Consumer & Retail Credit Forecasting: DFAST bank case study with Global Regulatory Requirements

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#RPC14

Agenda

- **Introductions**
- **Practical Case Study: Meeting business and global regulatory objectives**
  - ➢ **Forecasting & Stress Testing**
  - ➢ **Challenges around Regulatory Submissions**
  - ➢ **Gaining Value from the Exercise**
- **Consumer Credit Methodologies & Challenges**
  - ➢ **Panel-data structures: vintage analysis as a leading example**
  - ➢ **Multi-period simulation techniques**
  - ➢ **Optimal allocations**
  - ➢ **Reverse stress testing**

Practical Case Study

United States vs. Europe – The Core Requirements of Stress Testing Regulations are Aligned Across Regions

	Europe	United Kingdom	United States
Regulatory Body	EBA / ECB / NCA [1]	BoE / PRA[1]	Federal Reserve
Coverage	Largest Eurozone/Significant Banks (approx. 128 banks)	Largest UK Banks & Building Societies	BHC&FBO[6]; assets > than $10bn (DFAST), $50bn (CCAR)
Data Requirements / Reporting	Historical/AQR Data – Core (ADC, TR, CSV) & Additional (CSV) Templates[2,3]	FDSF[4] – Historical, Year-End Data & P/L Projections	FRY Reports – A/Q/M Data; P/L Projections
Modeling Approach	Bottom-Up & Challenger/Top-Down; Firms' Own Models	Bottom-Up /Granular; Firms' Own Models	Bottom-Up; Firms' Own Models; Dynamic Projections
Scenarios	Regulatory Baseline, Stress Scenario	Common Stress, Bespoke Firm Stress, Common Baseline	Baseline, Adverse, Severely Adverse; Firms' Scenarios
Disclosure	Public Disclosure of Results (Bottom-Up)	Public Disclosure of Results	Public Disclosure of Results
Frequency	Annual (2009-2011 EBA); 2014 (ECB)	Annual	Annual (regulator-led); semiannual (bank-led)
Corrective Measures / Use of Outputs	Recapitalization Plan	Input Capital Adequacy CRDIV & firms' PRA buffer; FPC Tool[5]	Input Capital Plan, Approval by Fed; Dividend Planning,…,etc.

Source – Moody's Analytics

Moody's Analytics

1.European Banking Authority (EBA), European Central Bank (ECB), National Competent Authorities (NCA), Bank of England (BoE), Prudential Regulation Authority (PRA)
2.Asset Quality Review (AQR)
3.Advanced data collection (ADC), Transparency (TR) and Calculation, Validation & Support (CSV) Templates
4.Firm Data Submission Framework (FDSF)
5.Financial Policy Committee (FPC); Capital Requirements Directive IV (CRD IV)
6. Bank Holding Companies (BHC), Foreign Banking Organizations (FBO)

Engaging the Business

- **Treat as a full business planning exercise, albeit one with highly pessimistic macroeconomic assumptions (akin to business continuity management)**
  - **Business Units "BAU" activities**
  - **Staffing Decisions / Collection Efforts**
- **Finance should take the lead role, though Risk may provide technical expertise and tools given additional modelling challenges**
- **Knowledgeable project manager should coordinate work streams**
- **Significant time should be invested in management actions, ensuring:**
  - **Actions are realistic given resource and operational constraints**
  - **Reaction time reflects reality and doesn't assume "benefit of foresight"**
  - **Customer impact is considered (avoid the sledgehammer)**
- **Existing mitigation impacts should be separated from new mitigants**

Stress testing is a "whole business" exercise.

The Right Tools for the Job

- Sophistication of modelling approach for a given portfolio should be driven by:
  - Portfolio materiality / activity
  - Data availability
  - Sensitivity
- Ideally a single consolidated model would capture all interrelated elements
- Acknowledge the limitations of any one modelling approach, triangulate
  - Top-down vs bottom-up
  - Analytical vs intuitive
  - Predictive vs experiential
- Model output must easily fit into current practices in the Institution
  - Business units manage portfolio with a roll-rate structure in mind
  - Business Units need accounts and Dollars forecasts
  - Business Units need segmentation: retail partnerships / risk levels

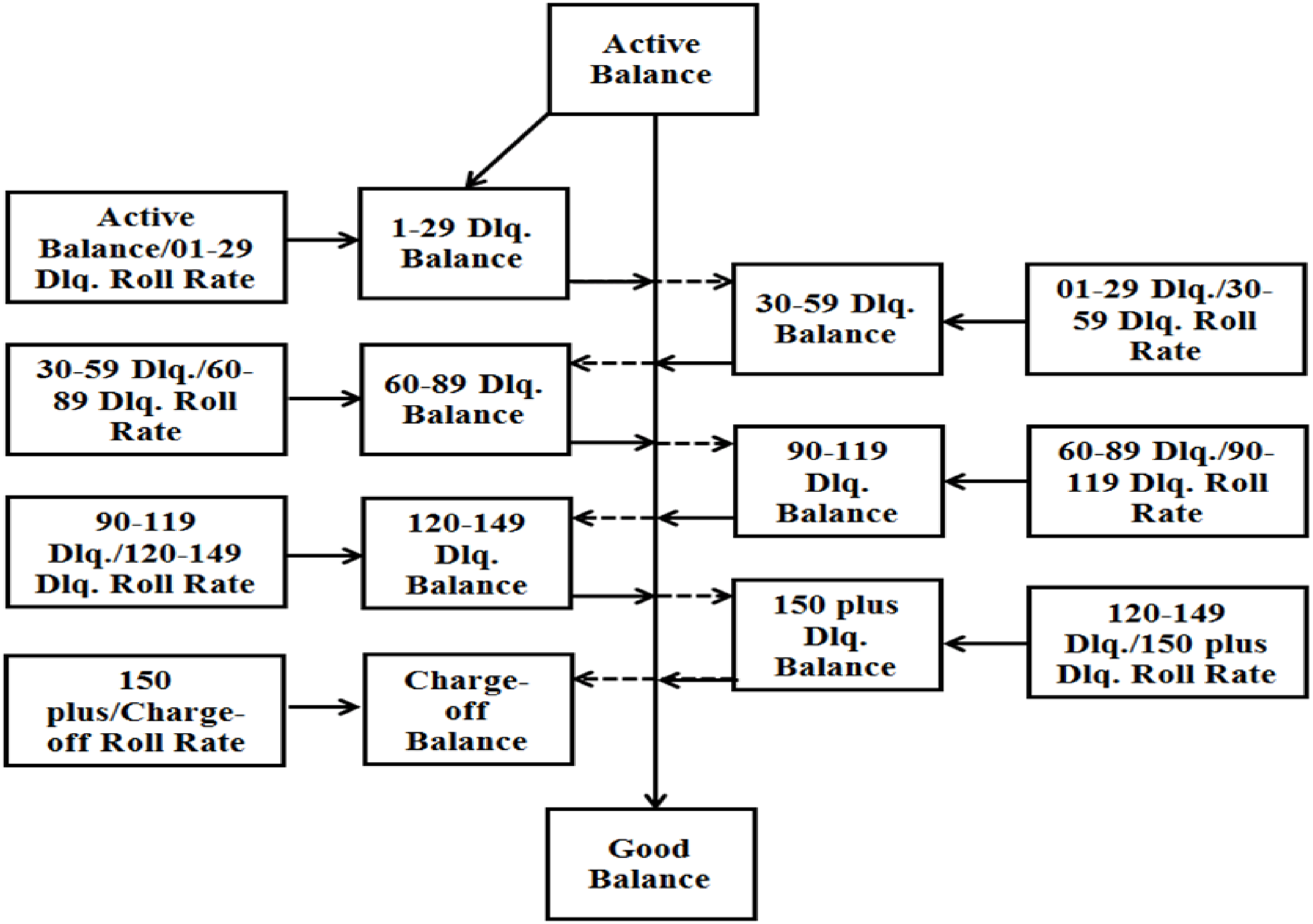
There is no one "best" approach.

