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#SASGF

Customer Lifetime Value

Presenter

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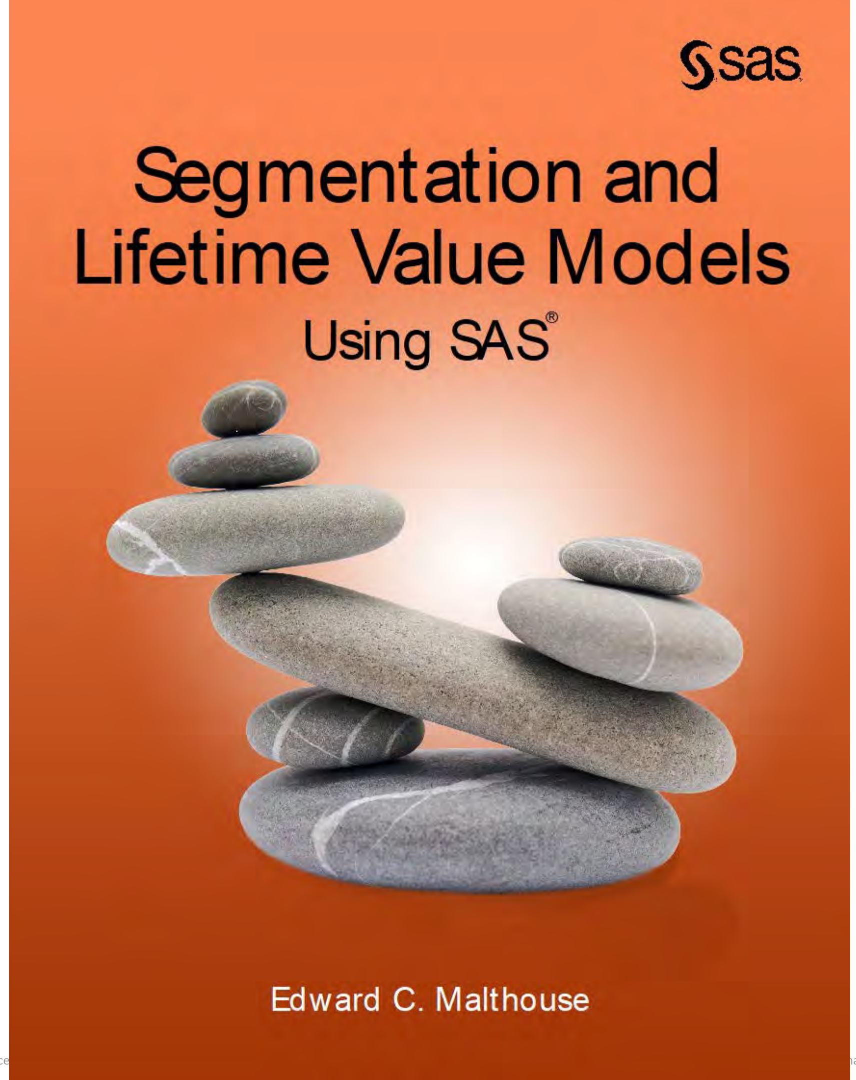
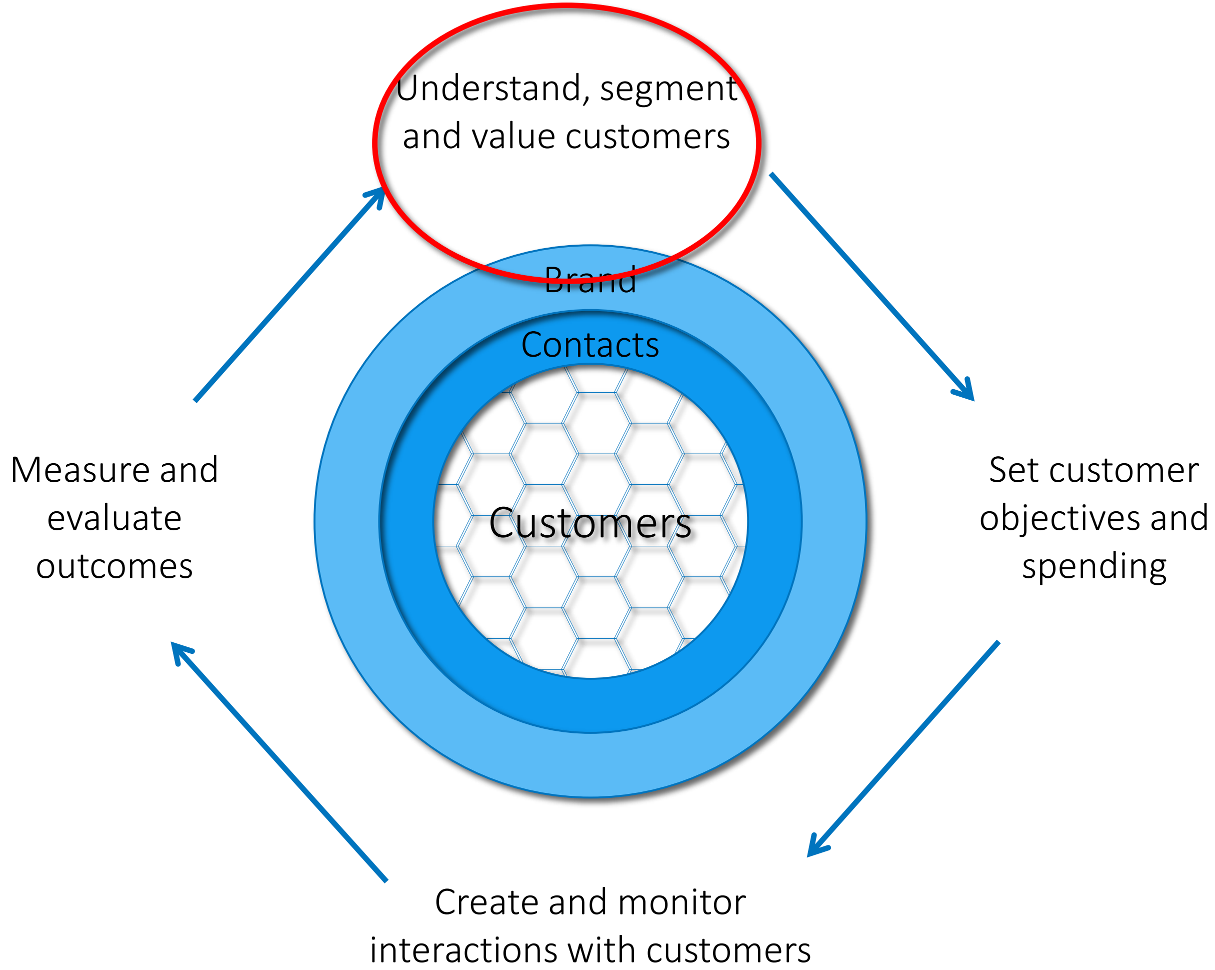
Customer Lifetime Value


