# Introduction to CLV

Lecture 5

Customer Analytics

Tilburg University

# Agenda

CLV, contractual setting

- Case 1: new customer
- Case 2: existing customer
- Case 3: new customer, profits come at the end

Retention rate dynamics

Towards a better model: customer heterogeneity

# CLV

Conceptual definition:

Revenues less costs of marketing, selling, production, servicing

the present value of the future profits associated with a particular customer

Uncertain from today's perspective—
it's a forecast/prediction!

Time value of money:
€1 today > €1 tomorrow

Only include costs attributable to the individual customer

# Start with the easiest setting: Contractual setting

- The customer has to notify the firm that he or she is quitting.
- The contract has to be broken

# Which firms are contractual?

# Why is this important?

- Knowledge of whether a customer is alive or not
- How do we predict whether a customer will be alive next period, the period after that …
- Simplest model is to say that the probability of quitting is the **same each period**

# Forecasting retention

Imagine, at the end of each period a customer flips a coin

**H**eads = renew

**T**ails = quit

| Probability of being "alive" after | flip # 1 | 2 | 3 | | $t$ |
|---|---|---|---|---|---|
| 1 period | **H** | | | | |
| 2 periods | **H** | **H** | | | |
| 3 periods | **H** | **H** | **H** | | |
| $t$ periods | **H** | **H** | **H** | **…** | **H** |

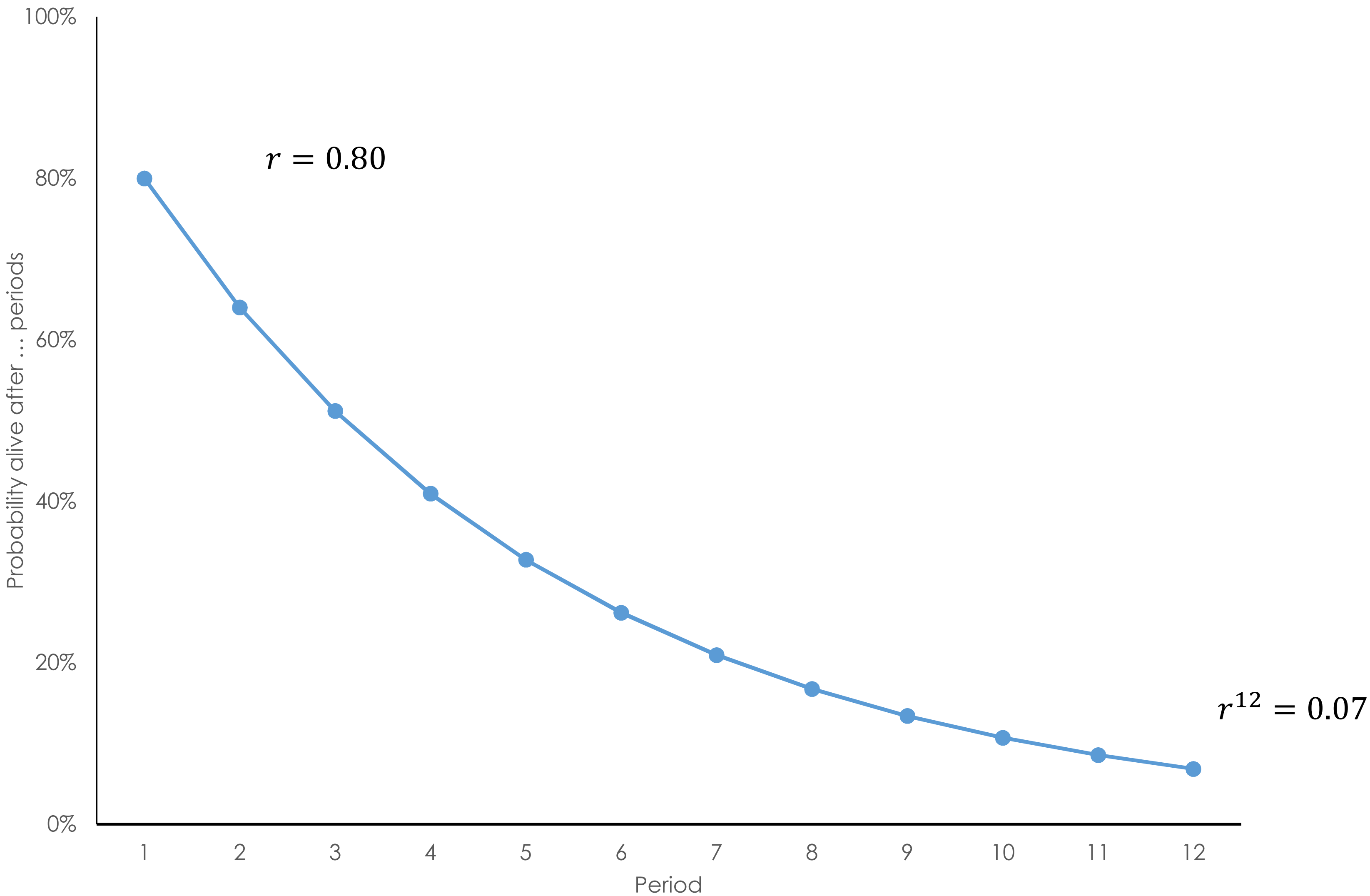
see "How to Project Customer Retention"

