An Introduction to Survival Analysis

Dr Barry Leventhal

Henry Stewart Briefing on Marketing Analytics
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Agenda

- Survival Analysis concepts
- Descriptive approach
- 1st Case Study – which types of customers lapse early
- Predicting survival times
- 2nd Case study – lifetimes of mobile phone customers
- Business applications of survival analysis
- Applications to different industries and problems
- Summary of business benefits

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Tracking the Customer Lifecycle - Financial Services

Golden Years

Moving up the Ladder

Forming a Family

Starting Out

Financial Indicators

Mortgage
Loan
Protection
Joint Accounts

Life Insurance
Loans
Higher monthly debits

Investments
Increased monthly deposits
Retirement Plans

Income Change
Retirement
Annuity
Move home

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Tracking the Customer Lifecycle – Telco

	Kids	Young Adults	Middle Aged	Golden Years
				
Features	Funky Phone Pay as You Go Heavy texting	Pay Monthly Smart Phone Data users	Good to talk Bluetooth Location-based services	Simpler handset Skype to grandchildren Emergency services

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What is Survival Analysis?
- Analysis of ***TIME***

- To understand length of time before an event occurs
- To predict time till next event
- To analyse duration of time in a particular state

"Event" can be:

- Customer churn
- Take-up new product
- Default on credit
- Make next purchase
- …

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How does Survival Analysis differ from Churn Analysis?

Churn Analysis

- **Examines customer churn within a set time window e.g. next 3 or 6 months**
- **Predicts likelihood of customer to churn during the defined window**
- **No indication about subsequent risk of churn**
- **Does not provide information on customer lifetime value**

Survival Analysis

- **Examines how churn takes place over time**
- **Describes or predicts retention likelihood over time**
- **Identifies key points in customer lifecycle**
- **Informs customer lifetime value**

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The value of understanding both Churn and Survival Time

Churn

- **Act on imminent event**
- **Understand combination of factors that are causing the current high probability of churn**
- **Understand why some customers churn**

Survival

- **Plan the customer lifecycle**
- **Understand how to extend time as customer before churn is imminent**
- **Understand why some customers are retained longer than others**
- **Act on predicted changes in survival time**

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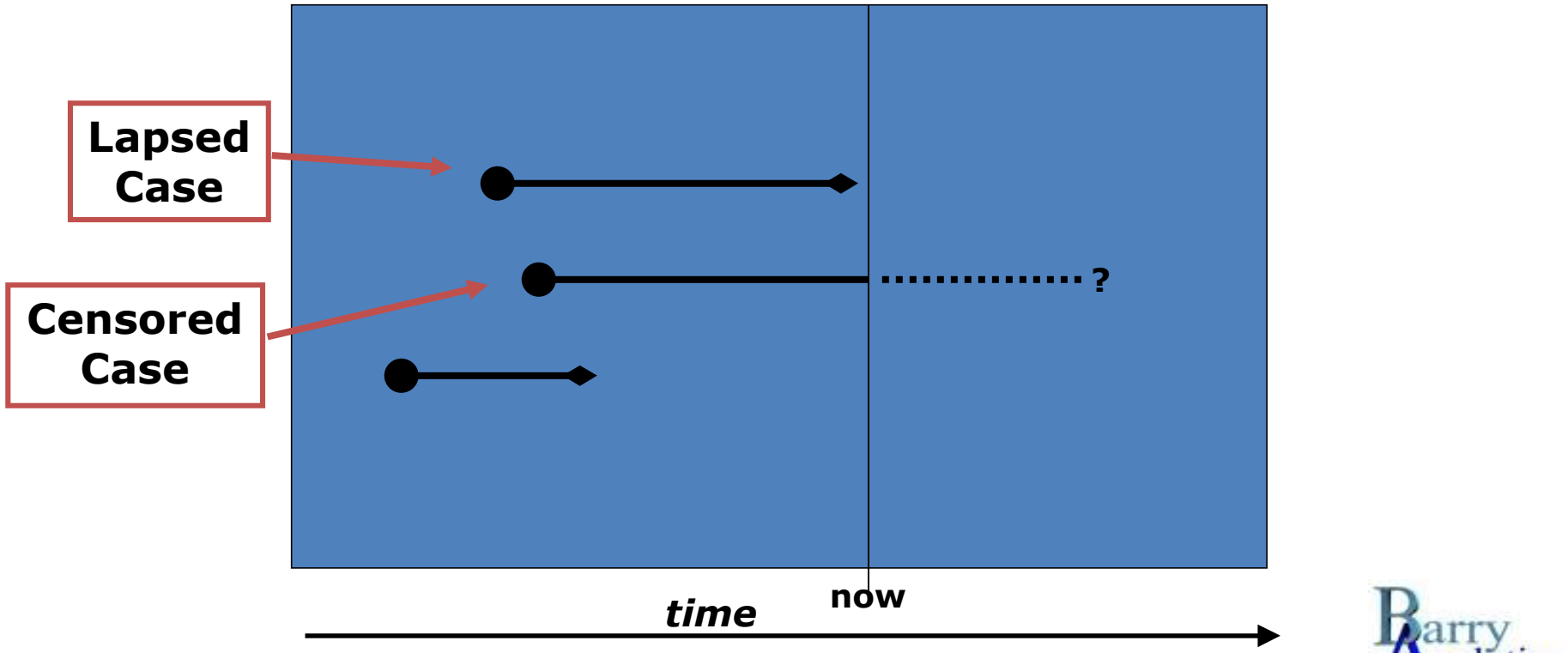
Customer Survival – a Censored Data Problem

