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Makes religion happy – or makes happiness religious? An analysis of a three-wave panel using and comparing discrete and continuous time techniques.

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1 Research Aim:

Nomization: Religiosity → Life Satisfaction

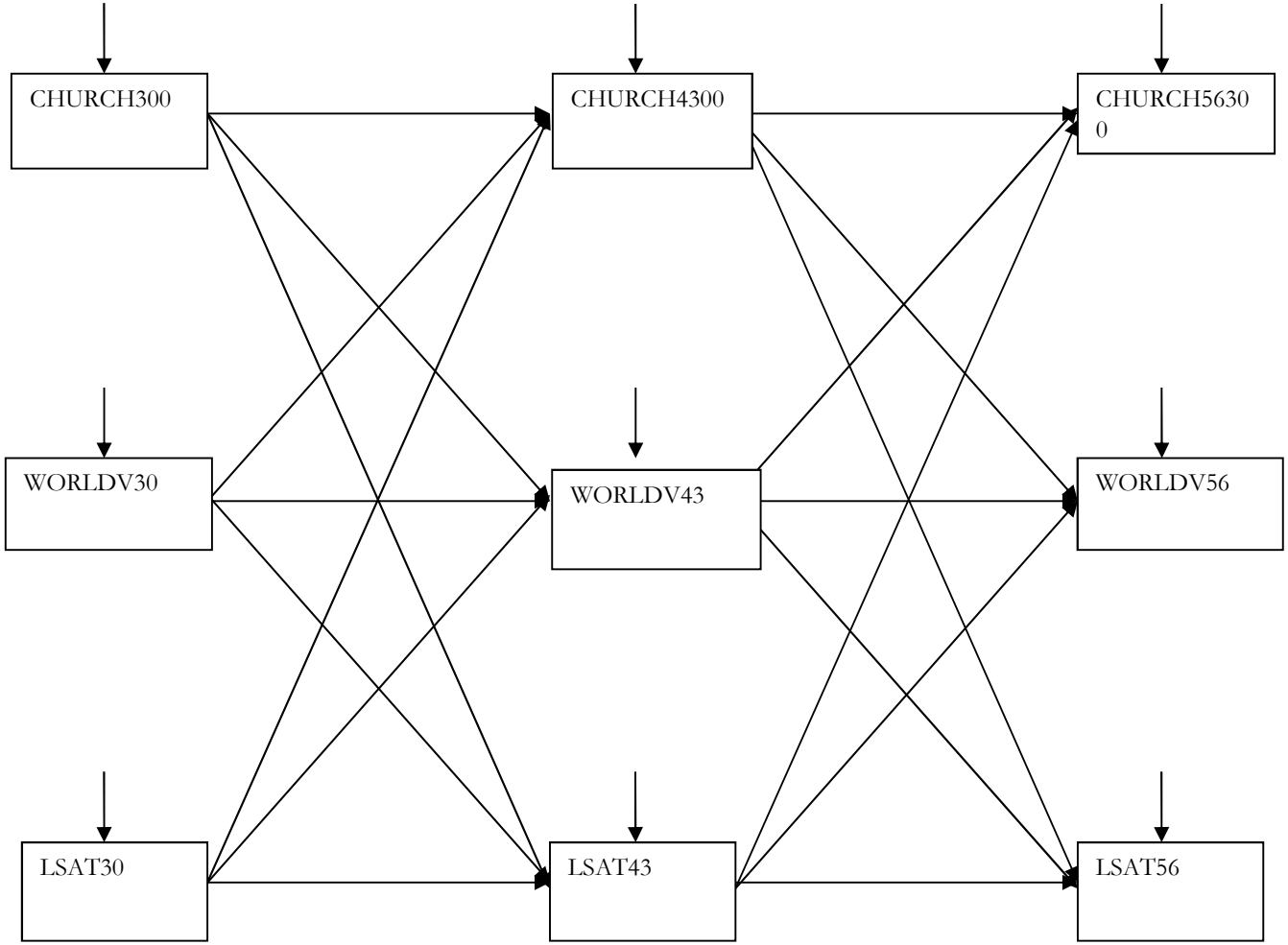
Optimism: Religiosity ← Life Satisfaction

Religion

- Practice: Church Attendance
- Belief: Christian World View

•Age 30 Age 43 Age56

Religiosity as Church Attendance (CHURCH) and Christian World View (WOLRDV) and Life Satisfaction (LSAT) at age 30, 43 and 56



2 Data

Cologne High School Panel. 10th grade high school students, socially selective, *Northrhine-Westfalia*

- 3240 respondents first interviewed in classroom about life plans in 1969
- 1301 re-interviewed in 1984, 1997 and 2010 about their life career between early and late mid-life, age 30, 43 and 56
- time intervals between interviews not for all exactly 13 years, exact time intervals for each subject known and used in CT analysis

Measurement at age 30, 43, 56

CHURCH single question with six ordered options.