# Geometric distribution

$\theta$ is the retention rate, probability of getting heads

$$S(t) = P(T > t | r) = r^t, \qquad t = 1, 2, \ldots, 0 \leq r \leq 1$$

| Probability of being “alive” | 1 | 2 | 3 | | $t$ | |
|---|---|---|---|---|---|---|
| 1 period | **H** | | | | | $r$ |
| 2 periods | **H** | **H** | | | | $r^{\mathbf{2}}$ |
| 3 periods | **H** | **H** | **H** | | | $r^3$ |
| $t$ periods | **H** | **H** | **H** | **…** | **H** | $r^t$ |

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# Ingredients

Assume all these things are the same each period:

1. Retention rate (marketing)

$r$ = likelihood of renewing contract at each period

2. Margins (accounting)

$m$ = revenue – costs of marketing, selling, production, servicing

3. Discount rate (finance)

$d$ = opportunity cost of capital

# Case 1: The standard approach

| | | | | | | |
|---|---|---|---|---|---|---|
| **Discounted to Present** | | $1/(1+d)^1$ | $1/(1+d)^2$ | $1/(1+d)^3$ | $1/(1+d)^4$ | |
| **Expected Revenue** | $250 | $200 | $160 | $128 | $103 | |
| **Probability of Still Being "Alive"** | | .8 | .64 | .51 | .41 | |
| **Margin** | $250 | $250 | $250 | $250 | $250 | |
| **Time (0 is present)** | **0** | **1** | **2** | **3** | **4** | … |
| | Period 1 | Period 2 | Period 3 | Period 4 | | |

Receive €m when contract is initiated at t = 0; customer renews at beginning of period 2 with probability r, in which case we receive another €m discounted by 1/(1+d)

# The standard approach (2)

| | | | | | |
|---|---|---|---|---|---|
| **Discounted to Present** | | $1/(1+d)^1$ | $1/(1+d)^2$ | $1/(1+d)^3$ | $1/(1+d)^4$ |
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| **Margin** | \$250 | \$250 | \$250 | \$250 | \$250 |
| **Time (0 is present)** | **0** | **1** | **2** | **3** | **4** |

Period 1 Period 2 Period 3 Period 4 …

$$E[CLV] = m + \frac{m\,r}{(1+d)} + \frac{m\,r^2}{(1+d)^2} + \frac{m\,r^3}{(1+d)^3} + \frac{m\,r^4}{(1+d)^4} + \cdots$$

# The standard approach (3)

$$E[CLV] = m + \frac{m\,r}{(1+d)} + \frac{m\,r^2}{(1+d)^2} + \frac{m\,r^3}{(1+d)^3} + \frac{m\,r^4}{(1+d)^4} + \cdots$$

$$= m \sum_{n=0}^{\infty} \left(\frac{r}{1+d}\right)^n$$

# Geometric series

$$\sum_{n=0}^{\infty} k^n = \frac{1}{1-k}, \qquad 0 < k < 1$$

# The standard approach (3)

$$E[CLV] = m + \frac{m\,r}{(1+d)} + \frac{m\,r^2}{(1+d)^2} + \frac{m\,r^3}{(1+d)^3} + \frac{m\,r^4}{(1+d)^4} + \cdots$$

$$= m \sum_{n=0}^{\infty} \left(\frac{r}{1+d}\right)^n$$

$$= \frac{m(1+d)}{1+d-r} \qquad (\text{where } k = r/(1+d))$$

# Our example

$$E[CLV] = \frac{m(1+d)}{1+d-r}$$

$$= \frac{250\ (1+.01)}{1+.01-0.8}$$

$$= 917$$

(If we sum until period 10, our E[CLV] = 889.)

