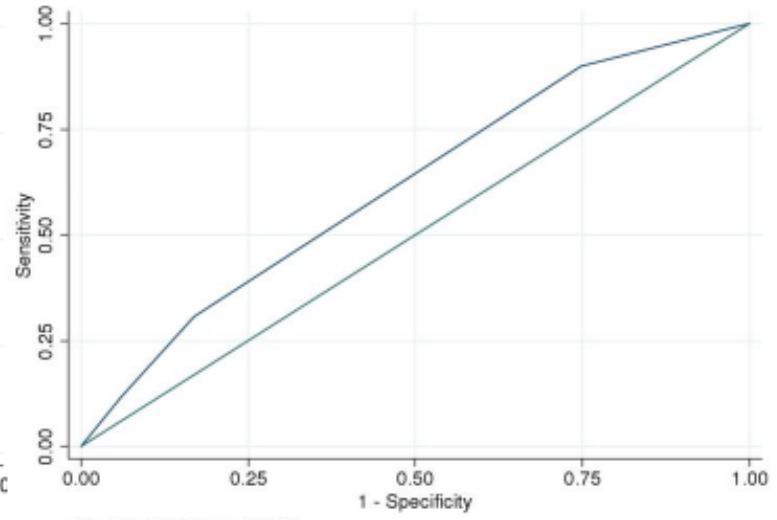


Figure 5: Area Under ROC Curve Across PD Segmentation Schemes



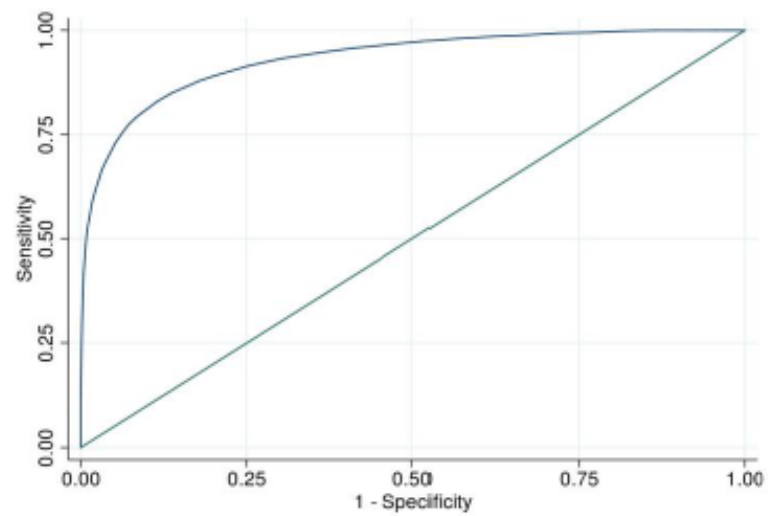
Area under ROC curve = 0.7925

Acyclical Segmentation



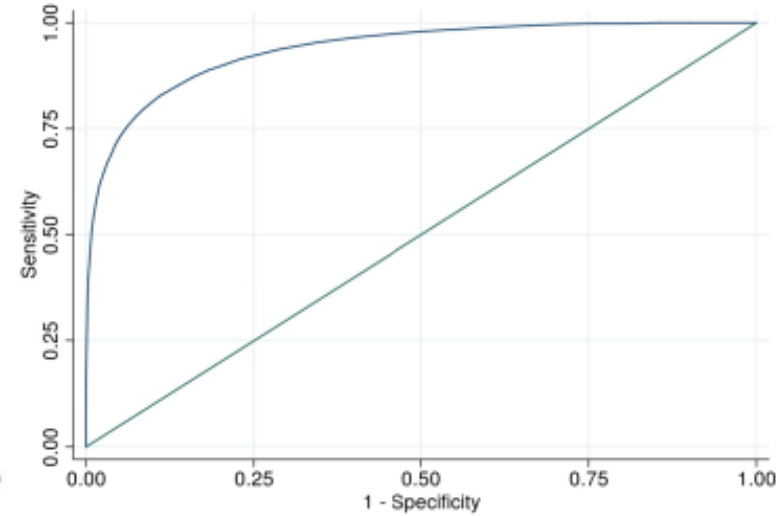
Area under ROC curve = 0.6147