- You know most about the customers you've lost
- You want to predict the future retention of customers you haven't yet lost



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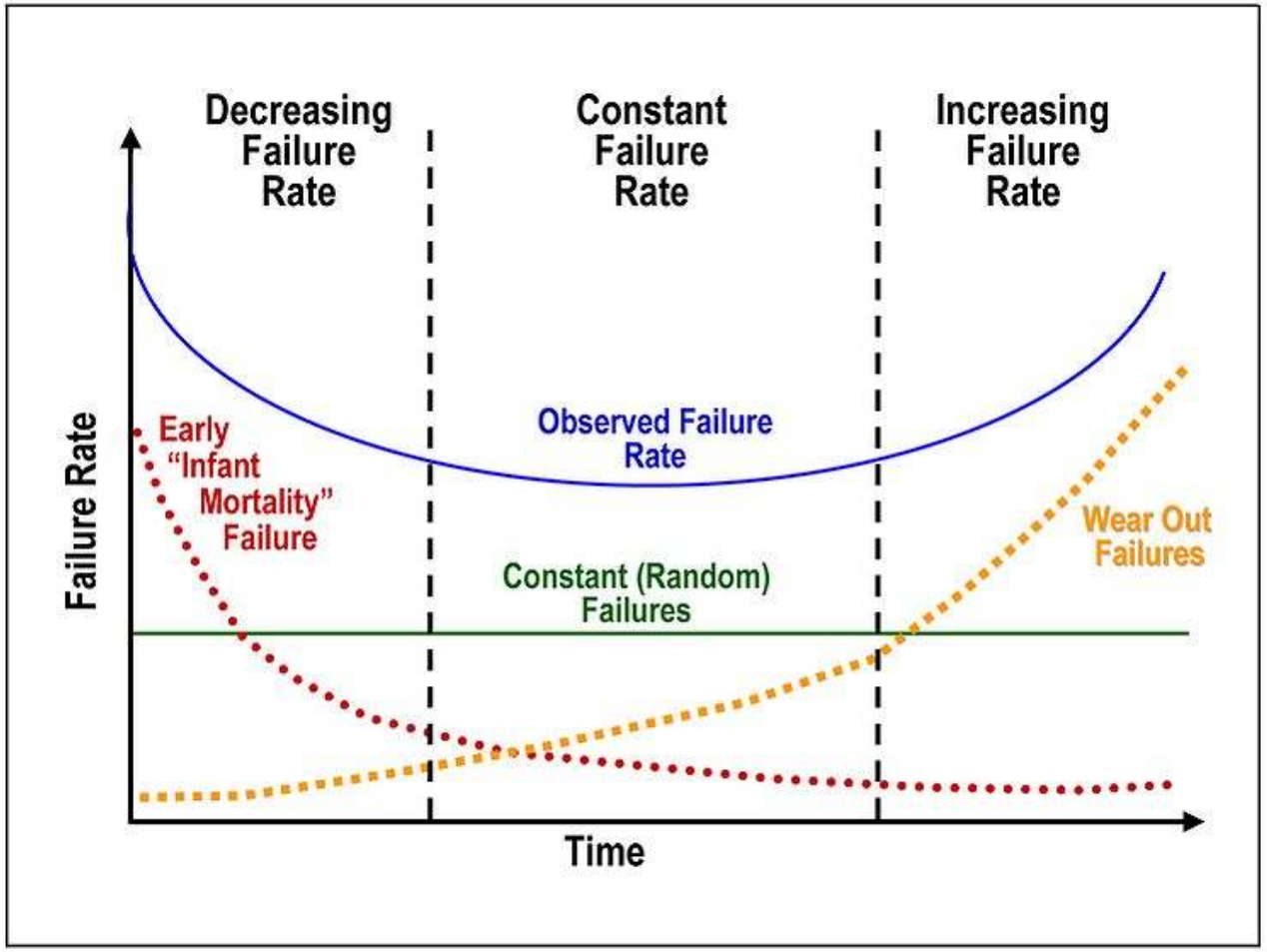
Terminology used in Survival Analysis

- Hazard Function
  - the risk of churn in a time interval after time t, given that the customer has survived to time t
  - usually denoted as: h(t)

- Survival Function
  - the probability that a customer will have a survival time greater than or equal to t
  - usually denoted as: S(t)

- Hazard and Survival functions are mathematically linked - by modelling Hazard, you obtain Survival