# Magic formula?

$$E[CLV] = \frac{m(1+d)}{1+d-r}$$

No, context really matters.

There is no one "true" formula.

# CLV vs. residual lifetime value (RLV)

**CLV** = for a not-yet-acquired customer, from first purchase

**RLV** = **r**esidual **l**ifetime **v**alue of **already existing** customer, including future purchases

# RLV

| Time (0 is present) | 0 | 1 | 2 | 3 | 4 | … |
|---|---|---|---|---|---|---|
| **Discounted to Present** | | $1/(1+d)^1$ | $1/(1+d)^2$ | $1/(1+d)^3$ | $1/(1+d)^4$ | |
| **Expected Revenue** | | \$200 | \$160 | \$128 | \$103 | |
| **Probability of Still Being "Alive"** | | .8 | .64 | .51 | .41 | |
| **Margin** | | \$250 | \$250 | \$250 | \$250 | |
| | **Customer joined** | | | | | |

Period 1   Period 2   Period 3   Period 4

$$E[RLV] = \frac{m\,r}{(1+d)} + \frac{m\,r^2}{(1+d)^2} + \frac{m\,r^3}{(1+d)^3} + \frac{m\,r^4}{(1+d)^4} + \cdots$$

# RLV

$$E[RLV] = \frac{m\,r}{(1+d)} + \frac{m\,r^2}{(1+d)^2} + \frac{m\,r^3}{(1+d)^3} + \frac{m\,r^4}{(1+d)^4} + \cdots$$

$$= m \sum_{n=1}^{\infty} \left(\frac{r}{1+d}\right)^n$$

$$= m \left[ \left\{ \sum_{n=0}^{\infty} \left(\frac{r}{1+d}\right)^n \right\} - 1 \right]$$

$$= \frac{mr}{1+d-r} \qquad \text{(where } k = r/(1+d)\text{)}$$

# CLV with profit arriving at the end

| | | | | | | |
|---|---|---|---|---|---|---|
| **Discounted to Present** | | $1/(1+d)^1$ | $1/(1+d)^2$ | $1/(1+d)^3$ | $1/(1+d)^4$ | |
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| **Margin** | | \$250 | \$250 | \$250 | \$250 | … |
| **Time (0 is present)** | **0** | **1** | **2** | **3** | **4** | |
| | Period 1 | Period 2 | Period 3 | Period 4 | | |

$$E[RLV] = \frac{m}{(1+d)} + \frac{m\,r}{(1+d)^2} + \frac{m\,r^2}{(1+d)^3} + \frac{m\,r^3}{(1+d)^4} + \cdots$$

# CLV with profit arriving at the end

$$E[CLV] = \frac{m}{(1+d)} + \frac{m\,r}{(1+d)^2} + \frac{m\,r^2}{(1+d)^3} + \frac{m\,r^3}{(1+d)^4} + \cdots$$