WORLDV three statements (Felling, Peters, and Schreuder 1987)

- “Life has meaning for me only because there is a God”
- “Life has a meaning because there is something after death”
- “I believe that human existence has a clear meaning and follows a specific plan”.

five steps of increasing agreement, averaged over items

LSAT “How satisfied are you nowadays altogether with your life”, scale 0-10 “highly satisfied”

For all three variables, values transformed into standardized scores of cumulative frequencies under normal distribution (z-scores)

3 DT model:

Age 30: exogeneous variables

- 3 initial means and 6 (co)variances = **9 parameters**

Age 43: same variables endogenous, each depends on every other one at age 30

- 9 regression parameters are needed
- as at age 30, 9 parameters for intercepts, residuals and residual covariances resulting in altogether **18 parameters**.

Age 56: exactly the same as at age 43, **18 parameters**.

DT: test for equality of each of the age 43 and age 56 parameters, set them equal if test is passed.

CT: questionable in frequent case of unequal intervals, significant differences could show up in DT even if the underlying parameters are equal.

Time-varying parameters not handled stepwise at each time point but by function covering the whole time range

To make DT analysis comparable to CT analysis:

All parameters at age 56 equal to the respective ones at age 43.

1 Parameter for trait variance in each of the 6 equations.

Sum: 9 +18 +1 = 28 parameters

Church Attendance, Christian Worldview, and Life Satisfaction at age 30, 43 and 56 in DT model.

Initial parameters (age 30)					
		Means	(Co)variances		
			CHURCH	WORLDV	LSAT
	CHURCH	.0819***	.4751***		
	WORLDV	-.0436	.1903***	.5024***	
	LSAT	-.0541	-.1076***	-.0437*	.8847***
Dynamic parameters (ages 43, 56)					
		Intercepts	Regressions		
			CHURCH	WORLDV	LSAT
	CHURCH	-.0516**	.4892***	-.0279	-.1188***
	WORLDV	.0235	-.0244	.4432***	-.1117***
	LSAT	.0318	-.2049***	-.1410***	.2591***
		Residual (co)variances			
			CHURCH	WORLDV	LSAT
		CHURCH	.3074***		
		WORLDV	.0468***	.4679***	
		LSAT	-.0589***	-.0741***	.6339***
		Trait variance	.2051***		

DT Results

Contrary to expectation

- neither church attendance nor Christian worldviews have a positive effect on life satisfaction
- nor life satisfaction on church attendance or Christian worldviews.

Cross-regressions

- religiosity and life satisfaction: All significantly negative.