Segmentation and
Lifetime Value Models
Using SAS®
Edward C. Malthouse


Understand, segment and value customers
Brand
Contacts
Customers
Set customer objectives and spending
Create and monitor interactions with customers
Measure and evaluate outcomes

Multisystem Operator (MSO) case:

- An MSO provides cable TV (basic, expanded and premium), 3 speeds of high-speed data (HSD) and land-line telephone service
- Customers subscribe to different combinations of services. They can add or drop services at any time, and even terminate the relationship
- Those who terminate could subscribe to satellite TV services and/or HDS/phone services from telephone companies
- They have a database of 20M customers
- How can the increase the value of their customers?

Possible Segments

	Percent of database	Video Mean	HSD Mean	Phone Mean	Retention Rate	Life Time Revenue
HSD basic	15%	$0	$35	$0	97.1%	$900
HSD star	10%	$0	$60	$0	97.0%	$1,500
HSD/Video basic	20%	$65	$40	$0	97.1%	$2,700
HSD/phone	5%	$0	$40	$25	98.4%	$2,500
HSD/Video star	15%	$100	$50	$0	97.7%	$4,600
Triple basic	15%	$75	$35	$25	98.8%	$6,200
Triple	15%	$110	$40	$20	98.9%	$8,200
Triple star	5%	$150	$45	$15	99.0%	$10,600

More services imply more loyalty???