Example Hazard Function – the classic "Bathtub" curve



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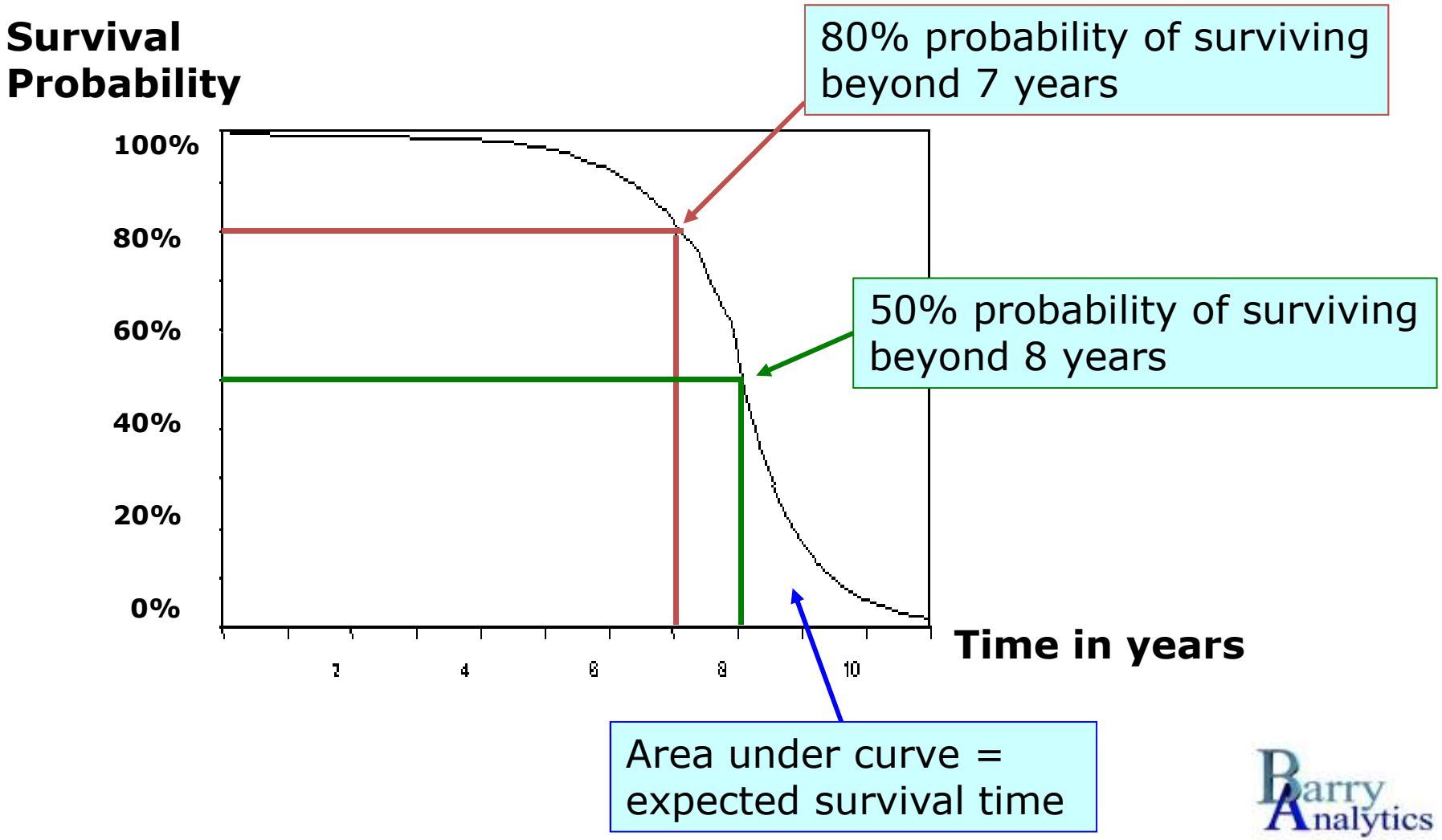
Example Survival Curve



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Descriptive Survival Analysis

- Compute the survival curve for your customer base
  - Understand 'natural patterns' in customer survival
  - Identify key points where survival rates fall
- Compare survival curves between
  - Demographic groups
  - Customer segments
  - Sales channels
  - Product plans, etc
- Identifies key factors influencing 'time till churn'
- Enables you to predict monthly numbers of churners – but does not identify which customers will churn

- Most widely used method: Kaplan-Meier

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1st Case Study
Which types of customers lapse early?