$$= \frac{m}{1+d} \sum_{n=0}^{\infty} \left(\frac{r}{1+d}\right)^n$$

$$= \frac{m}{1+d-r} \qquad \text{(where } k = r/(1+d))$$

# Cases

1. Not yet acquired customer (BKN, p. 111)
$$E[CLV] = \frac{m(1+d)}{1+d-r}$$

2. Already acquired customer
$$E[RLV] = \frac{mr}{1+d-r}$$

3. Not yet acquired customer, profit arrives at end
$$E[CLV] = \frac{m}{1+d-r}$$

# Ideal valuation

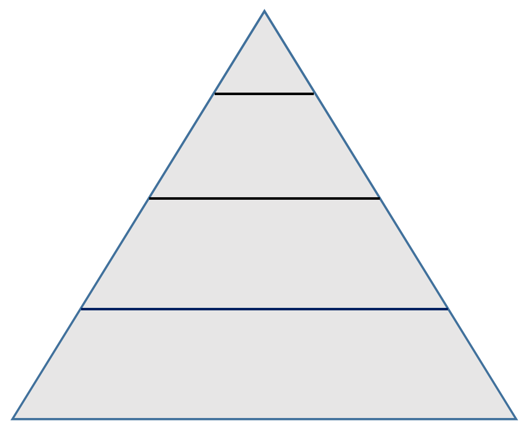
- Ideally, you could now calculate for every current customer and prospective customer, his or her CLV or RLV

- What can you do with this?

# Form segments based on valuation

Divide customers into tangible segments, separating high value customers from less valuable groups

"80/20 rule", i.e., 80% of CLV come from 20% of the customers.



# How much to acquire?

## Should we acquire a customer at cost? Up to what costs are we willing to acquire these customers?

- Assume a firm spends €2.00 per prospect for mailing/printing a catalog, which is sent to 1 million prospects. The response rate is 1%. (1% become customers)
- Prospects who become customers spend €200 per year, at the beginning of each year.
- A customer has a probability of renewing each year of 80%.
- The firm also spends €20 per year in marketing to each active customer
- The firm has a gross margin of 50% and uses a discount rate of 15%

Should the firm acquire this customer?

# Aside: acquisition costs per customer

- Often report total acquisition costs spent on total number of prospects

  €100 spent on 100 prospects

- But, what we want is amount spent per acquired customer.

  1 customer acquired, €100 per customer

  2 customers €50 per customer

  10 customers €10 per customer

# Aside: acquisition costs per customer

$$\text{cost per customer} = \text{cost per prospect} \,/\, \text{response rate}$$

# Other applications

How much would you be willing to spend to invest in a retention program that would increase retention by 10%?

How much would you be willing to spend to invest in a customer expansion program (e.g., cross-selling) that would increase margins by 10%?

Up to what amount would you be willing to acquire a small provider who has a customer base consisting of 1 million high cost, high margin smartphone subscribers (r = .9, m = 250) and 9 million low cost low margin subscribers (r = .6, m= 150)?

# Takeaways

- You should be able to create your own CLV/RLV formula to fit the situation at hand:
  - Timing of the revenues
  - Timing of the renewal decision

- <u>Conceptual</u> way to calculate profitability of customers, use it to evaluate retention, acquisition, cross-selling, firm valuation

