Core Deposit Analytics
Session 1

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Agenda

• Session 1 - Deposit Analytics
  – Contractual vs. Actual Behavior
  – Pricing Betas
  – Decay Rates
  – Surge Balances
  – Vintage Analysis of Decay Rates

• Session 2 – Application of Core Deposit Analytics
  – Interest Rate Risk Modeling
  – Developing Funding Strategies
    • Using Segmentation to Modify Core Deposit Behaviors
    • Application of Core Deposit Analytics in Developing Blended Funding Approaches
CDs

• Contractual Behaviors
  – Generally fixed rate
  – Stated term
  – Early withdrawal penalty
  – Automatic renewal

• General Rule
  – The more features of an account that are important to a customer other than rate, the less sensitive they will be to rate paid
  – CD Features
    • Rate
    • Term
    • Penalty

• Actual Behaviors
  – Rates on some of these accounts respond relatively quickly in response to changes in market rates
  – Balances stay with the institution after maturity 65% to 85% of the time.
  – Acts like: Stable supply, variable rate (reprices at renewal), long-term
  – Actual Counterpart – Adjustable-rate mortgage
  – Key Inputs to A/L Model
    • How much will you raise rates as market rates increase?
Non-Maturity Deposits

- **Contractual Behaviors**
  - Immediately repricable
  - Immediately withdrawable
  - Sounds like fed funds

- **General Rule**
  - The more features of an account that are important to a customer other than rate, the less sensitive they will be to rate paid
  - NMD Features
    - Rate
    - Immediate Access
    - Transaction Capability

- **Actual Behaviors**
  - Rates on some of these accounts respond moderately and slowly in response to changes in market rates
  - Balances are retained for long periods of time in spite of rate behavior
  - Acts like: Stable supply, semi-fixed rate, long-term
  - Actual Counterpart – laddered portfolio of fixed-rate long-term CDs
  - Key Inputs to A/L models
    - How will pricing respond to changes in rates?
    - How long will the funds be out there?
2 Most Common Core Study Outputs

• Pricing Betas – the extent to which a change in market rates is passed along to deposit customers
  – Income at risk analysis
  – EVE analysis

• Decay rates – The speed at which non-maturity deposits decay off books over time
  – EVE analysis
  – Liquidity analysis

What’s about missing component? **SURGE BALANCES**
FDIC NMD Assumptions

Deposit Price Sensitivity (Beta)

- Measures deposit rate changes relative to market rate changes

- Beta = \[
\frac{\text{Change in Product Rate}}{\text{Change in Market Rate}} = \frac{40 \text{ bps}}{100 \text{ bps}} = 40\%
\]

- Betas can differ in falling and rising rate scenarios

- What “market rate” we should be watching?

- Why would they differ? Is that a “management action?”
FDIC NMD Assumptions

Consider and Adjust for Qualitative Factors

- Flight to quality / rate differentials (surge deposits)
- Customer behavior (parked funds)
- Non-deposit alternatives for cash
- Diminished impact of early withdrawal penalties
- Changing technology, demographics, competition, etc.
Pricing Betas

• Definition – A pricing beta is a variable that is used to predict the effect of an increase in market rates on rates paid on a product.

• For example, if market rates increase 200 bp and your beta for MMDAs is 0.5 (50%) then the beta would predict you will raise MMDA rates by 100 bp
  \[\text{200 Bp} \times 0.5 = 100 \text{ Bp}\]

• Betas can be:
  – SWAG’d
  – Derived statistically from historic data.
  – Examiners prefer the latter

• Betas can also be modified by use of segmentation strategies.
How Betas Play Out in Industry