- two dimensions of religiosity: (slightly and not significantly) negative

Auto regressions: Church > Worldview >> Life Satisfaction

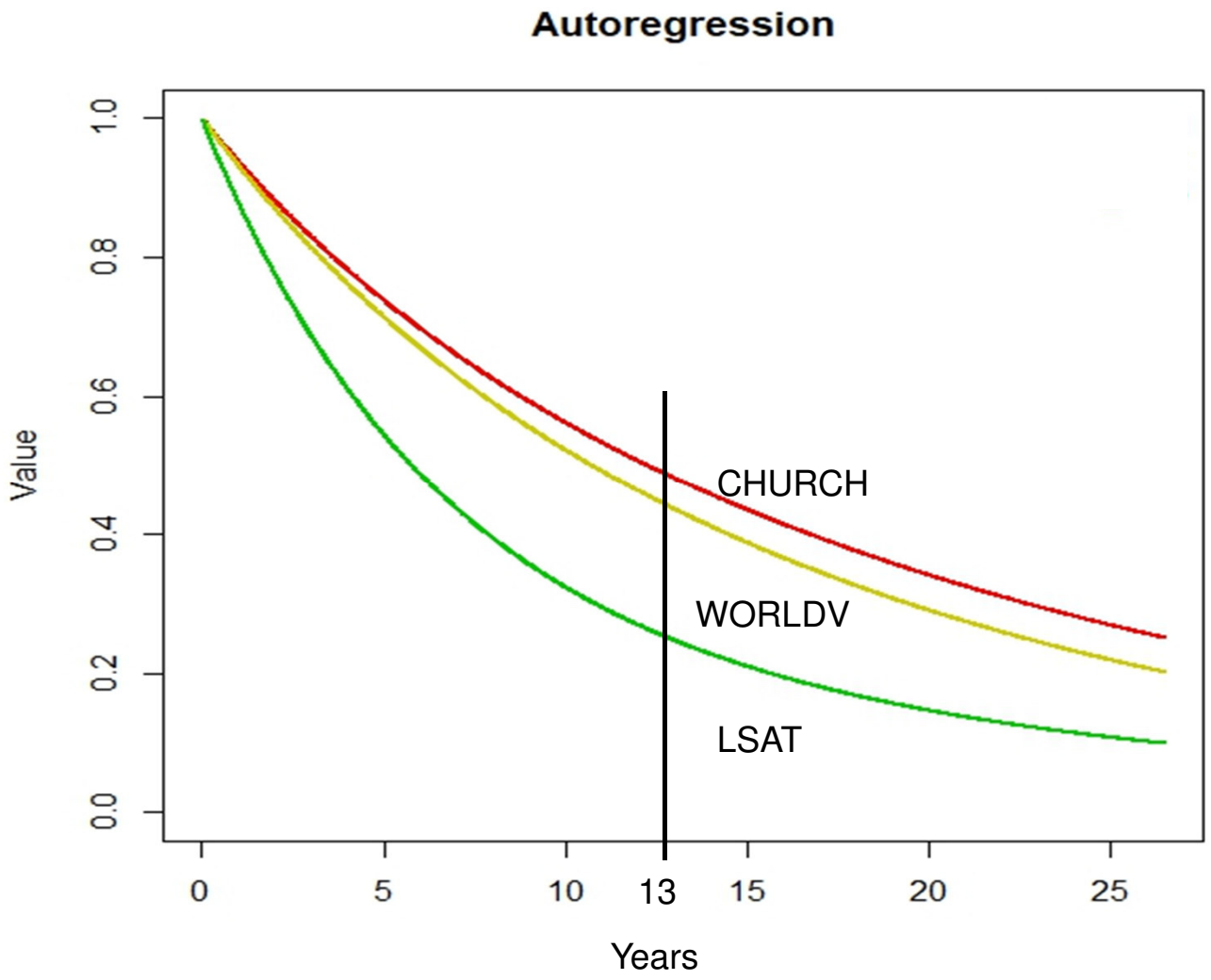
Residual variances: Church < Worldview << Life satisfaction

