MISOC ESRC Research Centre on Micro-social Change

A multiple process latent transition model of poverty and health

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Overview

- Background
- Introduction to the MPLTM
- Data
- Model development
- Results
- Summary

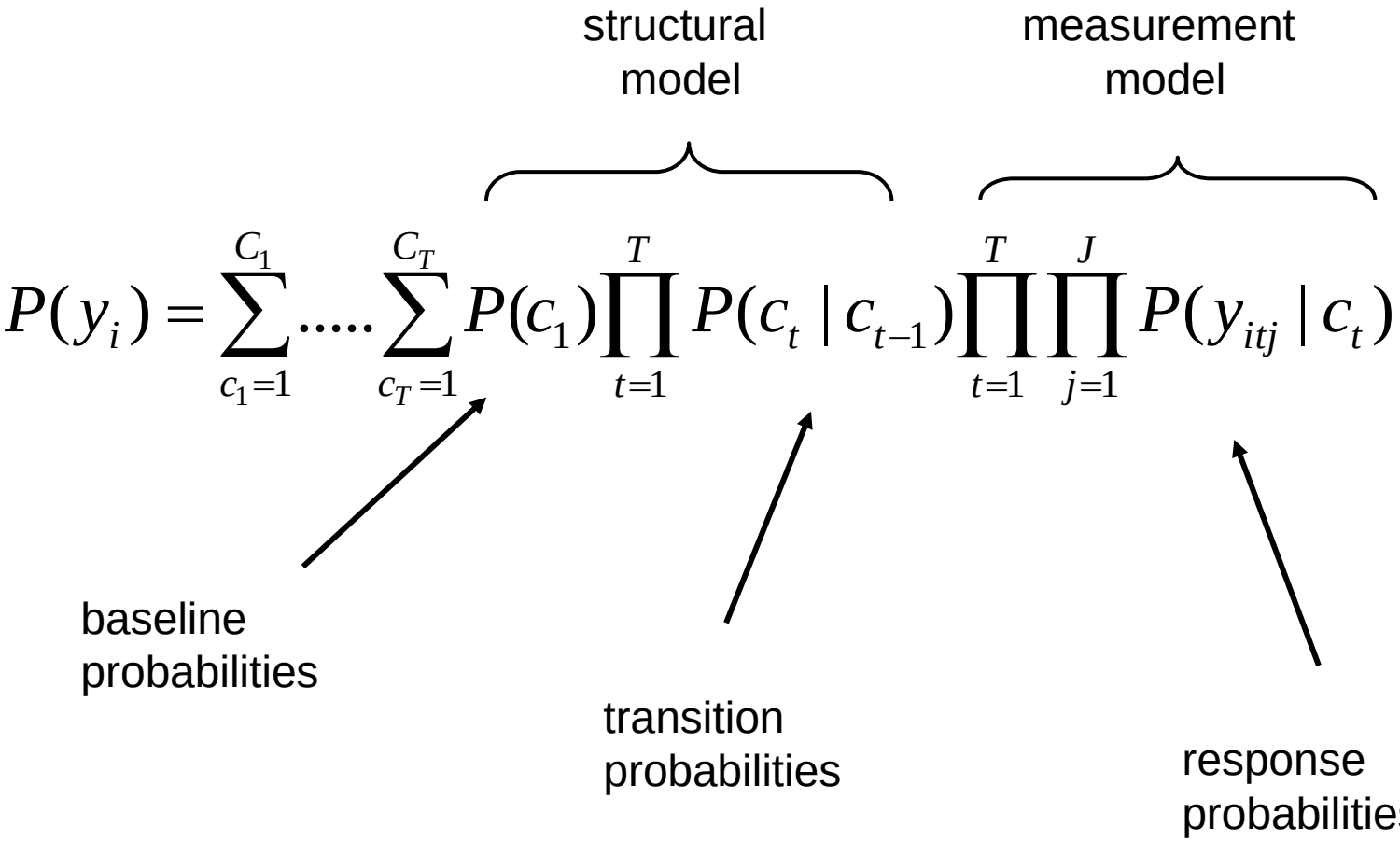
Background

- The association between health and socio-economic position is well established but remains poorly understood
- Epidemiologists: disadvantage “causes” ill health
- Economists: poor health increases the risk of poverty
- But both acknowledge that reverse causation a possibility
- And equally plausible that disadvantage undermines recovery from ill health or that health related benefits lift people out of poverty