- Premium MMDA & CDs
- Regular Savings

Lag
Y = a + bx = Rate Paid
Pricing Betas

Questions:
1. Which of these cost of funds profiles would you prefer to have with rising rates?
2. What would that information allow you to do with asset and funding allocation?
<table>
<thead>
<tr>
<th>Rate</th>
<th>Lag</th>
<th>Correlation</th>
<th>Beta</th>
<th>Last Spread</th>
<th>Avg Spread</th>
<th>id</th>
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</thead>
<tbody>
<tr>
<td>Indexed Agency Year - 1</td>
<td>1</td>
<td>0.935</td>
<td>0.197</td>
<td>0.353%</td>
<td>1.399%</td>
<td>9</td>
</tr>
<tr>
<td>Indexed Agency Year - 2</td>
<td>1</td>
<td>0.935</td>
<td>0.222</td>
<td>0.498%</td>
<td>1.632%</td>
<td>10</td>
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<td>Indexed Agency Year - 2</td>
<td>2</td>
<td>0.935</td>
<td>0.218</td>
<td>0.555%</td>
<td>1.702%</td>
<td>10</td>
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<td>Indexed Agency Year - 1</td>
<td>2</td>
<td>0.934</td>
<td>0.192</td>
<td>0.386%</td>
<td>1.476%</td>
<td>9</td>
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<tr>
<td>Indexed Agency - 3 Months</td>
<td>1</td>
<td>0.933</td>
<td>0.186</td>
<td>0.319%</td>
<td>1.287%</td>
<td>7</td>
</tr>
<tr>
<td>Indexed Agency - 6 Months</td>
<td>1</td>
<td>0.933</td>
<td>0.186</td>
<td>0.379%</td>
<td>1.324%</td>
<td>8</td>
</tr>
<tr>
<td>Indexed Agency - 3 Months</td>
<td>0</td>
<td>0.931</td>
<td>0.191</td>
<td>0.329%</td>
<td>1.208%</td>
<td>7</td>
</tr>
<tr>
<td>Indexed Agency Year - 3</td>
<td>2</td>
<td>0.930</td>
<td>0.250</td>
<td>0.749%</td>
<td>2.061%</td>
<td>11</td>
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<tr>
<td>Indexed Agency Year - 3</td>
<td>1</td>
<td>0.930</td>
<td>0.253</td>
<td>0.799%</td>
<td>1.997%</td>
<td>11</td>
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<tr>
<td>Indexed Agency - 6 Months</td>
<td>0</td>
<td>0.930</td>
<td>0.191</td>
<td>0.403%</td>
<td>1.247%</td>
<td>8</td>
</tr>
<tr>
<td>Indexed Agency Year - 2</td>
<td>3</td>
<td>0.928</td>
<td>0.213</td>
<td>0.495%</td>
<td>1.773%</td>
<td>10</td>
</tr>
<tr>
<td>Indexed Agency Year - 1</td>
<td>0</td>
<td>0.926</td>
<td>0.201</td>
<td>0.453%</td>
<td>1.324%</td>
<td>9</td>
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<tr>
<td>Indexed Agency - 6 Months</td>
<td>2</td>
<td>0.927</td>
<td>0.180</td>
<td>0.400%</td>
<td>1.403%</td>
<td>8</td>
</tr>
<tr>
<td>Indexed Agency - 3 Months</td>
<td>2</td>
<td>0.927</td>
<td>0.180</td>
<td>0.359%</td>
<td>1.366%</td>
<td>7</td>
</tr>
<tr>
<td>Indexed Agency Year - 1</td>
<td>3</td>
<td>0.927</td>
<td>0.186</td>
<td>0.344%</td>
<td>1.551%</td>
<td>9</td>
</tr>
<tr>
<td>2 Year US Treasury</td>
<td>2</td>
<td>0.926</td>
<td>0.200</td>
<td>-0.026%</td>
<td>1.240%</td>
<td>4</td>
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<tr>
<td>3 Year US Treasury</td>
<td>2</td>
<td>0.925</td>
<td>0.221</td>
<td>0.074%</td>
<td>1.523%</td>
<td>5</td>
</tr>
<tr>
<td>Indexed Agency Year - 3</td>
<td>3</td>
<td>0.924</td>
<td>0.246</td>
<td>0.764%</td>
<td>2.128%</td>
<td>11</td>
</tr>
</tbody>
</table>

Treasuries, Agencies, FHLB Advances – 3, 6, 12, 24, 36, 60 months lagged 0-12 months
= 234 combinations
Rate Paid vs. Equation (Back Test)
Passbook Savings

Indexed Agency Year - 1, Lag 1 / Passbook Svgs

- Indexed Agency Year - 1, Lag 1
- Passbook Svgs
- Fit: $y = 0.22 + 0.20x$
- Spread

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Good Funding Source for LT FR Loans as Long As They are LT
Key Question Impacting Risk

• Interest Rate Risk & Liquidity Risk Both Impacted by this question....

How long will I want you
As long as you want me too
And longer by far
US Commercial Bank Data

Total Deposits by Type ($ Millions)

- Time Deposits < $100K
- Time Deposits >= $100K
- Other Savings
- Money Market
- NOW & ATS
- Demand Deposit

2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

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US Commercial Bank Data

Deposits as % of Total Assets

MMDA = 21% in 2006

MMDA = 31.2% in 2012

Total NMD funding up from 35.96% in '06 to **55.4%** in '13
Look at the Regulators View

Non-maturity Deposit Assumptions are Critical

Deposit Shares of Earning Assets

What is the trouble with how this graph is presented? Why are we looking at % of Earning Assets?

Source: FDIC, based on median figures of all banks under $1B in assets.
Where’s the surge?

