Rebirth after Disaster: Models of Post-Pandemic Fertility and Marriage

Joshua R. Goldstein
UC Berkeley
Original talk for "Demographic Aspects of the COVID-19 Pandemic and its Consequences"
Updated for BFDW 2022

Monday, November 30, 2020, Updated June 2022

For an introduction, see . . .

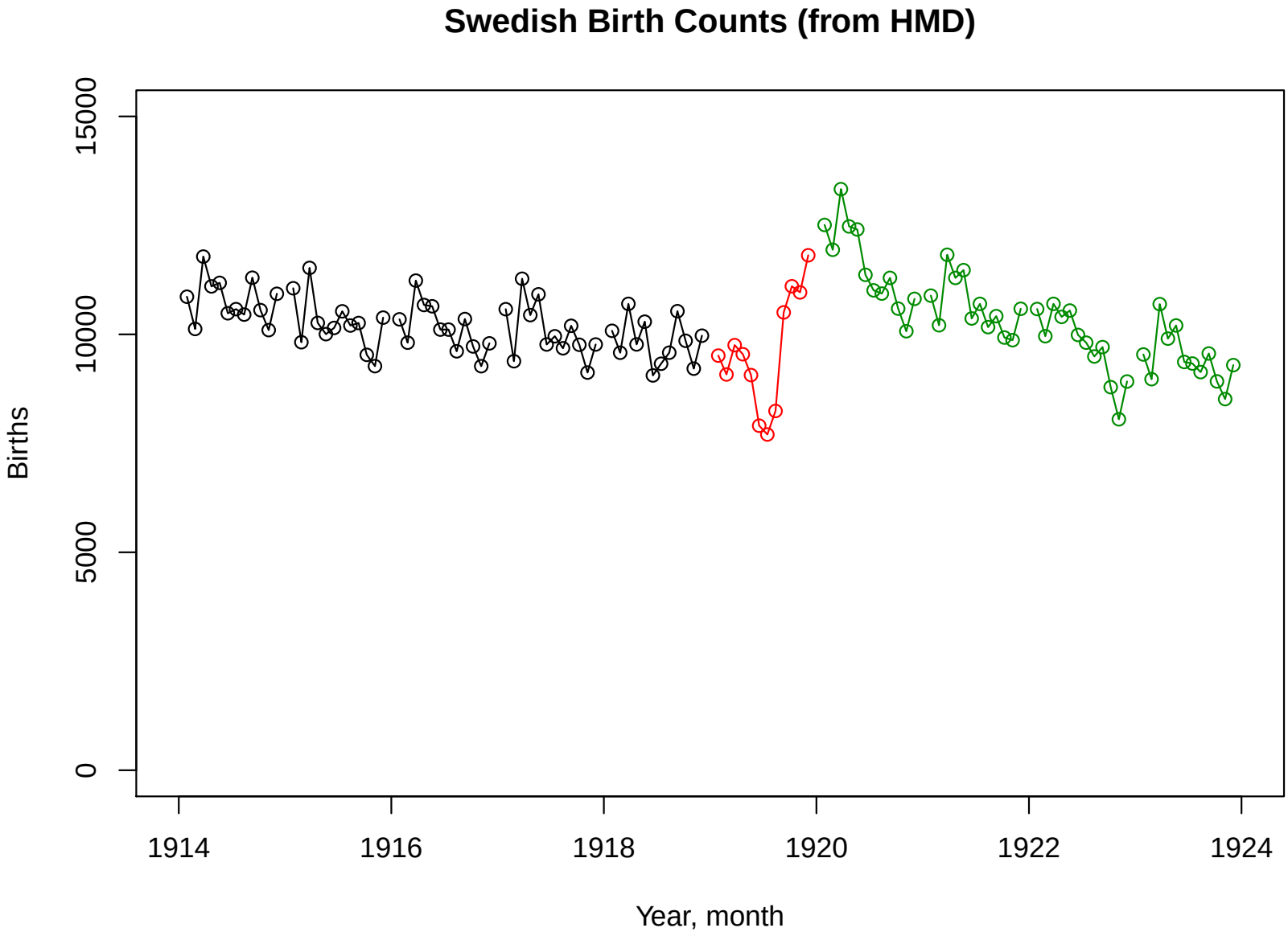
Goldstein, Joshua & Cassidy, Thomas. (2016).
"Amplified Changes: An Analysis of Four Dynamic Fertility Models,"
Chapter 1 in _Dynamic Demographic Analysis_
(editor, Robert Schoen). Springer.

Agenda

- Some examples from present and past
- Models?
  1. Descriptive ("rescheduling" vs. "postponement")
  2. Demographic dynamics (revisiting Lee's moving target)
  3. Contagious behavior (revisiting Hernes)
- Conclusions and possible directions