Gaining Value from the Exercise

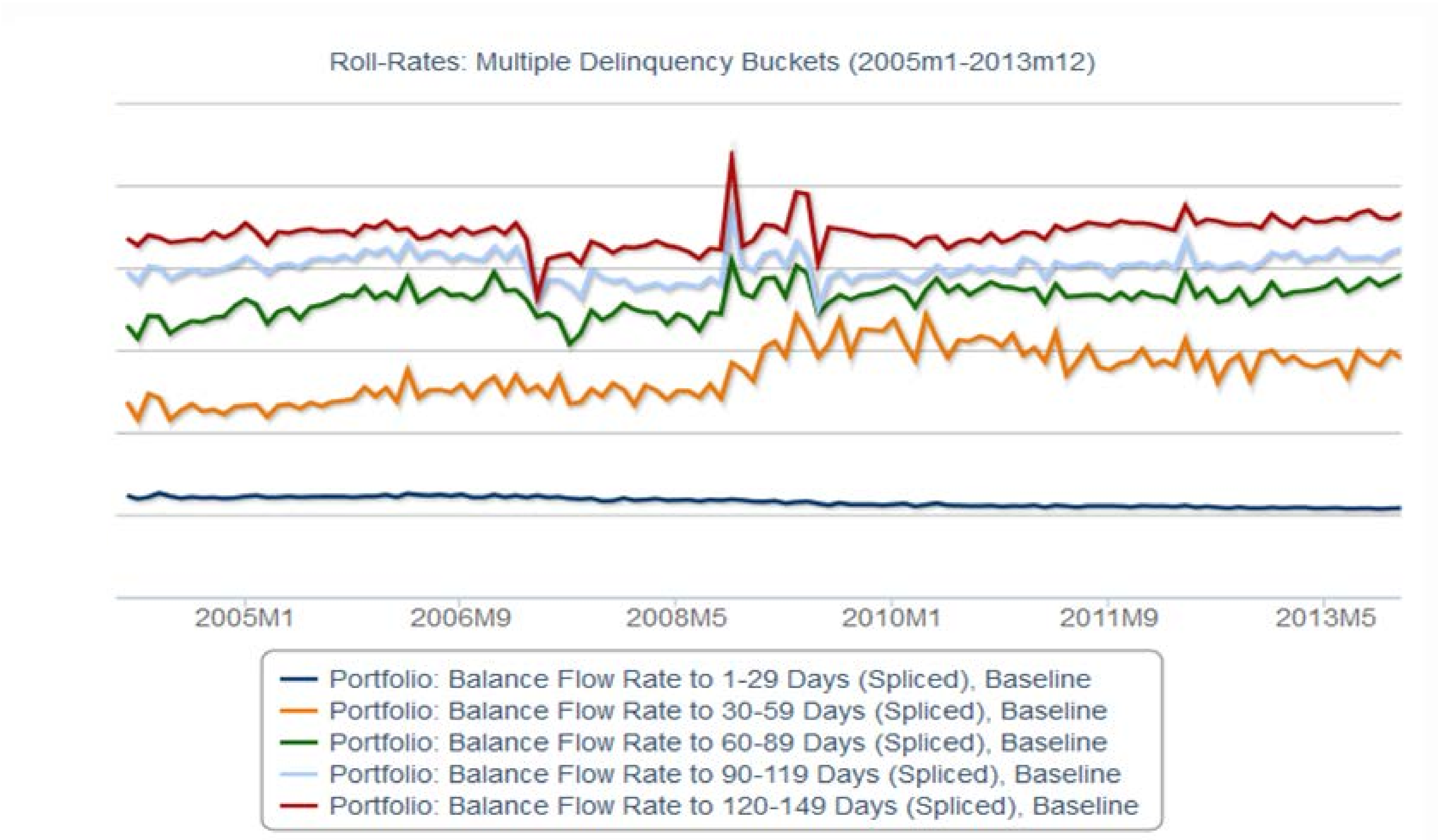
- **Building stress testing models will improve baseline models**
- **Discussing management actions under highly stressed scenarios improves response time to less severe situations and identifies operational deficiencies preventing effective responses**
- **Developing strong controls and processes for stress testing improves regular business planning activities**
- **Meeting rigorous external documentation requirements provides a sound framework for internal documentation**
- **Offers an opportunity to consolidate organizational knowledge**
- **Fully documented models**
- **Modelers support to key personal to ensure proper ownership of the model**

Stress testing is a theoretical exercise with practical value.