Total Deposits by Asset Size

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comm Banks $50M-$100M</td>
<td>112,258</td>
<td>106,427</td>
<td>101,985</td>
<td>92,527,2</td>
<td>89,484,8</td>
<td>86,044,3</td>
<td>81,376,0</td>
<td>76,182,2</td>
<td>70,208,0</td>
</tr>
<tr>
<td>Comm Banks $100M-$300M</td>
<td>361,67</td>
<td>363,10</td>
<td>365,19</td>
<td>363,67</td>
<td>374,57</td>
<td>372,10</td>
<td>366,55</td>
<td>358,14</td>
<td>342,20</td>
</tr>
<tr>
<td>Comm Banks $300M-$500M</td>
<td>227,550</td>
<td>236,641</td>
<td>234,515</td>
<td>217,526</td>
<td>229,610</td>
<td>213,369</td>
<td>209,202</td>
<td>222,740</td>
<td>224,969</td>
</tr>
<tr>
<td>Comm Banks $500M-$1B</td>
<td>264,795</td>
<td>292,622</td>
<td>299,675</td>
<td>304,811</td>
<td>313,211</td>
<td>298,420</td>
<td>306,442</td>
<td>310,995</td>
<td>311,761</td>
</tr>
</tbody>
</table>
Where’s the surge?

So, total deposits have not moved much, but deposits/asset have increased!

<table>
<thead>
<tr>
<th>Axis Title</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comm Banks $50M-$100M</td>
<td>83.59%</td>
<td>83.31%</td>
<td>82.55%</td>
<td>82.07%</td>
<td>84.20%</td>
<td>85.06%</td>
<td>85.39%</td>
<td>85.51%</td>
<td>85.87%</td>
</tr>
<tr>
<td>Comm Banks $100M-$300M</td>
<td>82.67%</td>
<td>82.91%</td>
<td>82.17%</td>
<td>81.66%</td>
<td>83.53%</td>
<td>84.67%</td>
<td>84.84%</td>
<td>85.25%</td>
<td>85.30%</td>
</tr>
<tr>
<td>Comm Banks $300M-$500M</td>
<td>81.52%</td>
<td>81.46%</td>
<td>79.91%</td>
<td>80.39%</td>
<td>82.87%</td>
<td>83.72%</td>
<td>84.09%</td>
<td>84.72%</td>
<td>84.79%</td>
</tr>
<tr>
<td>Comm Banks $500M-$1B</td>
<td>79.16%</td>
<td>79.72%</td>
<td>78.73%</td>
<td>78.85%</td>
<td>81.39%</td>
<td>82.16%</td>
<td>82.35%</td>
<td>83.14%</td>
<td>83.16%</td>
</tr>
</tbody>
</table>
Where's the surge

Which group of banks has used brokered CDs more in the past?

**Brokered Deposits/Total Deposits by Asset Size**

<table>
<thead>
<tr>
<th>Year</th>
<th>Comm Banks $50M-$100M</th>
<th>Comm Banks $100M-$300M</th>
<th>Comm Banks $300M-$500M</th>
<th>Comm Banks $500M-$1B</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>2.34%</td>
<td>3.74%</td>
<td>0.41%</td>
<td>0.36%</td>
</tr>
<tr>
<td>2006</td>
<td>3.13%</td>
<td>4.39%</td>
<td>0.57%</td>
<td>0.44%</td>
</tr>
<tr>
<td>2007</td>
<td>3.02%</td>
<td>4.73%</td>
<td>0.55%</td>
<td>0.58%</td>
</tr>
<tr>
<td>2008</td>
<td>4.17%</td>
<td>6.54%</td>
<td>0.72%</td>
<td>0.66%</td>
</tr>
<tr>
<td>2009</td>
<td>3.29%</td>
<td>4.95%</td>
<td>1.39%</td>
<td>1.80%</td>
</tr>
<tr>
<td>2010</td>
<td>2.56%</td>
<td>3.61%</td>
<td>0.34%</td>
<td>0.38%</td>
</tr>
<tr>
<td>2011</td>
<td>1.91%</td>
<td>2.98%</td>
<td>0.28%</td>
<td>0.22%</td>
</tr>
<tr>
<td>2012</td>
<td>1.51%</td>
<td>2.45%</td>
<td>0.21%</td>
<td>0.25%</td>
</tr>
<tr>
<td>2013</td>
<td>1.75%</td>
<td>2.51%</td>
<td>0.23%</td>
<td>0.26%</td>
</tr>
</tbody>
</table>
Check this math

• Deposits/Assets Up by 2-4% since 2009
• Brokered CDs (classified as a deposit) down 2-3%
• Total Deposits In banks < $500mm have remained flat or shrunk
  – How does the deposit/asset ratio rise if deposits have held flat or shrunk?
  – What does this say about newer accounts vs. older accounts? Are they the “same” depositor?
  – How do you treat deposits in your modeling?
Non-Maturity Deposit Life

• **Key Concept**
  – Non-maturity deposits don’t all ‘mature’ at the same time.
  – Instead, balances in accounts decay off the books over time.
  – Decay rates can be statistically measured.
  – Once measured, decay rates can be used to forecast cash flows coming off pools of non-maturity deposits.

