

NC STATE UNIVERSITY

Financial Mathematics



CECL and Credit Risk Modelling Summit
at NC State

(Apr 11-12th, Raleigh NC)



DEFENDABLE ANALYTICS



CECL: Selecting a Method

- Thomas Caragher



When it comes to CECL choosing a method can be stressful.

Planning, preparing and asking questions will make it easier.

In this session, we will discuss:

- Most commonly discussed methods for CECL
- How those methods work
- Data to consider for those methods



Thomas Caragher

Director, Product Management, Online CECL



- Tom Caragher is the Director of Product Management at ZM Financial Systems. He is responsible for the overall direction and strategy for the company's on-line CECL solution.
- Before joining ZM Financial Systems he spent 12 years as the Sr. Product Manager for the risk products at a financial software company.
- Prior to that Tom spent 5 years as an interest rate risk consultant as well as several years at the Chicago Board of Trade in back office operations and a credit analyst for GreenTree Financial.



Effective Dates

Measure impact as of:

- SEC Filers – January 1, 2020
 - Adopt in Q1 2020
- Public Business Entity – January 1, 2021
 - Adopt in Q1 2021
- Non-Public Business Entity – January 1, 2022
 - Adopted in Q1 2022

Modified effective date to January 1, 2022 for non-public business entities.

Purpose of this change was to correct the effective date for non-public business entities to match the FASB's original intention to have an extra year.



Regulatory Capital Option

- Optional 3-year phase in of day one impact on regulatory capital
 - Must elect as part of first call report after adoption
- No change to 1.25% of RWA limit in Tier 2 capital

| (000's) | Adoption impact | Transitional amounts for each year of the 3 year phase in period | | |
|---|-----------------|--|-------|------|
| Increase retained earnings & average assets | \$158 | \$119 | \$79 | \$40 |
| Decrease DTA | \$42 | \$31 | \$21 | \$10 |
| Decrease allowance | \$200 | \$150 | \$100 | \$50 |



We Should be Thinking About...

- Historical Data
- Methods
- Q-Factors
- Reporting



Build a Team

- Create a “CECL Committee”
 - This is important for visibility and transparency
 - Regulators encourage building a committee
- Understand how much what types for data are needed
- Review existing allowance for loss calculation and credit risk management practices to identify processes that can be leveraged
 - See if your ALM system already credit adjusts cash flows and provides the discounted cash flow methodology
 - See if you ALM system incorporates third party loss metrics for benchmarking



Preparation is Critical for CECL

Data capture and model development need to begin immediately



- Consider:
 - The amount of data needed
 - The amount currently stored
 - Running parallel for a year prior to the first filing
- Is there a gap between what you need to do and what you can do?
- ZM Financial Systems can help bridge that gap and help meet the CECL mandate.



Need Historical Data to Support Assumptions

Sample data points

Original LTV
Current LTV
Original FICO/Credit Rating
Current FICO/Credit Rating
Region – City/State/Zip

Collateral Type
Origination Date
Maturity Date
Original Balance
Current Balance
Rate
Rate type
Payment Type
Payment Frequency
Cost Center

Non-Performing Flag
Charge-Off Amounts
Recovery Amounts
Days Delinquent
Resolution/Disposal Dates
Expense Related to
Disposal/Recovery
Loss Probabilities



Data

| End of Period Date | | 12/31/2011 | 3/31/2012 | 6/30/2012 | 9/30/2012 | 12/31/2012 | 3/31/2013 | 6/30/2013 | 9/30/2013 | 12/31/2013 | 3/31/2014 | 6/30/2014 |
|-----------------------------|--|------------|-----------|-----------|-----------|------------|-----------|-----------|-----------|------------|-----------|-----------|
| Construction and Land | | 94,382 | 6,016 | 6,990 | 196 | 3,313 | 4,359 | 3,603 | 4,135 | 6,534 | 10,894 | 9,535 |
| Farmland | | 0 | 9,919 | 10,204 | 12,050 | 13,782 | 14,184 | 14,391 | 14,937 | 16,251 | 18,566 | 20,564 |
| 1-4 Family Residential | | 280,566 | 11,090 | 11,087 | 11,448 | 12,989 | 14,010 | 14,252 | 14,930 | 13,487 | 13,202 | 14,815 |
| Multifamily | | 63,540 | 248 | 236 | 230 | 223 | 0 | 0 | 0 | 268 | 3,852 | 1,777 |
| Commercial Real Estate | | 67,202 | 125 | 218 | 6,873 | 4,309 | 4,032 | 3,423 | 3,581 | 2,601 | 2,154 | 1,821 |
| Agricultural | | 12,411 | 12,775 | 12,844 | 14,299 | 16,028 | 18,435 | 17,901 | 18,629 | 20,134 | 21,249 | 19,016 |
| Commercial & Industrial | | 10,878 | 11,254 | 10,464 | 10,906 | 15,370 | 15,120 | 16,131 | 20,494 | 19,442 | 23,233 | 23,114 |
| Consumer, Leases, and Other | | 5,308 | 5,146 | 5,306 | 5,738 | 9,433 | 8,797 | 9,678 | 10,674 | 10,031 | 9,566 | 8,593 |
| | | 534,287 | 56,573 | 57,349 | 61,740 | 75,447 | 78,937 | 79,379 | 87,380 | 88,748 | 102,716 | 99,235 |
| | | 0 | (838) | (539) | (199) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |



Data

| CHARGE OFFS | | | | | | | | |
|-----------------------------|------|-------|-------|-------|-------|-------|-----|--|
| Construction and Land | 617 | - | 121 | 23 | 5 | (8) | 9 | |
| Farmland | - | - | - | - | - | - | - | |
| 1-4 Family Residential | (4) | 13 | 82 | 73 | 132 | 136 | 168 | |
| Multifamily | - | - | - | - | - | - | - | |
| Commercial Real Estate | - | - | (4) | 256 | 106 | (17) | 150 | |
| Agricultural | (39) | 2,383 | - | (472) | - | - | - | |
| Commercial & Industrial | 203 | 185 | 1,735 | 2,098 | 696 | 888 | 286 | |
| Consumer, Leases, and Other | 44 | 29 | 37 | 36 | 64 | 13 | 51 | |
| | - | - | - | - | - | - | - | |
| CHARGE OFFS | | | | | | | | |
| Construction and Land | 617 | - | 134 | 23 | 5 | - | 9 | |
| Farmland | - | - | - | - | - | - | - | |
| 1-4 Family Residential | - | 17 | 105 | 75 | 133 | 137 | 169 | |
| Multifamily | - | - | - | - | - | - | - | |
| Commercial Real Estate | - | - | - | 256 | 106 | - | 150 | |
| Agricultural | - | 2,386 | - | - | - | - | - | |
| Commercial & Industrial | 206 | 224 | 1,745 | 2,129 | 709 | 1,041 | 317 | |
| Consumer, Leases, and Other | 65 | 48 | 45 | 48 | 80 | 21 | 58 | |
| | 888 | 2,675 | 2,029 | 2,531 | 1,033 | 1,199 | 703 | |
| | - | - | - | - | - | - | - | |
| RECOVERIES | | | | | | | | |
| Construction and Land | 0 | 0 | 13 | 0 | 0 | 8 | 0 | |
| Farmland | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1-4 Family Residential | 4 | 4 | 23 | 2 | 1 | 1 | 1 | |
| Multifamily | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Commercial Real Estate | 0 | 0 | 4 | 0 | 0 | 17 | 0 | |
| Agricultural | 39 | 3 | 0 | 472 | 0 | 0 | 0 | |
| Commercial & Industrial | 3 | 39 | 10 | 31 | 13 | 153 | 31 | |
| Consumer, Leases, and Other | 21 | 19 | 8 | 12 | 16 | 8 | 7 | |



Need Historical Data to Support Assumptions

Sample data points

Original LTV
Current LTV
Original FICO/Credit Rating
Current FICO/Credit Rating
Region – City/State/Zip

Collateral Type
Origination Date
Maturity Date
Original Balance
Current Balance
Rate
Rate type
Payment Type
Payment Frequency
Cost Center

Non-Performing Flag
Charge-Off Amounts
Recovery Amounts
Days Delinquent
Resolution/Disposal Dates
Expense Related to
Disposal/Recovery
Loss Probabilities



Methods

The Methodologies

- Loss Rate
 - Weighted average remaining maturity (“WARM”) (*balance sheet approach*)
 - Snapshot in time (*balance sheet approach*)
 - Vintage (*activity based*)
- Discounted cash flow
- Migration (roll-rate)
- Probability of default/ Loss given default (PD/ LGD)
- Regression

A large teal arrow pointing upwards, indicating a progression from less complex to more complex methodologies.

Less Complex, Data
Intensive & Sensitive

A large teal arrow pointing downwards, indicating a progression from more complex to less complex methodologies.

More Complex,
Computational
Intensive & Sensitive



Methods

The most commonly discussed methods

- Historic Loss Rate/Snapshot
- Vintage
- Remaining Maturity
- Migration
- Discounted Cash Flows (DCF)



Interagency Webinar...