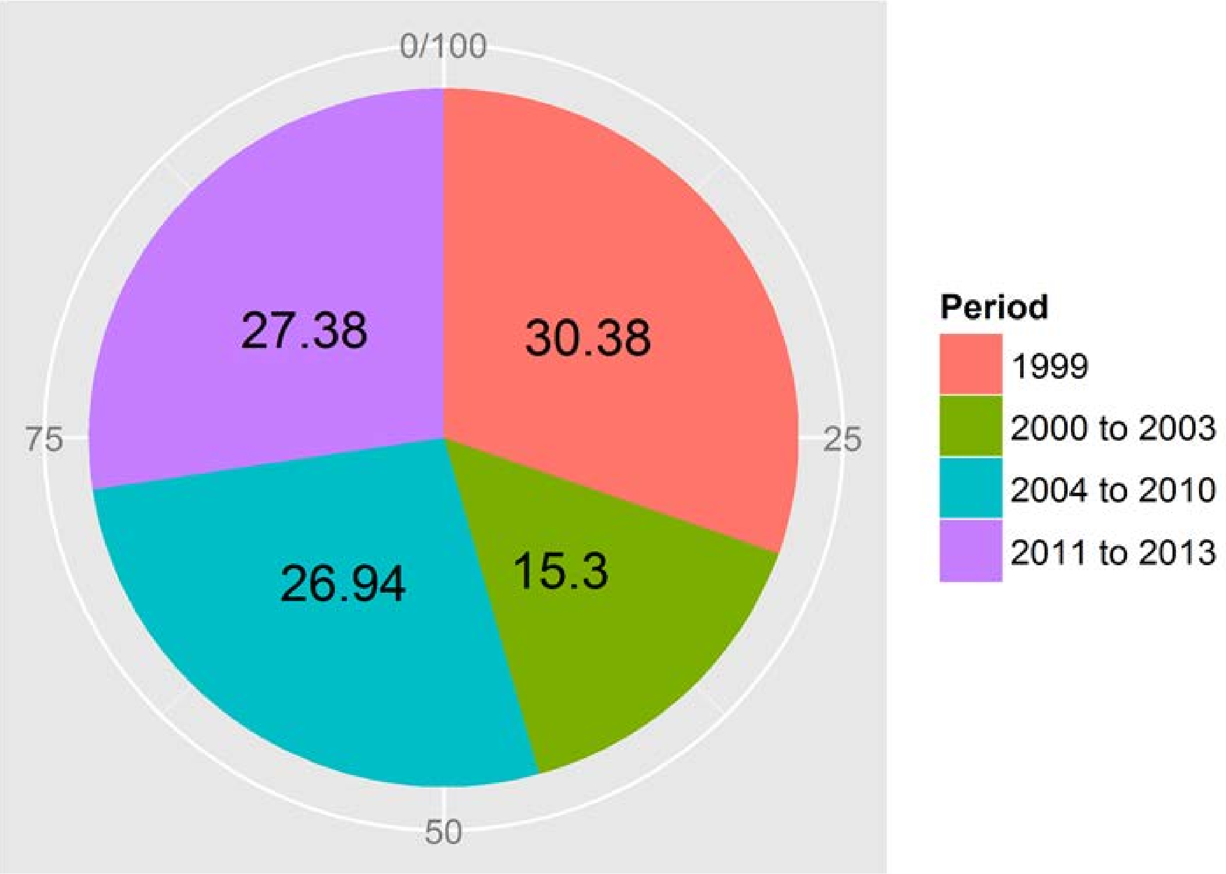
Model Structure Diagram: A Vintage Approach



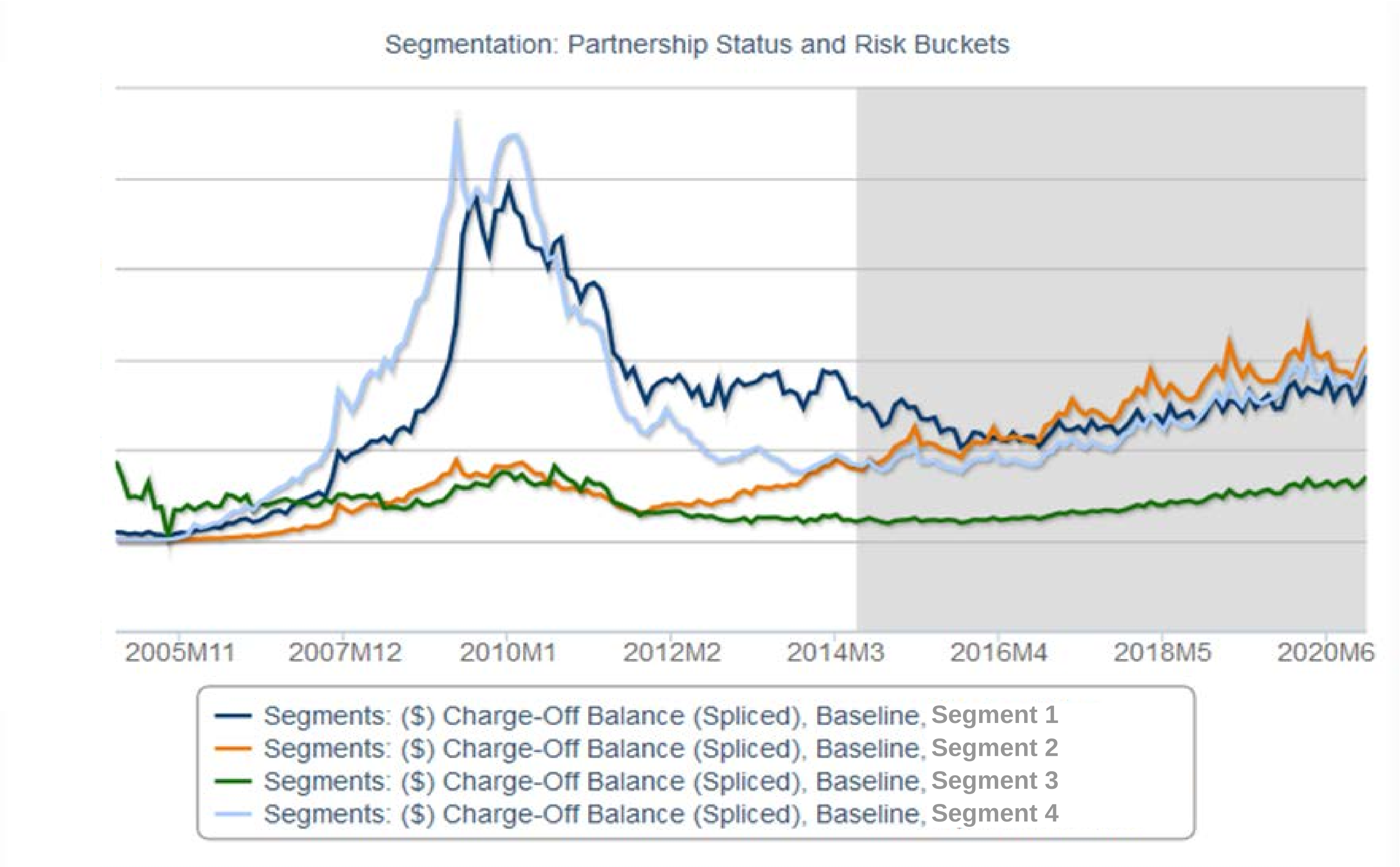
Model Output
Portfolio Level Roll-Rates: Multiple Delinquency States



Great Variation in Vintages Sizes (as of 2013m12)



