Longitudinal Data Analysis for Social Science Researchers

Re-introducing Analysis Methods

www.longitudinal.stir.ac.uk

Structure of this talk…

- Simple Revision (survey analysis)
- Statistical models
- How data are organised
- Software
- Some practical points

Notation and terms -

Notation and terms are never completely standard but we'll try to keep things consistent

A Joke...

$$\frac{\exp(\theta_j + \underline{\beta}'\underline{x}_{it})}{1+\exp(\theta_j + \underline{\beta}'\underline{x}_{it})}; j = 1,...,3$$

These equations are all Greek to me!

Simple Revision

- Probability p
- Odds (p/1-p)
- Probability therefore = (odds/1+odds)
- Logarithm denoted as ln
- The anti-log or exponential is denoted as exp
- Greek symbol Σ is the sum of

Revision – Types of data

- Binary outcome has two 'discrete' states - 0 (failure) and 1 (success)
- Categorical outcome has more than two 'discrete' states - 0 (unemployed), 1 (ft work) & 2 (retired)
- [Ordered Categorical outcome has more than two 'discrete' states that have on order

  0 (no view), 1 (weak view) & 2 (strong view)]
- Continuous outcome (metric) takes on a range of values e.g. weekly income (£)

Statistical Models

Why model data?

My view – It might be controversial.... In social science research it is unlikely that a bivariate (two variable) explanation will capture the complexity of the real social world. Therefore there is no choice other than to fit a statistical model.

In social science research, unlike in experimental situations, 'randomisation' is very often not appropriate. Therefore there is a lack of control and a need for more advanced statistical methods.

In simple terms a model does two things…

- Tells us what is important (e.g. which variables are significant).
- Tell us how important variables are (i.e. their strength).

Notation and terms – (Regression) Models

- **Y** is the dependent, outcome or response variable
- **X** is the explanatory or independent variable
- A discrete X is often called a **factor**
- A continuous X is often called a **covariate**
- **^** is called 'hat' and means an estimate
- (Beta) β is the estimate or coefficient for an associated X variable – e.g. $\beta_1 X_1$
- (Beta zero) β_0 however is the intercept or constant
- An individual is denoted with the subscript ***i***
- Time is denoted with the subscript ***t***
- ε is an error term

How data are organised

The Variable By Case Matrix

	Variables			
Subjects (PID)	Y_1	X_1	X_2	X_3
001	…	…	…	…
002	…	…	…	…
003	…	…	…	…
004	…	…	…	…
005	…	…	…	…

The Variable By Case Matrix

	Variables			
Subjects (PID)	Y_1	X_1	X_2	X_3
001	…	…	…	…
002	…	…	…	…
003	…	…	…	…
004	…	…	…	…
005	…	…	…	…

The variable by case matrix – with a measure of Y at a certain time point

The Variable By Case Matrix

	Variables			
Subjects				
(PID)	Y1	Y2	X1	X2
001	…	…	…	…
002	…	…	…	…
003	…	…	…	…
004	…	…	…	…
005	…	…	…	…

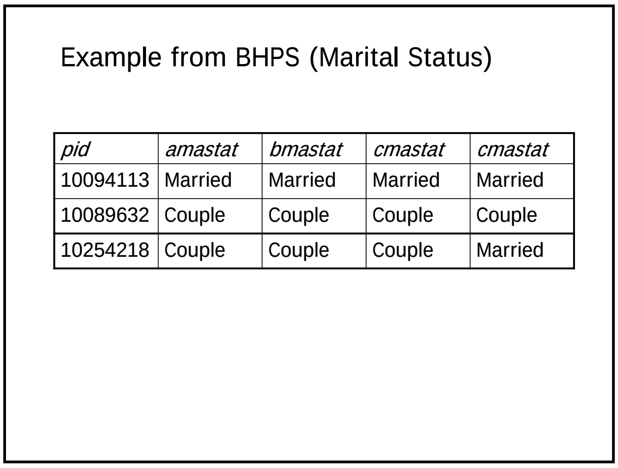
The Variable By Case Matrix

	Variables			
Subjects				
(PID)	Y1	Y2	X1	X2
001	…	…	…	…
002	…	…	…	…
003	…	…	…	…
004	…	…	…	…
005	…	…	…	…

The variable by case matrix – with two observations of Y and associated X vars variables