Trait variance: strong (success + personality)

CT results

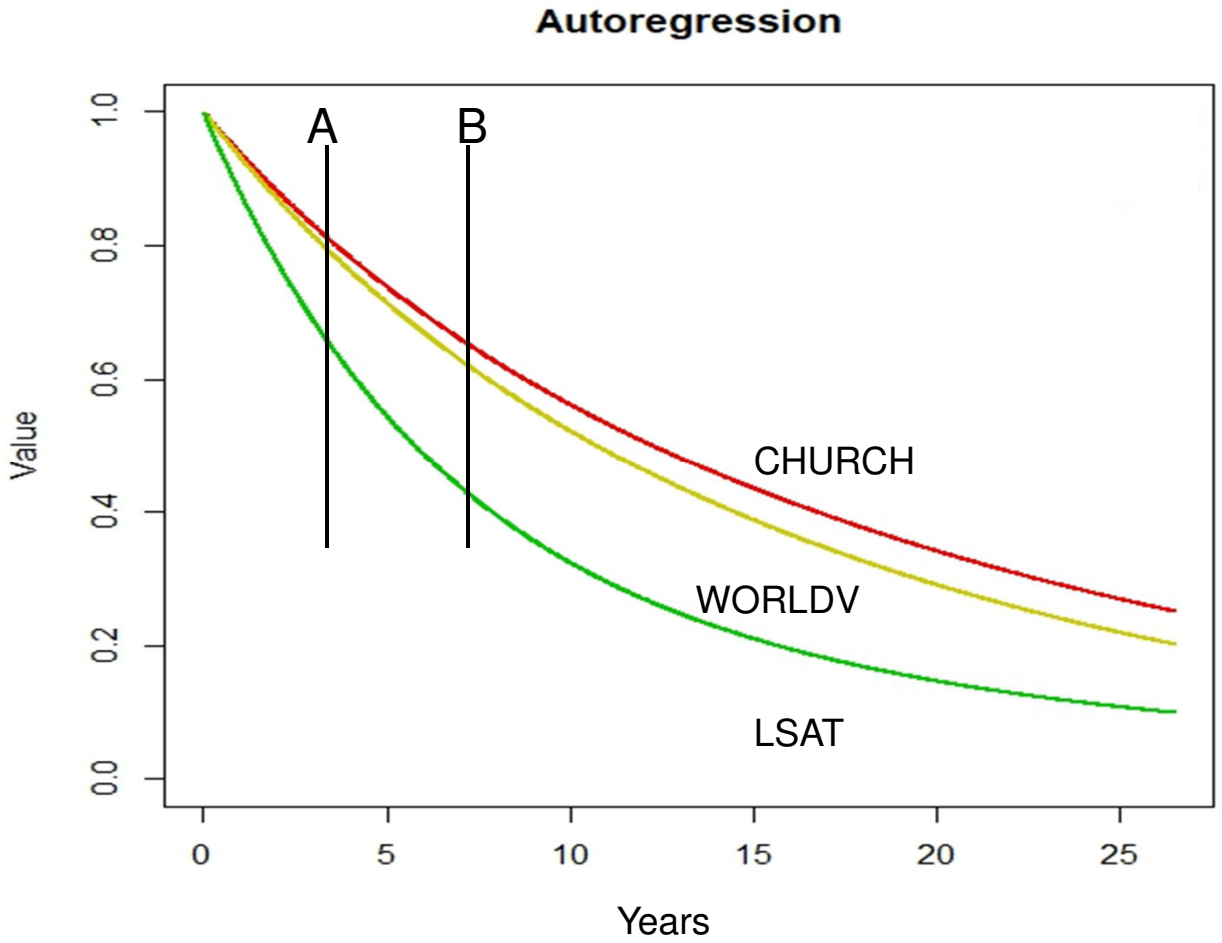
(1) DT: auto- and crossregressions and other results only at the discrete-time interval (13 years in this case).