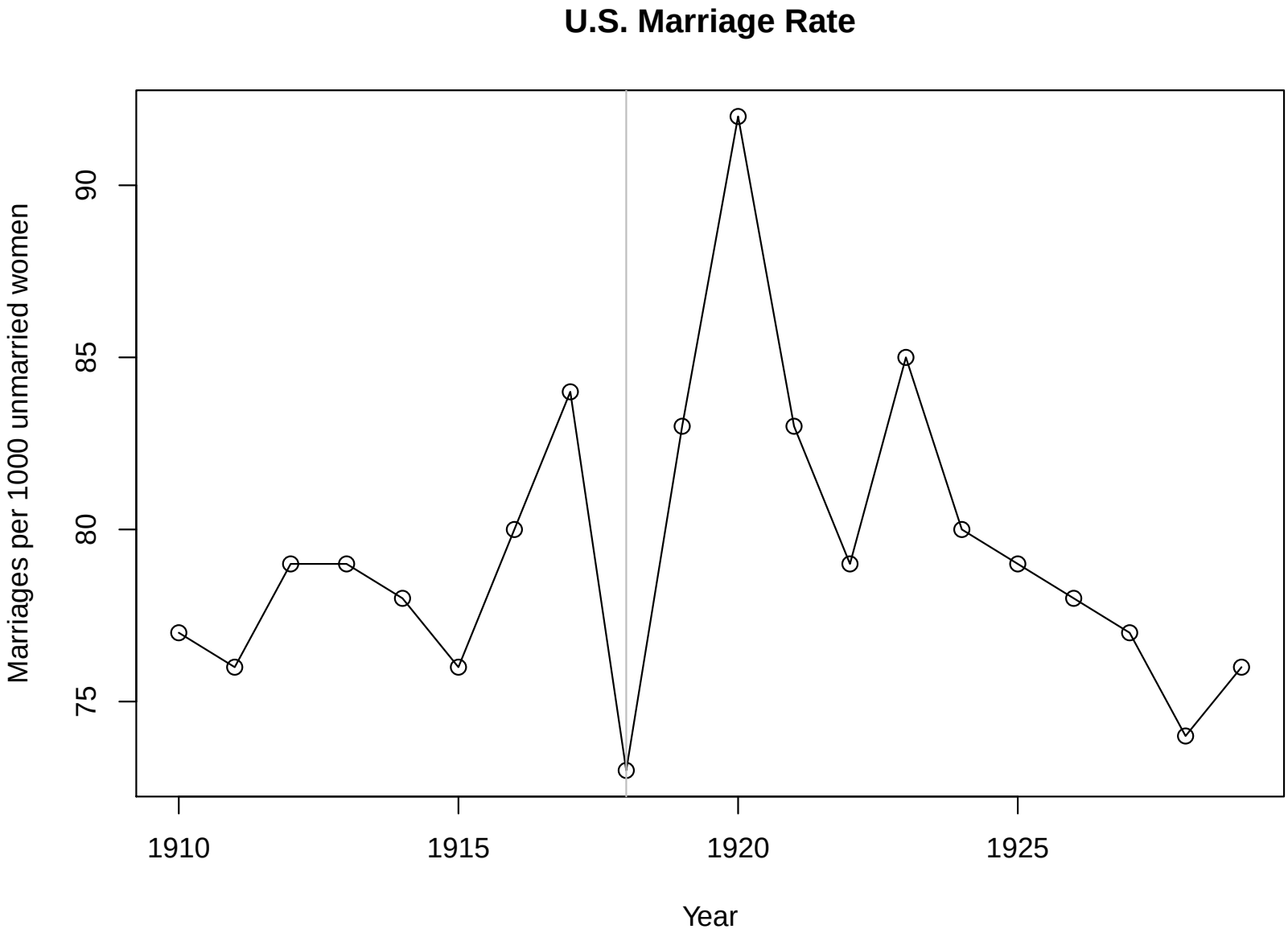
Some examples from the past and present

Sweden and the Spanish Flu



Immediate boom, which lasts

Historical Bust and Bounce of US Marriages



Delayed boom, which also lasts

What is happening today?

- We don't know births, yet.
- But we can see weddings

Marriages in my childhood home (Lane County, Oregon).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
2019	86	82	115	112	163	267	259	284	266
2020	95	114	90	78	126	153	156	275	166

Big declines, on the order of 40 percent.

A more recent update

Marriages in my childhood home (Lane County, Oregon).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	
2019	86	82	115	112	163	267	259	284	266	
2020	95	114	90	78	126	153	156	275	166	
2021	66	68	87	129	196	251	224	184	171	+ 72 same sex
2022	44	117	70							+ 15 same sex

Recovery? Or not?

Our questions for demography after the pandemic

- Will there be a baby and/or wedding "boom"?

Our questions for demography after the pandemic

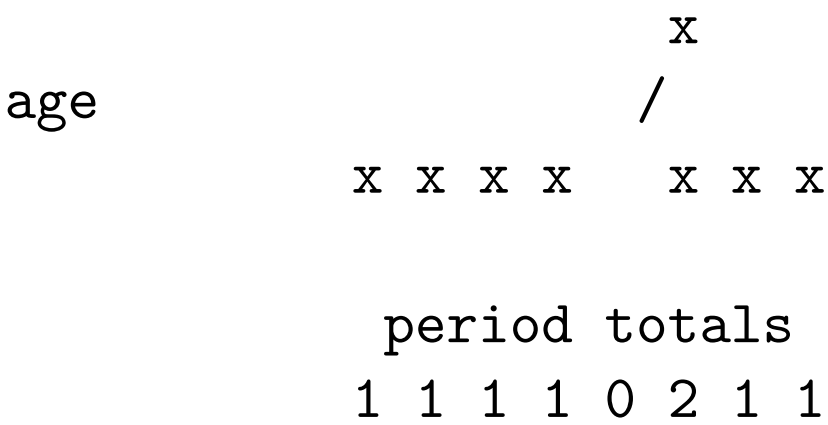
- Will there be a baby and/or wedding "boom"?
- Will cohorts "recuperate"?

Our scaled-back questions that we hope models can anwer

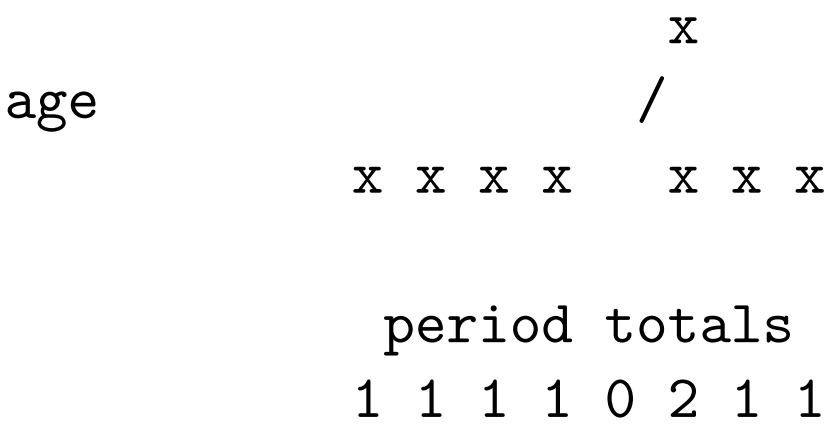
- *Under what conditions might* there be a boom or bounce?
- *What dynamics or assumptions would we need* for cohorts to recuperate?

1. Descriptive Models

“Rescheduling” (What non-demographers imagine)



"Rescheduling" (What non-demographers imagine)



What does this assume?

"Rescheduling" (What non-demographers imagine)

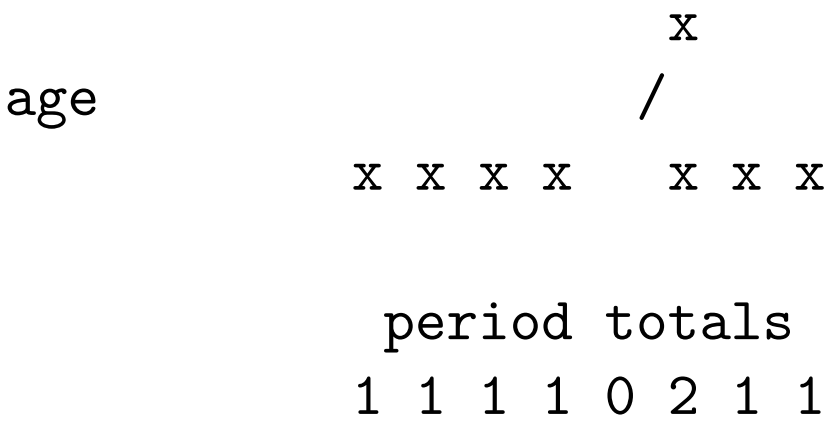
```
                      x
age                  /
          x x x x   x x x

           period totals
          1 1 1 1 0 2 1 1
```

What does this assume?