• **Cash Flow Decay rates affected by:**
  – Life events – death, divorce, population turnover.
  – Satisfaction with the institution.
  – Movements in market rates and your pricing strategy.
  – Economic events – local (plant closings), and national (911, stock market health, economic outlook, etc.).
  – Technology.
  – Interaction between CSRs and customers.
  – Flight to quality (Surge).
  – Relationship between CD and NMD rates (Surge).

For all these reasons, your decay rates could be dramatically different than national averages.
4 Methods for Calculating Decay Rates

• Method 1: Change in Account Method
  – Calculate the changes in # of Accounts between beginning and ending periods
    • Strengths
      – Based on account level data
      – Fast analytics can be performed
    • Weaknesses
      – Assumes balance trends move in relation to number of accounts
      – Not recognized as industry standard
      – Fails to identify “surge” balances as no study of balance trends
      – What happens when total balances increase but number of accounts decline?
From the “Careful what you wish for” File…

• True story: a client was unhappy with study results - surge balances had negative impact on EVE levels

• Had a second study done
  – Study used “Account #” method to calculate decay rates.
    • Compare # of accounts at beginning and end of month
    • Calculate the change in accounts
    • Repeat next month…

• Computes change in # of accounts and converts to change in balance levels
  – Single Monthly Mortality (SMM) approach

• Average Life calculated on average decline in accounts

• **Major Assumption**
  – Balance trends will follow account closure rate
From the “Careful what you wish for” File…

- Simplifies the analysis process
- Uses “Account Level” details
- But what does account maintenance do to the decay rates?
- How do we ID Surge?

**Result:** EVE improved from -35% in +3% shock to -3%.

**Question:** How can there be so much variance?
4 Methods for Calculating Decay Rates

Method 2: Change in Balance Method

– Calculate the changes in account balances on accounts in place at beginning of the period

• Old OTS Call Report Method

### DECAY RATE ANALYSIS - MMDA

<table>
<thead>
<tr>
<th>Quarter and Year</th>
<th>01/07</th>
<th>02/07</th>
<th>03/07</th>
<th>04/07</th>
<th>1/08</th>
<th>02/08</th>
<th>03/08</th>
<th>04/08</th>
<th>01/09</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MMDA-BOQ (Mill $'s)</td>
<td>19823.26</td>
<td>19480.35</td>
<td>18384.27</td>
<td>18386.04</td>
<td>18089.74</td>
<td>17987.96</td>
<td>17483.49</td>
<td>17791.73</td>
<td>17864.21</td>
</tr>
<tr>
<td>2. MMDA-EOQ (Mill $'s)</td>
<td>19480.35</td>
<td>18384.27</td>
<td>18386.04</td>
<td>18089.74</td>
<td>17988.0</td>
<td>17483.5</td>
<td>17791.7</td>
<td>17864.2</td>
<td>18907.3</td>
</tr>
<tr>
<td>3. EOQ Bal - New MMDA</td>
<td>3</td>
<td>2.5</td>
<td>120</td>
<td>2.5</td>
<td>115.5</td>
<td>607.4</td>
<td>702.4</td>
<td>624.6</td>
<td>1198.1</td>
</tr>
<tr>
<td>4. EOQ Bal - Old MMDA (2-3)</td>
<td>19477.4</td>
<td>18381.8</td>
<td>18266.0</td>
<td>18087.2</td>
<td>17872.4</td>
<td>16876.1</td>
<td>17089.3</td>
<td>17239.6</td>
<td>17709.2</td>
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<tr>
<td>5. Chg in Old MMDA Ball (1-4)</td>
<td>345.9</td>
<td>1098.6</td>
<td>118.2</td>
<td>298.8</td>
<td>217.3</td>
<td>1111.9</td>
<td>394.2</td>
<td>552.1</td>
<td>155.0</td>
</tr>
<tr>
<td>6. Qtrly Decay - Old MMDA (5/1)</td>
<td>1.74%</td>
<td>5.64%</td>
<td>0.64%</td>
<td>1.63%</td>
<td>1.20%</td>
<td>6.18%</td>
<td>2.25%</td>
<td>3.10%</td>
<td>0.87%</td>
</tr>
<tr>
<td>7. Annual Decay - Old MMDA (6*4)</td>
<td>6.98%</td>
<td>22.56%</td>
<td>2.57%</td>
<td>6.50%</td>
<td>4.81%</td>
<td>24.73%</td>
<td>9.02%</td>
<td>12.41%</td>
<td>3.47%</td>
</tr>
<tr>
<td>8. MMDA/Tot Dep - BOQ</td>
<td>2.17%</td>
<td>2.11%</td>
<td>2.01%</td>
<td>2.03%</td>
<td>1.97%</td>
<td>1.87%</td>
<td>1.81%</td>
<td>1.84%</td>
<td>1.79%</td>
</tr>
<tr>
<td>9. MMDA/Tot Dep - EOQ</td>
<td>2.11%</td>
<td>2.01%</td>
<td>2.03%</td>
<td>1.97%</td>
<td>1.87%</td>
<td>1.81%</td>
<td>1.84%</td>
<td>1.79%</td>
<td>1.78%</td>
</tr>
<tr>
<td>10. Change MMDA/Dep (8-9)</td>
<td>0.06%</td>
<td>0.11%</td>
<td>-0.03%</td>
<td>0.06%</td>
<td>0.10%</td>
<td>0.06%</td>
<td>-0.03%</td>
<td>0.05%</td>
<td>0.02%</td>
</tr>
<tr>
<td>11. % Change MMDA PB/Dep (10/8)</td>
<td>2.58%</td>
<td>5.11%</td>
<td>-1.45%</td>
<td>3.05%</td>
<td>5.17%</td>
<td>3.05%</td>
<td>-1.49%</td>
<td>2.61%</td>
<td>0.95%</td>
</tr>
<tr>
<td>12. Ann % Change MMDA/Dep (11*4)</td>
<td>10.33%</td>
<td>20.44%</td>
<td>-5.79%</td>
<td>12.19%</td>
<td>20.69%</td>
<td>12.19%</td>
<td>-5.96%</td>
<td>10.43%</td>
<td>3.79%</td>
</tr>
<tr>
<td>13. Decay NRS MMDA (7-12)</td>
<td>-3.35%</td>
<td>2.11%</td>
<td>8.36%</td>
<td>-5.69%</td>
<td>-15.88%</td>
<td>12.53%</td>
<td>14.97%</td>
<td>1.98%</td>
<td>-0.32%</td>
</tr>
</tbody>
</table>
Change in Balance Method