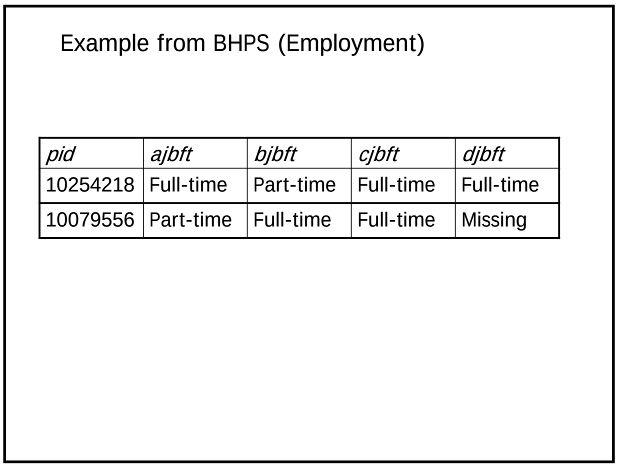
This is sometimes called wide format e.g. in STATA.

Example: BHPS teaching datasets



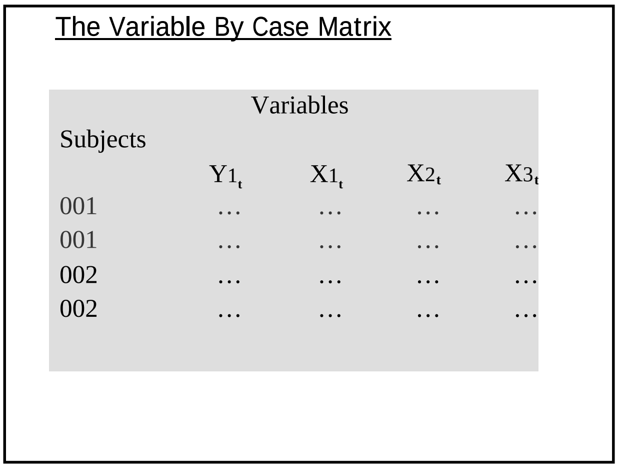
Example from BHPS (Marital Status)

pid	*amastat*	*bmastat*	*cmastat*	*cmastat*
10094113	Married	Married	Married	Married
10089632	Couple	Couple	Couple	Couple
10254218	Couple	Couple	Couple	Married



Example from BHPS (Employment)

pid	*ajbft*	*bjbft*	*cjbft*	*djbft*
10254218	Full-time	Part-time	Full-time	Full-time
10079556	Part-time	Full-time	Full-time	Missing



The Variable By Case Matrix

	Variables			
Subjects				
	$Y1_t$	$X1_t$	$X2_t$	$X3_t$
001	…	…	…	…
001	…	…	…	…
002	…	…	…	…
002	…	…	…	…

The Variable By Case Matrix

	Variables			
Subjects				
	$Y1_t$	$X1_t$	$X2_t$	$X3_t$
001	…	…	…	…
001	…	…	…	…
002	…	…	…	…
002	…	…	…	…

The variable by case matrix – with two observations of Y and associated X variables

The variable by case matrix – with two observations of Y and associated X variables

This is sometimes called long format e.g. in STATA.

Note:

- ➢This is the usual format for undertaking longitudinal data analysis.
- ➢The BHPS and other surveys usually require data management to construct a long format file.

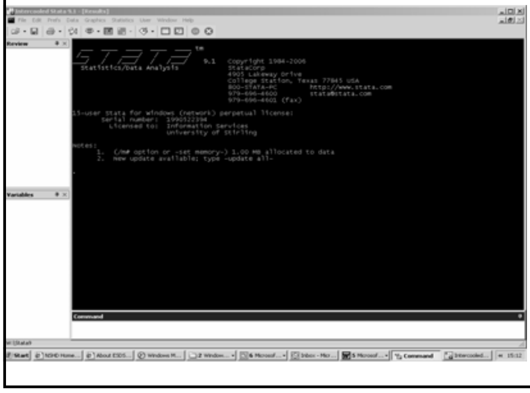
Example from BHPS

pid	zage	zmastat	wave
12287407	67	married	2
12287407	68	married	3
12287407	69	married	4
12287407	70	married	5
12287407	71	married	6
12287407	72	married	7
12287407	73	married	8
12287407	74	married	9
12287407	75	married	10
12287407	76	married	11
12287407	77	married	12

Software

- Our overall message is that if you are serious about doing longitudinal analyses try to move to using STATA as soon as possible!