- All births occur, just later than planned.

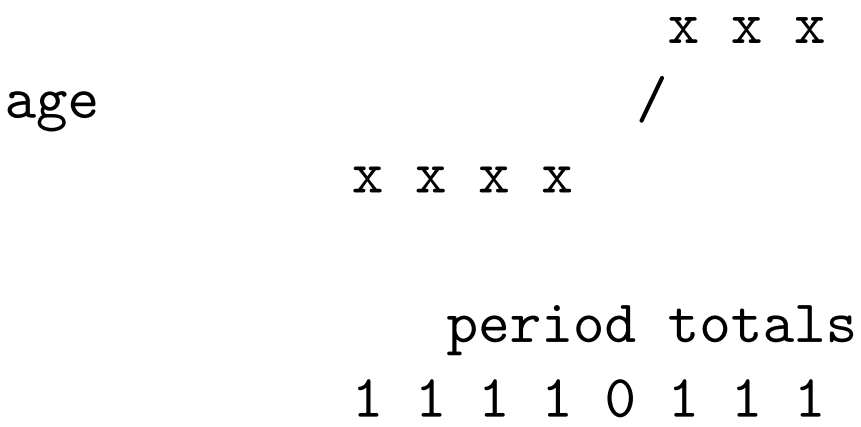
“Rescheduling” (What non-demographers imagine)



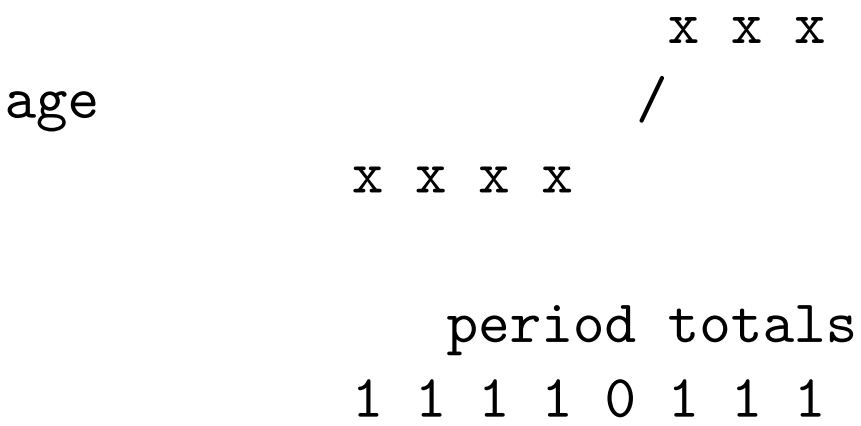
What does this assume?

- All births occur, just later than planned.
- Instant return to “old normal”.

“Postponement” (What demographers like Bongaarts and Feeney imagine)



“Postponement” (What demographers like Bongaarts and Feeney imagine)



What does this assume?

- All births occur, just later than planned.
- We stay at the “new normal”

2. Models that combine demography and behavior

Ron Lee's "moving target"

Ingredients:

- Cohorts have a target family size
- Unfulfilled fertility happens at a constant rate
- Birth timing and period level is an output of model, not an input.

An equation relating flow of births to stock of children

$$\begin{aligned} \text{fertility} &= \text{rate} \times \text{(unachieved family size target)} \\ f_x &= \alpha \times (T - F_x) \\ &= 0.3 \times (2.0 - 1.0) \end{aligned}$$

- f_x birth rate x years after onset of childbearing
- α rate at which unachieved desires are achieved, constant by duration
- T desired family size target (Ron lets T vary by period).
- F_x children already born

Innovation: to model epidemic, we let α vary by period.

A simple example of a cohort $\alpha = 1/2,\ T = 1$

		period		
	3			1/16
duration	2		1/8	
	1	1/4		
	0	1/2		

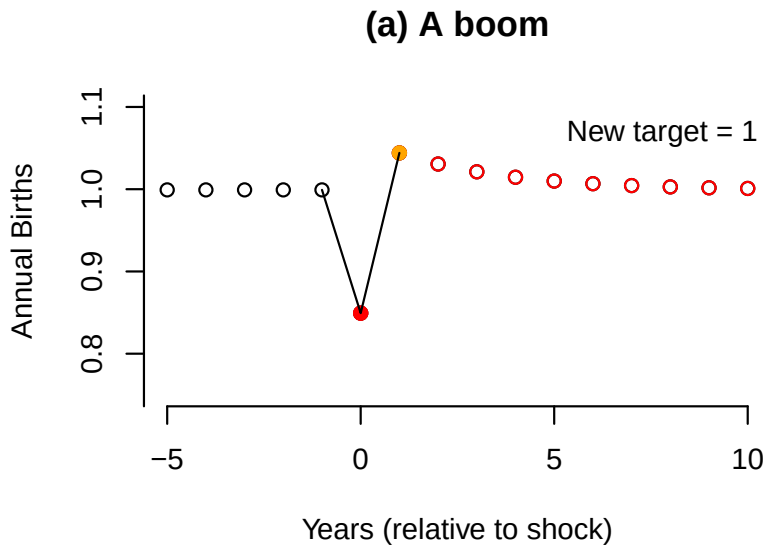
Filling in the Lexis surface

		period			
	3	1/16	1/16	1/16	1/16
duration	2	1/8	1/8	1/8	1/8
	1	1/4	1/4	1/4	1/4
	0	1/2	1/2	1/2	1/2
		---	---	---	---
total		1	1	1	1