- Financial services company cross-selling Personal Accident insurance via telemarketing
- Company experienced an increase in monthly lapse rates and reduction in retention levels
- Wanted to understand which types of customers were lapsing early and identify optimal intervention point for reducing lapse rates

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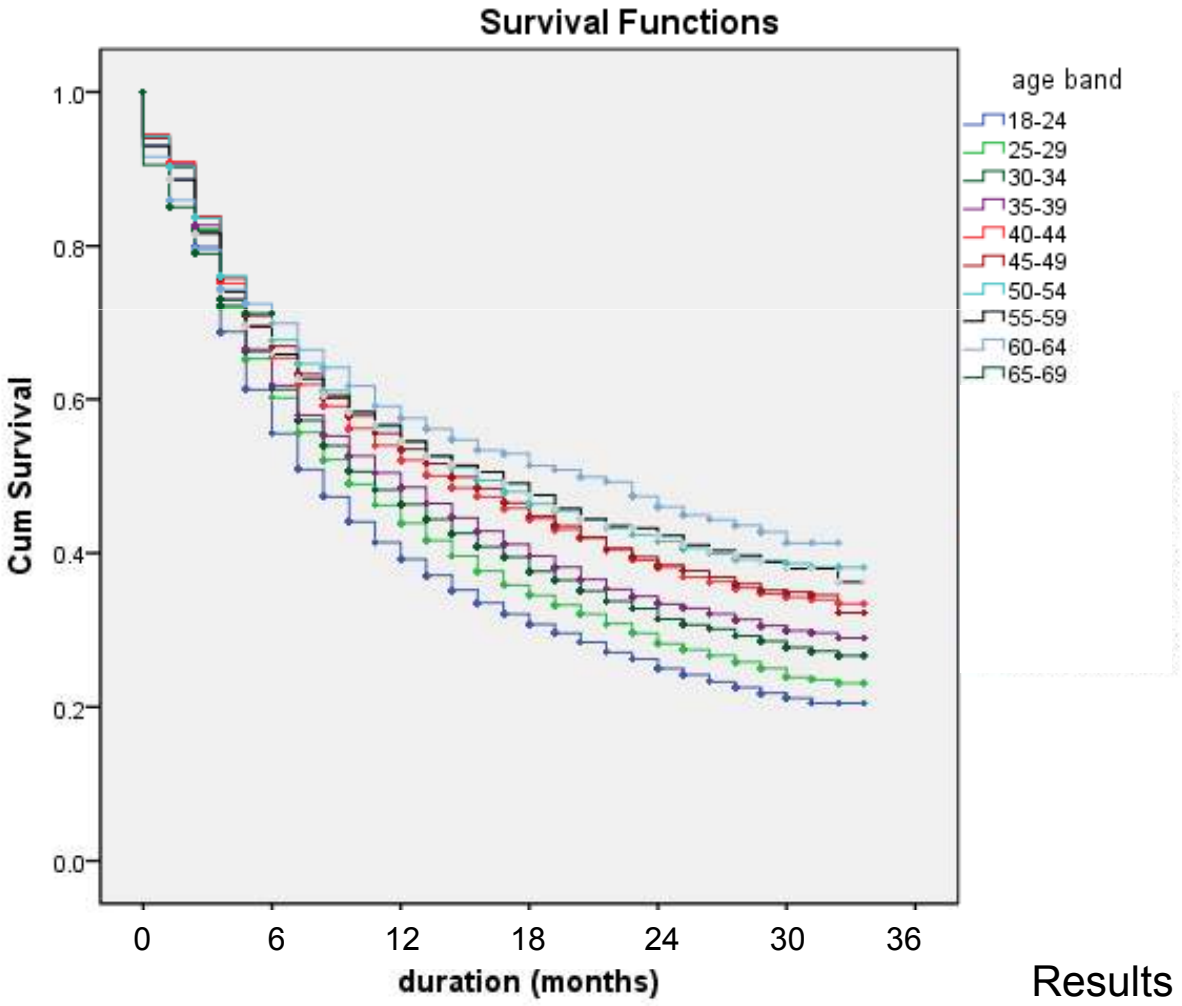
Descriptive Survival Analysis – by Age Bands

- Survival chances increase with Age
  - the older the customer, the longer they are likely to retain PA insurance



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Results have been disguised

Predicting Survival Times

- Hazards Model
  - a model for predicting the hazard of an individual

- Cox Proportional Hazards Model
  - a particular form of hazards model, for predicting hazard as a combination of survival time and individual characteristics

$$h(t,x,b) = h_o(t) \,.\, e^{xb}$$

Baseline hazard

Individual effect: data value x, regression coefficient b

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Case Study Example: Survival Model for European Pre-pay Mobile Phone Operator

- Data from the Data Warehouse extracted for a sample of pre-pay mobile customers
- Both active customers and previous churners were represented
- Wide range of variables and attributes were extracted, that could help to explain length of customer relationship

Source of Case Study: Teradata Partners User Group Conference

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Example data for Pre-pay Survival Analysis

- Calling data
  - Inbound / Outbound
  - Home / Roam
  - Voice / SMS (inbound and outbound)
  - Voice Mail usage
  - In-network / Out of network
  - Dropped calls
  - Customer care interactions
  - Product usage
  - Volatility of call patterns

- Top-up data
  - Frequency of top-ups
  - Time between top-ups
  - Value of top-ups
- Customer data
  - Age
  - Gender
  - Geodemographic data - postcodes
  - Handset information
  - Registered

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Example Results: Key factors that influence lifetime of a pre-pay customer