Charge-off Amount Across Segments



Case Study Summary

- **Large Credit Card Business with footprint in different countries**
  - **Engaging the business**
  - **Using the right tools**
  - **Gaining value from the exercise**
- **Unified methodology to forecast future performance and implement scenario analysis and stress testing exercises**
  - **Transparency**
  - **Unified methodology facilitates flow of information within the Institution**
- **On the other hand:**
  - **Different Regulatory Environments, particularly around Stress Testing exercises**
  - **Specific Business Needs**

Vintage Methodology and Stress Testing Challenges

Methodology: Dynamic Panel-Data Structure

Time series performance for a given vintage and segment = *f*

(1) Lifecycle component

- Dynamic evolution of vintages as they mature
- Nonlinear model against “age"

(2) Vintage-quality component

- Vintage attributes (LTV, asset class/collateral type, geography, etc.) define heterogeneity across cohorts
- Early arrears serve as proxies for underlying vintage quality
- Economic conditions at origination matter
- Econometric technique accounts for time-constant, unobserved effect

(3) Business cycle exposure component

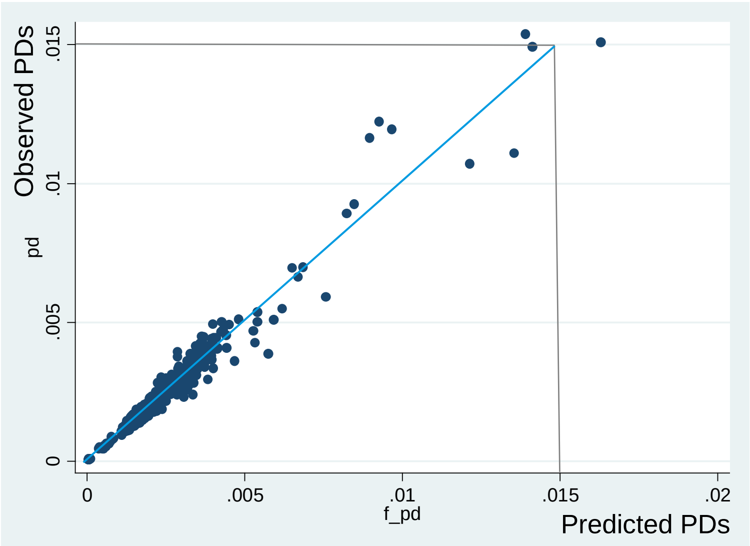
- Sensitivity of performance to the evolution of macroeconomic and credit series

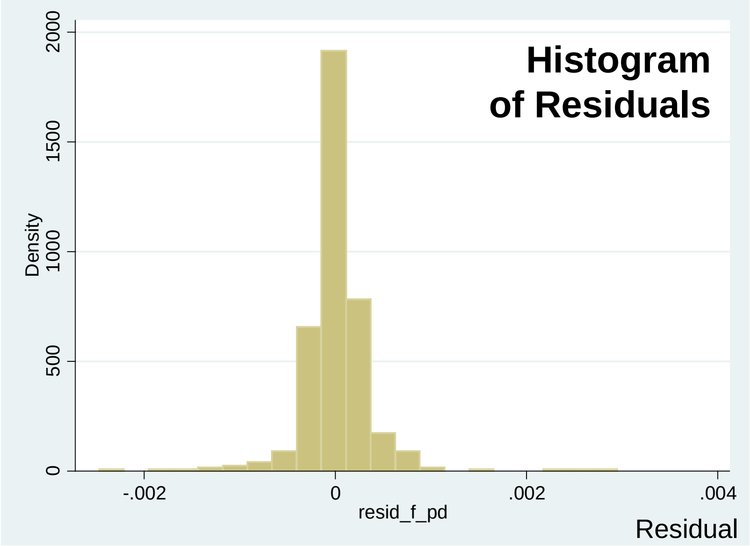
US Auto PD Model – Fixed-Effects Panel Data Estimation

Source	SS	df	MS
Model	475.617452	48	9.90869691
Residual	5.67184058	416	.013634232
Total	481.289292	464	1.03726141

Number of obs =	465
F(48, 416) =	726.75
Prob > F =	0.0000
R-squared =	0.9882
Adj R-squared =	0.9869
Root MSE =	.11677

log_pd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
dummy_age_1	1.631347	.0473693	34.44	0.000	1.538234	1.72446
dummy_age_2	2.217711	.0805545	27.53	0.000	2.059367	2.376056
dummy_age_3	2.041324	.1159124	17.61	0.000	1.813477	2.269171
dummy_age_4	1.656777	.1465386	11.31	0.000	1.368728	1.944825
dummy_age_5	1.279536	.1661623	7.70	0.000	.9529135	1.606158
dummy_age_6	.9403923	.1689269	5.57	0.000	.6083356	1.272449
dummy_age_7	.6509373	.1515249	4.30	0.000	.3530873	.9487873
dummy_age_8	.4172649	.1202897	3.47	0.001	.1808134	.6537164
dummy_age_9	.2342105	.0842995	2.78	0.006	.0685044	.3999166
dummy_age_10	.1064866	.0533284	2.00	0.046	.0016599	.2113132
_Sage1	.4617167	.0382239	12.08	0.000	.3865806	.5368529
_Sage2	-2.43758	.7499189	-3.25	0.001	-3.911683	-.9634771
_Sage3	3.49146	1.867412	1.87	0.062	-.1792793	7.162199
_Sage4	.0557114	1.343793	0.04	0.967	-2.585759	2.697182
_Sage5	-2.24524	1.020941	-2.20	0.028	-4.252087	-.2383932
_Sage6	12.29499	5.932834	2.07	0.039	.6329204	23.95706
_Sage7	-73.15822	17.33315	-4.22	0.000	-107.2297	-39.08674
qvintage						
338	.601827	.0729246	8.25	0.000	.4584803	.7451737
339	.5244618	.0729165	7.19	0.000	.3811311	.6677925
340	.4954991	.0730174	6.79	0.000	.35197	.6390282
341	.4845197	.0731541	6.62	0.000	.3407218	.6283175
342	.4445133	.0732872	6.07	0.000	.3004539	.5885728
343	.2103228	.0734188	2.86	0.004	.0660047	.3546408
344	.1467453	.0735917	1.99	0.047	.0020874	.2914032
345	.0346756	.0737311	0.47	0.638	-.1102564	.1796076
346	-.0674085	.0738179	-0.91	0.362	-.2125111	.0776941
347	-.2844975	.0739212	-3.85	0.000	-.4298031	-.1391919
348	-.4057279	.0740411	-5.48	0.000	-.5512692	-.2601866
349	-.2669378	.0741856	-3.60	0.000	-.4127632	-.1211124
350	-.1222775	.0743673	-1.64	0.101	-.26846	.0239049
351	-.2567755	.0745765	-3.44	0.001	-.4033692	-.1101818
352	-.2296637	.0748362	-3.07	0.002	-.376768	-.0825595
353	-.2030854	.0751339	-2.70	0.007	-.3507749	-.0553959
354	-.0445987	.0754846	-0.59	0.555	-.1929775	.1037801
355	-.1113241	.0758966	-1.47	0.143	-.2605128	.0378646
356	-.052321	.0764052	-0.68	0.494	-.2025093	.0978674
357	-.0819127	.0770081	-1.06	0.288	-.2332863	.0694609
358	.1114787	.077755	1.43	0.152	-.041363	.2643204
359	.0163052	.0786526	0.21	0.836	-.1383008	.1709113
360	.0436907	.0797796	0.55	0.584	-.1131306	.200512
361	.0318062	.0812167	0.39	0.696	-.12784	.1914524
362	.1373737	.0831042	1.65	0.099	-.0259829	.3007303
363	.1125562	.0856832	1.31	0.190	-.0558698	.2809822
364	.0530714	.0894275	0.59	0.553	-.1227147	.2288574
366	-.1760582	.1069851	-1.65	0.101	-.3863569	.0342406
367	-.1396401	.1361635	-1.03	0.306	-.4072943	.1280141
lbr	.0409895	.0049577	8.27	0.000	.0312443	.0507347
gdp	-.0543942	.0093621	-5.81	0.000	-.0727972	-.0359913
_cons	-9.938466	.076754	-129.48	0.000	-10.08934	-9.787592