Discussed the following three methods specifically...

- Historic Loss Rate/Snapshot
- Vintage
- Remaining Maturity



Incurred Loss

| Pool A | | | | |
|-------------------|-----------------|-------------|------------------|--|
| December 31, | Average Loan | Charge-offs | Annual Loss Rate | Average ANNUAL Historical Loss Rate |
| 12/2011 - 12/2012 | 40,000,000 | 135,000 | 0.34% | |
| 12/2012 - 12/2013 | 42,000,000 | 120,000 | 0.29% | |
| 12/2013 - 12/2014 | 43,430,000 | 95,000 | 0.22% | |
| 12/2014 - 12-2015 | 43,500,000 | 65,000 | 0.15% | |
| 12/2015 - 12/2016 | 42,750,000 | 40,000 | 0.09% | |
| 12/2016 - 12/2017 | 43,600,000 | 25,000 | 0.06% | |
| 12/2017 - 12/2018 | 44,000,000 | 10,000 | 0.02% | 0.17% |

| | |
|---------------------------|------------|
| Average Annual Loss Rate | 0.17% |
| Total Adjustments | 0.08% |
| Total CECL Loss Rate | 0.25% |
| Amortized Cost at YE 2018 | 44,000,000 |
| CECL Reserve | 108,430 |



Remaining Maturity

| December 31, | Average Loan | Charge-offs | Annual Loss Rate | Average ANNUAL Historical Loss |
|--------------|-----------------|-------------|------------------|-----------------------------------|
| 2014 | 40,000,000 | 135,000 | 0.34% | |
| 2015 | 42,000,000 | 120,000 | 0.29% | |
| 2016 | 43,430,000 | 95,000 | 0.22% | |
| 2017 | 43,500,000 | 65,000 | 0.15% | |
| 2018 | 42,750,000 | 40,000 | 0.09% | |
| 2019 | 43,600,000 | 25,000 | 0.06% | |
| 2020 | 44,000,000 | 10,000 | 0.02% | 0.17% |

| Year | Cost at December 31, 2020 | Amortization/ Prepayments | Average ANNUAL Historic Loss Rate |
|---------------------------------------|------------------------------|------------------------------|--------------------------------------|
| 0 | 44,000,000 | | 0.17% |
| 1 | 39,750,000 | 4,250,000 | 0.17% |
| 2 | 32,250,000 | 7,500,000 | 0.17% |
| 3 | 25,125,000 | 7,125,000 | 0.17% |
| 4 | 19,400,000 | 5,725,000 | 0.17% |
| 5 | 12,000,000 | 7,400,000 | 0.17% |
| 6 | 8,000,000 | 4,000,000 | 0.17% |
| 7 | - | 8,000,000 | 0.17% |
| Blended Lifetime Historical Loss Rate | | | 0.68% |
| Current Conditions Adjustment | | | 0.03% |
| Forecast Adjustments | | | 0.05% |
| Total CECL Factor | | | 0.76% |
| Amortized Cost at YE 2020 | | | 44,000,000 |
| CECL Reserve | | | 333,449 |



Historic Loss Rate/Snapshot

| Period Ending | XYZ Call Code Amortized Cost | XYZ Call Code Annual Loss | Incurred Loss Example | | CECL Example | |
|---------------|------------------------------|---------------------------|--|--|-------------------------|-----------------------------------|
| | | | XYZ Annual Loss Rate (%) | | XYZ Call Code 2010 Loss | |
| 2010 | \$ 1,500,000 | \$ 4,000 | 0.28% | | \$ - | |
| 2011 | 1,610,000 | 4,300 | 0.28% | | 3,900 | |
| 2012 | 1,730,000 | 4,600 | 0.28% | | 3,700 | |
| 2013 | 1,850,000 | 4,900 | 0.27% | | 3,400 | |
| 2014 | 1,980,000 | 5,300 | 0.28% | | 3,200 | |
| 2015 | 2,120,000 | 5,700 | 0.28% | | 2,900 | |
| 2016 | 2,270,000 | 6,100 | 0.28% | | 2,400 | |
| 2017 | 2,430,000 | 6,500 | 0.28% | | 2,000 | |
| 2018 | 2,610,000 | 7,000 | 0.28% | | 1,000 | |
| 2019 | 2,800,000 | 7,500 | 0.28% | | - | |
| 2020 | 3,000,000 | 8,000 | 0.28% | | - | |
| | | \$ 63,900 | | | | |
| | | | 0.28% 1 Year Emergence (%) | | \$ 22,500 | 2010 - Cumulative Loss |
| | | | + 0.50% Q-Factor (Hypothetical) | | + \$ 1,500,000 | 2010 Ending Balance XYZ Call Code |
| | | | = 0.78% Total Incurred Loss (%) | | = 1.50% | 10 Year Cumulative Loss (%) |
| | | | x \$ 3,000,000 Year-end 2020 XYZ Call Code | | + 0.00% | Q-Factor for Current Conditions |
| | | | = \$ 23,300 Total Incurred Loss (\$) | | + 0.10% | Q-Factor - Forecast RE Values |
| | | | | | + 0.05% | Q-Factor - Forecast Unemployment |
| | | | | | + 0.00% | Other Forecast |
| | | | | | = 1.65% | Total Expected Loss (%) |
| | | | | | x \$ 3,000,000 | Year-end 2020 XYZ Call Code |
| | | | | | = \$ 49,500 | Total Expected Loss (\$) |