Standardized Segmentation



Area under ROC curve = 0.9314

Cyclical Segmentation A



Area under ROC curve = 0.9367

Cyclical Segmentation B



Figure 6: Segment Migration Across Different PD and LGD Segmentation Schemes

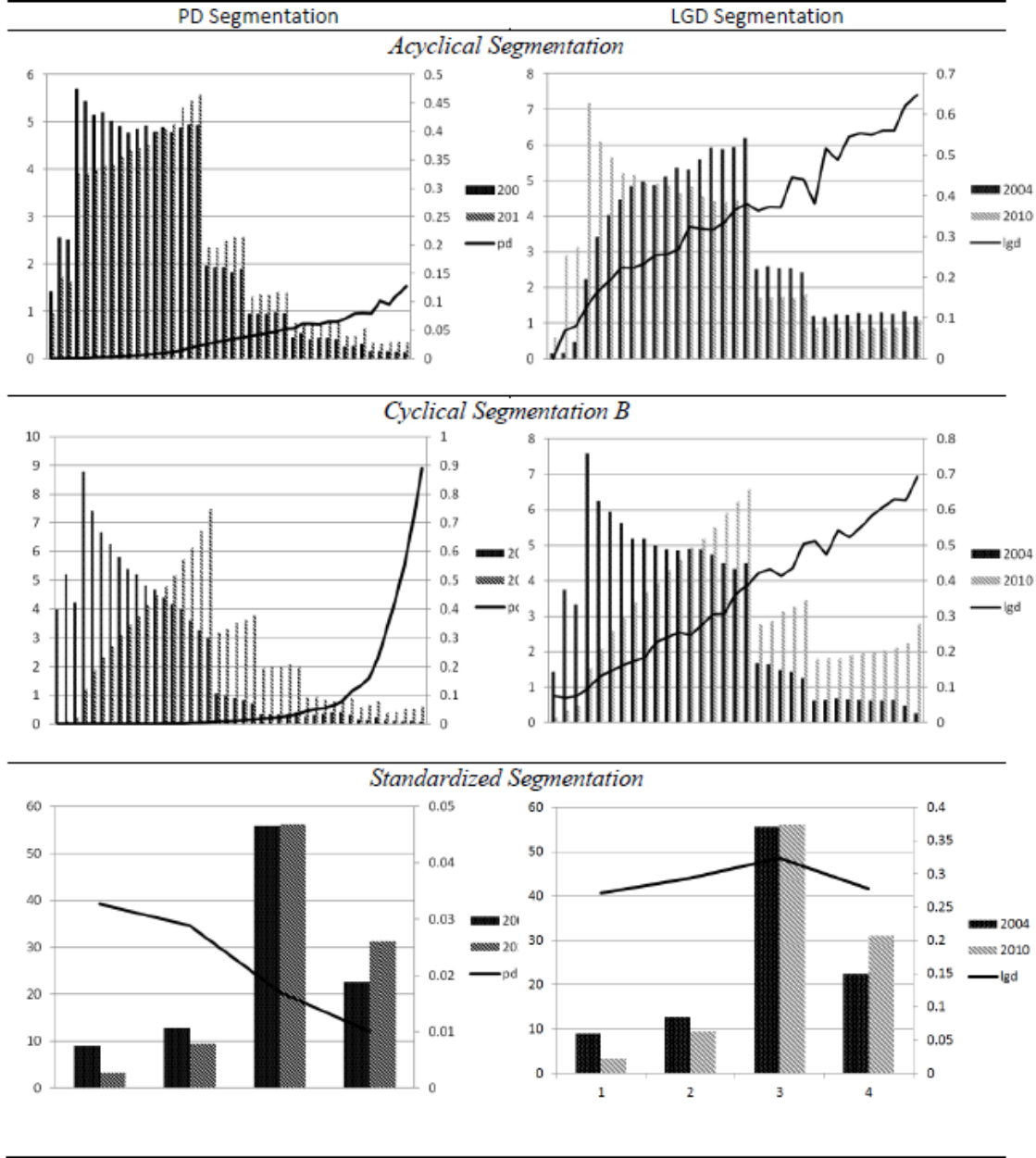
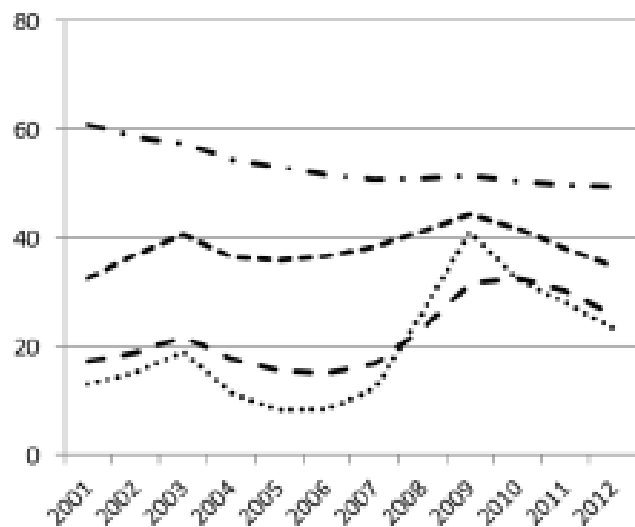


