Keeping on the Rails
When Delinquency Overshoots ...

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Framework: Credit Feedback Loop

Policy Formulation → Credit Committee

Analysis/Measurement → Missed Payments → Customer Actions

Policy Implementation

Reporting
Control Mechanism: Feedback Loop

Theme of Talk: Portfolio Management Process

- Anticipate discrepancies
- Identify potential problems quickly
- Minimise departures from budget
- Learn about the portfolio
Control Mechanism: Focus on Policy Analysis

Economy → Market → ???

→ Operations → Black Box → Customer Actions

Policies → Budget

Policy Formulation → Comparison/Analysis

Results

Time Lags on Feedback Loops
Marketing and Risk

Policy Formulation → Analysis/Measurement → Operational Actions

1-3 months

Customer Activity

6-24 months

Customer Risk

Management Challenge: speed up the risk loop
Keeping on the Rails

*Presentation Outline*

**When delinquency goes over target ...**

げる How do we know?
- Finding the cause ... Is it real?
- Formulating a response

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**Targets: Made to be Missed**

- Policy based on assumptions
  - Environment
  - Execution
  - Understanding of customers
- Policy → “Expected” results
  - = Budget
- Measure actual results vs. expectations
  - Actual always different
- Understanding differences leads to better policies

Realistic Targets → Better Diagnostics → Faster Adaptation
Triple Test for Delinquency Level

How much is too much?

- Importance = Business Threshold
  - Distance measure
  - Amber: Observed Rate $\geq 110\% \times$ Budget Rate
  - Red: Observed Rate $\geq 125\% \times$ Budget Rate

- Reliability = Statistical Test
  - Measure of certainty
  - Given sample size, could this difference be “random fluctuation”
  - Amber: 5% chance under random fluctuation
  - Red: 1% chance
  - See next slide

- Pattern = Coherent Story
  - One-off cause or repeated over time? Sustained?
  - Across similar portfolios?

Alarm signal: Must meet ALL 3 criteria

Tolerances:
Random Fluctuation and Real Variation

Sources of Variation
- Could differences arise “by accident”??
- Bad Rate by Cases
- Statistical test:
  - How likely is this much variation ...
  - If there is no “real” change
- Test: Chi² Test
- Apply across sub-populations
  - Business channel
  - Scorebands

Example

<table>
<thead>
<tr>
<th></th>
<th>Goods</th>
<th>Bads</th>
<th>Total</th>
<th>Bad Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan</td>
<td>5421</td>
<td>179</td>
<td>5600</td>
<td>3.20%</td>
</tr>
<tr>
<td>Actual</td>
<td>5396</td>
<td>204</td>
<td>5600</td>
<td>3.64%</td>
</tr>
</tbody>
</table>

Chi²: 3.46, p-level: 6.31%

- Sample: 204 bads/5600 accounts
- 3.64%/3.20% = 115% of budget
- ... Importance: AMBER ... BUT ...
- 6% chance of this big a discrepancy ...
  - if no “real” variation in bad rate
- Amber: 5%, Red: 1% - GREEN
- Overall Status: GREEN

Statistical test: can you believe your eyes?
Average Balance: Average Balances Increased on “Bads”? 

**Variation in Balances**
- Actual/Expected Bad Balances = Actual Cases x Actual Avg Bal
  Expected

- Budget: cases AND balance
  - Different reasons for variation
  - Different consequences
  - Need to control separately

- E.g. Budget:
  - Average “bad” balance = 3200€

**Example: T-test**
- Actual:
  - Avg “bad” balance = 3600€
  - Standard deviation = 1600€
  - Number of “bads” = 204

- Distance: 3600/3200 = 113%
  - AMBER

- Reliability
  - T-statistic: \( \frac{3600 - 3200}{1600 / \sqrt{204}} = 3.57 \)
  - T-test: p-level = 0.02%

- Reliability RED
  - Very unlikely to be random

- Overall AMBER

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**Keeping on the Rails**

*Presentation Outline*

*When delinquency goes over target ...*

- How do we know?
- Finding the cause ... Is it real?
- Formulating a response
Hypotheses:

Reason for Increase

1. Budget is unrealistic

Credit Cycle

- Marketing
- New business
- Account Management
- Collections
- Recoveries

Is Budget Realistic?