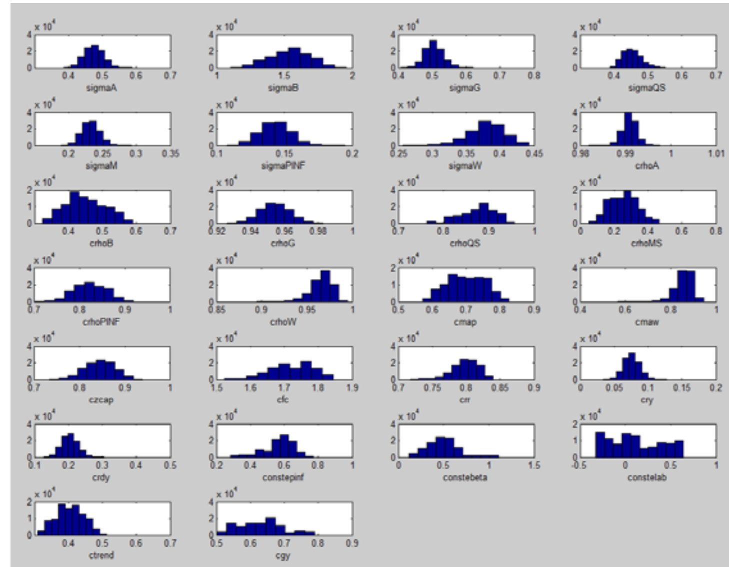
Multi-period Simulation Analysis

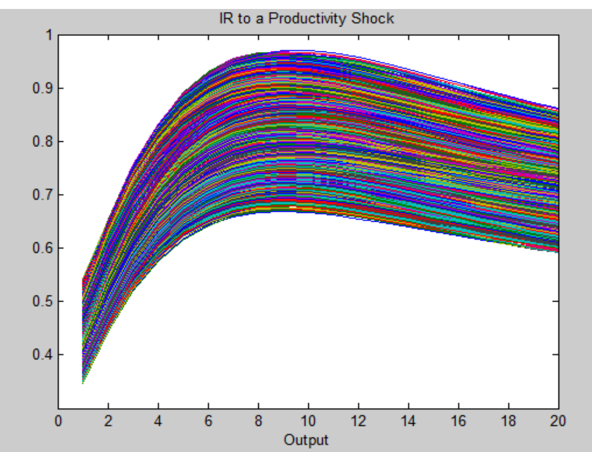
Dynamic Macroeconomic Scenarios

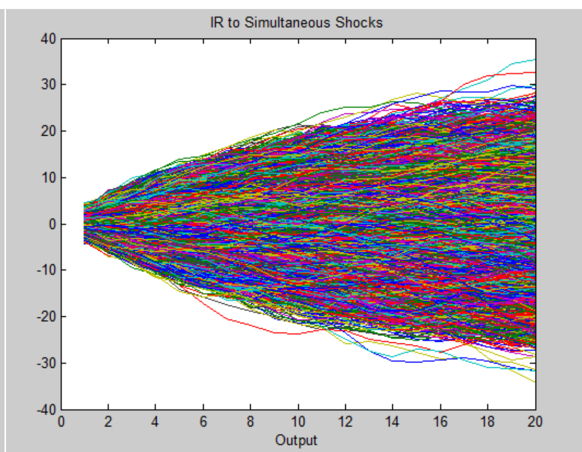
Bayesian Estimation – Prior & Posterior Distributions – Simulations

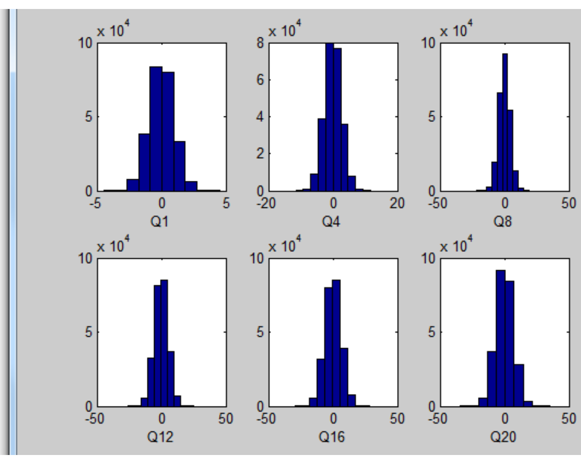
$$f(\theta \mid x) = \frac{f(x \mid \theta)\, f(\theta)}{f(x)}$$

Parameter	Density	(1)	(2)	Parameter	Density	(1)	(2)
σ_a	InvGamma	0.10	2.00	ρ_w	Beta	0.50	0.20
σ_b	InvGamma	0.10	2.00	μ_p	Beta	0.50	0.20
σ_g	InvGamma	0.10	2.00	μ_w	Beta	0.50	0.20
σ_i	InvGamma	0.10	2.00	ψ	Beta	0.50	0.15
σ_r	InvGamma	0.10	2.00	ρ	Beta	0.75	0.10
σ_p	InvGamma	0.10	2.00	Φ	Normal	1.25	0.12
σ_w	InvGamma	0.10	2.00	r_y	Normal	0.12	0.05
ρ_a	Beta	0.50	0.20	$r_{\Delta y}$	Normal	0.12	0.05
ρ_b	Beta	0.50	0.20	$\bar{l}$	Normal	0.00	2.00
ρ_g	Beta	0.50	0.20	$\bar{\gamma}$	Normal	0.40	0.10
ρ_i	Beta	0.50	0.20	ρ_{ga}	Beta	0.50	0.20
ρ_r	Beta	0.50	0.20	$\bar{\pi}$	Gamma	0.62	0.10
ρ_p	Beta	0.50	0.20	$100(\beta^{-1}-1)$	Gamma	0.25	0.10