CT: complete autoregression- and crossregression functions as well as the time path of means and variances/covariances.



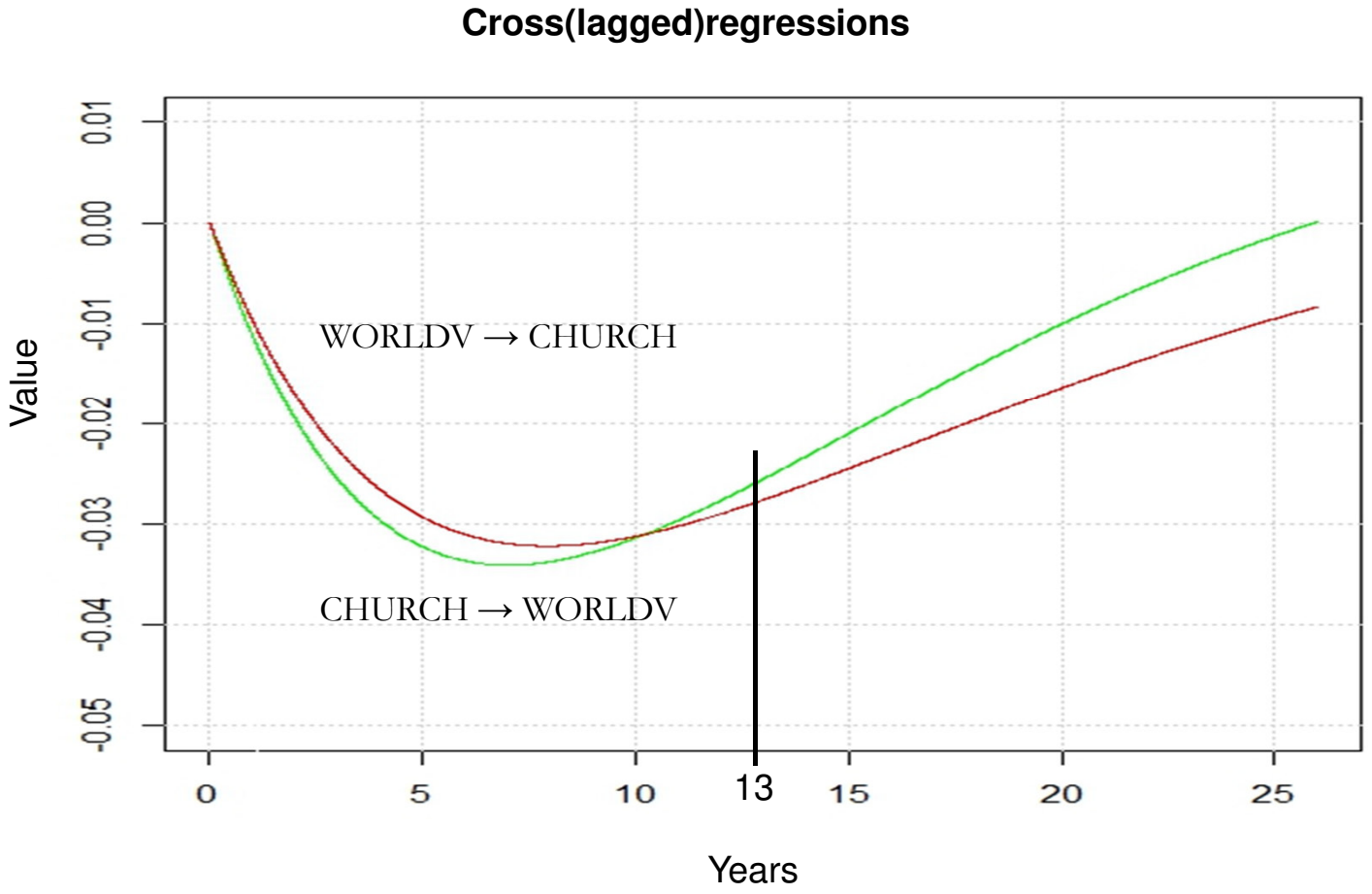
(2) DT: results dependent on observation interval, so results of studies A and B with different observation intervals cannot be compared (e.g., although WORLDV has everywhere lower autoregression than CHURCH, its value found in A is higher than in B even for CHURCH).