STATA Version 9.1 www.stata.com



```
  ___  ____  ____  ____  ____ tm
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   9.1   Copyright 1984-2006
  Statistics/Data Analysis            StataCorp
                                      4905 Lakeway Drive
                                      College Station, Texas 77845 USA
                                      800-STATA-PC        http://www.stata.com
                                      979-696-4600        stata@stata.com
                                      979-696-4601 (fax)

15-user Stata for Windows (network) perpetual license:
       Serial number:  1990522394
         Licensed to:  Information Services
                       University of Stirling

Notes:
      1.  (/m# option or -set memory-) 1.00 MB allocated to data
      2.  New update available; type -update all-

.
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STATA SOFTWARE – GOOD POINTS

- Does all the simple stuff (SPSS)
- Is specifically designed for survey analysis (all the weighting and design related issues are better catered for)
- Fits many more models than standard software
- You can get started easily (menus and help)
- There is a growing user community (lists etc)
- New features emerge almost daily
- There are good labour market opportunities (UK little known; USA well known)

STATA SOFTWARE – LESS GOOD POINTS

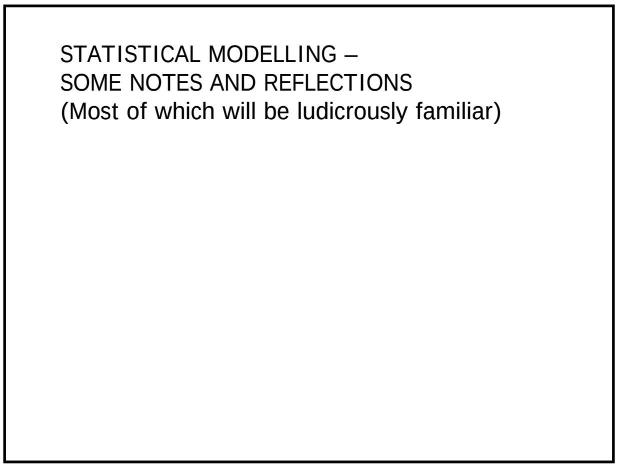
- Poor data handling (compared with SPSS etc)
- The weighting and design related issues can be complicated (some analysts ignore them)
- There are still some models that can't be fitted (see GLIM4; SABRE; MlWin etc)
- STATA syntax is a pain in the bum
- There is a growing user community, but they are generally GEEKBOYS (like myself!)
- New features emerge almost daily these are sometimes tricky to get to grips with

Other specialist software

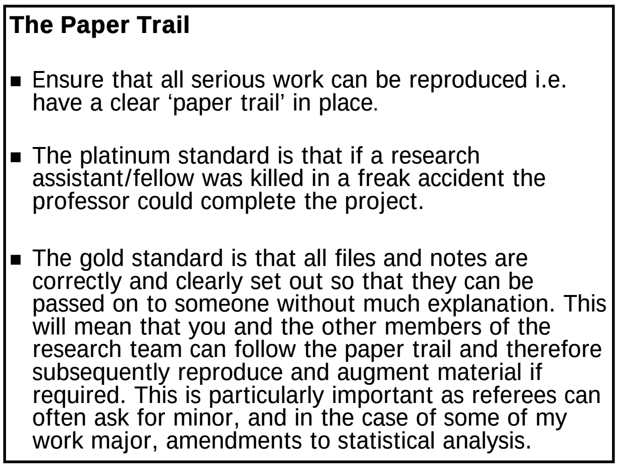
- SABRE – Software for the statistical analysis of binary recurrent events
- TDA (Transitions Data Analysis) – event history analysis software
- GLLAMM (Generalised Linear Latent and Mixed Models) – a STATA extension
- R – this is an advance programming language
- Data structure software
  - MLwIN – Multilevel modelling software
  - Mplus, LISREL – Structural Equation modelling

Some Practical Thoughts...

- *"The best habit you can get into is to get into good habits"*
- ..See handout: Statistical modelling – some notes and reflections

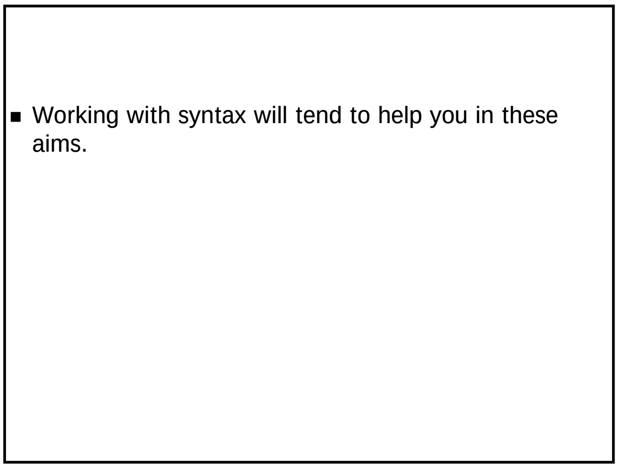


STATISTICAL MODELLING –
SOME NOTES AND REFLECTIONS
(Most of which will be ludicrously familiar)



The Paper Trail

- Ensure that all serious work can be reproduced i.e. have a clear ‘paper trail’ in place.
- The platinum standard is that if a research assistant/fellow was killed in a freak accident the professor could complete the project.
- The gold standard is that all files and notes are correctly and clearly set out so that they can be passed on to someone without much explanation. This will mean that you and the other members of the research team can follow the paper trail and therefore subsequently reproduce and augment material if required. This is particularly important as referees can often ask for minor, and in the case of some of my work major, amendments to statistical analysis.