Losses only attributable to loans outstanding at 2010 Year End



Historic Loss Rate/Snapshot

LoanType:Used Auto - 48 Month

| BranchName | Start Dat / | Starting Balance | Current Balance | Loss Dec-2013 | Loss Dec-2014 | Loss Dec-2015 | Loss Dec-2016 | Loss Dec-2017 | Loss Dec-2018 | Loss Dec-2019 | Loss Dec-2020 | Loss Dec-2021 | Loss Dec-2022 | Total Loss | Loss Rate | Total Adjustment | Total Adjusted Loss Rate | Reserve |
|------------|-------------|------------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------|-----------|------------------|-----------------------------|---------|
| A | 12/31/2012 | 1,264,187 | 1,367,990 | 26,190 | 13,925 | 6,395 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 46,510 | 3.68 % | 0.00 % | 3.68 % | 50,329 |
| B | 12/31/2012 | 1,048,550 | 1,442,750 | 3,500 | 13,000 | 19,250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 35,750 | 3.41 % | 0.00 % | 3.41 % | 49,190 |



Vintage

| Year of Origination | Loss Experience in Years Following Origination | | | | | |
|---------------------|--|--------|--------|--------|--------|----------|
| | Year 1 | Year 2 | Year 3 | Year 4 | Total | Expected |
| 20X1 | \$ 50 | \$ 120 | \$ 140 | \$ 30 | \$ 340 | - |
| 20X2 | \$ 40 | \$ 120 | \$ 140 | \$ 40 | \$ 340 | - |
| 20X3 | \$ 40 | \$ 110 | \$ 150 | \$ 30 | \$ 330 | - |
| 20X4 | \$ 60 | \$ 110 | \$ 150 | \$ 40 | \$ 360 | - |
| 20X5 | \$ 50 | \$ 130 | \$ 170 | \$ 50 | \$ 400 | - |
| 20X6 | \$ 70 | \$ 150 | \$ 180 | \$ 60 | \$ 460 | \$ 60 |
| 20X7 | \$ 80 | \$ 140 | \$ 190 | \$ 70 | \$ 480 | \$ 260 |
| 20X8 | \$ 70 | \$ 150 | \$ 200 | \$ 80 | \$ 500 | \$ 430 |
| 20X9 | \$ 70 | \$ 160 | \$ 200 | \$ 80 | \$ 510 | \$ 510 |