• Track beginning and ending balances
  – Requirements
    • Ability to ID ending period balance levels on accounts opened during the period
  – Strengths
    • Account numbers not needed
    • Over long horizons sample moves with changes in customer characteristics.
  – Weaknesses
    • Not recognized as industry standard
    • No correlation between # of accounts and balances
    • In periods where accounts are adding balances, decay rates go negative.
4 Methods for Calculating Decay Rates

Method 3: Single Pool Account Study

– Track changes in initial study group accounts over time.
– Calculate the changes in account balances and # of account on accounts

• Strengths
  – Able to correlate changes in actual accounts and balances
  – Recognized as “industry standard”

• Weaknesses
  – Data required from “pre-crisis” starting point (2007 or earlier) for most relevant analysis
  – Ignores all new accounts
  – Applies old account behaviors to all newly opened accounts
Rolling Decays as Surge Indicators

Decay rate on outstanding study balances

Decay rate on outstanding study accounts

Marginal (12 month rolling) decay rate
After surge adjustment (20% surge) the marginal decay rate tracks along the cumulative average decay rate.
Average Balances Before and After

Gross vs Net Average Balance

Surge
Surge-Adjusted Decays

Periodic/Cumulative Decay Rates & Balances

- New Money
- Surge Balances
- Net Study Balances
- 12 Mo Roll Decay
- Cumulative Decay