- Working with syntax will tend to help you in these aims.

Making A Start

- IT IS ESSENTIAL TO KNOW YOUR DATA.
- This includes understanding how concepts have been operationalised (e.g. via the survey instrument). It is worth thinking about how the survey instrument has been applied. Think about all the tiny nuts and bolts, for example the rubric of questions and how the routing has been worked out. These minor issues may have a major impact on your data.
- Understanding how variables have been measured and coded is OBVIOUSLY essential. It is also worth getting to know the distribution of variables and some simple measures of central tendency (e.g. means and modes).

Making A Start

- Make sure that you are working with the best data available. In the case of the BHPS this will be the most recent release of the data.
- ALWAYS MAKE BACK-UP FILES. Work with as clean a set of data as possible.
- Always start with exploratory analysis.
- EVERY recode, compute, re-labelling task should be documented and be traceable in the paper trail.
- DON'T START MODELLING TOO SOON!

Some tricks

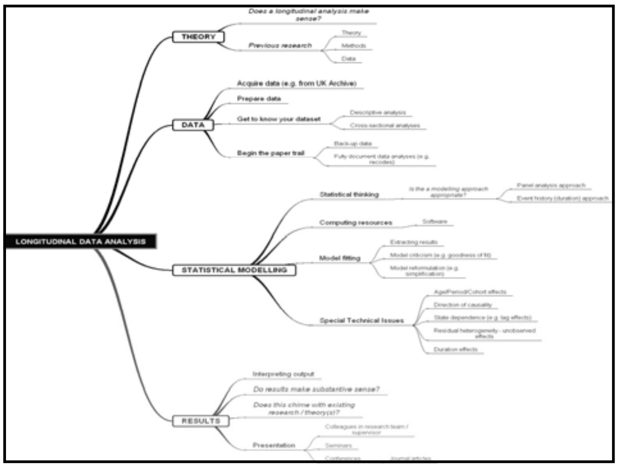
- Always “guesstimate” the output before you formally estimate (i.e. fit) your model. This will help trap errors or indicate when your data is “behaving badly”.
- Always have a notebook handy (or use notepad or your word processor) to help with the paper trail.
- Keep a calculator handy.
- If a job is incomplete keep a record. For example I frequently e-mail myself at the end of the day so that I am reminded the next time I log on.

Statistical modelling

- Always proceed from a position informed by substantive theory. The economists are particularly good at this (although occasionally a little rigid). The modelling building process should (ideally) always be guided at all stages by your substantive theory(s).

Statistical modelling

- REMEMBER – REAL DATA IS MUCH MORE MESSY, BADLY BEHAVED, HARD TO INTERPRET ETC. THAN THE DATA USED IN BOOKS AND AT WORKSHOPS.
- In the case of longitudinal analysis spend as much time as possible getting the underlying social process clear before you fit a model. The best way to do this is to build upon well thought out cross-sectional analysis.


LONGITUDINAL DATA ANALYSIS
THEORY
Does a longitudinal analysis make sense?
Previous research
Theory
Methods
Data
DATA
Acquire data (e.g. from UK Archive)
Prepare data
Get to know your dataset
Descriptive analysis
Cross-sectional analyses
Begin the paper trail
Back-up data
Fully document data analyses (e.g. recodes)
STATISTICAL MODELLING
Statistical thinking
Is the a modelling approach appropriate?
Panel analysis approach
Event history (duration) approach
Computing resources
Software
Model fitting
Extracting results
Model criticism (e.g. goodness of fit)
Model reformulation (e.g. simplification)
Special Technical Issues
Age/Period/Cohort effects
Direction of causality
State dependence (e.g. lag effects)
Residual heterogeneity - unobserved effects
Duration effects
RESULTS
Interpreting output
Do results make substantive sense?
Does this chime with existing research / theory(s)?
Presentation
Colleagues in research team / supervisor
Seminars
Conferences
Journal articles