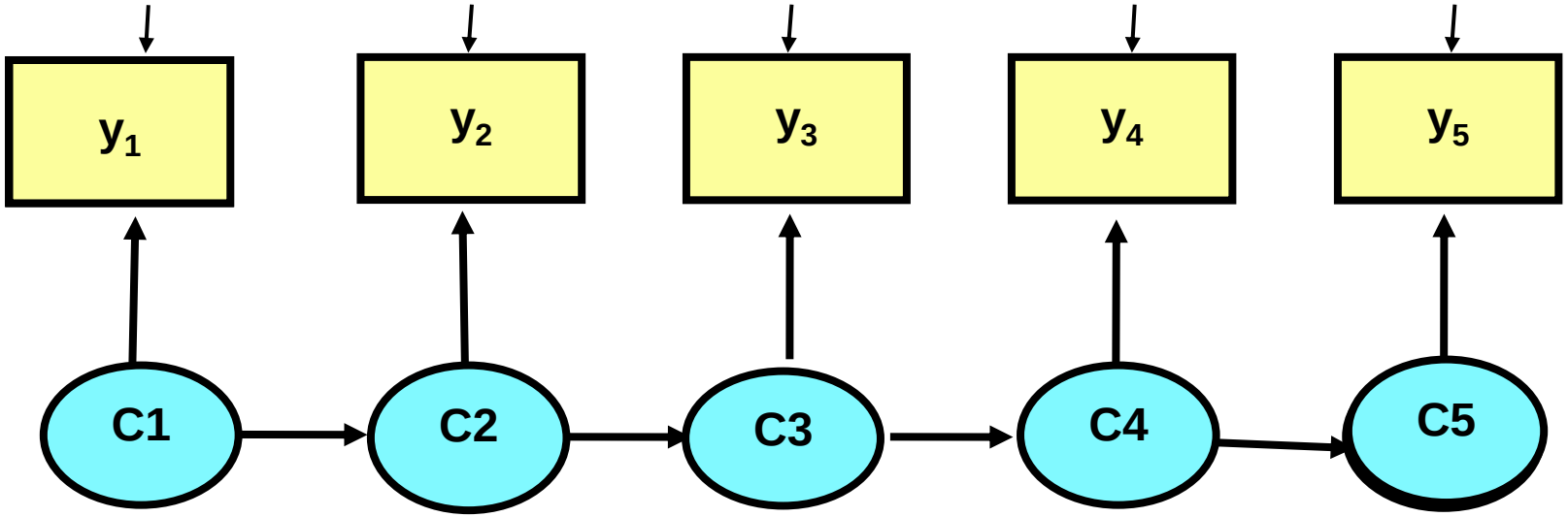
Multiple process latent transition analysis (MPLTA)

- For fitting models where there are two sequences of latent states
- Interested in the relationship between the sequences over time
- Does latent state in process A predict latent state in process B?
- Does change in process A predict change in process B?

The single process latent transition model



A simple LTA model



The multiple process latent transition model

$$P(y_i) = \sum_{c_1=1}^{C_1} \sum_{d_1=1}^{D_1} \ldots\ldots \sum_{c_T=1}^{C_T} \sum_{d_T=1}^{D_T} P(c_1,\ldots\ldots, c_T, d_1,\ldots. d_T) P(y_i \mid c_1,\ldots., c_T, d_1,\ldots., d_T)$$

where

$$P(y_i \mid c_1,\ldots., c_T, d_1,\ldots., d_T) = \prod_{t=1}^{T} \prod_{j=1}^{J} P(y_{itj} \mid c_t, d_t)$$

and

$$P(c_1,\ldots\ldots, c_T, d_1,\ldots. d_T) = P(c_1) P(d_1 \mid c_1) \prod_{t=2}^{T} P(c_t \mid c_{t-1}, d_{t-1}) P(d_t \mid c_{t-1}, c_t, d_{t-1})$$

The conditional MPLTM

$$P(y_i \mid z_i) = \sum_{c_1=1}^{C_1} \sum_{d_1=1}^{D_1} ..... \sum_{c_T=1}^{C_T} \sum_{d_T=1}^{D_T} P(c_1,....., c_T, d_1,....d_T \mid z_i) P(y_i \mid c_1,...., c_T, d_1,...., d_T, z_i)$$

where

$$P(y_i \mid c_1,...., c_T, d_1,...., d_T, z_i) = \prod_{t=1}^{T} \prod_{j=1}^{J} P(y_{itj} \mid c_t, d_t, z_{it})$$

and

$$P(c_1,....., c_T, d_1,....d_T, z_i) = P(c_1 \mid z_{i1}) P(d_1 \mid c_1, z_{i1}) \prod_{t=2}^{T} P(c_t \mid c_{t-1}, d_{t-1}, z_{it}) P(d_t \mid c_{t-1}, c_t, d_{t-1}, z_{it})$$

Methods

- British Household Panel Study
  - Six waves data (1991, 1994, 1997, 2000, 2003, 2006)
- Analyses restricted to adults of working age and followed-up to 2007 (N=2344)
- Self-rated health
  - “Please think back over the last 12 months about how your health has been. Compared to people of your own age, would you say that your health has on the whole been excellent, good, fair, poor, very poor, don’t know?”
- Poverty defined as adjusted annual HH income below 60% of national median for that year
- Covariates
  - Age in 1991, gender, number of weeks worked in previous year

Distribution of observed variables (N = 2344)

Year	1991	1994	1997	2000	2003	2006
Mean age	33.2	36.2	39.2	42.2	45.2	48.2
Females	49.2	49.2	49.2	49.2	49.2	49.2
Employment in previous year						
0 weeks	13.8	15.7	14.7	15.0	16.0	17.6
0< wks<52	12.2	10.4	8.1	6.5	7.3	6.8
≥ 52 weeks	74.0	73.9	77.2	78.6	76.7	75.6
Self-rated health						
Excellent	33.2	25.6	28.0	23.7	22.7	23.2
Good	46.9	50.2	46.3	49.3	48.4	49.0
Fair	14.6	18.1	18.6	19.2	20.6	19.2
Poor	4.3	5.1	5.3	6.1	6.7	6.5
Very poor	1.0	1.0	1.8	1.8	1.7	2.1
Poverty status						
Non poor	84.3	85.4	85.1	87.0	87.4	86.8
Poor	15.7	14.6	14.9	13.0	12.6	13.2