- Prepayment top-up behaviour
  - High value prepayments
  - Medium value prepayments
  - Frequent prepayments made
- Calling behaviour in home calling area
  - Value of outbound voice calls
  - Number of inbound calls and text messages
  - Use of added-value services, such as voicemail
  - Out of network outbound voice calls
- Customer Demographics
  - Gender
  - Age
  - Geodemographic segments
- Quality issues

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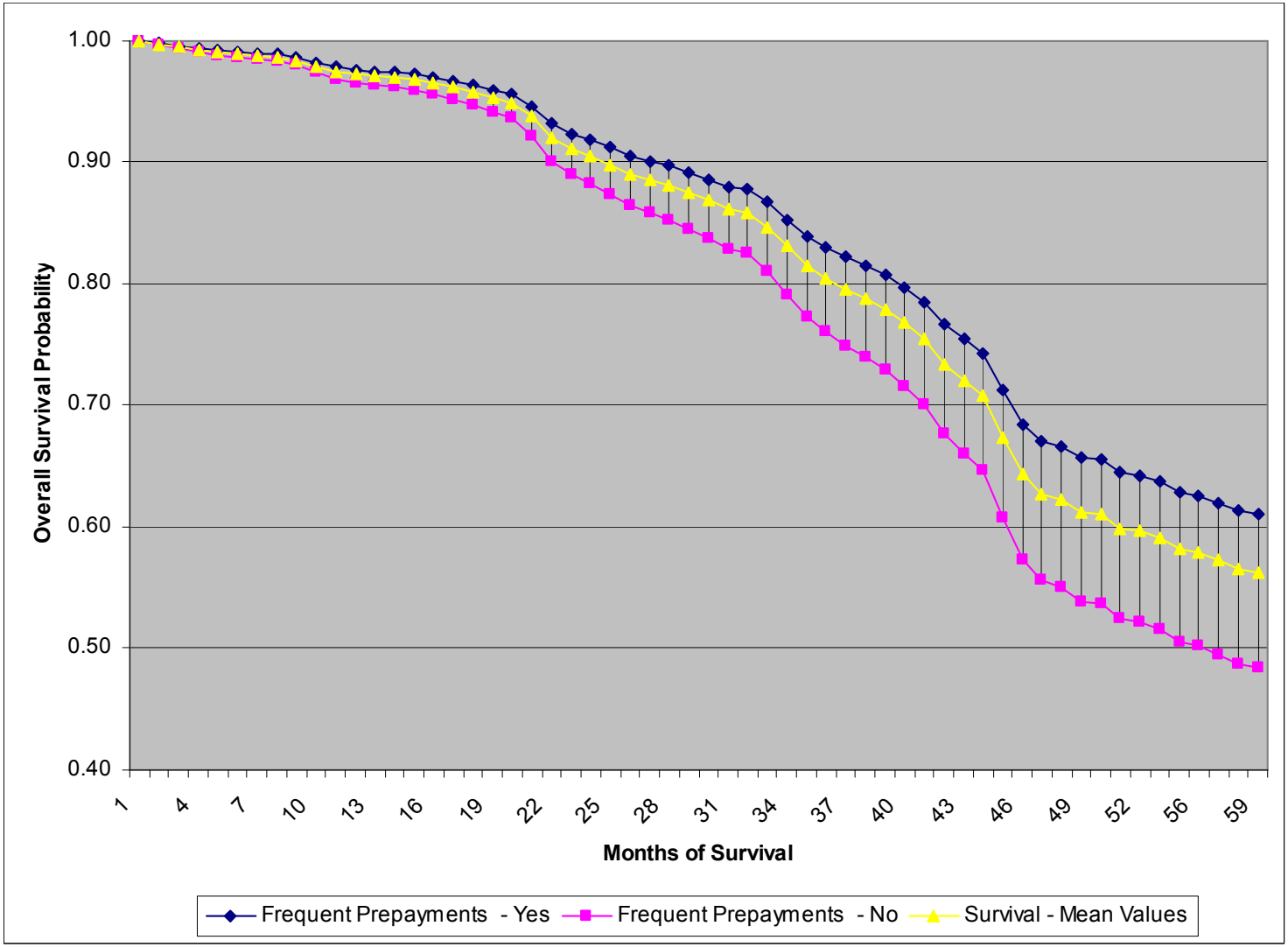
Example Results: How Factors Influence Survival – Customers making frequent pre-payments