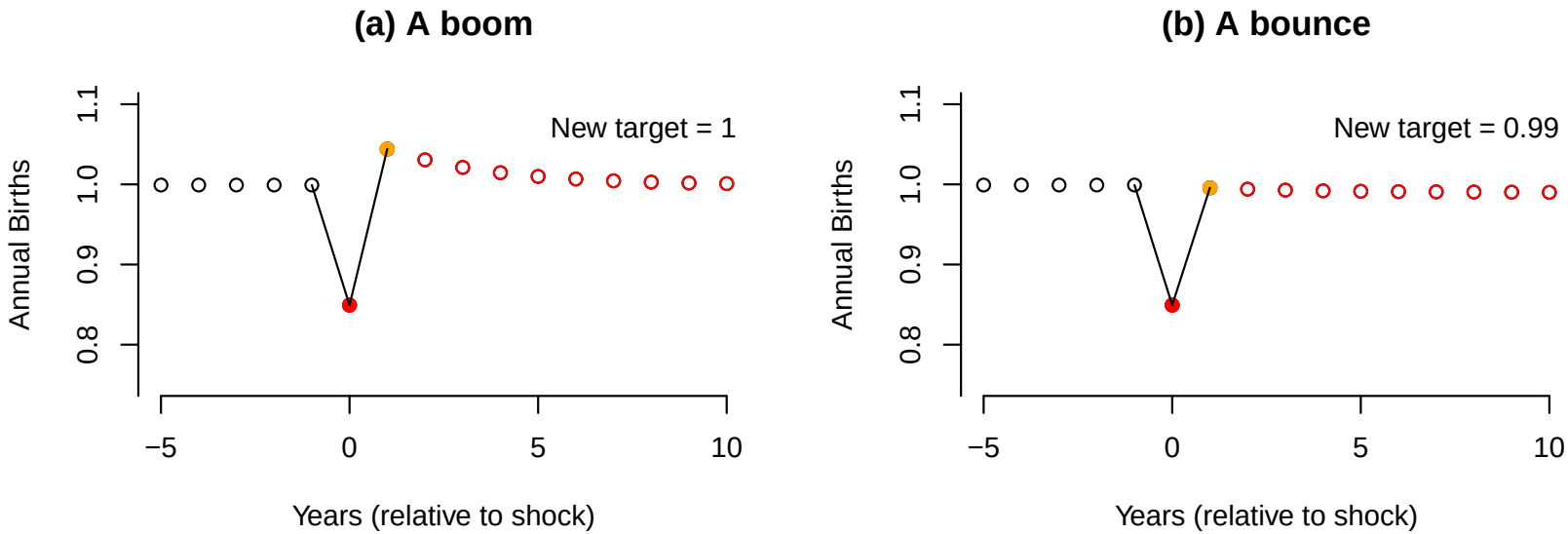
Recovery after a zero-fertility year

		period			
	3	1/16	0	1/8	1/8
duration	2	1/8	0	1/4	1/4
	1	1/4	0	1/2	1/4
	0	1/2	0	1/2	1/2
		---	---	---	---
total		1	0	3/2	5/4 ...

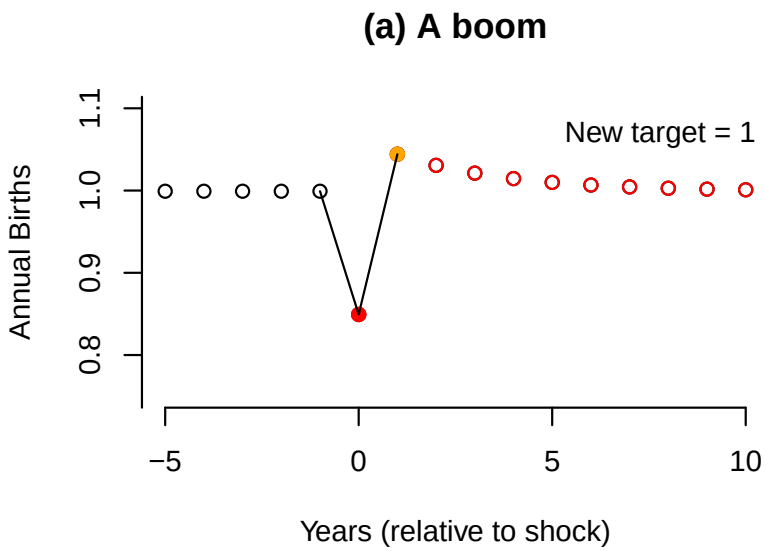
A simulated boom, after 15% decline with no change in target

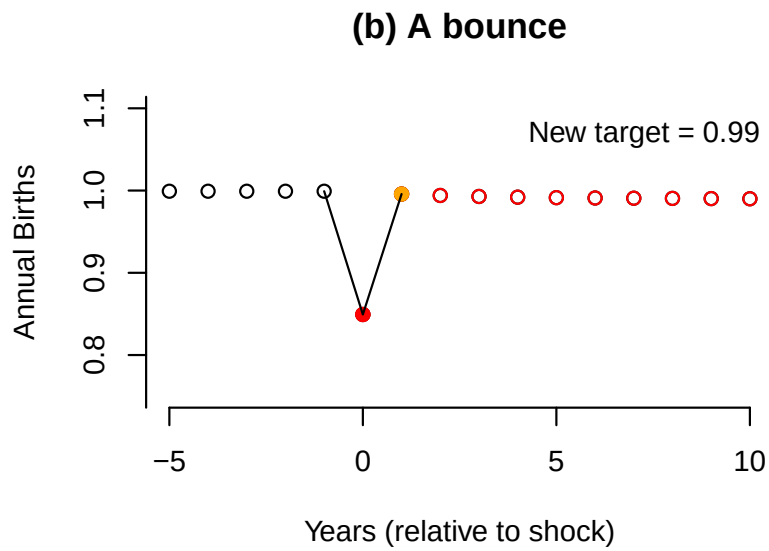


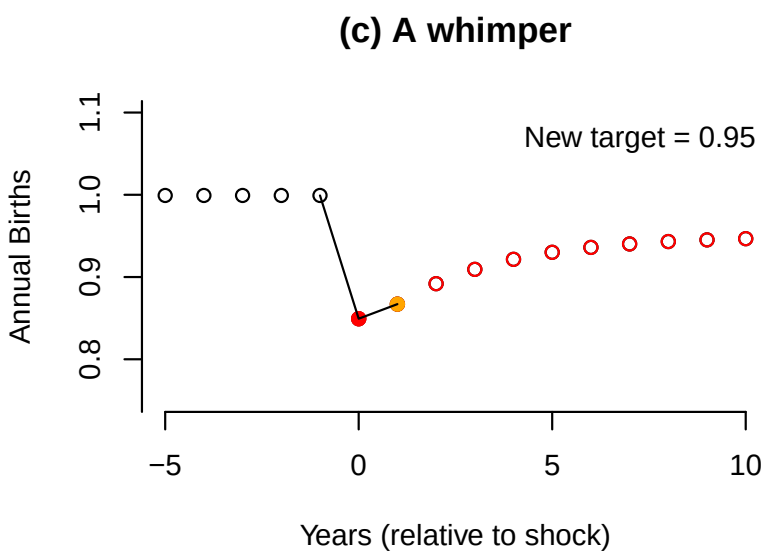
No boom, but return to previous level, if target declines just slightly



