Chapter 15:
Applications of CRM in B2B and B2C Scenarios (Part 1)
Overview

Topics discussed:

- Measuring customer Profitability
- The Life-time-Profitability relationship in a non-contractual setting
- A model for incorporating customers’ projected profitability into lifetime duration computation
- A model for identifying the true value of a lost customer
Measuring Customer Profitability

- Managers are challenged to understand how their marketing efforts affect customers.
- Customers are dynamic and involve several marketing variables:
  - Tenure of the customers with the firm
  - Profitability of the customers
  - Purchase behavior
  - Adoption of multiple channels to purchase
  - Demographic factors governing purchase behavior
- **Customer Lifetime Value (CLV)**
  - Multi-period evaluation of a customer’s value to the firm
  - Assists managers to allocate resources optimally and develop customer-level marketing strategies
## Computing CLV

<table>
<thead>
<tr>
<th></th>
<th>Contractual</th>
<th>Non-Contractual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>Customers are bounded by a contract</td>
<td>Customers are not bounded by a contract</td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td>Cable TV subscription</td>
<td>Grocer store purchase</td>
</tr>
<tr>
<td><strong>Business Implication</strong></td>
<td>Firms get stream revenue or fixed monthly revenue</td>
<td>No stream revenue</td>
</tr>
</tbody>
</table>

### Baseline

\[
CLV_i = \sum_{t=1}^{T} \frac{\text{Base GC}}{(1+d)^t} + \sum_{t=1}^{T} \hat{p}(\text{Buy}_{it} = 1) \frac{\hat{GC}_{it}}{(1+d)^t} - \frac{\hat{MC}_{it}}{(1+d)^t}
\]

- **Baseline**
  - NPV of future streamed revenue from the customer

### Augmented CLV

- **Augmented CLV**
  - NPV of future cash flows from a customer based on products/service purchased

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V. Kumar and W. Reinartz – Customer Relationship Management
Drivers of CLV

In order to successfully implement a marketing initiative based on CLV, management must understand the drivers of CLV and how to measure those drivers.

CLV drivers:

- **Exchange characteristics**: variables which affect the customer-firm relationship
  - Spending level
  - Cross-buying behavior
  - Multi-channel shopping
  - Focused buying
  - Average inter-purchase time

- **Customer characteristics**: demographic variables
  - B2B setting: industry, annual revenue, location of the business
  - B2C setting: age, gender, spatial income, physical location of the customers

Product returns
- Relationship benefits
- Loyalty instrument
- Frequency of marketing contacts
- Bi-directional communication
The Life-time-Profitability Relationship in a Non-contractual Setting

Background and objective

- The firm has to ensure that the relationship stays alive since the customer typically splits his/her category expenses with several firms.
- Main Objective: Rigorous and differentiated empirical analysis of the lifetime-profitability relationship in a ‘non-contractual’ context.
- Tests to achieve the objective:
  - The strength of the lifetime duration – profitability relationship.
  - Whether profits increase over time (lifetime profitability pattern).
  - Whether the costs of serving long-life customers are actually less.
  - Whether long-life customers pay higher prices.
The Life-time-Profits-Relationship Relationship in a Non-contractual Setting (2)

Conceptual model

- To investigate the consequences of customer retention, namely, profitability:
  - Individual customer lifetime profits are modeled as a function of a customer’s lifetime duration
  - Revenue flows over the course of a customer’s lifetime
  - Firm cost is associated with the marketing exchange
Customer Lifetime and Firm Profitability

Proposition 1: The nature of the lifetime-profitability relationship is positive
Customer Lifetime and Firm Profitability (2)

Proposition 2: Profits increase over time

- Analysis of the dynamic aspects of the lifetime-profitability relationship
- Non-contractual setting:
  - cost of serving customer can easily exceed the profit margin brought in by the customer
  - Profits may not increase over time
- Example: catalog shopping or direct mail offerings
  - The customer may end up buying once a year and spend a smaller amount
  - Cost of serving the customer can easily exceed the profit margin brought in by the customer
Proposition 3: The costs of serving longer-life customers are lower