Basic Concepts

- *Customer profitability (CP)* is the difference between the revenues earned from, and the costs associated with, the customer relationship during a specified period.
- *Lifetime Value* is the present value of all *future* cash flows attributed to the customer relationship.
- *Long-term value* limits "future" to finite window.
- *Customer equity (CE):* the sum of CLV over individuals within the group. CE emphasizes that customers are *financial assets of a company.*

True or False:

If a contact point results in an order for $100, then the value of the response is $100 – relevant costs

True or False:

The firm should identify their best customers and invest more marketing resources in them.

Setting Objectives

- The objective for all customer segments should be to increase customer lifetime value (CLV).
- CLV is the discounted sum of future cash flows due to a relationship.
  - CLV refers to the future
- The objective is to *increase* CLV (not to spend more money on high CLV customers)

Objective: Increase CLV

- Remain customer longer, e.g., increase retention rate
- Increase spending level
  - Buy from more product categories (e.g., as a way of increasing share of wallet)
  - Buy higher-margin products
  - Buy more often
- Be less costly to serve
  - Banks: migrate customers from tellers to ATMs
  - Netflix: use download rather than mail
  - Airlines/hotels encourage customers to use their web sites
  - Consolidate order
- Reduce marketing expenses, e.g., switch to longer-term contracts
- Register, sign up for newsletter, etc.
- Reactivate
- Referrals, WOM

Estimating CLV

- Gone for good (aka bangers): customers generate period cash flows until they "die," and then they never come back, e.g., subscriptions (cable TV, cell phones), services, media.
  - Simple retention model
  - General retention model / survival analysis
- Always a share (aka whimpers): customer inactivity during a period does not mean the customer is "gone," e.g., retailers, airlines, hotels, nonprofits.
  - Markov chain models
  - Regression approaches
  - Probability models, e.g., NBD/Pareto and beta-geometric

The Simple Retention Model

- Customer generates cash flow M each period t=0, 1, 2, … until canceling during period T.
- Customer may cancel during any period, and never returns.
- The probability that a customer is retained at time t is r (*retention rate*). Discount rate is d.
- The event that a customer cancels immediately before payment t has a *geometric* distribution with

$$P(T=t) = r^{t-1}(1-r)$$

- Random variable T has mean $E(T) = 1/(1-r)$
- Mean LTV

Cash Flow Comes At	
End of Period	Beginning of Period
$\frac{mr}{1+d-r}$	$\frac{m(1+d)}{1+d-r}$

Example

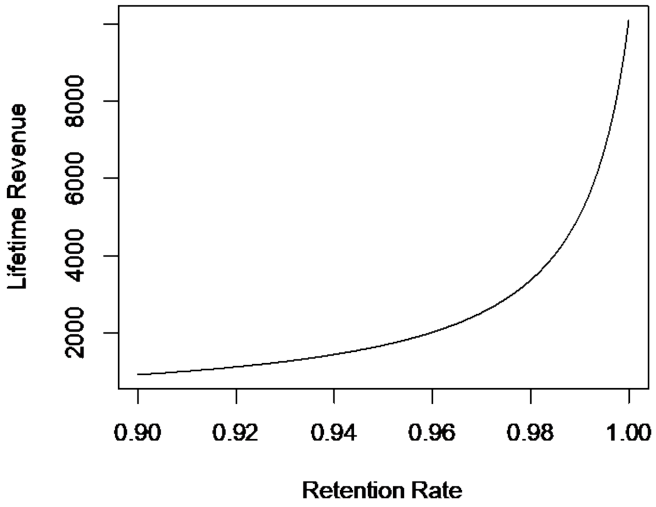
Netflix acquires customers, who generate profits of $10/month until they cancel the service. Customers may cancel at any time. Payments occur the beginning of the month. Compute the expected cancellation time and life-time value, assuming a monthly discount rate of 1% and a monthly retention rate of 95%. Find CLV.