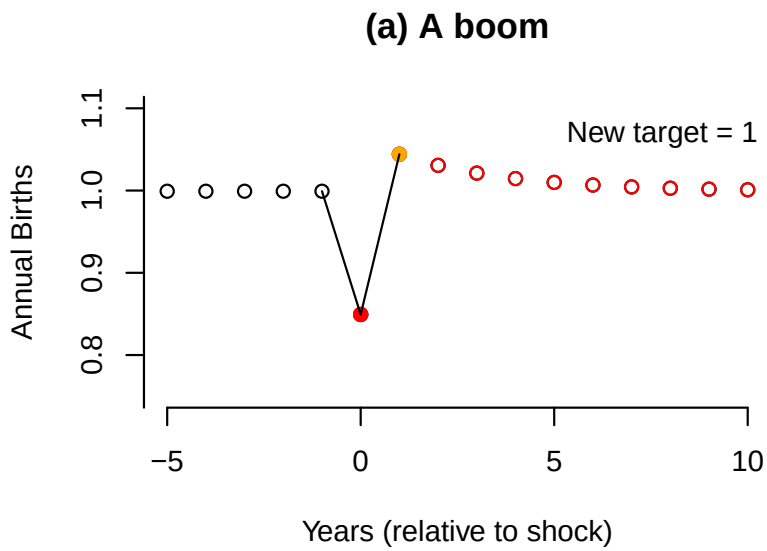
Even a small decline in target can overwhelm rebound

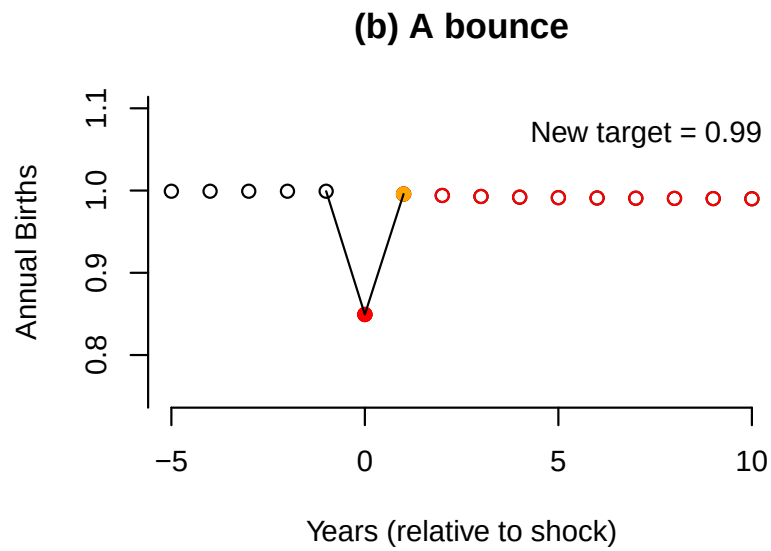


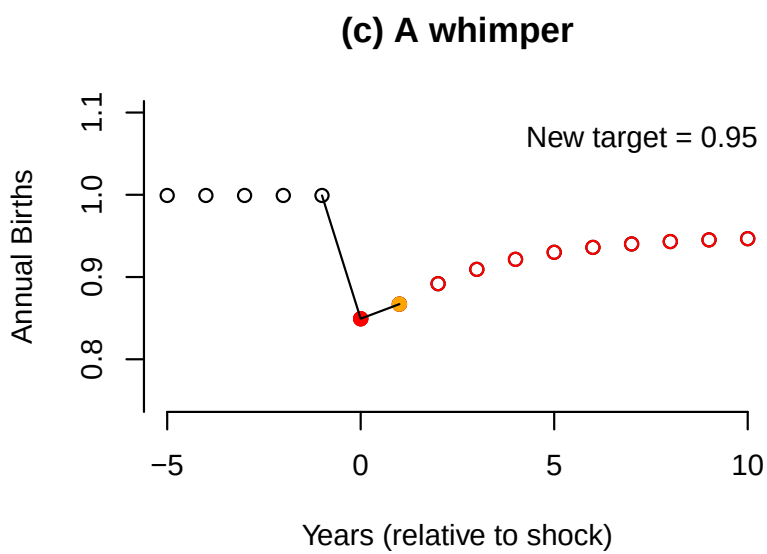


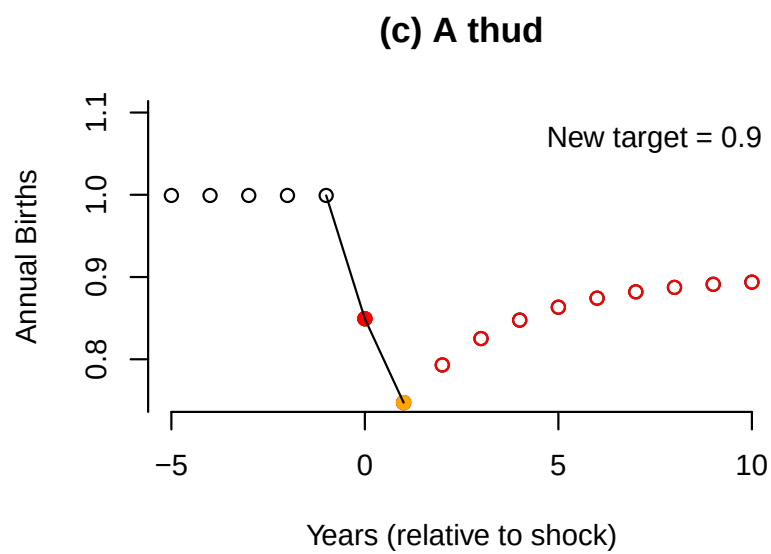


A larger decline in target can make fertility continue to fall









Moving Target Model, preliminary conclusions

- Super simple model, but still creates complicated dynamics
- Even small changes in target have very large effects
- Perhaps, boom after Spanish Flu in Sweden consistent with no change in target.
- Covid today? Target expected to decline, making boom unlikely. (Recovery, whimper or thud?)

Moving Target Model, preliminary conclusions

- Super simple model, but still creates complicated dynamics
- Even small changes in target have very large effects
- Perhaps, boom after Spanish Flu in Sweden consistent with no change in target.
- Covid today? Target expected to decline, making boom unlikely. (Recovery, whimper or thud?)
- But, who knows? Will there be a turn, a new spring, that will increase targets?

3. Diffusion models for behavioral change

Endogenous targets?

Can the target be the output of a model, rather than an input?