- Lower transaction costs for longer-life versus shorter-life customers (e.g. retail sector)
- The costs associated with promotional expenditures directed at longer- and shorter-life customers actually differ

Proposition 4: Longer-life customers pay higher prices

- Existing customers pay effectively higher prices than new ones
- Higher value consciousness (lower average prices paid) of long-term customers
Model for measuring customer lifetime for non-contractual relationships

- Data: 3 year window of daily sales of an established U.S. catalog retailer
- Negative Binomial Distribution (NBD)/Pareto model
- Based on the customer-specific probability of being alive, the model can be used to determine which customers should be deleted from active status
- Continuous $P(Alive)$ estimate is transformed into a dichotomous “alive/dead” measure
- Knowing a person’s “time of birth” and given a specified probability level (threshold), can approximate when a customer is deemed to have left the relationship
- The time from birth, $t_0$, until the date associated with the cut-off threshold, $t_{cut-off}$, constitutes the lifetime of the customer
  - Calculate finite lifetime for each customer, for profitability analysis
Illustrative Lifetime Determination of Individual Household

Source: Reinartz W. And Kumar V., “On the Profitability of Long-life Customers in a Non-Contractual Setting: An empirical Investigation and Implications for Marketing
Measuring Customer Lifetime for Non-Contractual Relationships

Establishment of cut-off threshold

- The Length of the lifetime estimate for each customer
- Establishment of cut-off threshold that produces the highest percentage of correct classifications
- Use 0.5 as the cut-off threshold

Lifetime estimation

- Final lifetime estimates

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Mean Lifetime (months)</th>
<th>Standard deviation</th>
<th>% Right-Censored</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohort 1</td>
<td>28.7</td>
<td>7.8</td>
<td>41.1</td>
<td>11</td>
<td>36</td>
</tr>
<tr>
<td>Cohort 2</td>
<td>27.9</td>
<td>7.9</td>
<td>41.7</td>
<td>12</td>
<td>35</td>
</tr>
</tbody>
</table>
Measuring Customer Lifetime for Non-Contractual Relationships (contd.)

Profit calculation

Net-present value of profit is calculated on an individual customer basis for the period of 36 months as:

\[ LT\pi_i = \sum_{t=1}^{36} (GC_{ti} - C_{ti}) \left( \frac{1}{1+.0125} \right)^t \]

where \( LT\pi_i \) = individual net-present lifetime profit for 36 months

\( GC_{ti} \) = gross contribution in month \( t \) for customer \( i \),

\( C_{ti} \) = mailing cost in month \( t \) for customer \( i \), and

0.0125 = monthly discount rate (based on 0.15 rate per year)
Test of the Propositions

Proposition 1: The nature of the lifetime-profitability relationship is positive

- Could customers with shorter tenure might actually be more profitable than long-term customers, a claim that runs counter to the theoretical expectations of a relationship perspective?
- Which group of customers is of more interest to the firm, the one that buys heavily for a short period (segment 3) or the one with small spending but with long-term commitment (segment 2)?
Test of the Propositions (2)

Proposition 2: Profits increase over time
- Examine the profitability evolution visually
- Analyze the sign of the slope coefficient
- The exact specification of the regression is:
  \[ \text{Profits} = a_s + b_{1s} \times \text{Dummy} + b_{2s} \times t_s + \text{error} \]
  where \( t = \text{month}, \ b_{is} = \text{regression coefficient}, \ s = \text{segment}, \) and \( \text{Dummy} = 1 \) if first purchase month, else 0

Proposition 3: The costs of serving long-life customers are lower
- Compute the ratio of promotional costs in a given period over the revenues in the same period