CT: complete auto- and crossregression functions are given, independently of the observation interval.

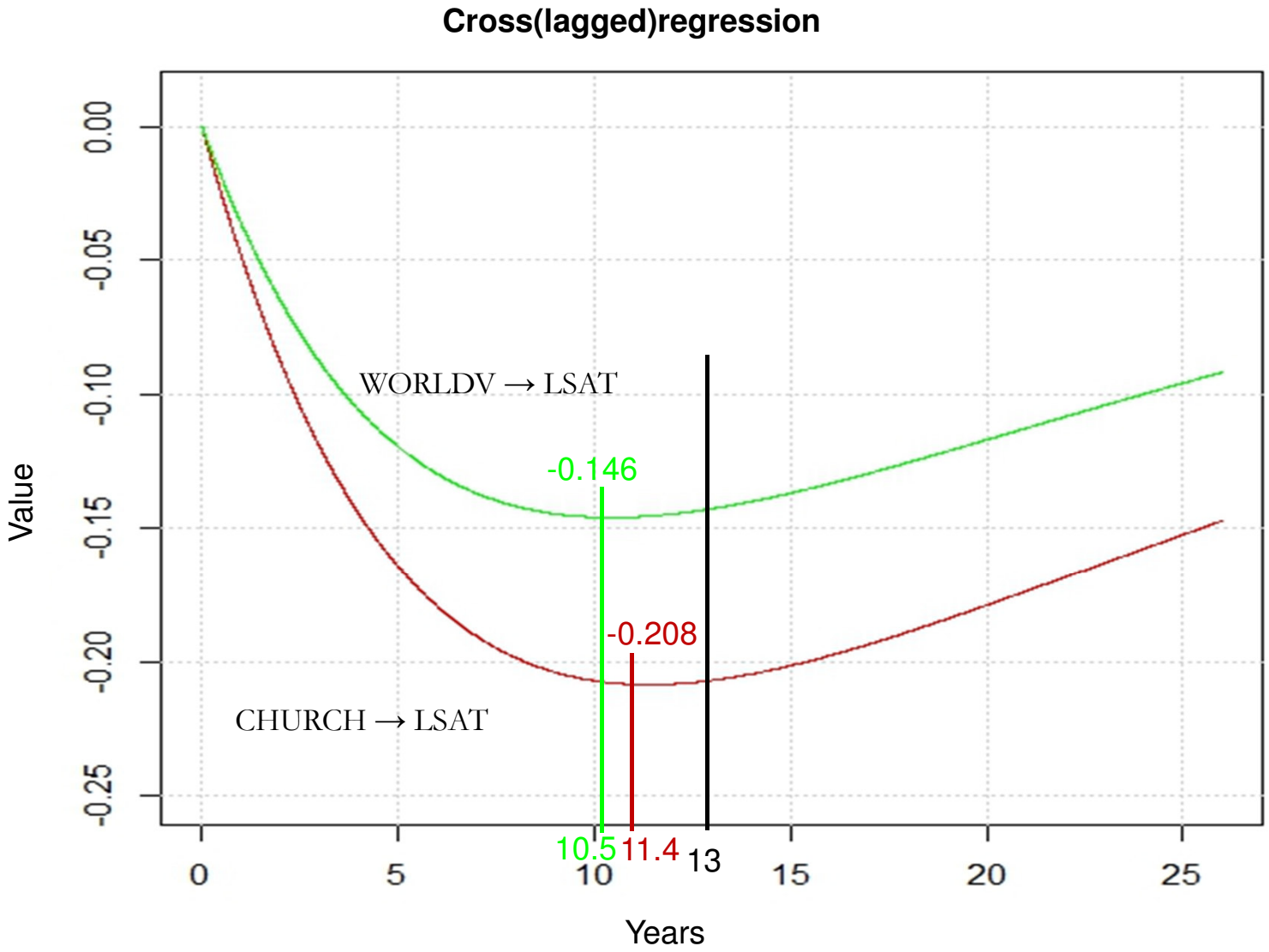


(3) DT: for crossing auto- and crossregression functions special DT problems relate to the crossing point. For example, in CT the effect of CHURCH on WORLDV is found to be more negative than of WORLDV on CHURCH but in DT in terms of crossregressions this will be found only for discrete-time intervals below 10.3 years, while for intervals > 10.3 (also for our interval of 13 years) the opposite conclusion will be found.

CT: providing both effects and complete crossregression functions leaves no room for wrong causal conclusions on the basis of the cross-regressions.

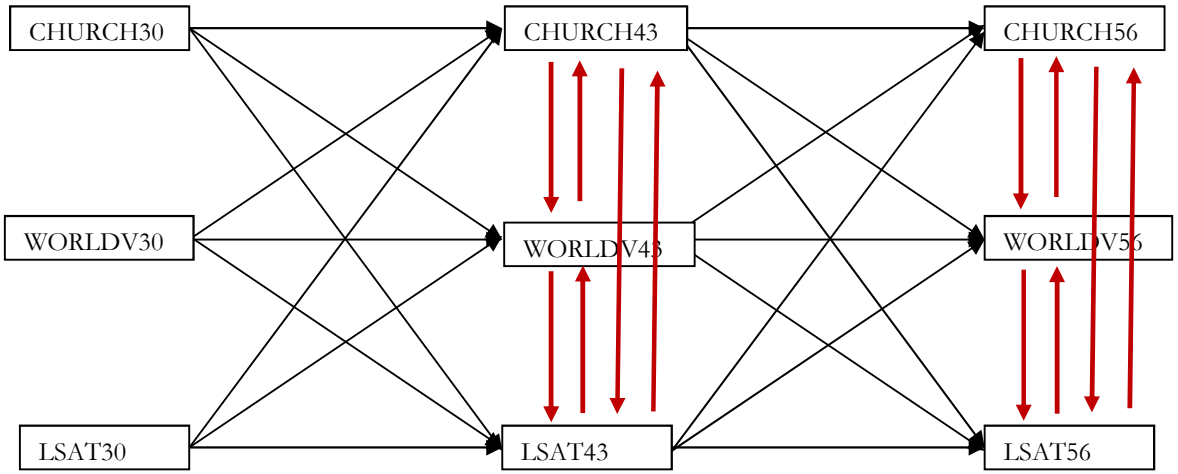


(4) DT: no information at all about the maximum impact on y of a unit x impulse,
even not whether it is located at the left or the right of the observation interval
CT: providing exact information about the maximum impact values and location
in the crossregession functions.



(5) DT: lagged and instantaneous effects dilemma.

CT: solves the dilemma by estimating the approximate discrete model (ADM) or still better the exact discrete model (EDM).



The fear to miss short-term effects within the observation interval led econometricians and social scientists to consider instantaneous effects, instead of or in addition to the lagged effects.

Structural equation modeling by recursive or, in the case of reciprocal effects, nonrecursive simultaneous equation systems was born.

(a) Fierce discussion in econometrics about the interpretation, identification and estimation of especially nonrecursive models.

(b) In general lagged and instantaneous effects will give different values. What should we believe?

An interpretation and adaptation of nonrecursive systems which solves the lagged and instantaneous effects dilemma, is Bergstrom's ADM:
Rex Bergstrom (1966): "*Nonrecursive models as discrete approximations to systems of stochastic differential equations*".

ADM: linear constraints on the structural form equation, giving an approximate CT-solution; traditional SEM programs like LISREL and AMOS can be used.