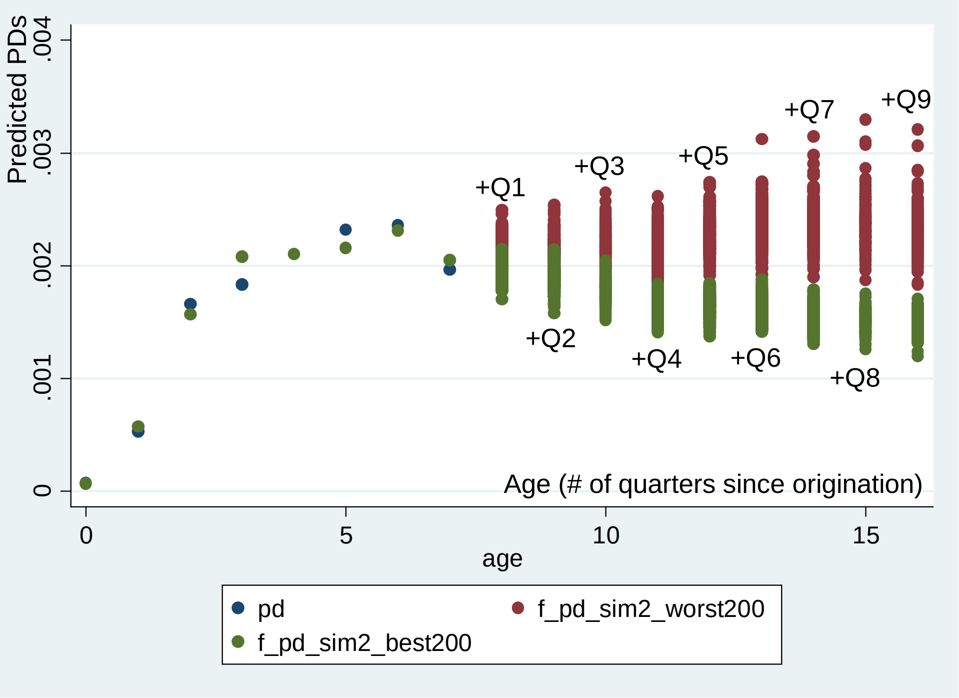


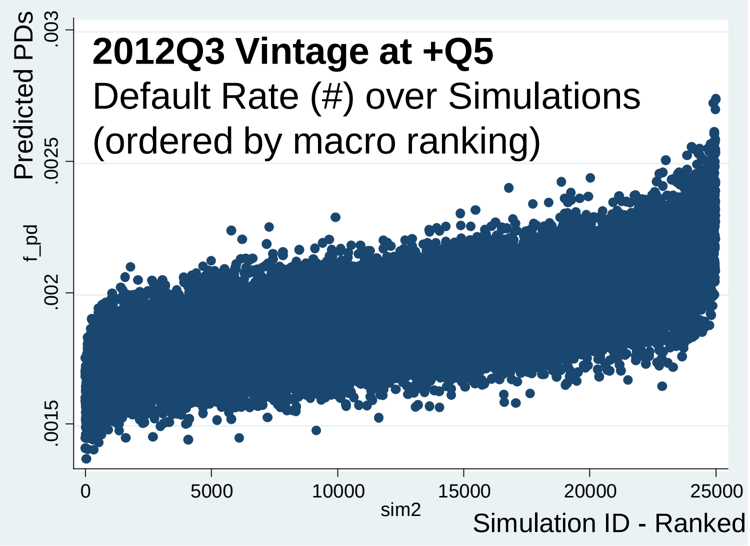


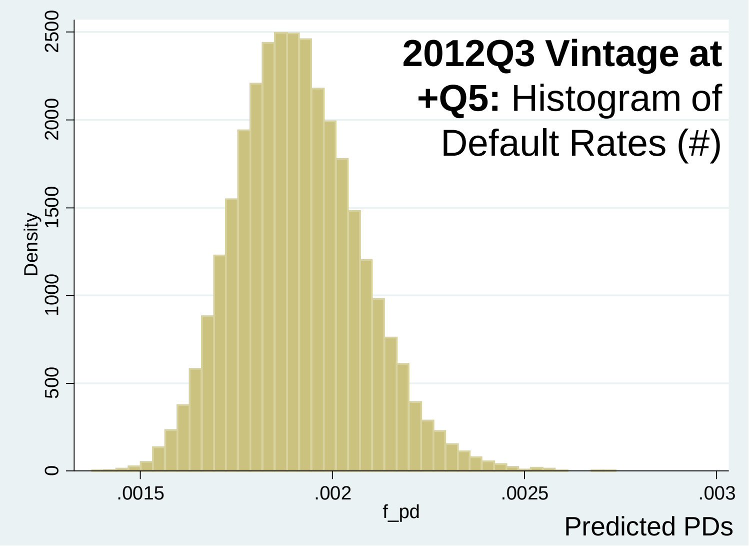




US Auto PD Model – Projections – 2012Q3 Vintage

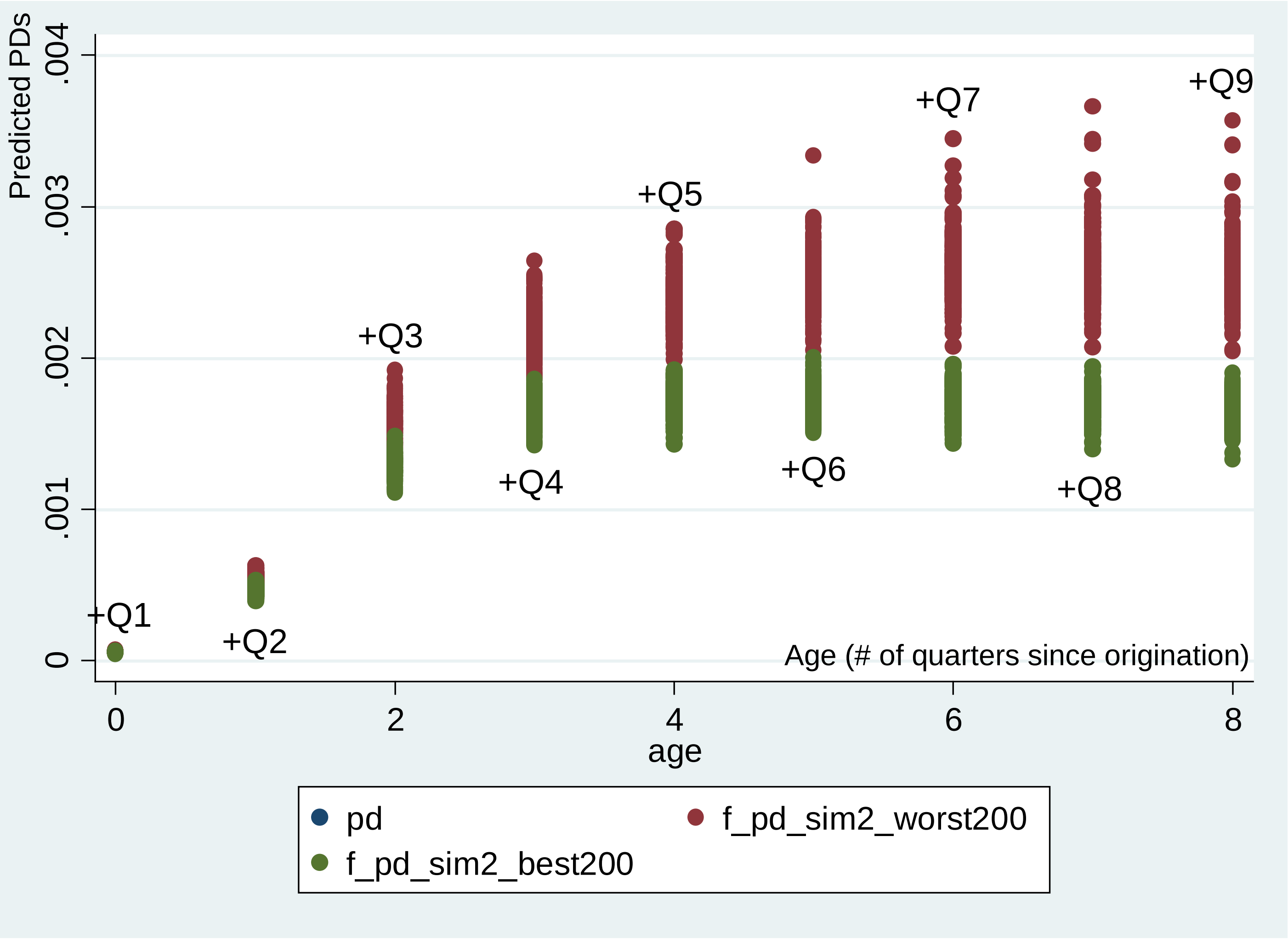






US Auto PD Model – Projections – 2014Q3 Vintage

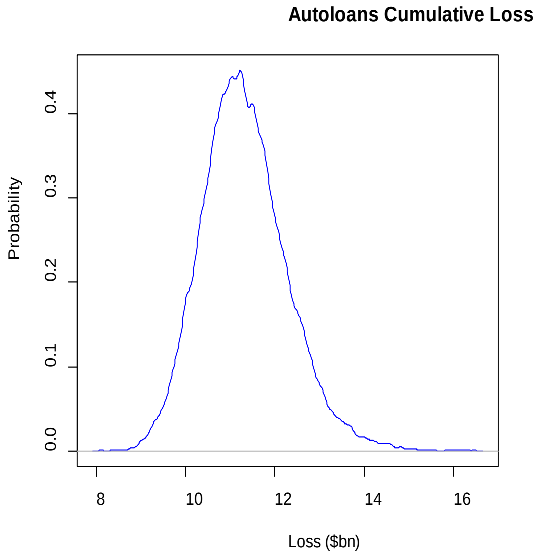
Dynamic Forecast – Example of PD Projections for a "Future" Vintage



Optimal Asset Allocation

US Auto Lending – Multi-period Analytical Metrics
Expected and Unexpected (Volatility) Losses

Period	EL ($m)	Analytical Volatility ($m)	Monte Carlo Volatility ($m)	Cumulative EL ($m)	Cumulative Analytical Volatility ($m)	Cumulative Monte Carlo Volatility ($m)
Q1	1321	80.3	80.3	1321	80.3	80.3