Answer: m=$10, d=.01, r=95%

$$CLV = \frac{\$10(1+.01)}{1+.01-.95} = \$168.33$$

The importance of high retention rates

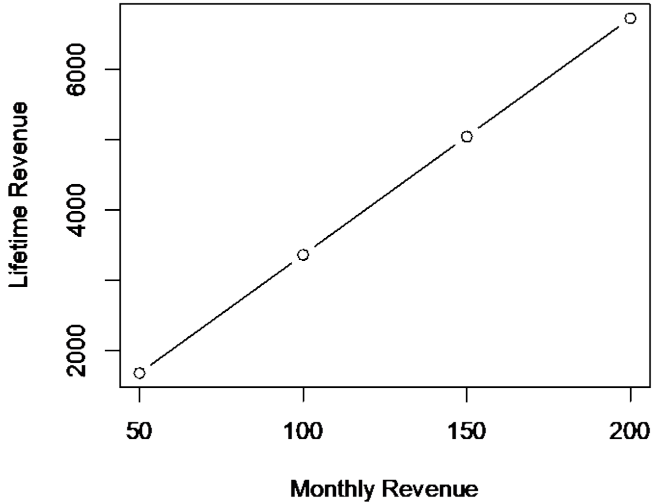
Retention Rate (*R*)	Expected Payments	Lifetime Revenue
.9	1/(1-.9)=10	$918
.92	12.5	$1122
.94	16.67	$1443
.95	1/(1-.95)=20	$1683
.96	25	$2020
.97	33.33	$2525
.98	1/(1-.98)=50	$3367
.99	100	$5050
.995	200	$6733
1	Forever	$10,100



- This assume $100 revenue per month and a monthly discount rate of 1%
- Lifetime revenue increases quickly with small changes in the retention rate (when it is high, but not low)!

The effect of cross/up-selling

Monthly Revenue (*M*)	Lifetime Revenue
$50	$1683
$100	$3367
$150	$5050
$200	$6733



- This assumes a 98% retention rate and 1% monthly discount rate
- Note that cross/up-selling has a linear effect on lifetime revenue, while changes in the retention rate have a nonlinear effect.
- With low retention rates, CLV more sensitive to *M*

Estimating Retention Rates

- Estimation difficult because not all customers have canceled (i.e., they are censored)
- Suppose *n* customers have canceled, and *m* have not (censored).
- Let $t_1, t_2, \ldots, t_n$ be cancel times and $c_1, c_2, \ldots, c_m$ be the censoring
- Then (1 – number cancels/number flips)

$$\hat{r} = 1 - \frac{n}{\sum t_i + \sum c_i}.$$

Example (R=Retained, C=Canceled)

Id	1	2	3	4	5	6	7	8	9	10	11	12	*t*	*c*
1						R	R	C					3	
2		R	R	R	R	R	R	R	R	R	R	C	11	
3	R	R	R	R	R	R	R	R	R	R	R	R		12
4						R	R	R	R	C			5	
5	R	R	R	R	R	R	R	R	R	R	R	R		12
6					R	R	R	R	R	R	R	R		8
7					R	R	R	R	R	R	R	C	8	
8	R	R	C										3	

$\Sigma\, t_i = 3 + 11 + 5 + 8 + 3 = 30$ $\Sigma\, c_i = 12 + 12 + 8 = 32$

$$\hat{r} = 1 - \frac{5}{30+32} = 92\%.$$

The General Retention Model (GRM)

- An organization acquires customers who generate cash flows each discrete period t=0, 1, 2, … until canceling during period T
- Cancelation time T is a random variable
- Customer may cancel during any period, perhaps with a penalty and never return
- The event that a customer cancel in a period is independent of other periods
- The probability that customer is retained at time t is r_t

Three Fundamental Functions

- The *survival function* is the chance that the customer cancels at time t or later, or equivalently, that the customer is retained the first $t-1$ periods:

$$S(t) = P(T \geq t) = \prod_{i=1}^{t-1} r_i = r_{t-1}S(t-1)$$

  For example, let R_t be the event that the customer is retained in period t. Using independence,

$$P(R_1 \cap R_2) = P(R_1) \times P(R_2) = r_1 \times r_2.$$

- The *probability mass function* (PMF or "PDF") of T gives the probability that a customer is retained during the first $t-1$ periods and not retained during period t,

$$f(t) = P(T = t) = S(t)(1 - r_t) = S(t) - S(t+1).$$

- The quantity $\pi_t = 1 - r_t$ is the conditional probability that the customer cancels at time t, given that the customer has not already canceled, and is sometimes called the *hazard rate*:

$$\pi_t = P(T = t | T \geq t) = \frac{P(T = t)}{S(t)} = 1 - r_t.$$

CLV and the GRM

- Let m_t be the discounted cash flows at time $t = 0, 1, \ldots$.
- Lifetime value is a function of cancelation time t