Starting Point: Net Flow Rates

<table>
<thead>
<tr>
<th></th>
<th>Feb-11</th>
<th>Mar-11</th>
<th>Roll Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>6531</td>
<td>6509</td>
<td></td>
</tr>
<tr>
<td>Up to date</td>
<td>6337</td>
<td>6314</td>
<td></td>
</tr>
<tr>
<td>1 to 30</td>
<td>99</td>
<td>99</td>
<td>99/6337 = 1.6%</td>
</tr>
<tr>
<td>31 to 60</td>
<td>18</td>
<td>20</td>
<td>20/99 = 19.8%</td>
</tr>
<tr>
<td>61 to 90</td>
<td>10</td>
<td>10</td>
<td>10/18 = 55.2%</td>
</tr>
<tr>
<td>91 to 120</td>
<td>6</td>
<td>7</td>
<td>7/10 = 71.1%</td>
</tr>
<tr>
<td>121 to 150</td>
<td>9</td>
<td>5</td>
<td>5/6 = 82.5%</td>
</tr>
<tr>
<td>151 to 180</td>
<td>7</td>
<td>8</td>
<td>8/9 = 88.5%</td>
</tr>
<tr>
<td>&gt; 180</td>
<td>45</td>
<td>46</td>
<td>46/7 = 704.7%</td>
</tr>
</tbody>
</table>

- Roll rate = \( \frac{\text{Balance in state s+1 at time t+1}}{\text{Balance in state s at time t}} \)
- Assume all Arrears 3 balance in June was Arrears 2 in May
- Implicitly: any debt not rolling forward returns to order

Model is not realistic
Net Flow Rate Assumptions

Problems

- Deals with amounts, no reference to numbers
  - no statistical measure of accuracy
- All the accounts in a given status either move on to the next state or return to current status
  - not true
  - lots of movement between states (partial payments ...)
- Can give rise to roll rates > 100%

- Delinquency defined as time since last payment
  - problems with unstructured credit
- All up to date debt considered equally risky
  - no account of credit score, prior delinquency, time on books ...
- All accounts in a given arrears status equally likely to roll forward

Too fragile if portfolio structure is changing ...
... and structure is always changing

Gross Flow Rates:

Realistic Picture

<table>
<thead>
<tr>
<th>March</th>
<th>Up to date</th>
<th>1 to 30</th>
<th>31 to 60</th>
<th>61 to 90</th>
<th>91 to 120</th>
<th>121 to 150</th>
<th>151 to 180</th>
<th>&gt; 180</th>
<th>Write-off</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>6315</td>
<td>99</td>
<td>34</td>
<td>10</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>46</td>
<td>6</td>
</tr>
<tr>
<td>Up to date</td>
<td>6337</td>
<td>6211</td>
<td>92</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>1 to 30</td>
<td>99</td>
<td>58</td>
<td>7</td>
<td>34</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>31 to 60</td>
<td>18</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>61 to 90</td>
<td>10</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>91 to 120</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>121 to 150</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>151 to 180</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 180</td>
<td>45</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>41</td>
<td>2</td>
</tr>
</tbody>
</table>

- Movements in all directions
  - Roll Forward
  - Partial payments
  - Payment plans
  - Write-offs

- Changes to balance
  - Interest
  - Fees
  - New spend
  - Repayments

Where are delinquent balances coming from?
Gross Flow Rates: → Markov Model

- Move forward portfolio composition one month at a time
- Model spend, interest, payments
- Need ~ 30-50 states to get realistic picture

→ Portfolio Cash Flow Model

<table>
<thead>
<tr>
<th></th>
<th>Up to date</th>
<th>1 to 30</th>
<th>31 to 60</th>
<th>61 to 90</th>
<th>91 to 120</th>
<th>121 to 150</th>
<th>151 to 180</th>
<th>&gt; 180</th>
</tr>
</thead>
<tbody>
<tr>
<td>February</td>
<td>100%</td>
<td>98.5%</td>
<td>1.5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>58.9%</td>
<td>7.0%</td>
<td>34.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>46.0%</td>
<td>0.5%</td>
<td>2.3%</td>
<td>51.1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>25.0%</td>
<td>0.4%</td>
<td>1.0%</td>
<td>6.1%</td>
<td>67.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>17.1%</td>
<td>0.2%</td>
<td>0.5%</td>
<td>1.5%</td>
<td>4.7%</td>
<td>75.8%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>12.3%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.4%</td>
<td>0.9%</td>
<td>3.6%</td>
<td>82.3%</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>7.5%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.5%</td>
<td>5.2%</td>
<td>88.0%</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>3.1%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.1%</td>
<td>0.8%</td>
<td>91.4%</td>
</tr>
</tbody>
</table>