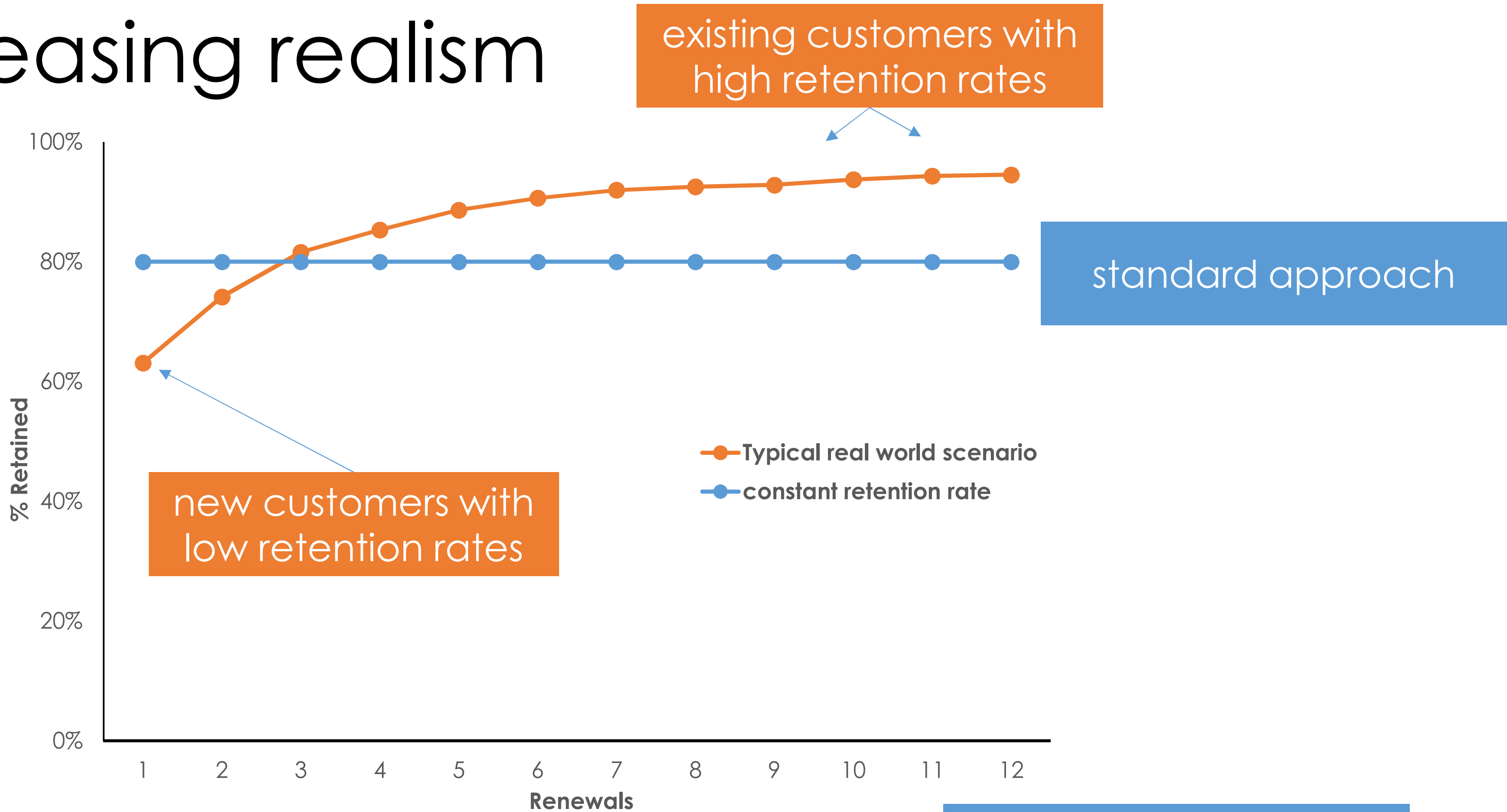
# Problems with simple CLV

- Where do these numbers come from?

- Typically we know about an "average" customer, but not a specific one..

- But using averages can be misleading

# Increasing realism




Why do retention rates increase?

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# Non-constant retention rates

- Who cares?
  - Our model is essentially an average retention rate for new and old customers, $\bar{r}$.

| Group | Retention rate (1-θ) | % of total customers |
|---|---|---|
| New | 0.70 | 50 |
| Old | 0.90 | 50 |

average = 0.80

# Non-constant retention rates (2)

- Who cares?
  - Our model is essentially an average retention rate for new and old customers, $\bar{r}$.

$$E[T] = \frac{1}{\theta}$$

| Group | Retention rate (1-θ) | % of total customers | Average lifetime |
|---|---|---|---|
| New | 0.70 | 50 | 3.3 |
| Old | 0.90 | 50 | 10.0 |

average r = 0.80

# Non-constant retention rates (3)

- Who cares?
  - Our model is essentially an average retention rate for new and old customers, $\bar{r}$.

$$E[T] = \frac{1}{\theta}$$

| Group | Retention rate (1-θ) | % of total customers | Average lifetime |
|---|---|---|---|
| New | 0.70 | 50 | 3.3 |
| Old | 0.90 | 50 | 10.0 |
| Average | 0.80 | | 6.7 |

BUT, using average r,
average lifetime = $\frac{1}{1-0.8} = 5$

$$= 3.3 * 0.5 + 10.0 * 0.5$$

# Non-constant retention rates (4)

- Who cares?
  - Our model is essentially an average retention rate for new and old customers, $\bar{r}$.

- The problem is that you underestimate lifetime (and CLV/RLV) if you use $\bar{r}$.

# Building a better model

- At the end of each period, each customer renews his contract with (constant and unobserved) probability $r$.
  - **Same as before**
    - $1 - r$ = "churn"
    - $r$= "renew"

- $r$ varies across customers
  - **New:** how does $r$ vary across customers?