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Decay Rates

**Surge Balance Burnout**

<table>
<thead>
<tr>
<th>Rate Env</th>
<th>Yr 1</th>
<th>Yr 2</th>
<th>Yr 3</th>
<th>Yr 4</th>
<th>Yr 5</th>
<th>Yr 6</th>
<th>Yr 7</th>
<th>Yr 8</th>
<th>Yr 9</th>
<th>Yr 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2%</td>
<td>6.19%</td>
<td>6.16%</td>
<td>6.13%</td>
<td>6.10%</td>
<td>6.08%</td>
<td>6.05%</td>
<td>6.03%</td>
<td>6.00%</td>
<td>5.98%</td>
<td>100.00%</td>
</tr>
<tr>
<td>-1%</td>
<td>6.19%</td>
<td>6.16%</td>
<td>6.13%</td>
<td>6.10%</td>
<td>6.08%</td>
<td>6.05%</td>
<td>6.03%</td>
<td>6.00%</td>
<td>5.98%</td>
<td>100.00%</td>
</tr>
<tr>
<td>0%</td>
<td>6.19%</td>
<td>6.16%</td>
<td>6.13%</td>
<td>6.10%</td>
<td>6.08%</td>
<td>6.05%</td>
<td>6.03%</td>
<td>6.00%</td>
<td>5.98%</td>
<td>100.00%</td>
</tr>
<tr>
<td>1%</td>
<td>9.70%</td>
<td>8.83%</td>
<td>8.10%</td>
<td>7.52%</td>
<td>7.04%</td>
<td>6.67%</td>
<td>6.38%</td>
<td>6.15%</td>
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<td>100.00%</td>
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<td>2%</td>
<td>10.72%</td>
<td>9.37%</td>
<td>8.31%</td>
<td>7.51%</td>
<td>6.92%</td>
<td>6.49%</td>
<td>6.17%</td>
<td>5.95%</td>
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<tr>
<td>3%</td>
<td>14.61%</td>
<td>10.37%</td>
<td>7.96%</td>
<td>6.68%</td>
<td>6.03%</td>
<td>5.71%</td>
<td>5.55%</td>
<td>5.47%</td>
<td>5.43%</td>
<td>100.00%</td>
</tr>
<tr>
<td>4%</td>
<td>14.61%</td>
<td>10.37%</td>
<td>7.96%</td>
<td>6.68%</td>
<td>6.03%</td>
<td>5.71%</td>
<td>5.55%</td>
<td>5.47%</td>
<td>5.43%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

**Truncation**

<table>
<thead>
<tr>
<th>Rate Env</th>
<th>Yr 1</th>
<th>Yr 2</th>
<th>Yr 3</th>
<th>Yr 4</th>
<th>Yr 5</th>
<th>Yr 6</th>
<th>Yr 7</th>
<th>Yr 8</th>
<th>Yr 9</th>
<th>Yr 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2%</td>
<td>6.19%</td>
<td>5.78%</td>
<td>5.40%</td>
<td>5.04%</td>
<td>4.72%</td>
<td>4.41%</td>
<td>4.13%</td>
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<td>3.62%</td>
<td>56.86%</td>
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<tr>
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<td>6.19%</td>
<td>5.78%</td>
<td>5.40%</td>
<td>5.04%</td>
<td>4.72%</td>
<td>4.41%</td>
<td>4.13%</td>
<td>3.86%</td>
<td>3.62%</td>
<td>56.86%</td>
</tr>
<tr>
<td>0%</td>
<td>6.19%</td>
<td>5.78%</td>
<td>5.40%</td>
<td>5.04%</td>
<td>4.72%</td>
<td>4.41%</td>
<td>4.13%</td>
<td>3.86%</td>
<td>3.62%</td>
<td>56.86%</td>
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<td>9.70%</td>
<td>7.97%</td>
<td>6.67%</td>
<td>5.69%</td>
<td>4.93%</td>
<td>4.34%</td>
<td>3.87%</td>
<td>3.50%</td>
<td>3.19%</td>
<td>50.14%</td>
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<td>2%</td>
<td>10.72%</td>
<td>8.36%</td>
<td>6.73%</td>
<td>5.58%</td>
<td>4.75%</td>
<td>4.14%</td>
<td>3.69%</td>
<td>3.33%</td>
<td>3.05%</td>
<td>49.65%</td>
</tr>
<tr>
<td>3%</td>
<td>14.61%</td>
<td>8.86%</td>
<td>6.09%</td>
<td>4.70%</td>
<td>3.96%</td>
<td>3.53%</td>
<td>3.23%</td>
<td>3.01%</td>
<td>2.83%</td>
<td>49.18%</td>
</tr>
<tr>
<td>4%</td>
<td>14.61%</td>
<td>8.86%</td>
<td>6.09%</td>
<td>4.70%</td>
<td>3.96%</td>
<td>3.53%</td>
<td>3.23%</td>
<td>3.01%</td>
<td>2.83%</td>
<td>49.18%</td>
</tr>
</tbody>
</table>

Assumption: 20% of balances are surge balances
Surges – Most don’t represent a liquidity threat, **BUT** they are a cost of funds threat as they will move back into higher beta accounts like CDs with rising rates. You need to knock surges out of low beta funding sources.
Remaining low beta funding sources (after surge knock outs) are long-term funding at a relatively fixed rate.
4 Methods for Calculating Decay Rates

Method 4: Multi Pool (Vintage) Study

– Track initial study group (single pool method) and subsequent pools of new accounts over time
– Track behaviors of newer accounts vs. older more seasoned accounts

• Strengths
  – Doesn’t ignore accounts representing > 50% of total deposit balances in a sector
  – Develops better metrics on new account behaviors
  – Helps to estimate “surge” deposits vs. “core”

Weaknesses

– More data and analysis required
– Many ALM models unable to process outputs properly
Problems with Traditional Core

- How “old” were the initial 12,959 accounts in this consumer savings study?