Q2	1322	96.2	96.4	2644	152.4	152.5
Q3	1309	110.0	109.9	3953	235.2	235.5
Q4	1287	123.1	123.2	5239	329.6	329.7
Q5	1265	135.2	135.3	6503	436.0	436.1
Q6	1243	145.5	145.6	7747	552.1	552.3
Q7	1225	155.1	155.2	8972	677.3	677.4
Q8	1210	164.6	164.7	10182	810.6	810.7
Q9	1197	172.1	172.1	11379	950.3	950.4



Portfolio Optimization

What is the portfolio composition n_i that minimises the portfolio loss volatility given a level of expected loss (and hence return) $EL = L$?

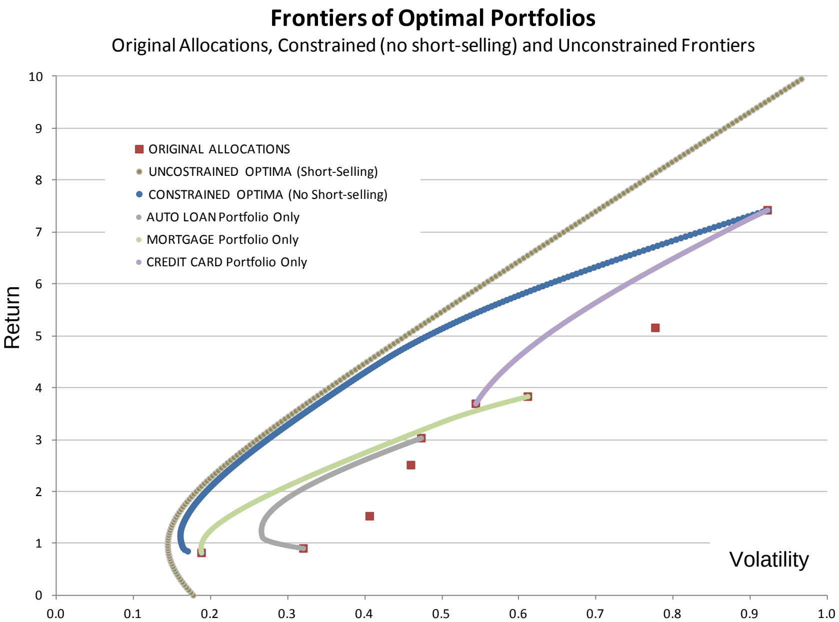
Using the Lagrange multipliers methodology:

$$\Lambda(n_i, \lambda) = \sigma(L;\, n_i) + \lambda(EL(n_i) - L)$$

The efficient frontier can be calculated by solving the following system of equations:

$$n_i C_i + \lambda EL_i^* = 0$$

$$\sum_{i=1}^{N} n_i EL_i^* - L = 0$$

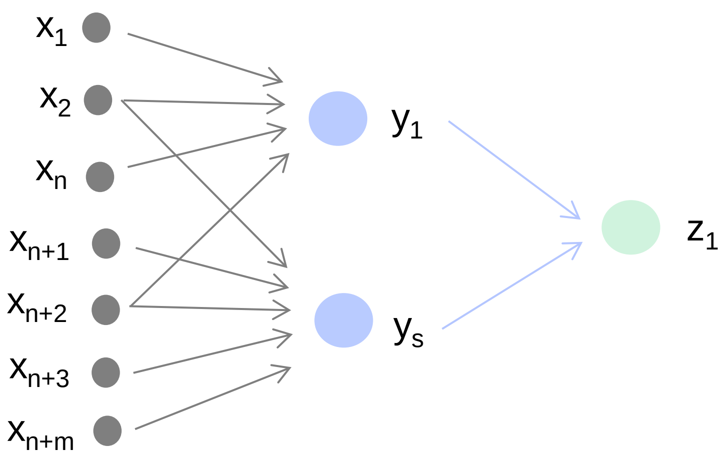


- Extend the current framework to study DYNAMIC OPTIMIZATION (infinite horizon). ***Recursive Dynamic Programming*** (Bellman Equations) and the study of the optimal solutions to the underlying stochastic difference equations

Reverse Stress Testing

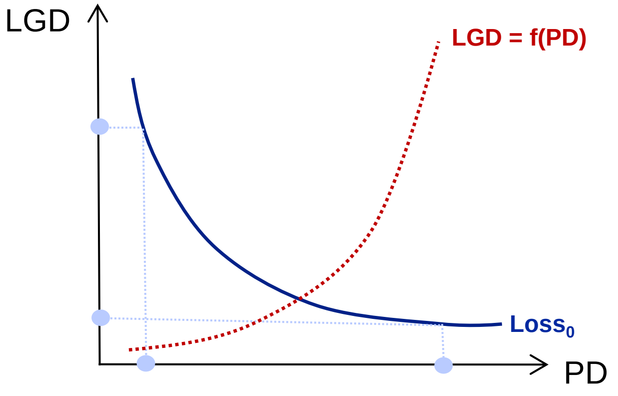
Reverse Stress Testing – Mathematical Challenges

The math behind reverse engineering of risk modeling

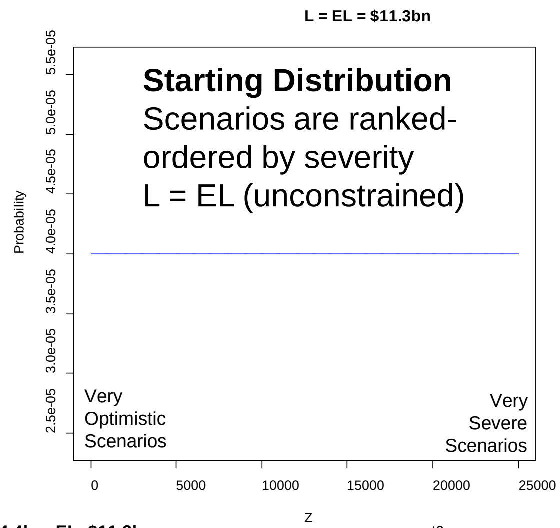


But $z1 \rightarrow \{y_1, y_2, \ldots, y_s\} \rightarrow \{x_1, x_2, \ldots, x_{n+m}\}$

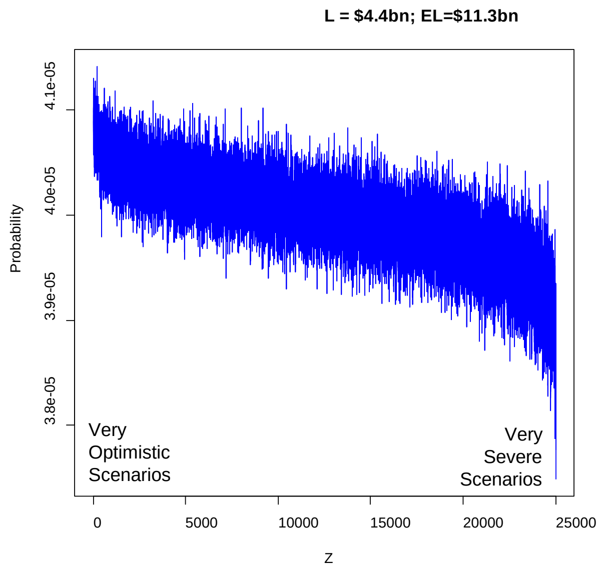
opens the door to **multiplicity**

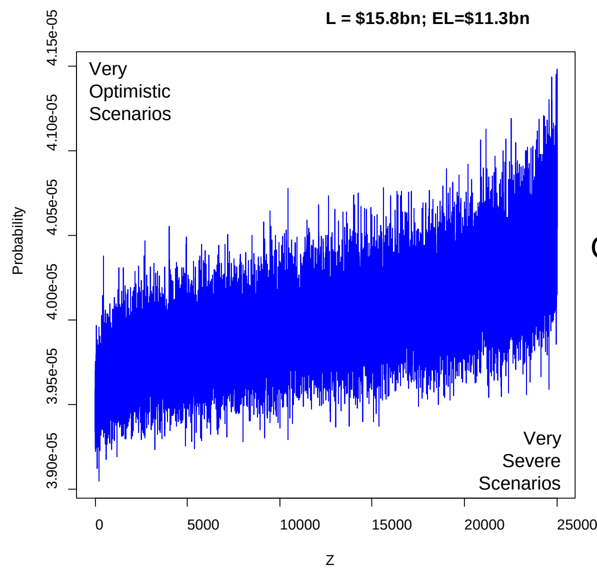


Reverse Stress Testing – US Auto Lending Example



Output: Updated Distribution of Scenarios
Case 1: L < EL





Output: Updated Distribution of Scenarios
Case 2: L > EL

Q&A

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To learn more about this topic:

» **Make an appointment to meet 1-1 with our experts in the Solutions Café:**

- Cris deRitis, Senior Director
- Erlind Dine, Senior Product Strategist
- Jeffrey Hollander, Solutions Specialist
- Juan Licari, Senior Director
- Tony Hughes, Managing Director

» **Attend related sessions taking place after this session:**

- Economic Scenario Generation for Stress Testing
- Consumer and Retail Credit Forecasting
- Cyclical Loss Volatility in Auto Lending

» **Read related materials available in the RPC Mobile App:**

- Designing Macroeconomic Scenarios for Stress Testing
- Is U.S. Auto Lending About to Bubble Over?