Endogenous targets?

Can the target be the output of a model, rather than an input?
Yes. "Social contagion" or "social diffusion" models produce eventual cohort levels as an output.

Hernes modeled marriage as a social contagion

- No target
- We just "seed" the behavior, and it spreads as cohort ages
- Age effect

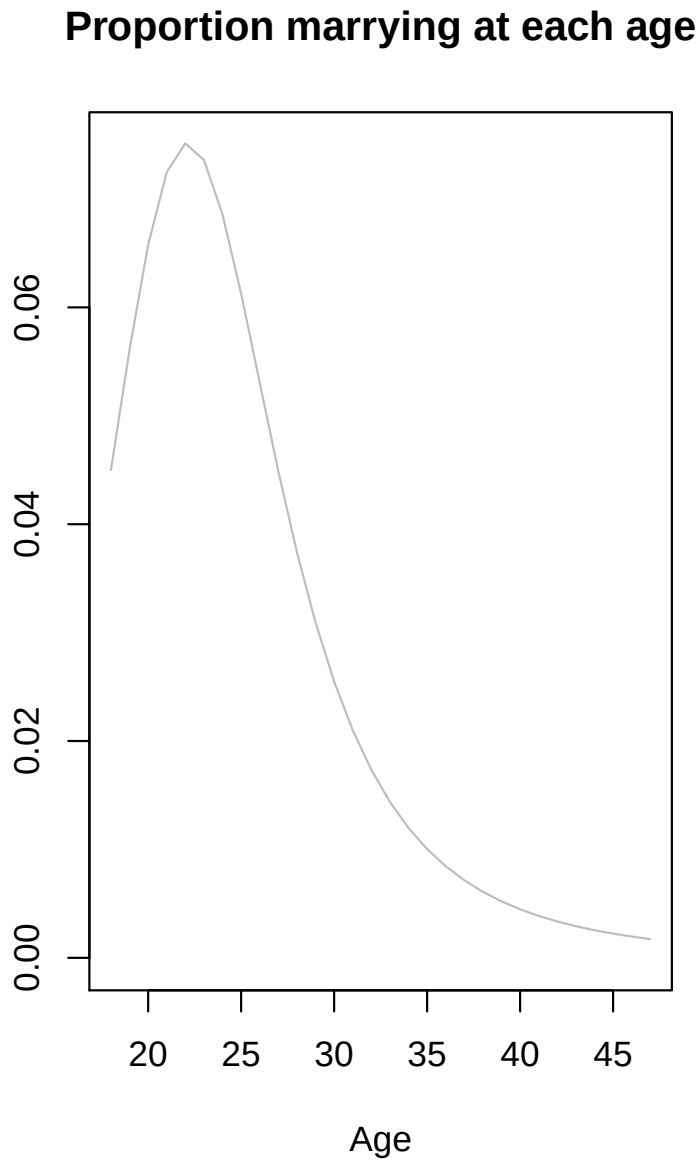
$$\text{marriages} = \text{unmarried} \cdot \text{marriage rate}\ (\text{contagion}, \text{age})$$

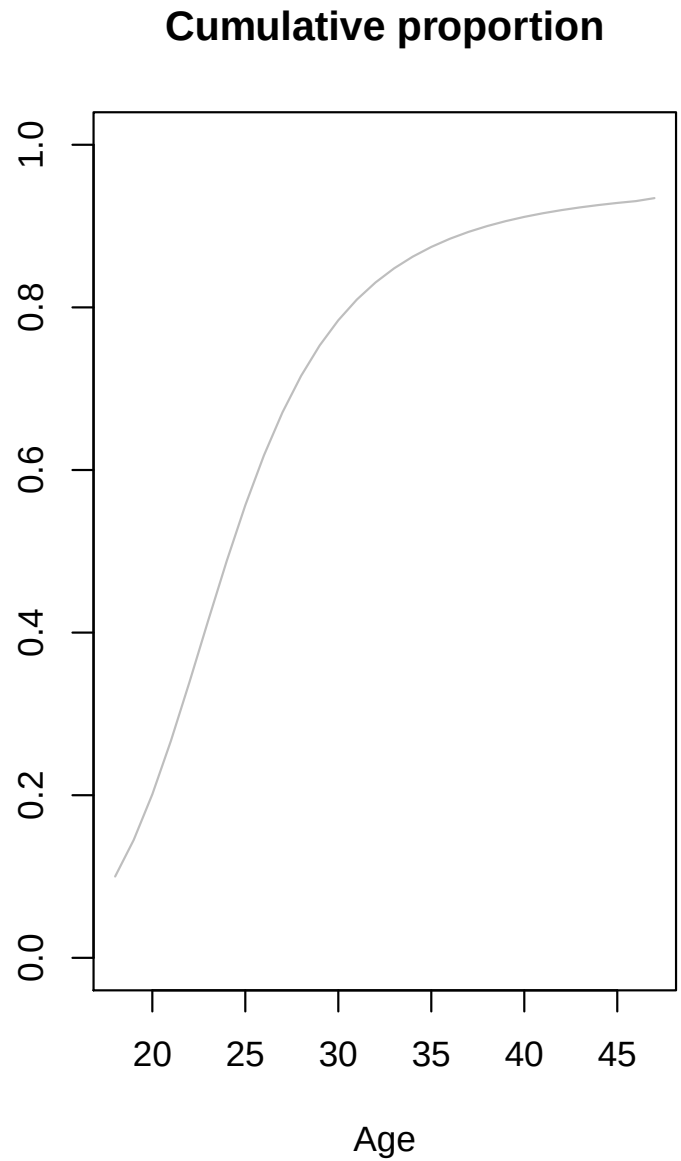
$$p_x = (1 - P_x) \quad \cdot a(P_x)e^{-bx}$$