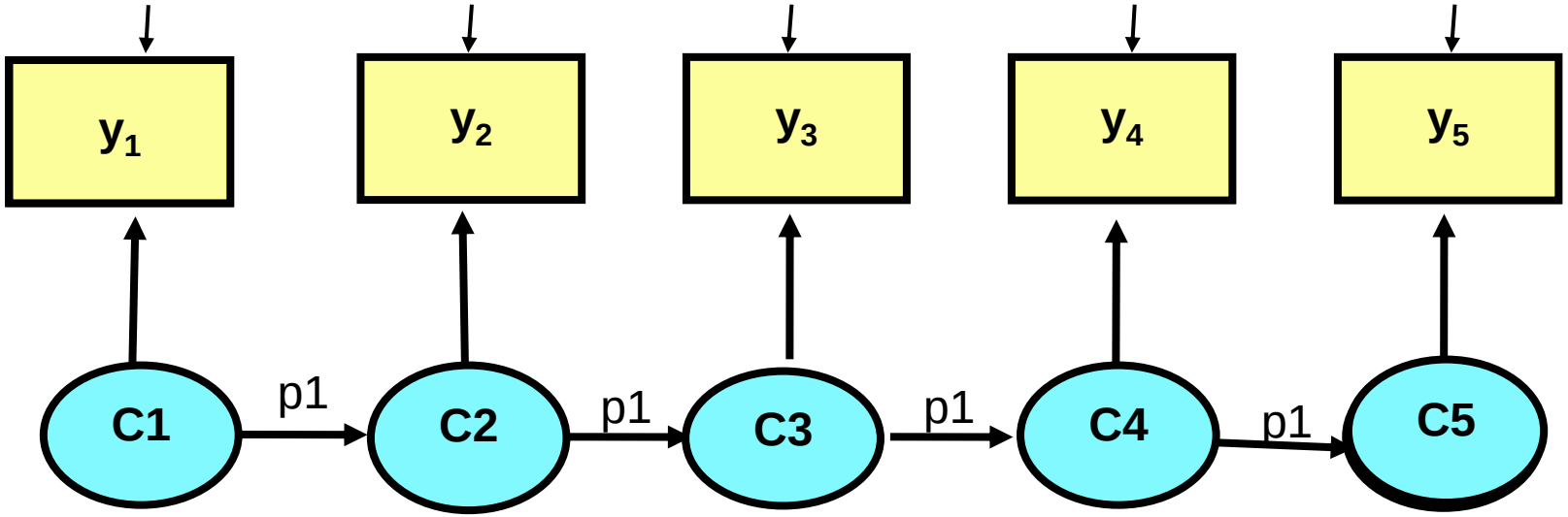
Longitudinal weights applied

Model development

Health and poverty processes

- Health
  - Previous work shown that self-rated health can be represented by two latent classes of good and poor health with a first order latent transition process
  - Tested 2 models
    - M1a: Free transition probabilities
    - M1b: Equal transition probabilities
- Poverty
  - Similarly, two latent poverty classes with a first order transition process
  - Tested 2 models
    - M2a: Free transition probabilities
    - M2b: Equal transition probabilities

Equal transition probabilities



Single process model fit

Model comparison	BIC	$\Delta\chi^2$	Δdf	p	comment
		Poverty single process model			
Free transition probabilities	9294	Ref			Equal transitions model more parsimonious, no loss of fit
Equal transition probabilities	9250	12.07	8	0.15	
		Health single process model			
Free transition probabilities	31961	Ref			Equal transitions model more parsimonious, marginal loss of fit
Equal transition probabilities	31922	16.53	8	0.04	

Nested series of MPLTA models

M3a Independence model:

$$P(c_t|c_{t-1})\ P(d_t|,d_{t-1})$$

M3b Cross-sectional model:

$$M3a + P(d_1|c_1)$$

M3c Unidirectional longitudinal model:

$$M3b + P(c_t|c_{t-1},d_{t-1})$$

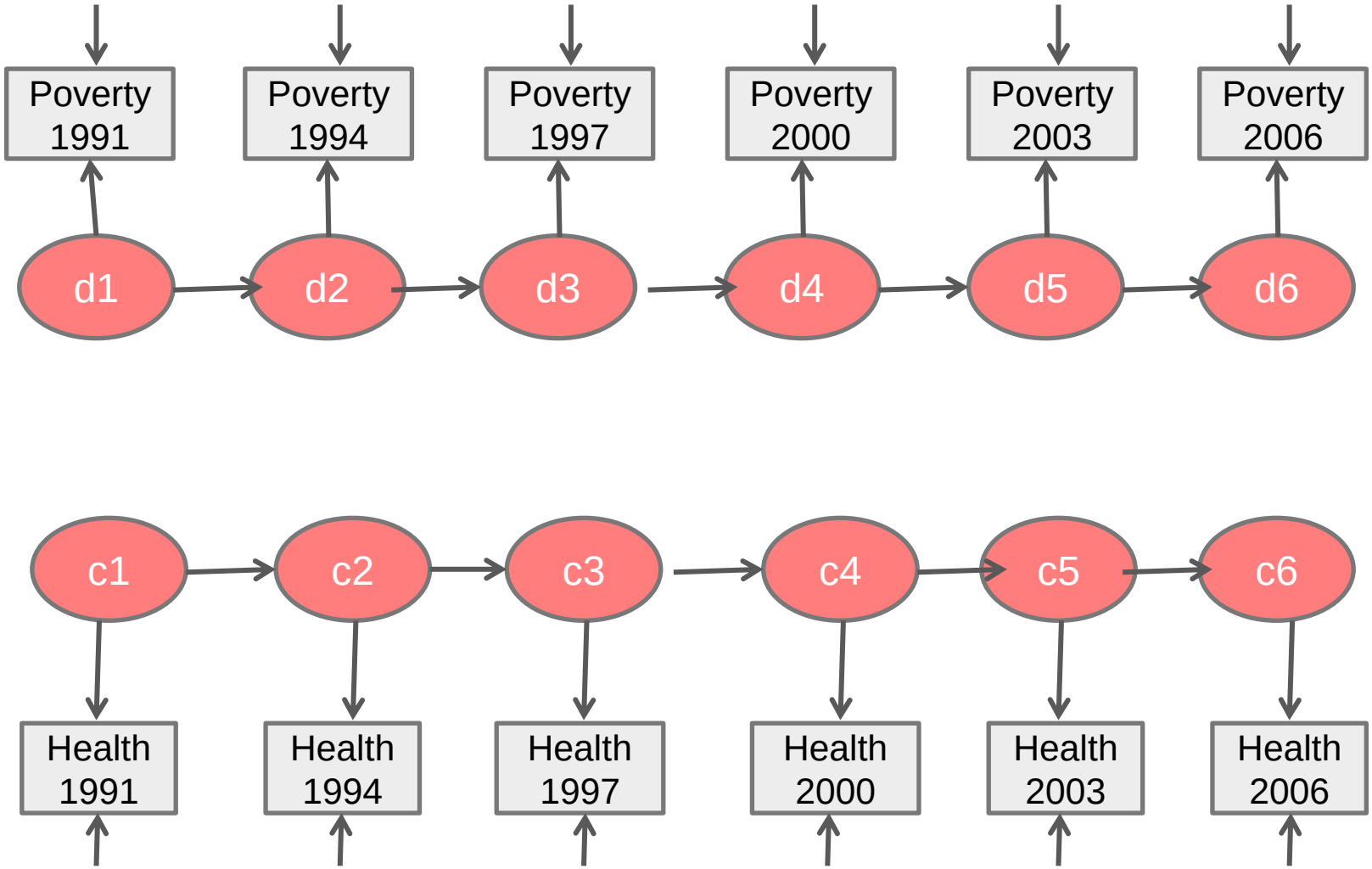
M3d Bidirectional longitudinal model:

$$M3c + P(d_t|c_{t-1},d_{t-1})$$

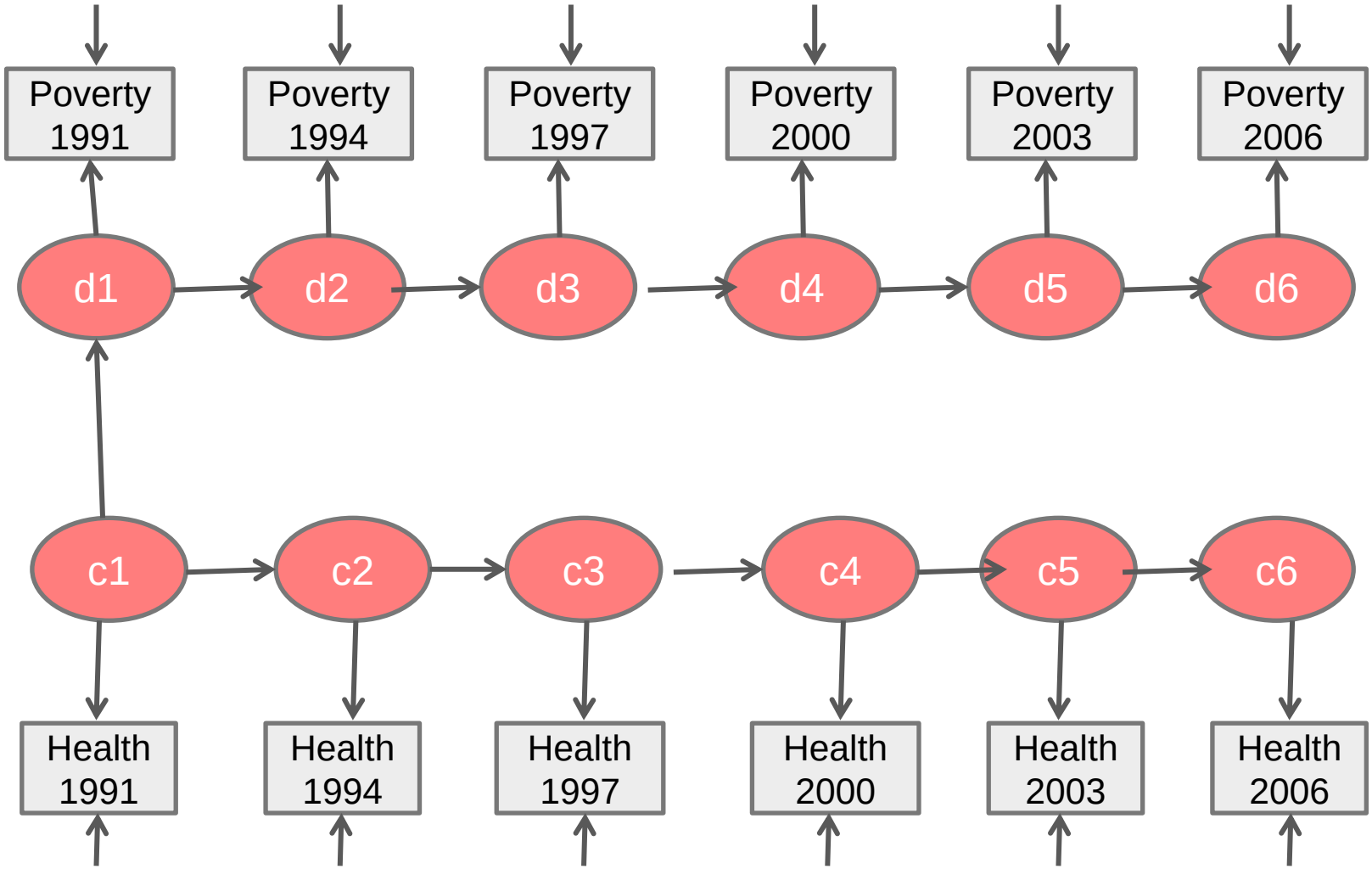
M3e Change model:

$$M3d + P(d_t|c_{t-1},\ c_{t-2},d_{t-1})$$

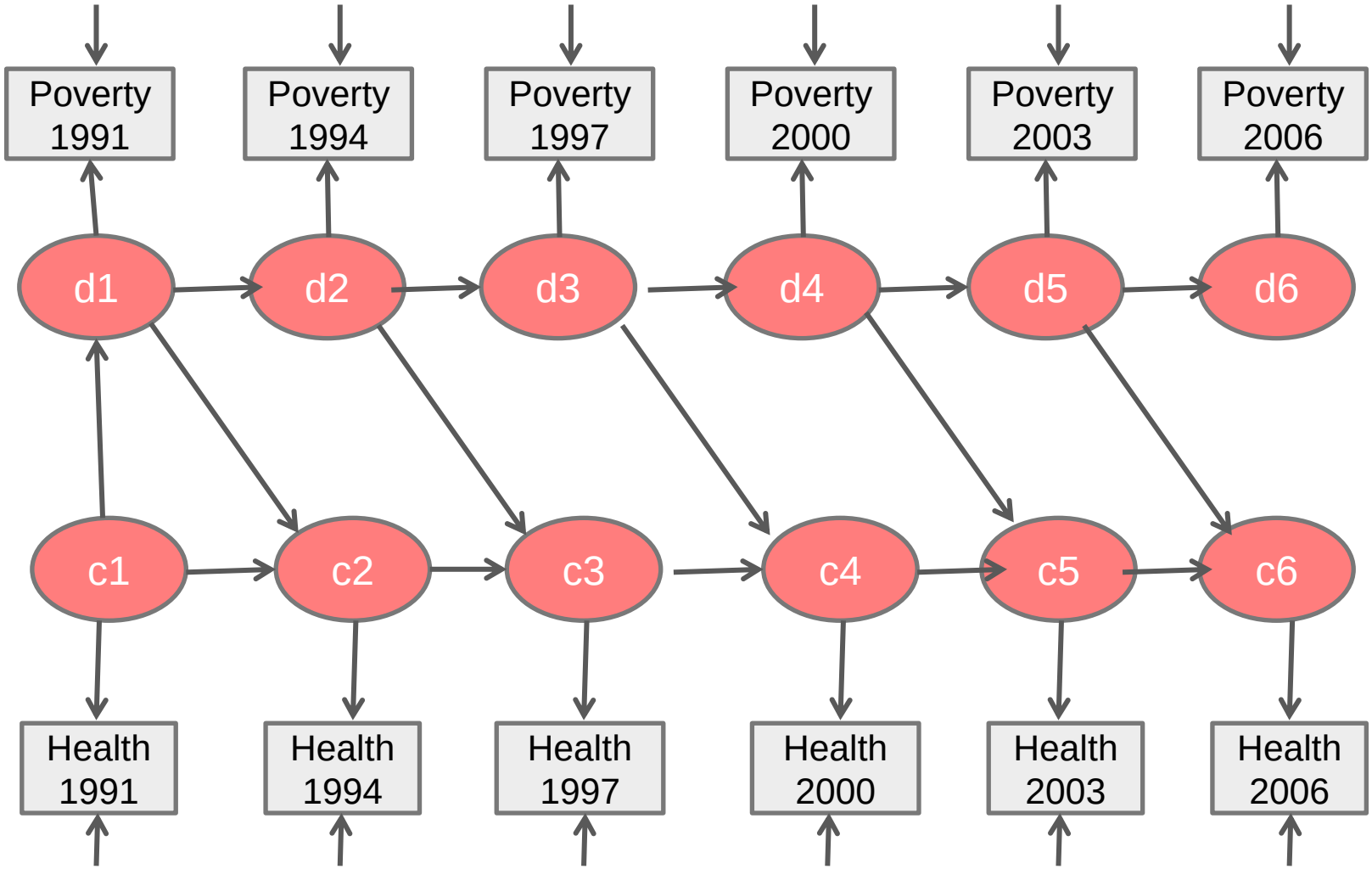
M3a: The independence model



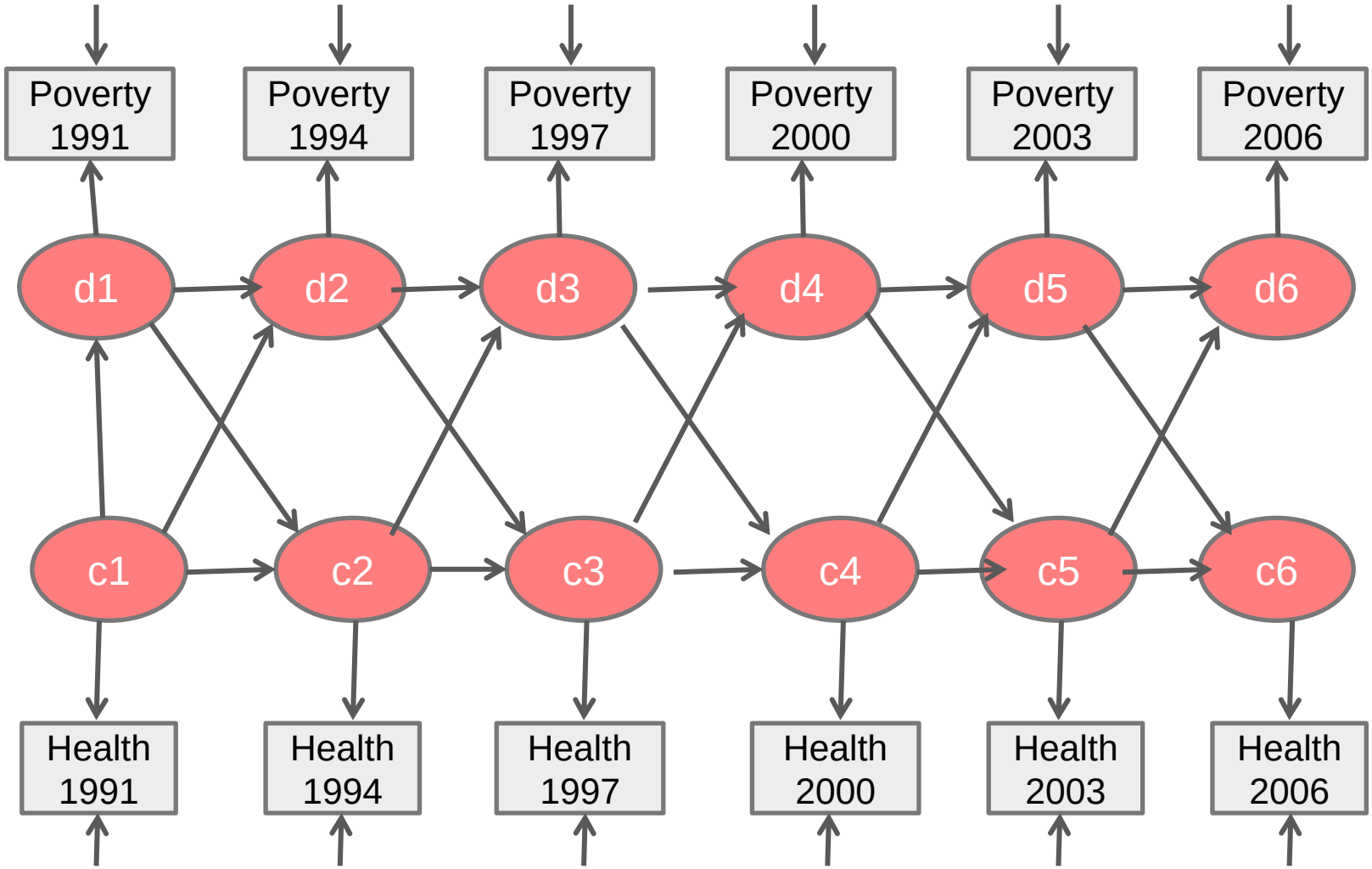