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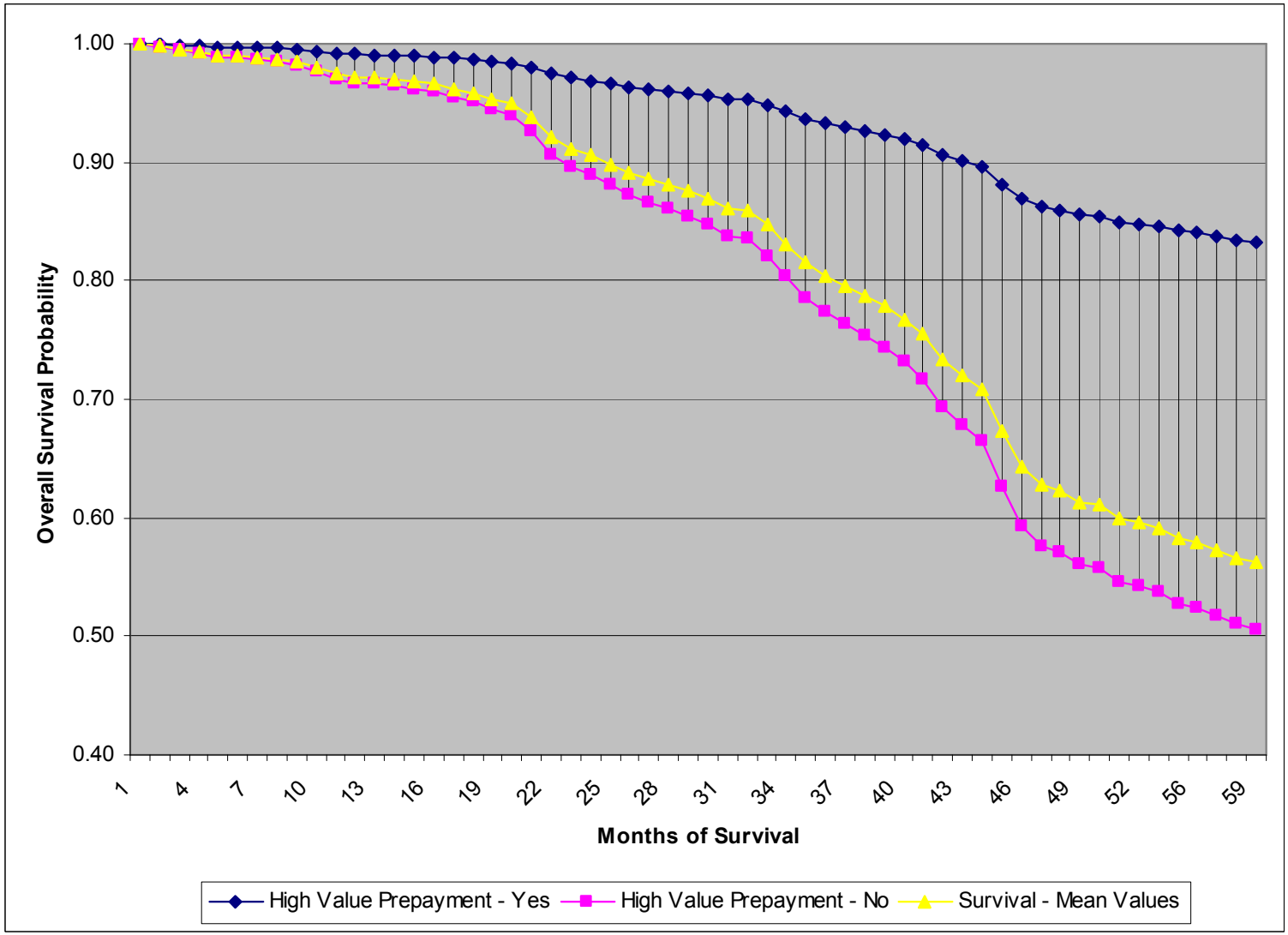
Example Results: How Factors Influence Survival – Customers making high-value pre-payments



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Outputs from Predictive Analysis

- Survival curve – all customers and sub-sets
- Key factors influencing "time till churn"
- Survival model – can apply to individual customers
  - Customers should be regularly rescored, and their scores saved and monitored

Business Applications of Survival Analysis
Customer Management

- Examine and act on predicted customer survival rates over time:
  - Identify customers whose predicted survival rates are low or rapidly falling
  - Examine implications if a key behaviour could be changed
  - Take the right marketing actions aimed at influencing behaviours with greatest impact on predicted survival rates
  - Address some behaviours by modifying service design or terms of use