Figure 7: Pro-Cyclicality of Capital



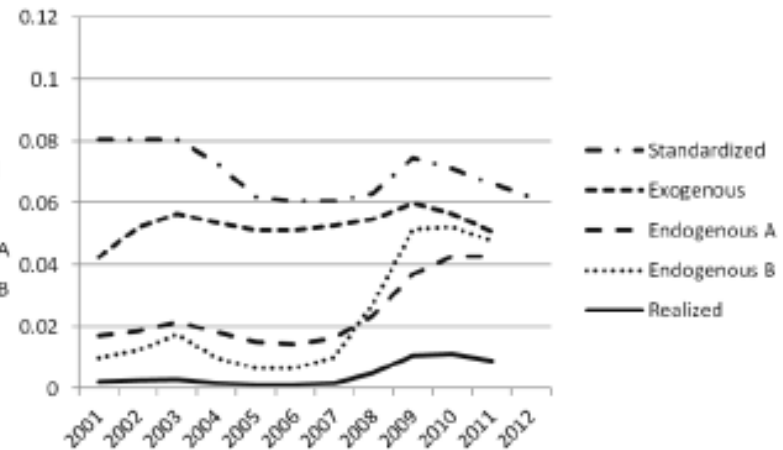
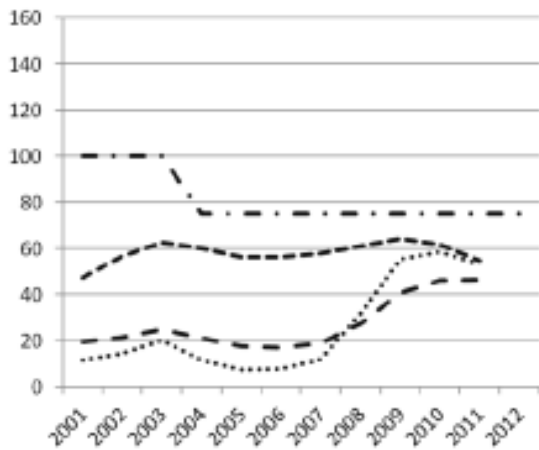
A.1 Portfolio Risk Weights



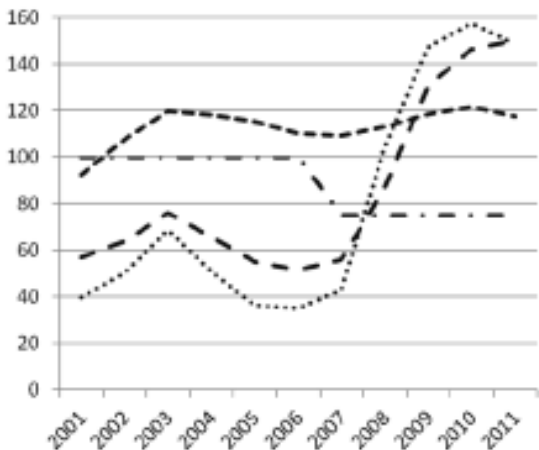
A.2 Portfolio Projected Loss Rate at the 99.9th Percentile vs. Realized Overall Portfolio Loss Rate



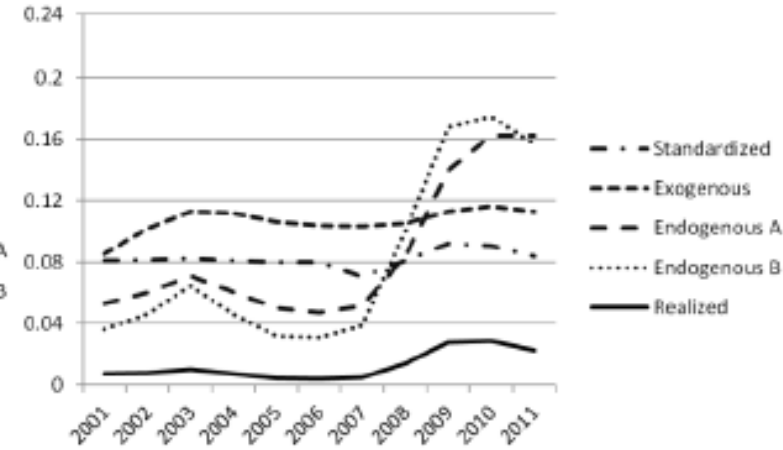
Figure 7: Pro-Cyclicality of Capital



B.1 Portfolio Risk Weights at the 75th Risk Percentile



B.2 Portfolio Projected Loss Rate at the 99.9th Percentile vs. Realized Overall Portfolio Loss Rate at the 75th Risk Percentile