M3b The cross-sectional model



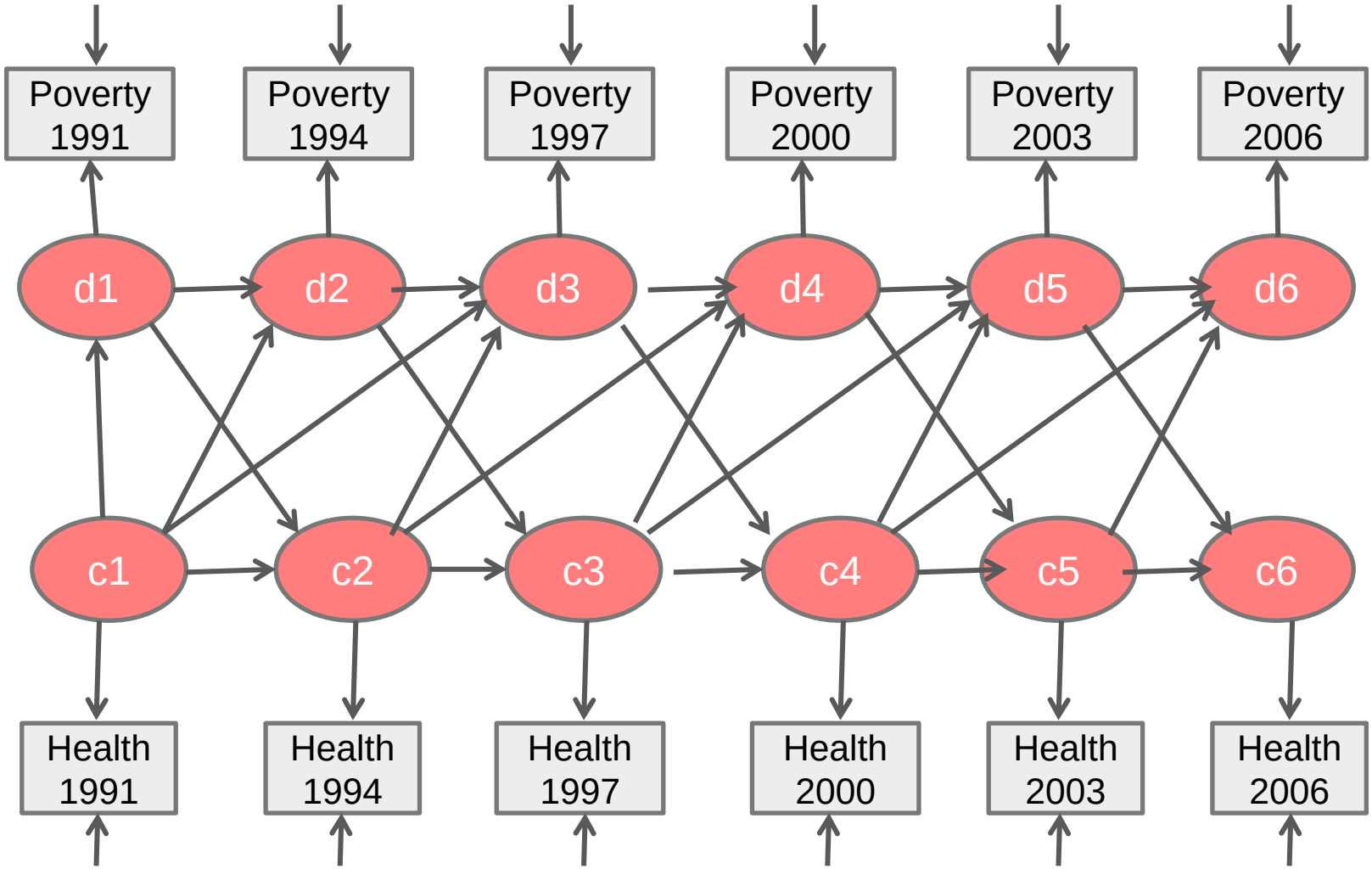
M3c The unidirectional longitudinal model