Proposition 4: Longer-life customers pay higher prices
- Whether longer-life customers do pay higher prices as compared to shorter-life customers
## Tests of Propositions - Results
(Cohort 2 results in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Segment 2</th>
<th>Segment 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Long Lifetime</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of customers</td>
<td>889 (973)</td>
<td>1322 (1546)</td>
</tr>
<tr>
<td>Lifetime Profit per Customer ($)</td>
<td>50.85 (55.26)</td>
<td>289.83 (322.03)</td>
</tr>
<tr>
<td>Relative Profit ($/month)</td>
<td>1.43 (1.56)</td>
<td>8.18 (9.31)</td>
</tr>
<tr>
<td>Mailing Cost/Sales Ratio</td>
<td>0.128 (0.124)</td>
<td>0.063* (0.062)*</td>
</tr>
<tr>
<td>Avg. Item Price</td>
<td>47.74 (48.72)</td>
<td>293 (322.03)</td>
</tr>
<tr>
<td># of customers</td>
<td>1322 (1546)</td>
<td>8.18 (9.31)</td>
</tr>
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</tr>
<tr>
<td>Average Item Price</td>
<td>58.43** (58.25)**</td>
<td>58.43** (58.25)**</td>
</tr>
</tbody>
</table>

| **Short Lifetime**   |           |           |
| # of customers       | 1208 (1504) | 783 (942) |
| Lifetime Profit per Customer ($) | 50.49 (53.67) | 257.96 (284.20) |
| Relative Profit ($/month) | 2.41 (2.67) | 11.67 (12.57) |
| Mailing Cost/Sales Ratio | 0.141 (0.143) | 0.065 (0.064) |
| Avg. Item Price      | 47.97 (46.80) | 63.54 (64.47) |

<table>
<thead>
<tr>
<th><strong>Low Lifetime Revenue</strong></th>
<th><strong>High Lifetime Revenue</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>* Difference between Segment 1 and Segment 3 is not significant</td>
<td></td>
</tr>
<tr>
<td>** Difference between Segment 1 and Segment 3 is significant at $\alpha = 0.05$</td>
<td></td>
</tr>
</tbody>
</table>
Interpretation of Results

- Both long-term customers (segment 1) and short-term customers (segment 3) constitute the core of the firm’s business.
- Relationship between lifetime and profits can be far from being positive and monotonic.
- In terms of profit per month, customers in segment 3 are the most attractive of all.
- Segment 3 customers purchase with high-intensity, thus generating higher profits in a relatively shorter period of time.
Interpretation of Results (2)

- The mean relative profit for each segment is significantly different from the other segment at least at $\alpha = 0.05$ (using the multiple comparison test).
- Segment 1 customers are the most desirable set for the firm – represents the loyalty effect at its best.
- For segment 3 customers (high revenue but short lifetime), there appears to be a good match between offerings and desires but their relationship duration may be complicated by moderating factors.
- Dissatisfaction might occur for segment 4 whose customers spend the lowest amount.
Aggregate Profits ($) for Short-life Segments

- Short life, low revenue (Segment 4)
- Short life, high revenue (Segment 3)
Aggregate Profits ($) for Long-life Segments

- Long life, low revenue (Segment 2)
- Long life, high revenue ('Segment 1)
Proposition 2: Do profits increase over time?

- Regression results for $t = 1$ to 36 months (Cohort 1)
- Validation results in parentheses (Cohort 2)

With the exception of Segment 2, the coefficient for the linear effect has a negative sign – highlights the negative profit trend over time for the 3 segments.

All the coefficients for time are significant at $\alpha = 0.01$
Proposition 3: Are the Costs of Serving Long-Life Customers Lower?

- The ratio of mailing cost per dollar sales in the longer-life segment (segment 1) is statistically not different from the mailing cost per dollar sales in the shorter-life segment (segment 3)
- In terms of cost efficiency, segments 1 and 3 are the most attractive to the firm, although they have very different lifetime properties
- The ratio of mailing cost and revenues – which is one measure of efficiency – need not necessarily be lower for long-life-customers
Proposition 4: Do Long-Life Customers Pay Higher Prices?