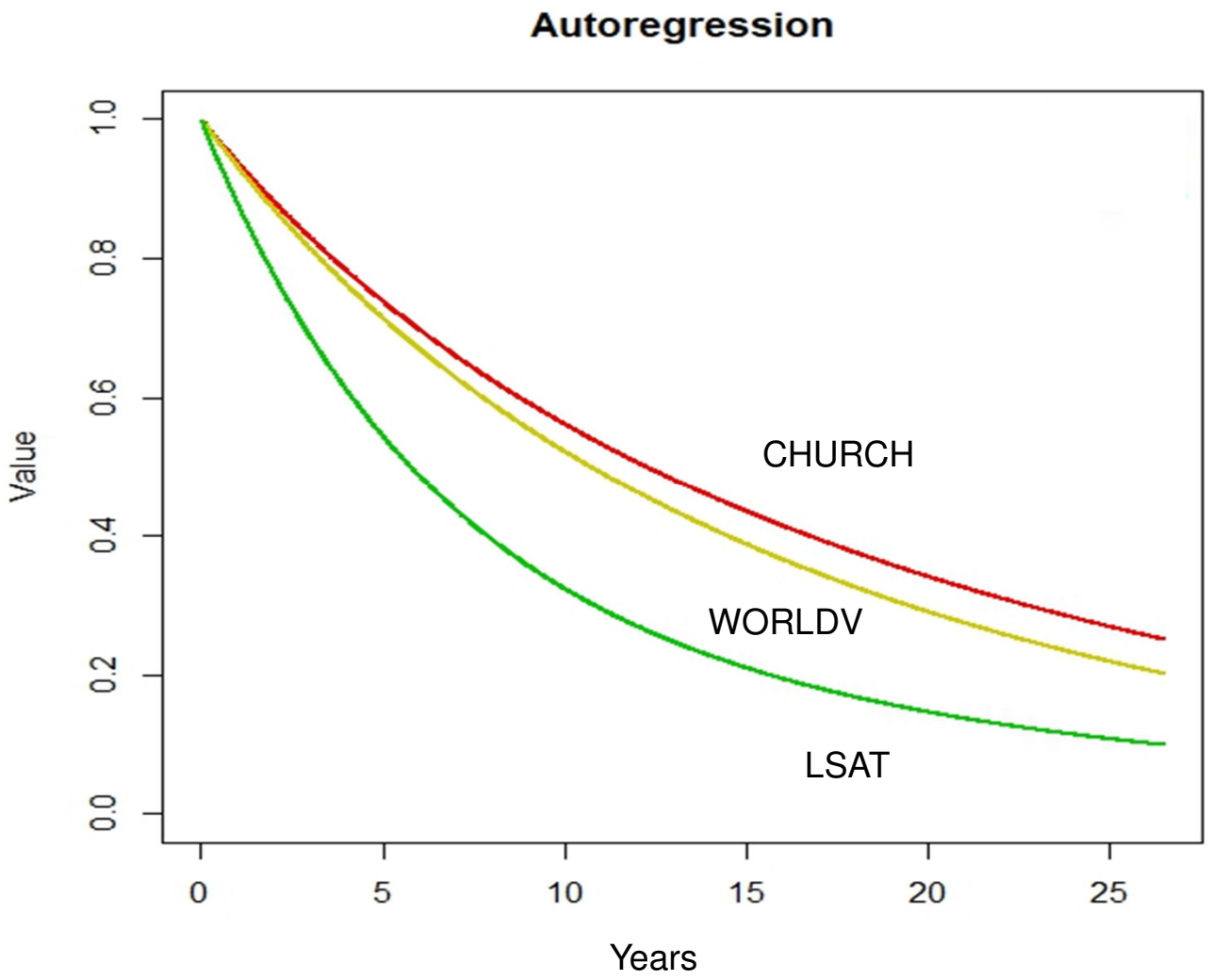
EDM: nonlinear constraints directly on the reduced form equation, giving the exact CT-solution; we used the R-package ctsem, interfacing to openMx.