$$\mathrm{CLV}(t) = \sum_{i=0}^{t-1} m_i.$$

- The expected value of $\mathrm{CLV}(T)$ is

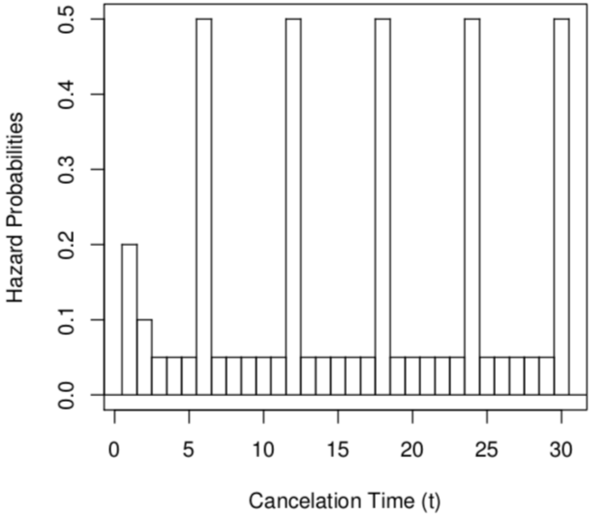
$$E[\mathrm{CLV}(T))] = \sum_{t=1}^{\infty} P(t)\mathrm{CLV}(t) = \sum_{t=1}^{\infty} P(t) \sum_{i=0}^{t-1} m_i$$

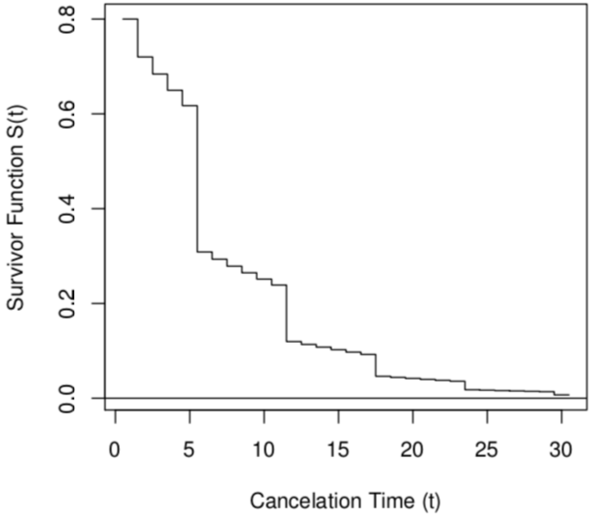
Cell Phone Example

A hypothetical cell phone provider offers only six-month contracts, where customers pay $50 at the beginning of each month. Suppose that 80% are retained in the first month, 90% in the second month, and 95% thereafter except at the times of contract renewal (months 6, 12, 18, …), when the retention rate is 50%. The lower retention rates during the first two months reflects an initial “burn-in” period. Find the expected lifetime revenue assuming a monthly discount rate of 1%.

A	B	C	D	E	F	G
t	$m_t = 50/1.01^t$	r_t	$S(t) = P(T \geq t) = S(t-1)r_{t-1}$	$P(t) = S(t) - S(t+1)$	$m_{t-1}S(t)$	$P(T)PV_t$
0	50					
1	$50/1.01$	0.8	1	$1 - .8 = .2$	50.00	10.00
2	$50/1.01^2$	0.9	$.8S(1) = .8$	$.8 - .72 = .08$	39.60	7.96
3	$50/1.01^3$	0.95	$.9S(2) = .72$	$.72 - .684 = .036$	35.29	5.35
4	48.05	0.95	$.95S(3) = .684$	.0342	33.19	6.74
5	47.57	0.95	$.95S(4) = .6498$	.0325	31.22	7.96
6	47.10	0.5	$.95S(5) = .6173$	.3087	29.37	90.33
7	46.64	0.95	$.5S(6) = .3087$	.0154	14.54	5.24
8	46.17	0.95	$.95S(7) = 0.2932$	.0147	13.67	5.67
9	45.72	0.95	$.95S(8) = 0.2786$	.0139	12.86	6.03
10	45.26	0.95	$.95S(9) = 0.2646$	.0132	12.10	6.33
11	44.82	0.95	$.95S(10) = 0.2514$	.0126	11.38	6.58
12	44.37	0.5	$.95S(11) = 0.2388$	.1194	10.70	67.87
13	43.93	0.95	$.5S(12) = 0.1194$	.0060	5.30	3.66
14	43.50	0.95	$.95S(13) = 0.1134$	.0057	4.98	3.72
⋮	⋮	⋮	⋮	⋮		
90	20.42	0.5	0.0000	0.0000	0.00	0.00
⋮	⋮	⋮	⋮	⋮	⋮	
Sum				1	337.09	337.09