M3d The bidirectional longitudinal model



M3e The change model



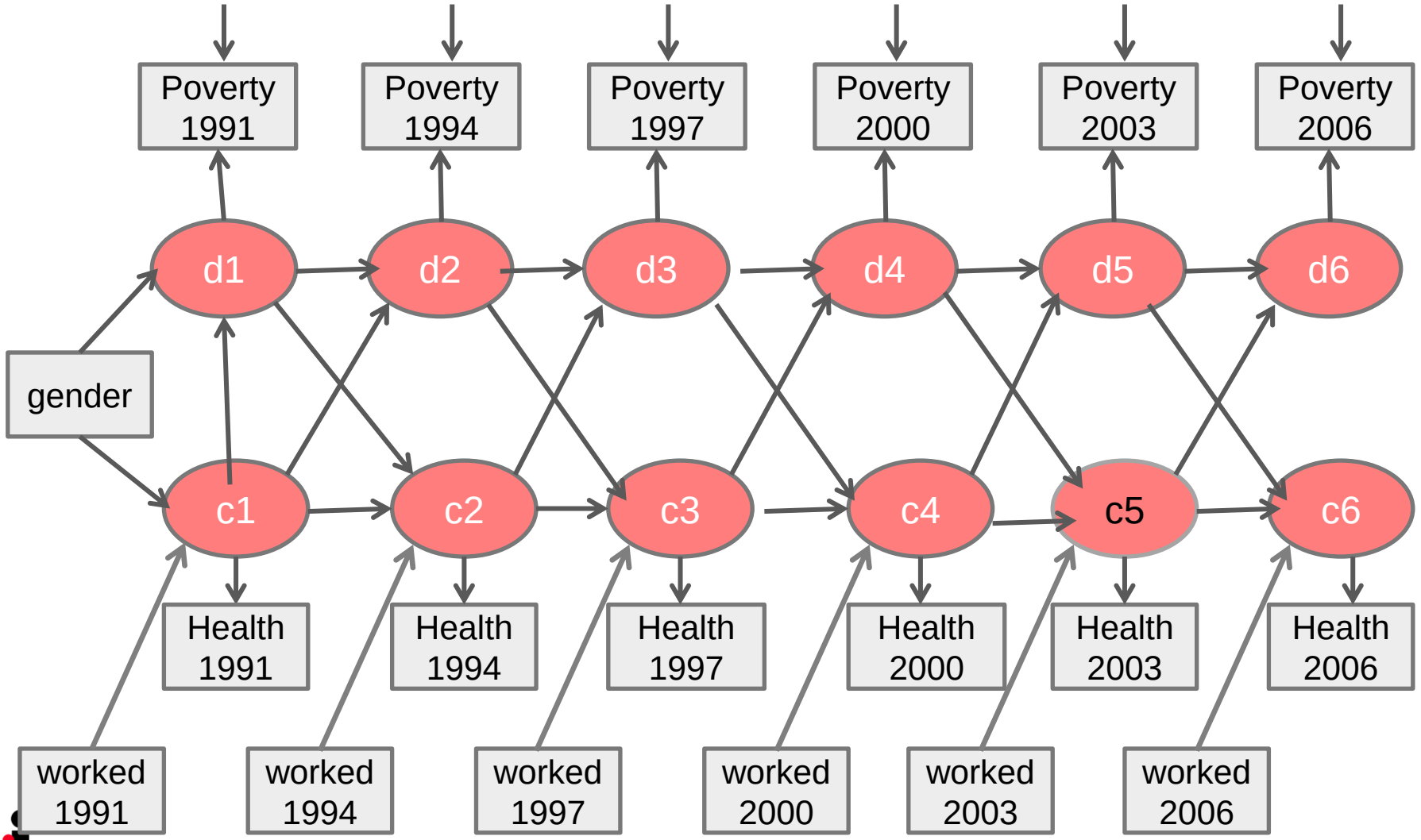
Multiple process model fit

	BIC	$\Delta\chi^2$	Δdf	p	Comment
M3a	41180	40.57	5	<0.00005	Model M3d selected by both BIC and χ^2 difference test as most parsimonious well-fitting model
M3b	41131	15.40	4	0.004	
M3c	41120	6.70	3	0.08	
M3d	41116	1.83	2	0.40	
M3e	41128	Ref			

Conditional MPLTA

- Covariate effects
  - On wave 1 latent states
  - On changes in latent states
- Time invariant covariates
  - Age in 1991 and gender
- Time varying covariate
  - Number of weeks worked in previous year

Conditional model



Nested series of models testing gender effects

- M4a: model 3d plus health & poverty independent of gender at all waves
- M4b: model 4a plus gender effect on baseline health and poverty only
- M4c: model 4b plus gender effect on all poverty states
- M4d: model 4c plus gender effect on all health states