p_x are marrages aged x

P_x are cumulative marrages by age x

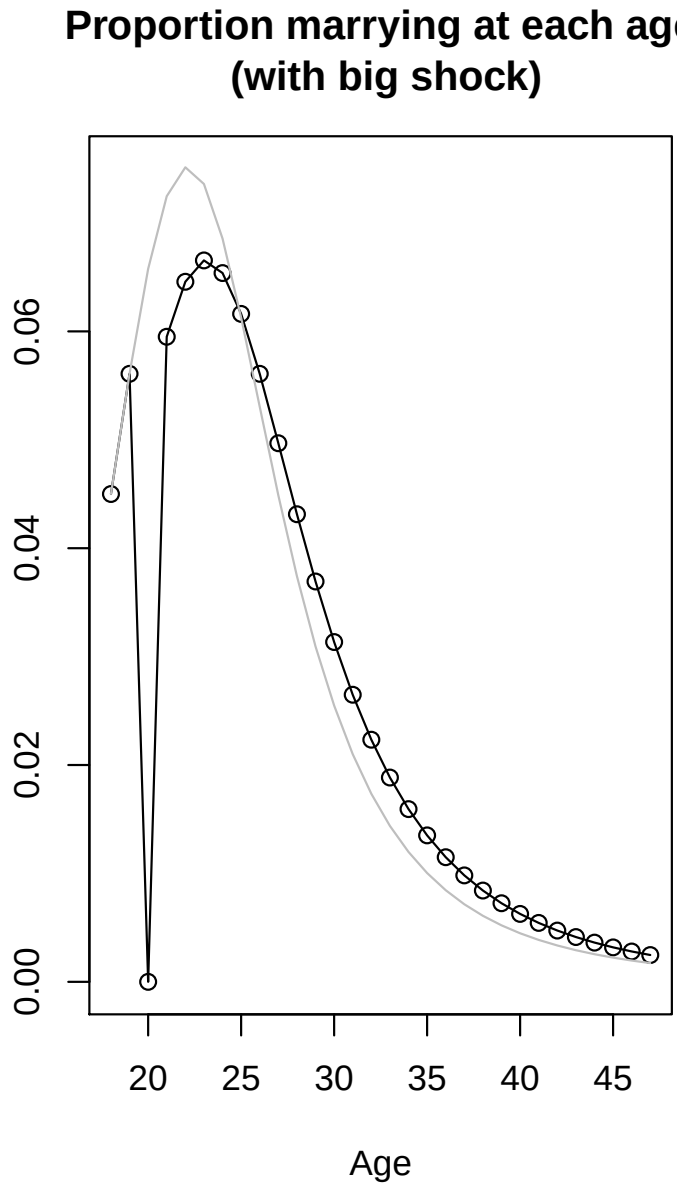
A sample Hernes schedule

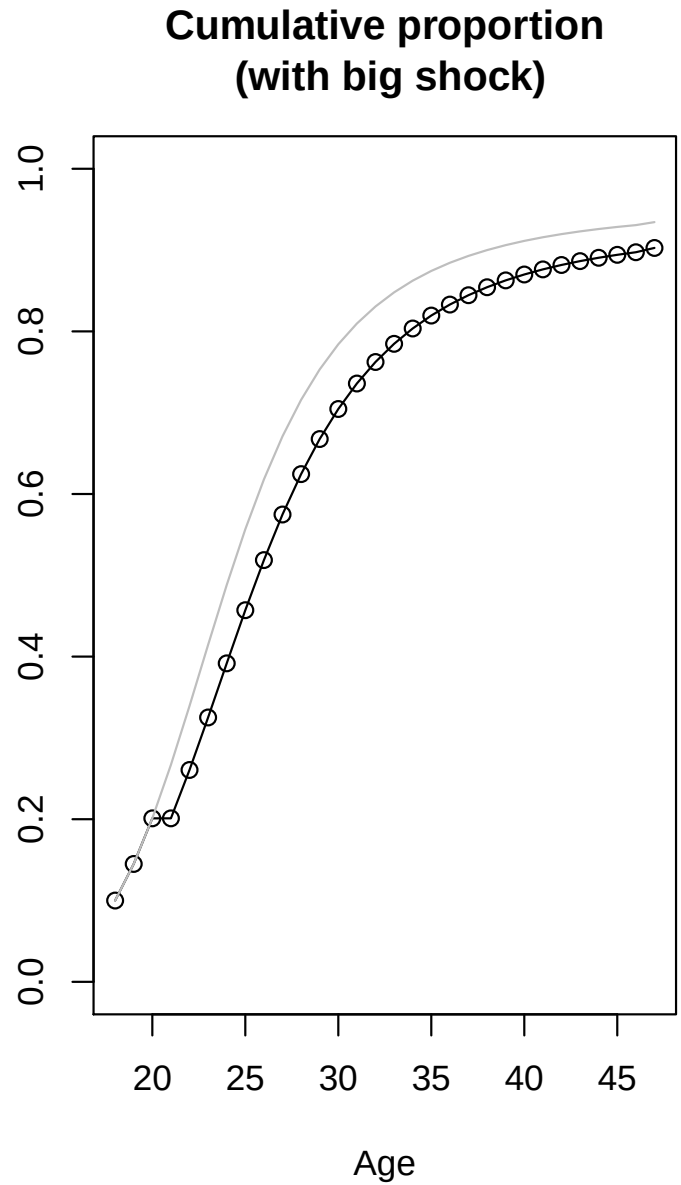




Can ask what happens if a shock occurs . . ..