- The average price per item for segment 3 is significantly ($\alpha = 0.05$) different from (and greater than) that of segment 1
- The highest average price paid for a single product item is in segment 3, the short-life segment
- The highly profitable short-term customers seem to be less sensitive to the product’s price
- The higher spending (average prices paid) by segment 3 customers may be due to some other benefit sought by them
Summary of Findings

- A strong linear positive association between lifetime and profits does not necessarily exist.
- A static and a dynamic lifetime-profit analysis can exhibit a much differentiated picture: profitability can occur for the firm from high and low lifetime customers.
- Profits do not increase with increasing customer tenure: the cost of serving long-life customers is not lower.
- Long-life customers do not pay higher prices.
Model for Incorporating Customers’ Projected Profitability into Lifetime Duration Computation

- Background and objective:
  - Critical for managers to understand customer’s profitability and decide when to let go of an unprofitable customer
- Key research tasks:
  - Empirically measure lifetime duration for non-contractual customer-firm relationships, incorporating projected profits
  - Understand the structure of profitable relationships and test the factors that impact a customer’s profitable lifetime duration
  - Develop managerial implications for building and managing profitable relationship exchanges
Conceptual Model of Profitable Customer Lifetime

Exchange characteristics

Profitable Lifetime Duration

Revenues
Cost

Customer Profitability

Lifetime Duration

Present Study
B-to-C and B-to-B contexts

Earlier Study
B-to-C context only

Observed heterogeneity

Non-contractual setting
Estimating Profitable Lifetime Duration

- Determine the contribution margin expected from each customer in future periods based on the average of the contribution margins in the past.
- Determine for each future period, the probability that the customer will be alive and will transact with the firm.
- Combine these two components.
- Discount the expected contribution margin in each future period to its Net Present Value (NPV) using the cost of capital applicable to the firm.
  - If in a given month, cost of additional marketing efforts is greater than NPV, determine that the Profitable Lifetime Duration of the customer has ended.
Antecedents of Profitable Lifetime Duration

- Predictor variables to incorporate into the model:
  - *Exchange variables*:
    - e.g. amount purchased, degree of cross-buying, degree of focused-buying, inter-purchase time, number of product returns, ownership of loyalty instruments, and mailing efforts undertaken by the firm
  - *Customer heterogeneity variables*:
    - e.g. location and income of the customer
- Conceptually:

  Profitable Lifetime Duration = f (Exchange characteristics, Customer heterogeneity)
Database structure for B-to-C setting

- The customer-firm interaction of Cohort 1 households is tracked for a 36-month time period, Cohort 2 for 35 and Cohort 3 for a 34-month time period.
- The households are sampled randomly from all households that started in January, February, and March 1995 respectively.
- The number of purchases ranges from 1 to 46 across the sample with a median number of 5 purchases, the median interpurchase time is 117 days, and the median transaction amount is $91 for each purchase.
Determining Profitable Customer Lifetime Duration

- Calculation of Net Present Value (NPV) of Expected Contribution Margin (ECM<sub>it</sub>):

\[
NPV \text{ of } ECM_{it} = \sum_{n=t+1}^{t+18} P(Alive)_{in} * AMCM_{it} \left( \frac{1}{1+r} \right)^n
\]

- \( ECM_{it} \) = estimated expected contribution margin for a given month \( t \)
- \( AMCM_{it} \) = average contribution margin in month \( t \) based on all prior purchases since birth (updated dynamically)
- \( r \) = discount rate (15% on a yearly basis)
- \( i \) = the customer
- \( t \) = month for which \( NPV \) is estimated
- \( n \) = number of months beyond \( t \)
- \( P( Alive)_{in} \) = probability that customer \( i \) is alive in month \( n \)
Decision of relationship termination

- Formally, if $NPV_{ECM_{it}} < Cost of Mailing$, the firm would decide to terminate the relationship
- Decision rule incorporates the cost of mailings and an average flat contribution margin before mailings of 25 percent
- Discount rate is assumed to be 15% per year