<table>
<thead>
<tr>
<th>Number of Accounts</th>
<th>Sep-2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Savings</td>
<td>12,959</td>
</tr>
<tr>
<td>&lt; 1 Year</td>
<td>670</td>
</tr>
<tr>
<td>1-2 Years</td>
<td>383</td>
</tr>
<tr>
<td>2-3 Years</td>
<td>335</td>
</tr>
<tr>
<td>3-4 Years</td>
<td>330</td>
</tr>
<tr>
<td>4-5 Years</td>
<td>350</td>
</tr>
<tr>
<td>&gt; 5 Years</td>
<td>10,891</td>
</tr>
<tr>
<td>Undetermined</td>
<td>0</td>
</tr>
</tbody>
</table>

**Acct Weighted Average Age** 7.91

- 84% of account open 5 Yr or More

- How old are they now?
Problems with Traditional Core

- So, the accounts are “Old” but what about the balances?

<table>
<thead>
<tr>
<th>Balances in Thousands</th>
<th>Sep-2007</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumer Savings</strong></td>
<td>21,998</td>
</tr>
<tr>
<td>&lt; 1 Year</td>
<td>663</td>
</tr>
<tr>
<td>1-2 Years</td>
<td>375</td>
</tr>
<tr>
<td>2-3 Years</td>
<td>423</td>
</tr>
<tr>
<td>3-4 Years</td>
<td>453</td>
</tr>
<tr>
<td>4-5 Years</td>
<td>533</td>
</tr>
<tr>
<td>&gt; 5 Years</td>
<td>19,551</td>
</tr>
<tr>
<td>Undetermined</td>
<td>0</td>
</tr>
</tbody>
</table>

**Balance Weighted Average Age** 8.27

- 88% of the initial $21.998 million in balances were > 5 Yrs. old
Problems with Traditional Core

- Examining the 12,000+ accounts
  - ½ had balances >= $500
- Rate of “decay” on gross accounts much faster than on net accounts
  - 12,000+ down to 6,000
  - 6,000 down to 4,000
- Which line represents funding risks to you?
  - Let’s look at balances

How would the account # decay look in comparison?
Problems with Traditional Core

- Despite the large decline in account #s balances have remained steady
  - Actually seen growth from 2010 to 2013
- Does the decline in # of accounts correlate to the level of funding risk?
- How can account balances grow in this vintage when account #’s are declining?
MMDA Example – Acct # Change

Account # Trends
Gross vs. Net of Dormant

- MMDA Accounts have very low levels of “dormant” or “low balance” accounts
  - Roughly 100 of 600 as of 12/2013
MMDA Example – Balance Change

• Avg Balance net of low balance accounts rises sharply from 2012-13 vs. true average

• How does average balance increase?
How does the change in the total balance and # of accounts from 2007 to 2013 impact your thoughts on single vintage?

- 1,164 accounts in 2007 to 3,140 accounts in 2013
- $45,137 in balances to $214,239 (not balances are in 000’s)

<table>
<thead>
<tr>
<th>2007 Account Age</th>
<th>Total Balance</th>
<th>% of Ttl. Balance</th>
<th># of Accounts</th>
<th>% of Accounts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>45,137</td>
<td>1,164</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 Year</td>
<td>16,812</td>
<td>37.2%</td>
<td>252</td>
<td>21.6%</td>
</tr>
<tr>
<td>1-2 Years</td>
<td>6,486</td>
<td>14.4%</td>
<td>214</td>
<td>18.4%</td>
</tr>
<tr>
<td>2-3 Years</td>
<td>2,788</td>
<td>6.2%</td>
<td>105</td>
<td>9.0%</td>
</tr>
<tr>
<td>3-4 Years</td>
<td>2,824</td>
<td>6.3%</td>
<td>92</td>
<td>7.9%</td>
</tr>
<tr>
<td>4-5 Years</td>
<td>4,023</td>
<td>8.9%</td>
<td>115</td>
<td>9.9%</td>
</tr>
<tr>
<td>&gt; 5 Years</td>
<td>12,204</td>
<td>27.0%</td>
<td>386</td>
<td>33.2%</td>
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<tr>
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<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Weighted Age (Yrs.)</td>
<td>4.64</td>
<td></td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>December 2013 Account Age</th>
<th>Total Balance</th>
<th>% of Ttl. Balance</th>
<th># of Accounts</th>
<th>% of Accounts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>214,239</td>
<td>3,140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 Year</td>
<td>17,432</td>
<td>8.1%</td>
<td>249</td>
<td>7.9%</td>
</tr>
<tr>
<td>1-2 Years</td>
<td>21,918</td>
<td>10.2%</td>
<td>387</td>
<td>12.3%</td>
</tr>
<tr>
<td>2-3 Years</td>
<td>33,256</td>
<td>15.5%</td>
<td>459</td>
<td>14.6%</td>
</tr>
<tr>
<td>3-4 Years</td>
<td>41,558</td>
<td>19.4%</td>
<td>560</td>
<td>17.8%</td>
</tr>
<tr>
<td>4-5 Years</td>
<td>25,428</td>
<td>11.9%</td>
<td>327</td>
<td>10.4%</td>
</tr>
<tr>
<td>&gt; 5 Years</td>
<td>74,647</td>
<td>34.8%</td>
<td>1,158</td>
<td>36.9%</td>
</tr>
<tr>
<td>Undetermined</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Weighted Age (Yrs.)</td>
<td>6.45</td>
<td></td>
<td>6.83</td>
<td></td>
</tr>
</tbody>
</table>
MMDA Example