Not to be Confused with Vintage Report

| | | Term Loans | | | | | | Revolving Loan | |
|-------------|-----------------------------|---|-----------------|-----------------|-----------------|-----------------|------------------|-----------------------|------------------|
| | | <u>Amortized Cost Basis by Origination Year</u> | | | | | | <u>Amortized Cost</u> | <u>Total</u> |
| | | <u>2018</u> | <u>2017</u> | <u>2016</u> | <u>2015</u> | <u>2014</u> | <u>Prior</u> | | |
| | <u>As of March 31, 2018</u> | | | | | | | | |
| Loan Pool | 30 Yr Fixed Mortgages | \$ 6,000,000.00 | \$ 7,000,000.00 | \$ 5,000,000.00 | \$ 4,500,000.00 | \$ 4,000,000.00 | \$ 23,500,000.00 | | \$ 50,000,000.00 |
| Risk Rating | FICO | | | | | | | | |
| | 810 - 850 | \$ 500,000.00 | \$ 583,333.33 | \$ 366,666.67 | \$ 375,000.00 | \$ 333,333.33 | \$ 1,958,333.33 | | \$ 4,116,666.67 |
| | 780 - 809 | \$ 1,250,000.00 | \$ 1,433,333.33 | \$ 1,041,666.67 | \$ 937,500.00 | \$ 833,333.33 | \$ 4,895,833.33 | | \$ 10,391,666.67 |
| | 740 - 779 | \$ 1,115,000.00 | \$ 1,300,833.33 | \$ 929,166.67 | \$ 836,250.00 | \$ 743,333.33 | \$ 4,367,083.33 | | \$ 9,291,666.67 |
| | 720 - 739 | \$ 2,000,000.00 | \$ 2,333,333.33 | \$ 1,616,666.67 | \$ 1,500,000.00 | \$ 1,333,333.33 | \$ 7,833,333.33 | | \$ 16,616,666.67 |
| | 700 - 719 | \$ 400,000.00 | \$ 466,666.67 | \$ 333,333.33 | \$ 300,000.00 | \$ 266,666.67 | \$ 1,566,666.67 | | \$ 3,333,333.33 |
| | 660 - 699 | \$ 300,000.00 | \$ 325,000.00 | \$ 250,000.00 | \$ 225,000.00 | \$ 200,000.00 | \$ 1,175,000.00 | | \$ 2,475,000.00 |
| | 620 - 659 | \$ 200,000.00 | \$ 233,333.33 | \$ 166,666.67 | \$ 150,000.00 | \$ 133,333.33 | \$ 783,333.33 | | \$ 1,666,666.67 |
| | 580 - 619 | \$ 150,000.00 | \$ 175,000.00 | \$ 125,000.00 | \$ 112,500.00 | \$ 100,000.00 | \$ 587,500.00 | | \$ 1,250,000.00 |
| | 530 - 579 | \$ 85,000.00 | \$ 99,166.67 | \$ 70,833.33 | \$ 63,750.00 | \$ 56,666.67 | \$ 332,916.67 | | \$ 708,333.33 |
| | 300 - 529 | | \$ 50,000.00 | \$ 100,000.00 | | | | | \$ 150,000.00 |
| | Total 30 Yr Fixed Mortgages | | | | | | | | |



Vintage

LoanType: New Auto - 48 Month

A

| | Origination Year Bucket | Originated Balance | Loss Year 1 | Loss Year 2 | Loss Year 3 | Loss Year 4 | Total Loss % | Total Loss \$ | Remaining Loss Expected % | Remaining Loss Expected \$ |
|---|-------------------------|--------------------|-------------|-------------|-------------|-------------|--------------|---------------|---------------------------|----------------------------|
| ▶ | 12/2017 - 12/2018 | 558,000 | 0.45 % | 2.00 % | 1.22 % | 0.61 % | 4.28 % | 23,855 | 4.28 % | 23,855 |
| | 12/2016 - 12/2017 | 602,000 | 0.00 % | 1.90 % | 1.22 % | 0.61 % | 3.73 % | 22,425 | 3.73 % | 22,425 |
| | 12/2015 - 12/2016 | 670,000 | 0.00 % | 2.39 % | 1.22 % | 0.61 % | 4.21 % | 28,229 | 1.83 % | 12,229 |
| | 12/2014 - 12/2015 | 606,000 | 0.00 % | 3.63 % | 2.15 % | 0.61 % | 6.38 % | 38,672 | 0.61 % | 3,672 |
| | 12/2013 - 12/2014 | 605,000 | 0.74 % | 0.99 % | 0.88 % | 0.71 % | 3.32 % | 20,106 | 0.00 % | 0 |
| | 12/2012 - 12/2013 | 807,000 | 0.31 % | 0.73 % | 0.71 % | 0.59 % | 2.34 % | 18,879 | 0.00 % | 0 |
| | 12/2011 - 12/2012 | 878,000 | 0.00 % | 0.85 % | 1.15 % | 0.51 % | 2.51 % | 22,025 | 0.00 % | 0 |

Grand Summaries

\$62,181.54

- ☐ Actual Loss
☒ Forecast Loss Rates
☐ Qualitative Adjustment

Apply Forecast Loss Rates

| | Origination Year Bucket | Originated Balance | Loss Year 1 | Loss Year 2 | Loss Year 3 | Loss Year 4 |
|---|-------------------------|--------------------|-------------|-------------|-------------|-------------|
| ▶ | 12/2017 - 12/2018 | 558,000 | 0.45 % | 2.00 % | 1.22 % | 0.61 % |
| | 12/2016 - 12/2017 | 602,000 | 0.00 % | 1.90 % | 1.22 % | 0.61 % |
| | 12/2015 - 12/2016 | 670,000 | 0.00 % | 0.00 % | 1.22 % | 0.61 % |
| | 12/2014 - 12/2015 | 606,000 | 0.00 % | 0.00 % | 0.00 % | 0.61 % |
| | 12/2013 - 12/2014 | 605,000 | 0.00 % | 0.00 % | 0.00 % | 0.00 % |
| | 12/2012 - 12/2013 | 807,000 | 0.00 % | 0.00 % | 0.00 % | 0.00 % |
| | 12/2011 - 12/2012 | 878,000 | 0.00 % | 0.00 % | 0.00 % | 0.00 % |

| | | | | | |
|---|---------------|--------|--------|--------|--------|
| ▶ | Apply Average | 0.18 % | 1.72 % | 1.22 % | 0.61 % |
|---|---------------|--------|--------|--------|--------|