→ Portfolio Cash Flow Model

Hypotheses: Reason for Increase

1. Budget is unrealistic
2. Collections

Credit Cycle

- Marketing
- New business
- Account Management
- Collections
- Recoveries
Collections Activity

Increase in 30+ Balances

Operational Problems
- Payment processing delays
- Slow down in cure rates
  - Collections operations
  - Less customer contact?
- Spending on delinquent accounts
  - Lack of operational control
- Less Re-aging of Delinquents
  - Cosmetic or real?

Implementation, Implementation, Implementation

→ Design Diagnostics to Identify Problem

Collections Lifecycle Curves

Biggest Short-Term Effect

Cure rate by time since entry to collection
- Same principle as for new business

But difficult to identify early effects
- Need Vintage Curve
Collections Vintage Curves

- Cure rate by date of entry
  - Compare at fixed horizons
  - Weighted by cases
- Better to measure in weeks

- Biggest performance difference in Month 1
  - Early collections more productive
  - Concentrate resource on early cures

Collections Activity

*Increase in 30+ Balances*

**Operational Problems**
- Payment processing delays
- Slow down in cure rates
  - Collections operations
  - Less customer contact?
- Spending on delinquent accounts
  - Lack of operational control
- Excessive fees on collections cases
- Less Re-aging of Delinquents
  - Cosmetic or real?

**How to Identify**
- Very rapid “cures” before action
- Vintage curves move closer
  - Vintages under-perform potential
- Balances grow on worst accounts
- Large fee income
  - Never collected?
- Use “Re-aging” vintage curves

→ Design Diagnostics to Identify Problem
Hypotheses: 
**Reason for Increase**

1. Budget is unrealistic
2. Collections
3. Account Management

Credit Cycle

- Marketing
- New business
- Account Management
- Collections
- Recoveries

Role of Limit Increases

Starting Point: Bads have more “credit appetite” than Goods

- Incremental utilisation of credit limit higher by (future) Bads
  - Short term deterioration in EAD (Exposure at Default)
- In recession, Goods de-leverage
  - Reduce borrowing
- Bads under pressure use available credit
  - Job loss, reduced income
  - Increase borrowing
- Ratio Good/Bad Balance deteriorates

Limit Utilisation by PD
Hypotheses:
Reason for Increase

1. Budget is unrealistic
2. Collections
3. Account Management
4. Underwriting

Credit Cycle

- Marketing
- New business
- Account Management
- Collections
- Recoveries

How Long to Evaluate Underwriting?

Stock of Delinquents

- Mortgage Book – 2+ Arrears
- Plateau delinquency ~36 months
- How fast can changes be identified?

Cf. “Speed Reading: Portfolio Tracking in a Recession”
- Best Practice Days 2009
Mortgage Portfolio Lifecycle Curve:
Flows: Entry to Early Delinquency

Flows: more sensitive than stocks – but smaller %ages

Vintage Index Matrix:
Allows Early Comparisons

Index number: delinquency rate in cell
rate in reference period (with same exposure)

- e.g. 1990/Q3, 10 - 12 m exposure: 4.0%/4.1% = .96
### Vintage Graph – Index Numbers

**Mortgage Portfolio**

- Most information in 4 month delq
  - ~ 50% correlation between 4 month and 24 month flows
- Even during recession ...
  - Can see early trends

### Underwriting Policies

**Q. 1: Does Scorecard work as expected?**

- Policy based on assumed score-risk relationship
  - Is assumption correct?
- Should have Default Rate = PD
  - Re-scale PDs to reflect actual Default Rates

**Basic Principle: Actual = Expected**
Underwriting Policies

Q. 2: Actual = Expected?

If scorecard is accurate, default rates should be close to PDs on all groups in population.