Hazard and Survival Functions





Estimating GRM Retention Rates

Survival analysis is a set of methods for understanding questions about the time when some “event” occurs (*T*)

- When is the event likely to occur (baseline hazard function)?
- How do static characteristics affect the hazard?
- How do things that happen over time-—time-dependent covariates—affect the hazard?

Survival Models in SAS

- Kaplan-Meier (KM) and lifetable methods: study baseline hazard function (proc lifetest)
- Discrete-time survival model (proc logistic)
- Many other approaches available:
  - Accelerated failure-time model (proc lifereg)
  - Cox proportional hazard model (proc phreg)

Educational Service Example

Censor	1	2	3	4	5	6	7	8	9	10	11	12	Total
	Time of Cancelation/Censoring												
No	0	4	16	20	37	28	61	24	19	13	10	13	245
Yes	3	0	2	1	7	33	49	63	30	16	34	188	426
Total	3	4	18	21	44	61	110	87	49	29	44	201	671

			Kaplan-Meier			Life Table	
T	Number Cancel d_t	Number Censor c_t	Number at Risk n_t	Retention Rate $1 - d_t/n_t$	Survivor Function $S(t)$	Number at Risk n_t	Survivor Function $S(t)$
1	0	3	671	1.0000	1.0000	669.5	1.0000
2	4	0	668	0.9940	0.9940	668	0.9940
3	16	2	664	0.9759	0.9701	663	0.9700
4	20	1	646	0.9690	0.9400	645.5	0.9400
5	37	7	625	0.9408	0.8844	621.5	0.8840
6	28	33	581	0.9518	0.8418	564.5	0.8402
7	61	49	520	0.8827	0.7430	495.5	0.7367
8	24	63	410	0.9415	0.6995	378.5	0.6900
9	19	30	323	0.9412	0.6584	308	0.6474
10	13	16	274	0.9526	0.6271	266	0.6158
11	10	34	245	0.9592	0.6015	228	0.5888
12	13	188	201	0.9353	0.5626	107	0.5173

```
DATA service1yr;
INPUT count censored bigT;
CARDS;
3 1 1
4 0 2
16 0 3
2 1 3
20 0 4
1 1 4
37 0 5
7 1 5
28 0 6
33 1 6
61 0 7
49 1 7
24 0 8
63 1 8
19 0 9
30 1 9
13 0 10
16 1 10
10 0 11
34 1 11
13 0 12
188 1 12
run;
```

```
/* proc lifetest gives KM estimates by default */
PROC LIFETEST DATA=service1yr;
  time bigT*censored(1);
  FREQ count;
run;
```