Notes

Save

Process



Vintage

ZM Current Expected Credit Loss (CECL) --- Vintage

LoanType: New Auto - 48 Month

A

| | Origination Year Bucket | Originated Balance | Loss Year 1 | Loss Year 2 | Loss Year 3 | Loss Year 4 | Total Loss % | Total Loss \$ | Remaining Loss Expected % | Remaining Loss Expected \$ |
|---|----------------------------|--------------------|----------------|----------------|----------------|----------------|--------------|---------------|------------------------------|-------------------------------|
| ▶ | 12/2017 - 12/2018 | 558,000 | 0.45 % | 2.00 % | 1.22 % | 0.61 % | 4.28 % | 23,855 | 4.28 % | 23,855 |
| | 12/2016 - 12/2017 | 602,000 | 0.00 % | 1.90 % | 1.22 % | 0.61 % | 3.73 % | 22,425 | 3.73 % | 22,425 |
| | 12/2015 - 12/2016 | 670,000 | 0.00 % | 2.39 % | 1.22 % | 0.61 % | 4.21 % | 28,229 | 1.83 % | 12,229 |
| | 12/2014 - 12/2015 | 606,000 | 0.00 % | 3.63 % | 2.15 % | 0.61 % | 6.38 % | 38,672 | 0.61 % | 3,672 |
| | 12/2013 - 12/2014 | 605,000 | 0.74 % | 0.99 % | 0.88 % | 0.71 % | 3.32 % | 20,106 | 0.00 % | 0 |
| | 12/2012 - 12/2013 | 807,000 | 0.31 % | 0.73 % | 0.71 % | 0.59 % | 2.34 % | 18,879 | 0.00 % | 0 |
| | 12/2011 - 12/2012 | 878,000 | 0.00 % | 0.85 % | 1.15 % | 0.51 % | 2.51 % | 22,025 | 0.00 % | 0 |

Grand Summaries

\$62,181.54



Migration

| 30 Yr Fixed Mortgages | | | As Of 12/31/2018 | | | | | | |
|-----------------------|---------------------|---------------------|------------------|-------------------|----------------------|-------------------------------|---------------------|------------------|--------------|
| Loan Pool | Since Originaton | Outstanding Balance | Migration Ratio | Dollars Migrating | Historical Loss rate | Current Conditions Adjustment | Forecast Adjustment | Allocation Ratio | Reserve |
| | Stayed Current | 3,670,049,796 | 98.87% | 3,628,735,915 | 0.00% | 0.05% | 0.05% | 0.10% | 3,628,735.91 |
| | 0 - 30 Days | | 0.84% | 30,985,411 | 0.15% | 0.15% | 0.30% | 0.60% | 185,912.47 |
| | 31 - 60 Days | | 0.28% | 10,328,470 | 0.45% | 0.15% | 0.45% | 1.05% | 108,448.94 |
| | 61 - 90 Days | | 0.00% | - | 3.60% | 0.15% | 0.45% | 4.20% | - |
| | > 90 Days | | 0.00% | - | 12.30% | 0.15% | 0.45% | 12.90% | - |
| | Current | 729,878,571 | 16.04% | 117,055,997 | 0.00% | 0.05% | 0.05% | 0.10% | 117,056.00 |
| | Stayed 0 - 30 Days | | 80.66% | 588,722,810 | 0.15% | 0.15% | 0.30% | 0.60% | 3,532,336.86 |
| | 31 - 60 Days | | 2.83% | 20,656,941 | 0.45% | 0.15% | 0.45% | 1.05% | 216,897.88 |
| | 61 - 90 Days | | 0.47% | 3,442,823 | 3.60% | 0.15% | 0.45% | 4.20% | 144,598.58 |
| | > 90 Days | | 0.00% | - | 12.30% | 0.15% | 0.45% | 12.90% | - |
| | Current | 268,540,229 | 2.56% | 6,885,647 | 0.00% | 0.05% | 0.05% | 0.10% | 6,885.65 |
| | 0 - 30 Days | | 1.28% | 3,442,823 | 0.15% | 0.15% | 0.30% | 0.60% | 20,656.94 |
| | Stayed 31 - 60 Days | | 83.33% | 223,783,524 | 0.45% | 0.15% | 0.45% | 1.05% | 2,349,727.00 |
| | 61 - 90 Days | | 8.97% | 24,099,764 | 3.60% | 0.15% | 0.45% | 4.20% | 1,012,190.09 |
| | > 90 Days | | 3.85% | 10,328,470 | 12.30% | 0.15% | 0.45% | 12.90% | 1,332,372.67 |