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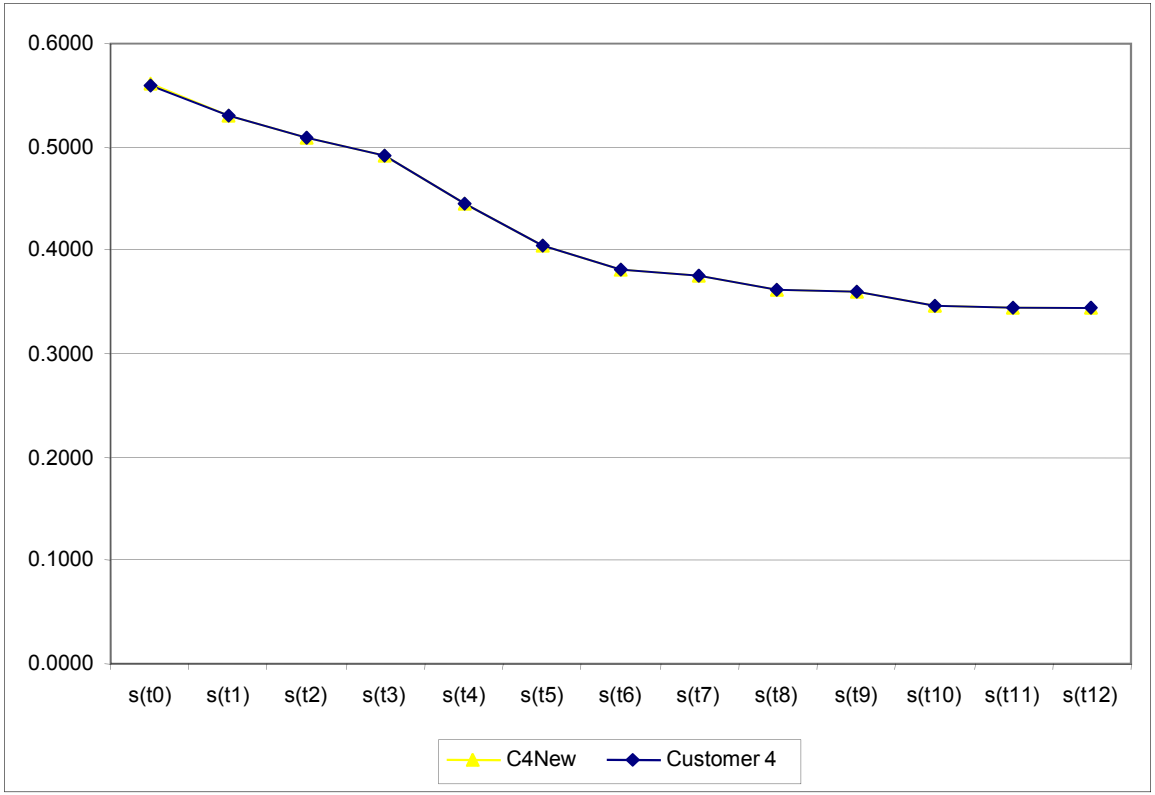
What are the implications of changes in the customer's behaviour on predicted survival?



Frequent Prepayments	**0**
20 Euro Prepayment	**0**
30 Euro Prepayment	**0**
Recent Outbound Voice Calls	**2**
Outbound Voice Calls 2 Months ago	**8**
Recent Inbound Voice Calls	**2**
Recent Text Messages Sent	**2**
Text Messages Sent 2 Months ago	**3**
Recent Voicemail Use	**5**
Recent Out-of-network Voice Calls	**5**

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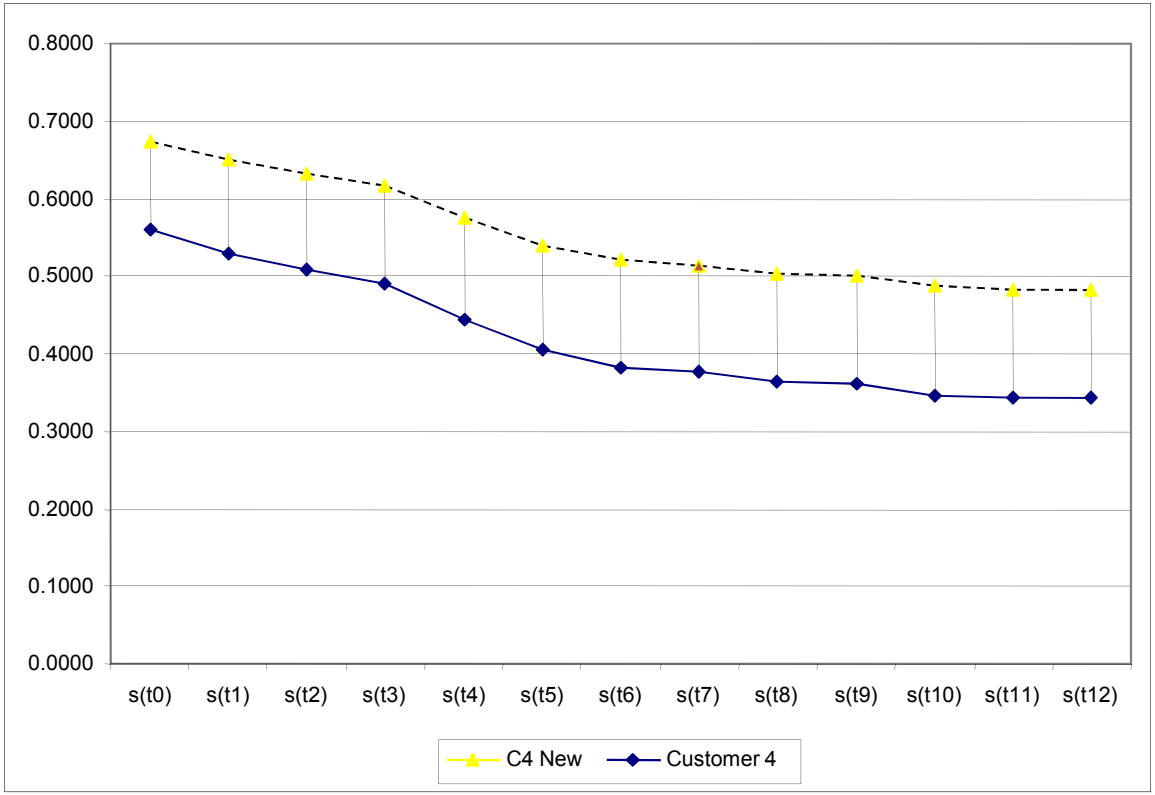