MPLTM plus gender model fit

	BIC	$\Delta\chi^2$	Δdf	p	Comment
M4a	41088	45.32	4	<0.00005	Model M4c selected as most parsimonious well-fitting model
M4b	41065	10.01	2	0.007	
M4c	41066	2.45	2	0.18	
M4d	41072	Ref			

Nested series of models testing cohort effects

- M5a: model 3d plus health & poverty independent of age in 1991
- M5b: model 5a plus age effect on baseline health and poverty
- M5c: model 5b plus quadratic effect on baseline health
- M5d: model 5c plus quadratic effect on baseline poverty
- M5e: model 5d plus age in 1991 on 1994-2006 health
- M5f : model 5e plus age in 1991 on 1994-2006 poverty
- M5g: model 5f plus quadratic effect on 1994-2006 health
- M5h: model 5g plus quadratic effect on 1994-2006 poverty

Summary of cohort effects

- Age in 1991 has
  - linear effect on baseline poverty
  - quadratic effect on baseline health
  - no effect on changes in poverty or health once baseline relationships were taken into account

Nested series of models testing employment effects

- M6a: model 3d plus health & poverty independent of weeks worked
- M6b: model 6a plus employment on poverty at each wave
- M6c: model 6b plus employment on health at each wave

MPLTM plus employment model fit

	BIC	$\Delta\chi^2$	Δdf	p	Comment
M6a	39807	3091	4	<0.00005	Model M6c selected as most parsimonious well-fitting model
M6b	38800	150	2	<0.00005	
M6c	38770	Ref			

Final step

- Check that covariates had unique effects on health and poverty states
- Found that all three covariates contributed independently to health and poverty over time

Substantive results

- Measurement model
- Structural model
- Covariate effects

Unconditional measurement model: poverty

		Observed poverty	
		Poor	Non poor
Latent poverty	Poor	0.746 (0.030)	0.019 (0.004)
	Non poor	0.254 (0.030)	0.981 (0.004)

Unconditional measurement model: health

	Observed health				
	Excellent	Good	Fair	Poor	Very poor
Latent health					
Good	0.451 (0.065)	0.511 (0.055)	0.034 (0.011)	0.005 (0.001)	0.000 (0.000)
Poor	0.019 (0.007)	0.449 (0.081)	0.374 (0.054)	0.123 (0.025)	0.035 (0.008)

Structural model: baseline probabilities conditional on age & gender

	Good health	Poor health
	0.65	0.35
	(0.07)	(0.08)
Non poor	0.86	0.72
	(0.01)	(0.04)
Poor	0.14	0.29
	(0.01)	(0.04)

* Probabilities for a man aged 35 at baseline

Structural model: poverty transitions conditional on age & gender

Time t-1		Time t: Non poor	Time t: Poor
Non poor	Good health	0.97	0.03
		(0.01)	(0.01)
	Poor health	0.96	0.04
		(0.01)	(0.01)
Poor	Good health	0.26	0.74
		(0.03)	(0.03)
	Poor health	0.19	0.81
		(0.02)	(0.02)

Structural model: health transitions conditional on age & gender

		Time t	
Time t-1		Good health	Poor health
Good health	Non poor	0.93	0.07
		(0.02)	(0.02)
	Poor	0.86	0.15
		(0.04)	(0.04)
Poor health	Non poor	0.03	0.97
		(0.01)	(0.01)
	Poor	0.01	0.99
		(0.01)	(0.01)

Covariate effects: regression of health and poverty on covariates

	Logit(se)	OR	Logit(se)	OR
Poor health (t = 1)				
on gender	0.60 (0.15)	1.62	0.37 (0.15)	1.44
on cohort	0.07 (0.09)	1.07	0.09 (0.09)	1.10
on cohort squared	0.34 (0.13)	1.41	0.34 (0.13)	1.41
on weeks employed			-0.02 (0.00)	0.99
Poor health (t > 1)				
on cohort	0.28 (0.09)	1.32	0.27 (0.08)	1.33
on weeks employed			-0.02 (0.00)	0.98
Poverty (t = 1)				
on gender	0.56 (0.14)	1.75	-0.11 (0.14)	0.90
on cohort	-0.20 (0.10)	0.75	-0.06 (0.10)	0.95
on weeks employed			-0.05 (0.00)	0.95
Poverty (t > 1)				
on gender	0.29 (0.09)	1.34	0.05 (0.08)	1.10
on weeks employed			-0.04 (0.00)	0.96

Poverty transitions conditional on age, gender and employment

Time t-1		Time t: Non poor	Time t: Poor
Non poor	Good health	0.97	0.04
		(0.003)	(0.003)
	Poor health	0.97	0.03
		(0.004)	(0.004)
Poor	Good health	0.52	0.48
		(0.04)	(0.04)
	Poor health	0.54	0.47
		(0.04)	0.04)

Health transitions conditional on age, gender and employment

Time t-1		Time t: Good health	Time t: Poor health
Good health	Non poor	0.94	0.06
		(0.01)	(0.01)
	Poor	0.92	0.08
		(0.02)	(0.02)
Poor health	Non poor	0.05	0.95
		(0.01)	(0.01)
	Poor	0.03	0.97
		(0.01)	(0.01)

- The multiple process latent transition analysis found that
  - Health and poverty were related cross-sectionally, longitudinally and reciprocally
    - Poverty was related to the stability of good health and declines in health
    - Health was associated with the permanence of poverty and movement out of poverty.
  - Adding weeks worked to the model reduced the cross-lagged effects to non-significance
    - Health related transitions into poverty appear to operate through the inability of unhealthy individuals to remain in the labour market
    - Poverty's causal role in health decline is confounded by employment status

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