Calculation of finite lifetime estimate

- Based on decision of relationship termination, average lifetime across Cohort 1 is 29.3 months, Cohort 2 is 28.6 months, and Cohort 3 is 27.8 months
- Variability in lifetime duration evidenced through
  - a wide range between lowest and highest lifetime estimate
  - the standard deviation of the lifetime estimate
  - the relatively small value of $s$ in the NBD/Pareto model
In the *proportional hazard model*, the hazard rate $h_i(t)$ for individual $i$ is assumed to take the form:

$$h_i(t) = h_0(t) e^{x_{it} \beta}$$

where

- $h_0(t)$ is the baseline hazard rate
- $(x_{it}\beta)$ is the impact of the independent variables

The hazard of a lifetime event of a household $i$ at time $t$ is given as:

$$h_i(t) = h_0(t) \exp(\beta_1 \text{Purchase Amount}_{it} + \beta_2 \text{Cross Buying}_{it} + \beta_3 \text{Focus of Buying}_{i} + \beta_4 \text{Average Interpurchase Time}_{it} + \beta_5 (\text{Average Interpurchase Time}_{it})^2 + \gamma_1 \text{Returns}_{it} + \gamma_2 \text{Loyalty Instrument}_{i} + \gamma_3 \text{Mailings}_{it} + \gamma_4 \text{Product Category}_{i} + \delta_1 \text{Population Density}_{i} + \delta_2 \text{Income}_{i} + \delta_3 \text{Age}_{i})$$
## Summary of Results

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Description</th>
<th>B-to-C Setting Result</th>
<th>B-to-B Setting Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>Positively related to the customer’s spending level</td>
<td>Supported</td>
<td>Supported</td>
</tr>
<tr>
<td><strong>2_a</strong></td>
<td>Positively related to degree of cross-buying behavior exhibited by customers</td>
<td>Supported</td>
<td>Supported</td>
</tr>
<tr>
<td><strong>2_b</strong></td>
<td>Related to the Focused Buying behavior exhibited by customers</td>
<td>Supported</td>
<td>Supported</td>
</tr>
<tr>
<td></td>
<td>However, the relationship is negative, indicating that buying in only a single department results in shorter lifetime duration</td>
<td></td>
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</tr>
<tr>
<td><strong>3</strong></td>
<td>Related to Average Interpurchase Time in an inverse U-shaped manner whereby intermediate AIT is associated with the longest profitable lifetime</td>
<td>Supported</td>
<td>Partial Support</td>
</tr>
<tr>
<td></td>
<td>Only the linear term is significant</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>Inversely related to the proportion of merchandise returned by the customers</td>
<td>Not Supported</td>
<td>Not Supported</td>
</tr>
<tr>
<td></td>
<td>However, the interaction of Returns with Purchase amount variable is significant</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Summary of Results (2)

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Description</th>
<th>B-to-C Setting Result</th>
<th>B-to-B Setting Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Positively related to the customer’s ownership of the company’s loyalty instrument (B-to-C) or the availability of line of credit (B-to-B)</td>
<td>Supported</td>
<td>Supported</td>
</tr>
<tr>
<td>6</td>
<td>Positively related to the number of mailing efforts of the company (B-to-C) or the number of contacts (B-to-B)</td>
<td>Supported</td>
<td>Supported</td>
</tr>
<tr>
<td>7</td>
<td>Profitable Customer Lifetime Duration is higher for customers living in areas with lower population density (B-to-C) or businesses existing in lower population density (B-to-B)</td>
<td>Supported</td>
<td>Not supported</td>
</tr>
<tr>
<td>8</td>
<td>Profitable Customer Lifetime Duration is positively related to the Income of the customer (B-to-C) or Income of the firm (B-to-B)</td>
<td>Supported</td>
<td>Supported</td>
</tr>
</tbody>
</table>
Estimation of $P(\text{Alive})$

- Method-of-moment approach
- Estimate the four parameters of the NBD/Pareto model ($r$, $\alpha$, $s$, $\beta$) with a Fortran routine with likelihood:

$$L(r, \alpha, s, \beta) = \prod_{i=1}^{M} P[X_i = x_i, t_i, T_i \mid r, \alpha, s, \beta]$$

where $M$ is a random sample of customers and customer $i$ made $X_i = x_i$ purchases in $(0, T_i)$ with the last transaction time at $t_i$.