### Example: Applicant Age

<table>
<thead>
<tr>
<th>Description</th>
<th>AGED</th>
<th>ACTUALS</th>
<th>EXPECTED (by score)</th>
<th>SCORE CORRECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Goods</td>
<td>Bads</td>
<td>Count</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Count</td>
<td>Total</td>
<td>Rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Errors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Information Value: 0.064

#### Chi Square Significance: 0.91%

<table>
<thead>
<tr>
<th>Worse</th>
<th>Better</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Goods</td>
</tr>
<tr>
<td>0 to 29</td>
<td>253</td>
</tr>
<tr>
<td>30 to 49</td>
<td>1056</td>
</tr>
<tr>
<td>50+</td>
<td>655</td>
</tr>
</tbody>
</table>

| Total (All) | 1964 | 338 | 2302 | 14.7% | 1964 | 338 | 2302 | 14.7% | 100.00% | 4.925 |

- Basic Principle: Actual = Expected
- Marginal Information Value: Distance
- Marginal Chi²: Reliability
- Quantify scorecard corrections needed

Underwriting Policies

Q. 3: Policy Rules and Overrides

<table>
<thead>
<tr>
<th>Policy</th>
<th>Volume</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Budget</td>
<td>Actual</td>
</tr>
<tr>
<td>Long term customer</td>
<td>150</td>
<td>183</td>
</tr>
<tr>
<td>Key Business Influencer</td>
<td>80</td>
<td>93</td>
</tr>
<tr>
<td>Savings Balance &gt; 10000€</td>
<td>15</td>
<td>13</td>
</tr>
</tbody>
</table>

- Same format as characteristics
- Marginal Chi² Analysis
  - Actual = Expected?
  - Compute p-level and Marg. IV
- Economic Measures:
  - Cost vs. Benefit Analysis
- Are they worth the trouble?

Policy Rules add complexity
→ Reduce transparency → Errors more likely
Hypotheses: 
Reason for Increase

1. Budget is unrealistic
2. Collections
3. Account Management
4. Underwriting
5. Marketing

Credit Cycle

New business → Account Management → Collections → Recoveries → Marketing

Business Source Evaluation

ACCOUNT OPENINGS 2008/Q2

<table>
<thead>
<tr>
<th>Store</th>
<th>PD in Budget</th>
<th>PD at Opening</th>
<th>Default at 9 months</th>
<th>Performance Absolute</th>
<th>Performance Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paris</td>
<td>3.5%</td>
<td>3.7%</td>
<td>3.9%</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Lille</td>
<td>5.0%</td>
<td>5.2%</td>
<td>4.8%</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Lyon</td>
<td>4.0%</td>
<td>3.9%</td>
<td>3.6%</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Marseille</td>
<td>4.8%</td>
<td>5.0%</td>
<td>5.3%</td>
<td>Poor</td>
<td>Poor</td>
</tr>
</tbody>
</table>

| Total  | 4.1%         | 4.2%          | 4.2%                |                      |                      |

- "At opening" figures derived from scores on account opening time
  - Profile of applicants different from budget expectations
- Isolate departures from expectations
  - Take account of differing potential
- Differences in marketing mix can cause deterioration

Identify source of problem ...
One Train Can Hide Another ...

Don’t stop at first explanation ... what else is happening?

 Keeping on the Rails

Presentation Outline

When delinquency goes over target ...

✓ How do we know?
✓ Finding the cause ... Is it real?
⇒ Formulating a response
Potential Responses
... and time lags

- Difficult to correct immediately
- Ripple effect on budget
- Solution may not be in problem area
  - E.g. Problem in marketing mix
  - Solution: More resources in collections
- Short-term solution may bring long-term problem
  - E.g. Price increase
  - Attract worse quality customers
  - Negative selection
- Must model effect on portfolio profit first

Impact on Portfolio Performance
... difficult to measure effects of policies
The Credit Committee: Formulating Operational Policies

Control Mechanism for Policy Formulation

Control Mechanism: Focus on Policy Analysis
How to be a Superforecaster

Good Judgment Project

Comparisons are important
  - Use relevant comparisons as a starting point;

Historical trends can help
  - Look at history unless you have a strong reason to expect change;

Average opinions
  - Experts disagree, so find out what they think and pick a midpoint;

Mathematical models
  - You should take model-based predictions into account;

Predictable biases exist and can be allowed for
  - Don’t let your hopes influence your forecasts
  - Don’t stubbornly cling to old forecasts in the face of news.

*(source: GoodJudgmentProject.com, quoted in Tim Harford “How to see into the future”, FT Magazine, 5 September 2014)*

Check your brakes!

Thank you!