- What was happening at the institution during this time?

Funding Sources ($)

- Time Deposits
- < $100K
- >=$100K
- Other Savings
- Money Market
- NOW & ATS
- Demand Deposit
MMDA Example

• What was happening at the institution during this time?
MMDA Example – Avg Balance by Vintage

- Note how gross average balance for each subsequent year is higher than the initial vintage
MMDA – Remaining Accts

Account # Trends by Vintage
Gross vs. Net of Dormant

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MMDA – Remaining Balance

Remaining Balance by Vintage

- Axis Y: $0, $10,000, $20,000, $30,000, $40,000, $50,000, $60,000

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Pricing Effect on Demand?

Linking Beta & Decay

Average MMDA Balance by Vintage vs. Offer Rate Spread to FHLB Advance

Note Ave Bal Increase as Offer Rate is well above market
Decay Rates By Vintage

Note higher volatility of newly originated accounts during “crisis” but acting more stable now. Big question is for how long?
## Summary Findings

### Current Balances as of Dec-2013

<table>
<thead>
<tr>
<th>Age</th>
<th>Balance</th>
<th>Vintage</th>
<th>Surge%</th>
<th>Surge</th>
<th>Core</th>
<th>Base Decay</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 Year</td>
<td>17,432</td>
<td>2012</td>
<td>45.00%</td>
<td>7,844</td>
<td>9,588</td>
<td>12.96%</td>
</tr>
<tr>
<td>1-2 Years</td>
<td>21,918</td>
<td>2011</td>
<td>60.75%</td>
<td>13,315</td>
<td>8,603</td>
<td>16.12%</td>
</tr>
<tr>
<td>2-3 Years</td>
<td>33,256</td>
<td>2010</td>
<td>70.00%</td>
<td>23,279</td>
<td>9,977</td>
<td>13.76%</td>
</tr>
<tr>
<td>3-4 Years</td>
<td>41,558</td>
<td>2009</td>
<td>53.00%</td>
<td>22,026</td>
<td>19,532</td>
<td>12.33%</td>
</tr>
<tr>
<td>4-5 Years</td>
<td>25,428</td>
<td>2008</td>
<td>70.00%</td>
<td>17,800</td>
<td>7,628</td>
<td>10.83%</td>
</tr>
<tr>
<td>5-6 Years</td>
<td>27,390</td>
<td>2007</td>
<td>52.00%</td>
<td>14,243</td>
<td>13,147</td>
<td>12.52%</td>
</tr>
<tr>
<td>original</td>
<td>47,257</td>
<td>2007</td>
<td>40.00%</td>
<td>18,903</td>
<td>28,354</td>
<td>8.86%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>214,239</strong></td>
<td><strong>54.80%</strong></td>
<td><strong>117,410</strong></td>
<td><strong>96,829</strong></td>
<td></td>
<td><strong>12.07%</strong></td>
</tr>
</tbody>
</table>

**Original Study:** Surge: 42.0%  
**New Study:** Surge: 54.8%  
**Base Decay:** 8.68%  
Base Decay: 12.07%

**Net Result:** Shorter duration, more volatile funding than single vintage study results. Captures essence of new accounts vs. seasoned.

**LIMITED SAMPLE – NOT FOR USE IN MODELING**
What Should Institutions Do?

• Review your beta study results for projected rates in rising scenario
  – Do they reflect current thinking?
  – What changes can you justify?
• Review current assumptions used for core deposit study
  – What type of study did you perform?
  – Did you get an estimate on surge balances?
  – Are you modeling surge in your ALM reports properly?
  – Are you comfortable with
    • Surge
    • Decay
• Consider rerunning ALCO reports to see impact of deviation from key decay & beta studies results
  – Does it change your risk profile?
  – Are you mode comfortable seeing the variance?
  – Impact on projected capital levels?
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