Frequent Prepayments	1
20 Euro Prepayment	0
30 Euro Prepayment	0
Recent Outbound Voice Calls	2
Outbound Voice Calls 2 Months ago	8
Recent Inbound Voice Calls	2
Recent Text Messages Sent	2
Text Messages Sent 2 Months ago	3
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Recent Out-of-network Voice Calls	5

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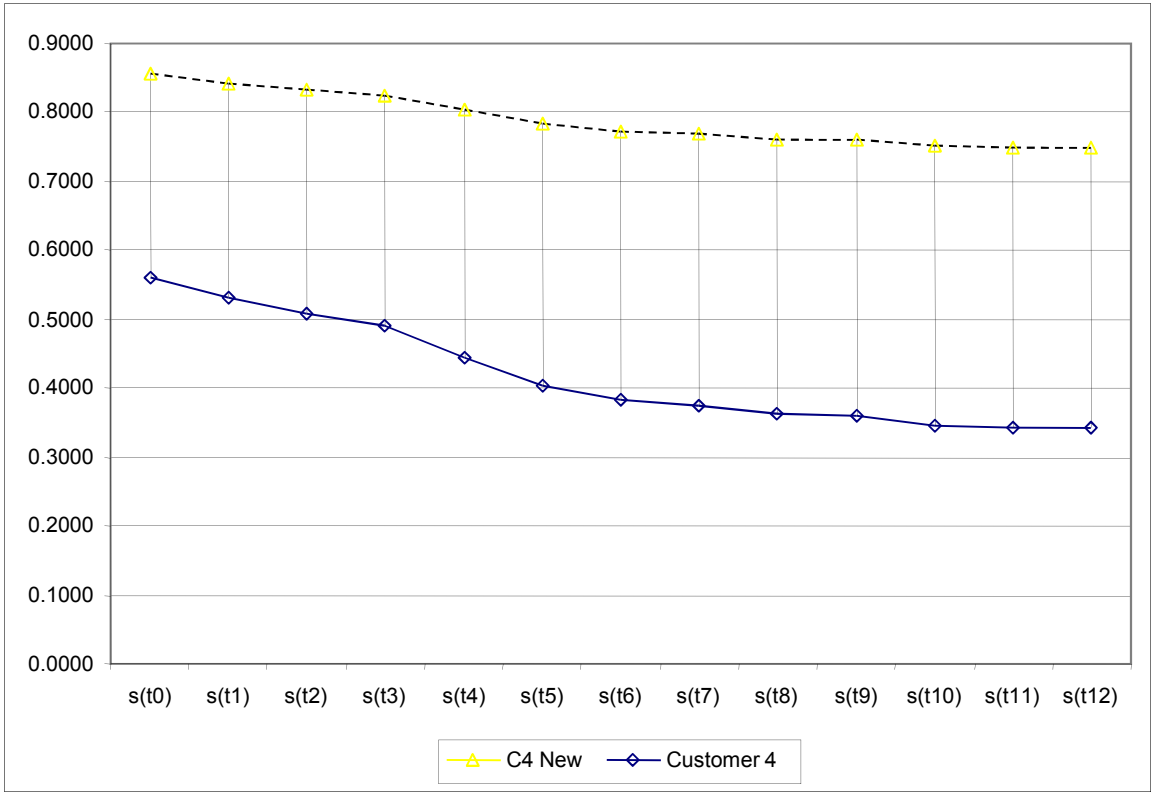

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Further Business Applications

- Business Planning
  - Forecast monthly numbers of lapses and use to monitor current lapse rates
- Lifetime Value prediction
  - Derive LTV predictions by combining expected survival times with monthly revenues
- Active customers
  - Predict each customer's time to next purchase, and use to identify "active" vs. "inactive" customers
- Campaign evaluation
  - Monitor effects of campaigns on survival rates

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Applications to different industries and business problems

- Telco – customer lifetime and LTV
- Insurance – time to lapsing on policy
- Mortgages – time to mortgage redemption
- Mail Order Catalogue – time to next purchase
- Retail – time till food customer starts purchasing non-food
- Manufacturing - lifetime of a machine component
- Public Sector – time intervals to critical events

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Business Benefits of Survival Analysis

- Improved planning and budgeting through better understanding of future events over time
- Ability to plan timing of churn-related customer communications
- Greater ability to manage customer lifecycles
- Better understanding of factors causing customers to stay for different lengths of time, enabling those factors to be influenced - either by improving service design or at customer level

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Thank you!

Barry Leventhal

+44 (0)7803 231870
Barry@barryanalytics.com

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