Discounted Cash Flows

| | | | <u>Period</u> | <u>Gross Balance</u> | <u>Prepayment</u> | <u>Default</u> | <u>Adjusted Balance</u> | <u>Actual Principal</u> | <u>Actual Interest</u> | <u>Total Principal Reduction</u> | <u>Recover</u> | <u>Total Cash Flow</u> | <u>Present Value Calc</u> |
|----------------------|----------------|--|---------------|----------------------|-------------------|----------------|-----------------------------|-----------------------------|----------------------------|--|----------------|----------------------------|-------------------------------|
| Balance | 5,000,000 | | | 5,000,000.00 | | | | | | | | | |
| Maturity | 360 | | 1 | 4,957,899.36 | 30,147 | 4,750 | 4,965,103 | \$7,204.10 | 16,666.67 | 42,100.64 | | 54,017.31 | \$53,837.85 |
| Amortization | 360 | | 2 | 4,920,662.23 | 29,893 | 4,710 | 4,923,297 | \$7,344.43 | 16,526.33 | 41,947.14 | | 53,763.47 | \$53,406.83 |
| | | | 3 | 4,883,525.48 | 29,668 | 4,675 | 4,886,319 | \$7,468.56 | 16,402.21 | 41,811.37 | | 53,538.95 | \$53,007.11 |
| Discount Rate | 4.00% | | 4 | 4,846,488.85 | 29,444 | 4,639 | 4,849,442 | \$7,592.35 | 16,278.42 | 41,675.98 | 950.00 | 54,265.04 | \$53,547.50 |
| Recovery Lag | 3 | | 5 | 4,809,552.08 | 29,221 | 4,604 | 4,812,664 | \$7,715.80 | 16,154.96 | 41,540.94 | 942.00 | 54,033.74 | \$53,142.11 |
| Coupon | 4.00% | | 6 | 4,772,714.88 | 28,998 | 4,569 | 4,775,985 | \$7,838.92 | 16,031.84 | 41,406.27 | 934.93 | 53,803.96 | \$52,740.33 |
| | | | 7 | 4,735,977.00 | 28,776 | 4,534 | 4,739,405 | \$7,961.72 | 15,909.05 | 41,271.96 | 927.87 | 53,574.80 | \$52,341.23 |
| Annual CPR | 7.00% | | 8 | 4,699,338.16 | 28,555 | 4,499 | 4,702,923 | \$8,084.17 | 15,786.59 | 41,138.02 | 920.83 | 53,346.26 | \$51,944.80 |
| Prepayment SMM | 0.603% | | 9 | 4,662,798.10 | 28,334 | 4,464 | 4,666,540 | \$8,206.30 | 15,664.46 | 41,004.43 | 913.81 | 53,118.34 | \$51,551.02 |
| | | | 10 | 4,626,356.55 | 28,113 | 4,430 | 4,630,255 | \$8,328.10 | 15,542.66 | 40,871.21 | 906.82 | 52,891.03 | \$51,159.89 |
| Default SMM | 0.095% | | 11 | 4,590,013.24 | 27,894 | 4,395 | 4,594,068 | \$8,449.58 | 15,421.19 | 40,738.34 | 899.84 | 52,664.33 | \$50,771.37 |
| Severity/LGD | 8.000% | | 12 | 4,553,767.92 | 27,675 | 4,361 | 4,557,978 | \$8,570.72 | 15,300.04 | 40,605.84 | 892.87 | 52,438.24 | \$50,385.46 |
| | | | 13 | 4,517,620.31 | 27,456 | 4,326 | 4,521,986 | \$8,691.54 | 15,179.23 | 40,473.69 | 885.93 | 52,212.77 | \$50,002.14 |
| PV of Total CF | \$4,901,077.11 | | 14 | 4,481,570.15 | 27,238 | 4,292 | 4,486,090 | \$8,812.03 | 15,058.73 | 40,341.89 | 879.01 | 51,987.90 | \$49,621.38 |
| Allowance Under CECL | \$98,922.89 | | 15 | 4,445,617.19 | 27,021 | 4,257 | 4,450,292 | \$8,932.20 | 14,938.57 | 40,210.46 | 872.10 | 51,763.63 | \$49,243.19 |
| | | | 16 | 4,409,761.15 | 26,804 | 4,223 | 4,414,590 | \$9,052.04 | 14,818.72 | 40,079.37 | 865.22 | 51,539.98 | \$48,867.53 |
| | | | 17 | 4,374,001.78 | 26,588 | 4,189 | 4,378,984 | \$9,171.56 | 14,699.20 | 39,948.64 | 858.35 | 51,316.92 | \$48,494.39 |
| | | | 18 | 4,338,338.82 | 26,372 | 4,155 | 4,343,474 | \$9,290.76 | 14,580.01 | 39,818.26 | 851.50 | 51,094.47 | \$48,123.76 |