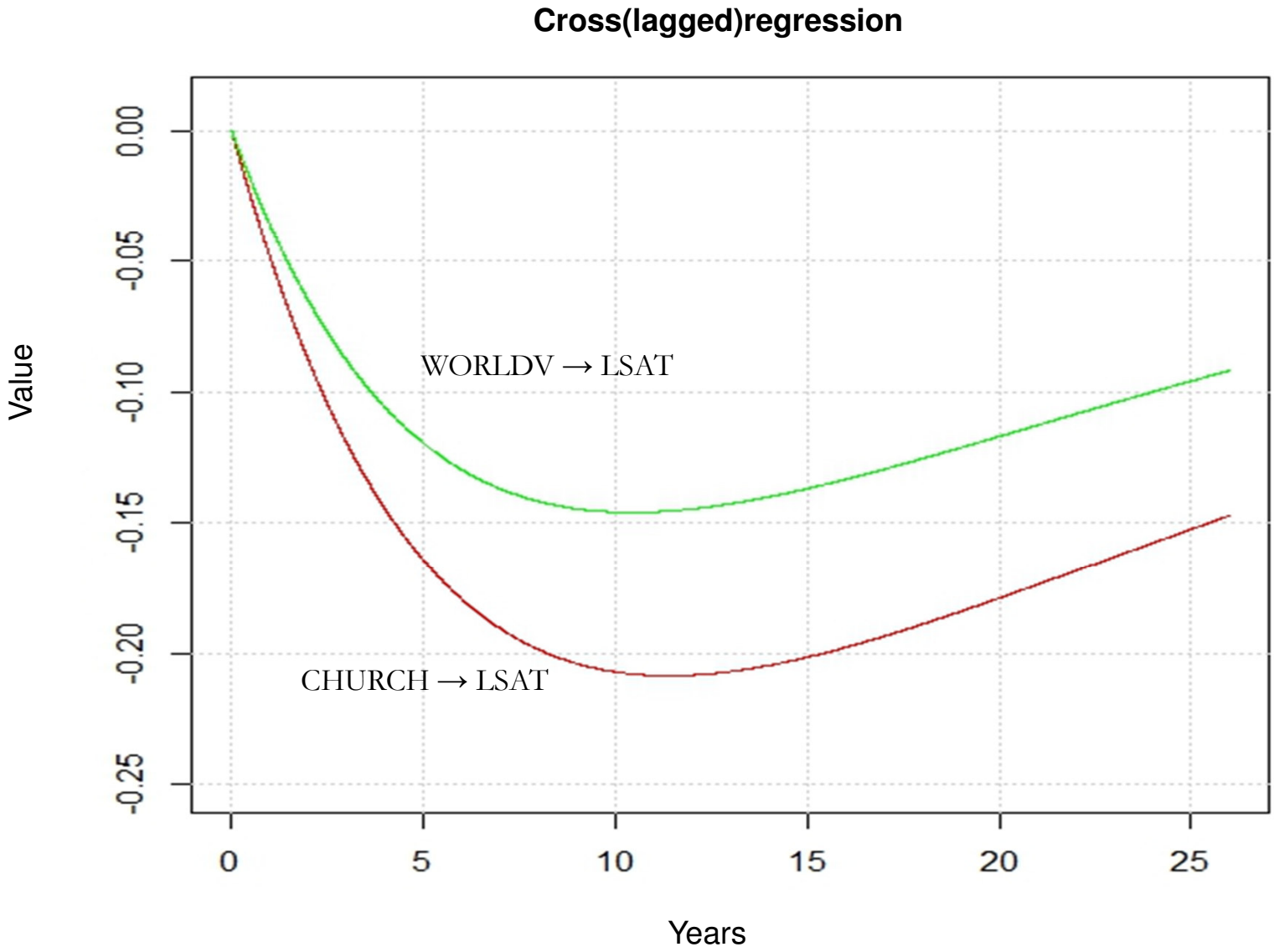
A big advantage of CT (by ADM or EDM) in comparison to DT is that it clearly differentiates the pure auto- and cross-effects from the derived auto- and crossregressions over discrete-time intervals.

$$\frac{\mathrm{d}\mathbf{x}(t)}{\mathrm{d}t} = \mathbf{A}\mathbf{x}(t) + \ldots \quad \textbf{auto - and cross - effects in drift matrix } \mathbf{A}$$

$$\mathbf{x}(t) = \mathbf{A}_{\Delta t}\mathbf{x}(t-\Delta t) + \ldots \quad \textbf{auto - and cross(lagged)regressions in matrix } \mathbf{A}_{\Delta t} = \mathbf{e}^{\mathbf{A}.\Delta t}$$

$$\mathbf{A} = \begin{bmatrix} -.065 & -.011 & -.031 \\ -.013 & -.070 & -.032 \\ -.054 & -.040 & -.129 \end{bmatrix} \quad \mathbf{A}_{\Delta t=13} = \begin{bmatrix} .481 & -.028 & -.119 \\ -.026 & .436 & -.114 \\ -.207 & -.143 & .247 \end{bmatrix} \quad \mathbf{A}_{\Delta t=0} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{matrix} \text{CHURCH} \\ \text{WORLDV} \\ \text{LSAT} \end{matrix}$$


Autoregression
Value
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
Years
CHURCH
WORLDV
LSAT


Cross(lagged)regression
Value
0.00
-0.05
-0.10
-0.15
-0.20
-0.25
WORLDV → LSAT
CHURCH → LSAT
0
5
10
15
20
25
Years

(6) DT: equal observation intervals, within and between sample units, are required and DT studies obsessively try to avoid missing values, that is to keep all intervals equal. However, in practice observation intervals almost never are exactly equal.

CT: observation time points and intervals are arbitrary. Even a study with all intervals unique is no problem. To the contrary, there is reason to distribute the intervals over the total time range of the study to improve the estimation quality of the auto- and cross-effects as well as auto- and crossregression functions.