- The larger the value of the shape parameter $r$ the more homogeneous the population of customers in terms of purchase rate
- The larger the value of the shape parameter $s$ the more homogeneous the population of customers in terms of dropout rate
- The concentration in dropout rates, $\beta$, depends on the parameter $s$ only
Estimation of \( P(\text{Alive}) \) (2)

- Probability that a customer with a particular observed transaction history is still alive at time \( T \) since trial:

\[
P [\text{Alive} | r, \alpha, s, \beta, x, t, T] = \frac{1 + \frac{s}{r + x + s} \left[ \left( \frac{\alpha + T}{\alpha + t} \right)^{r+x} \left( \frac{\beta + T}{\alpha + t} \right)^s F(a_1, b_1; c_1; z_1(t)) - \left( \frac{\beta + T}{\alpha + T} \right)^s F(a_1, b_1; c_1; z_1(T)) \right]}{1 + \frac{s}{r + x + s} \left( \frac{\alpha + T}{\alpha + t} \right)^{r+x} \left( \frac{\beta + T}{\alpha + t} \right)^s F(a_1, b_1; c_1; z_1(t)) - \left( \frac{\beta + T}{\alpha + T} \right)^s F(a_1, b_1; c_1; z_1(T))}^{-1}
\]

where \( a_1 = r+x+s, b_1 = s+1, c_1 = r+x+s+1, z_1(y) = (\alpha-\beta) / (\alpha+y) \),

\( F(a_1, b_1; c_1; z_1) \) is the Gauss hyper geometric function,

\( r, \alpha, s, \beta \) = model parameters,

\( x \) = number of purchases,

\( t \) = time since trial at which the most recent transaction occurred,

\( T \) = time since trial
A Model for Identifying the True Value of a Lost Customer

Conceptual background

- The value of a lost customer depends upon whether:
  - the customer defects to a competing firm or disadopts the product category

- **Defection**: The firm loses direct sales that customer would have brought in
- **Disadoption**: Customer stops purchasing from that product category
  - Affects the long term profitability by:
    - The loss of direct sales
    - Indirect effects of word of mouth, imitation, and other social effects
Modeling the Effects of Disadoption on the Value of a Lost Customer

- **Value of an average lost customer (VLC)** is calculated as:

\[ VLC = \alpha VLC_{\text{disadopter}} + (1- \alpha) VLC_{\text{defectors}} \]

\( \alpha \) is the proportion of disadopters in a firm’s lost customers

- **Profit impact of a lost customer =**

(sales estimate from new product growth model without disadoption) – (sales estimate when the customer disadopts after certain time)
Key determinants of the value of a lost customer:

- The time when customer disadopts has the largest impact on the value of the lost customer; earlier disadoption causes more loss of money
- The external influence, \( p \) has a negative impact
- The internal influence, \( q \) has a positive impact on penetration because higher \( q \) signifies stronger word of mouth
- Discount rate has positive impact on the value of lost customer
Summary

- A study of the Life-time-Profitability relationship in a non-contractual setting highlights concern with the widespread assumption of a clear-cut positive lifetime-profitability relationship and underlines the importance of a differentiated analysis.

- The empirical evidence showed that (1) a strong linear positive association between lifetime and profits does not necessarily exist; (2) profits do not necessarily increase with increasing customer tenure, (3) the cost of serving long-life customers is not lower, and (4) long-life customers do not pay higher prices.

- The main drivers of customer’s profitable lifetime duration are classified as exchange characteristics and customer heterogeneity.

- The key determinants of the value of a lost customer are identified as disadoption time, external and internal influences and the discount rate.

- The disadoption time is found to have the maximum negative impact on the value i.e., the earlier a customer disadopts, the higher is the value of the lost customer.