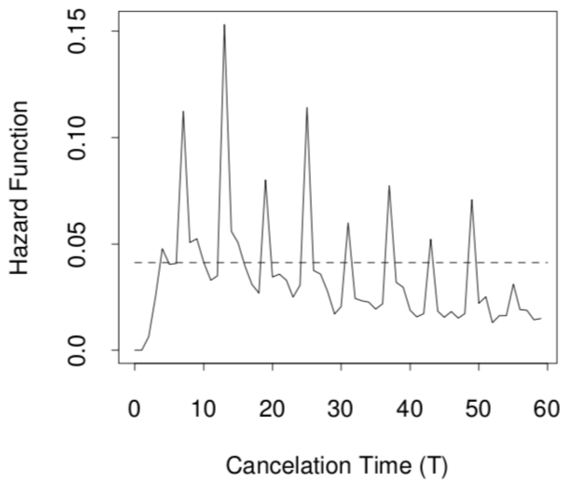
Product-Limit Survival Estimates

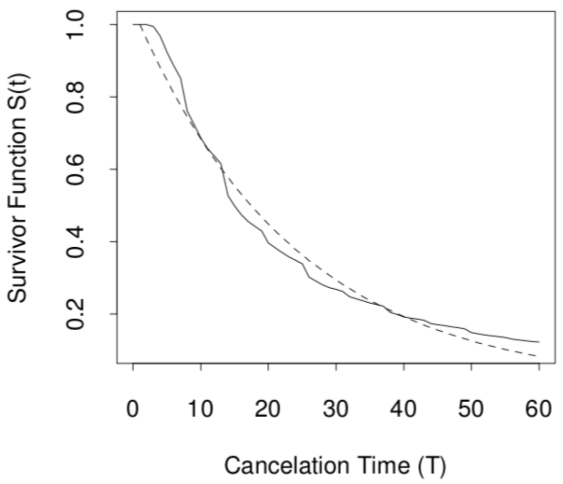
bigT	Survival	Failure	Survival Standard Error	Number Failed	Number Left	Freq
0.0000	1.0000	0	0	0	671	0
1.0000*	.	.	.	0	668	3
2.0000	0.9940	0.00599	0.00299	4	664	4
3.0000	0.9701	0.0299	0.00659	20	648	16
3.0000*	.	.	.	20	646	2
4.0000	0.9400	0.0600	0.00919	40	626	20
4.0000*	.	.	.	40	625	1
5.0000	0.8844	0.1156	0.0124	77	588	37
5.0000*	.	.	.	77	581	7
6.0000	0.8418	0.1582	0.0142	105	553	28
6.0000*	.	.	.	105	520	33
7.0000	0.7430	0.2570	0.0173	166	459	61
7.0000*	.	.	.	166	410	49
8.0000	0.6995	0.3005	0.0184	190	386	24
8.0000*	.	.	.	190	323	63
9.0000	0.6584	0.3416	0.0196	209	304	19
9.0000*	.	.	.	209	274	30
10.0000	0.6271	0.3729	0.0205	222	261	13
10.0000*	.	.	.	222	245	16
11.0000	0.6015	0.3985	0.0212	232	235	10
11.0000*	.	.	.	232	201	34
12.0000	0.5626	0.4374	0.0224	245	188	13
12.0000*	.	.	.	245	0	188

NOTE: The marked survival times are censored observations.

Educational Service 5-year

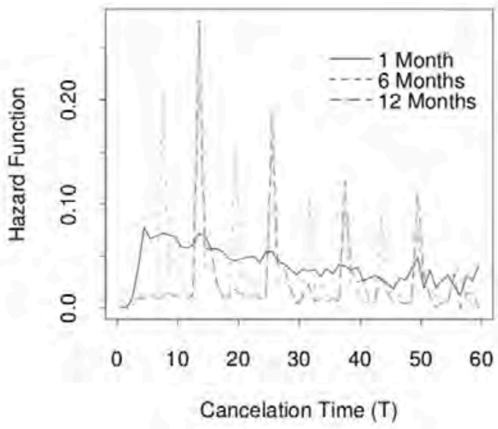
```
PROC LIFETEST DATA=curr.service5yr METHOD=LIFE INTERVALS= 1 TO 60 BY 1 OUTSURV=out1;
  TIME bigT*censored(1);
  FREQ count;
run;
```

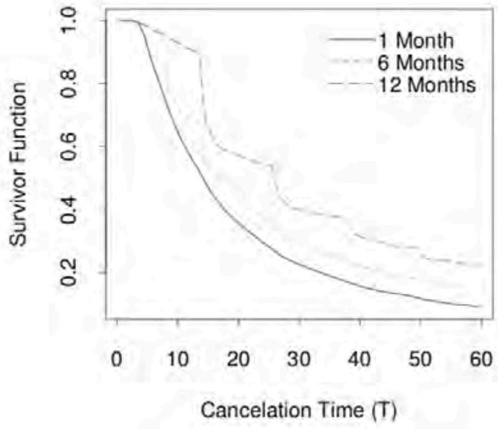




5-Year with Stratification

```
PROC LIFETEST DATA=curr.service5yr METHOD=LIFE INTERVALS= 1 TO 60 BY 1;
  STRATA startlen;
  TIME bigT*censored(1);
  FREQ count;
RUN;
```





Key Takeaways

- Plan beyond the next purchase
- Amount you can spend on an activity is bounded above by the change in CLV that results, i.e., ROI
- Use simple retention model for banger situations, migration model for whimper
- SAS survival functions essential for studying retention rates.

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