Economic Metrics

Date Range

Start Date: 12/31/1998

End Date: 12/31/2018

Metric Selection

Unemployment Rate

10-Year Treasury Yield

House Price Index

OFF

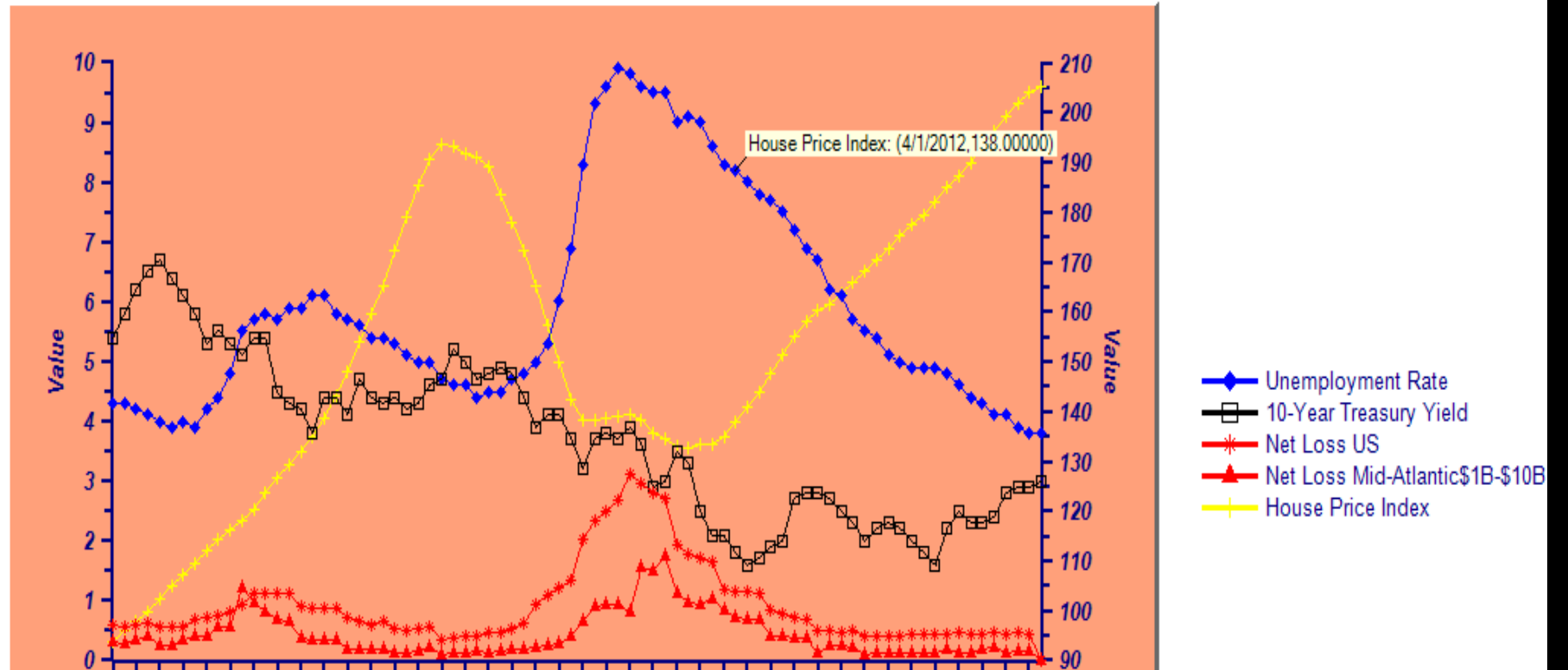
OFF

Market Loss Rate

Net Loss US

Net Loss Mid-Atlantic\$1B-\$10B

Economic Metrics





What Options Do You Have?

- The more data you have the more options you have with methods
- With more data and options, Q-Factors can be better estimated



Questions?

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