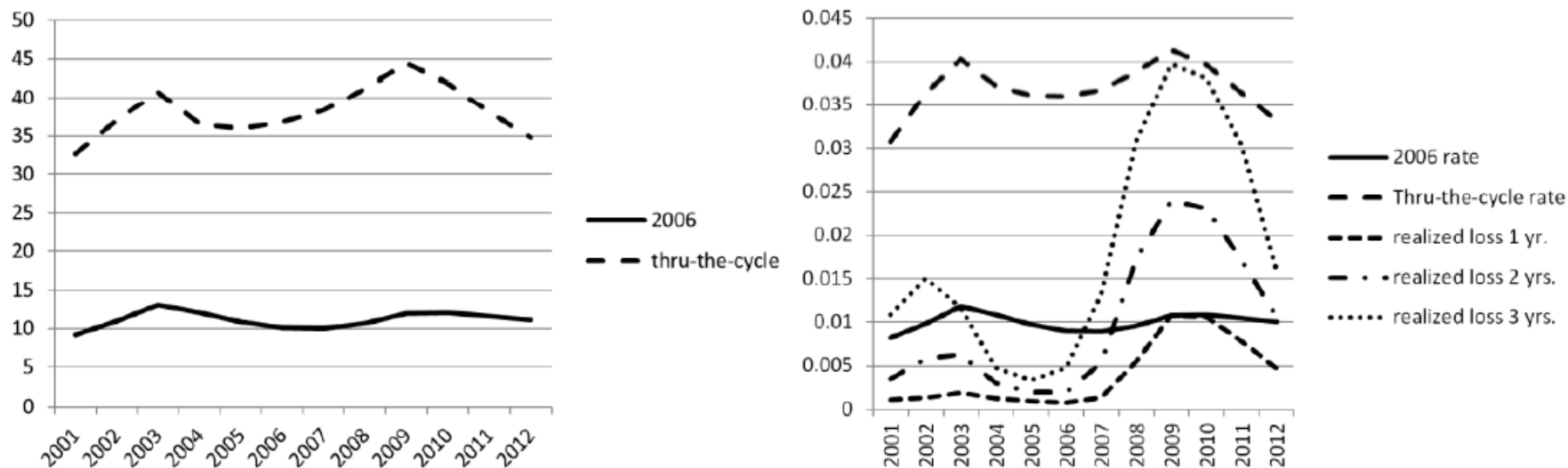


C.1 Portfolio Risk Weights at the 95th Risk Percentile

C.2 Portfolio Projected Loss Rate at the 95th Risk Percentile



Figure 8: Model Error from Lack of a Downturn in the A-IRB Quantification Framework



A. Portfolio Risk Weights Acyclical Segmentation with Data From Years 2001-2006 and TTC (2001-2012).

B. Projected Portfolio Loss Rate at the 99.9th Percentile vs. Realized Overall Portfolio Loss Rate over 1, 2, and 3 years.

Note: Projected portfolio risk weights and loss rates have been computed using data from the 2001–2006 sample of defaults or using data from the 2001–2012 sample, which is defined as the TTC sample.



- I show that pro-cyclicality in the A-IRB framework arises primarily at the portfolio segmentation level when the segmentation is endogenous to the economic cycle.
- A cyclical segmentation framework generates significant portfolio migration across segments over the business cycle, and, as a result, it also produces significant cyclicality in portfolio risk weights.
- A segmentation scheme based on risk drivers that are acyclical to the economic cycle is robust to this type of portfolio migration and cyclicality of risk weights.



- We also show that there is a trade-off between point-in-time predictive ability and acyclicity of the segmentation framework.
- This conflict between point-in-time accuracy and robustness to pro-cyclicality makes our principle-based analysis even more relevant as it highlights the restrictions required to build an A-IRB framework that portfolio risk weights that are stable over the cycle.
- From the perspective of validation and regulatory review the reduction in point-in-time predictive ability will have to be accommodated by considering validation standards that are both in terms of accuracy and back testing less stringent than those required for models where point-in-time accuracy is the primary concern.



- I also analyze the standardized Basel framework and show that it is consistent with the analysis of a stable segmentation but is restricted in its risk-ranking ability by its constrained segmentation structure.
- I show that if the A-IRB quantification framework lacks sufficient coverage of downturn economic conditions this results in capital levels that are significantly lower than those of an A-IRB framework that includes a mix of economic conditions comprising a full economic cycle, a requirement of the rule. This empirical exercise illustrates the high sensitivity of the A-IRB framework to judgments related to data availability and sample coverage.



Questions?