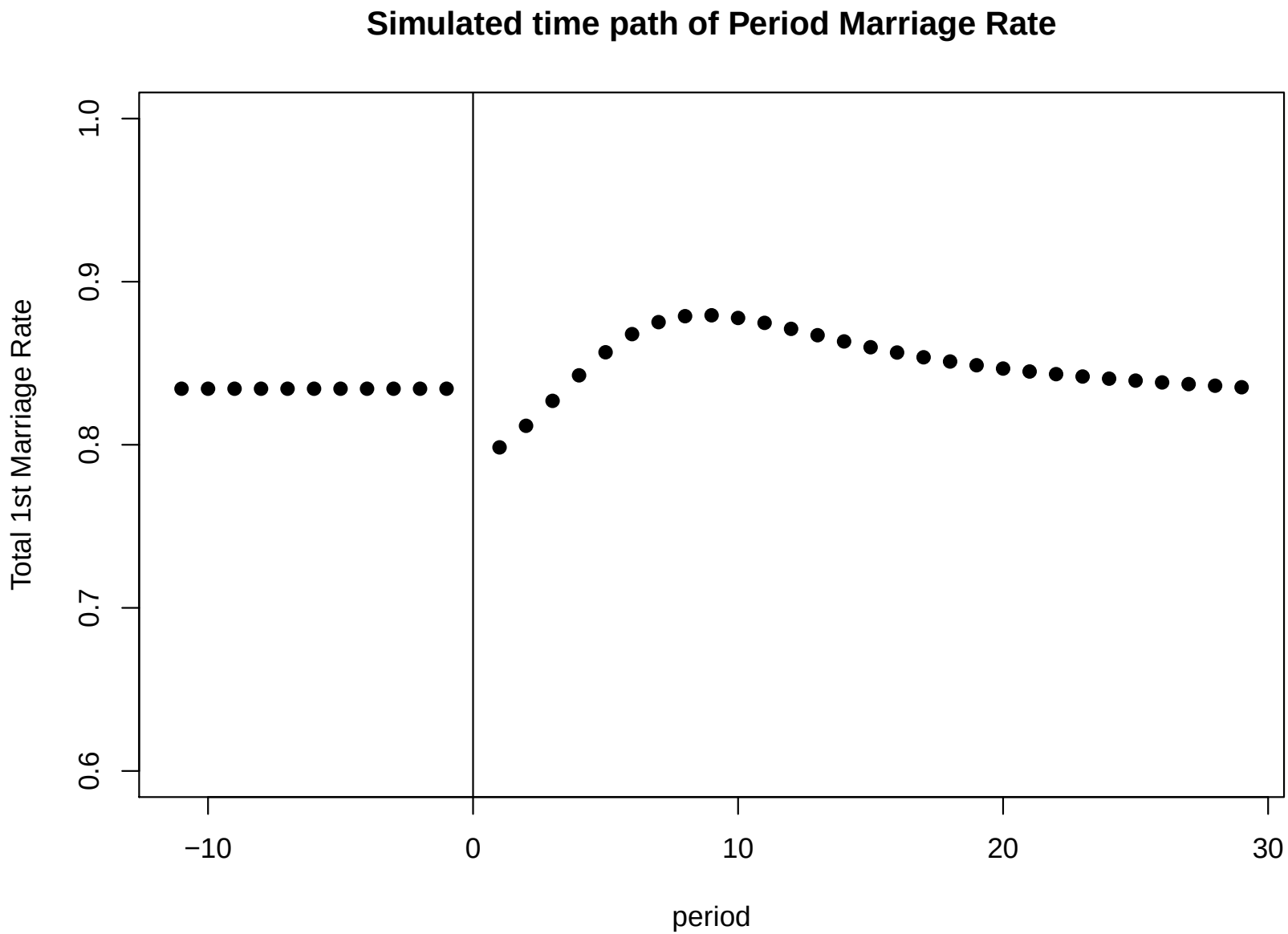
A big shock, e.g., for cohort born in year 2000





No boom, only some recuperation. (endogenous target)

A Bust and Boom in Period Marriages



As cohorts tend to bust and recuperate in rough synchrony

Two specific conclusions

1. Lee model suggests period birth rebound will depend very strongly on what happens to target.
2. Hernes model suggests period partnership rebound could happen even if cohorts don't recuperate.

Broader lessons

- Unpredictability: anything goes right after the pandemic ends
- Patience: even short-lived shock could reverberate for years
- Lagged effects even stronger in real world – epidemic won't suddenly end for everyone at the same time
  (e.g., Great Recession)

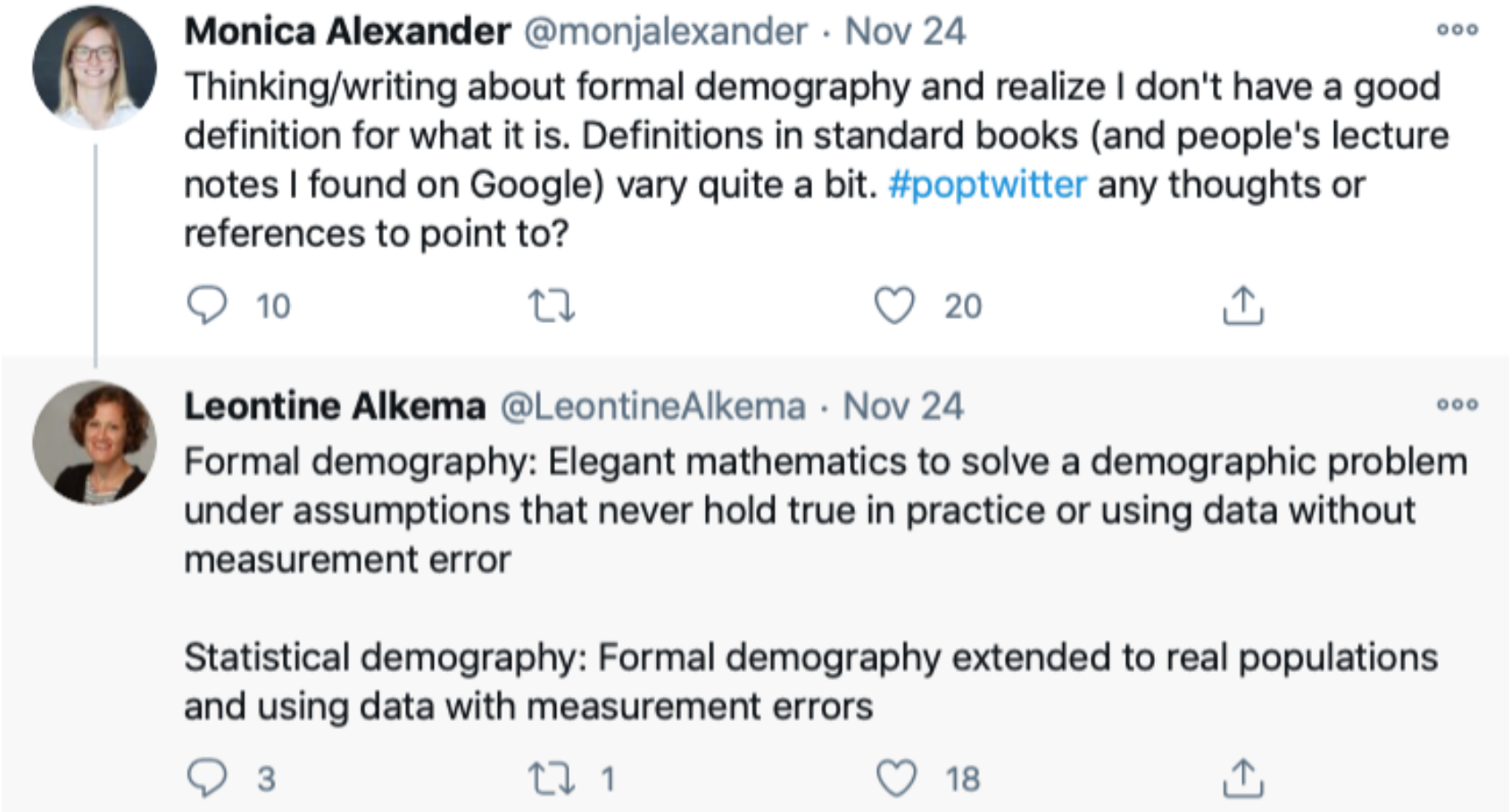
Future theoretical directions

- Extension: cohort diffusion across whole of Lexis surface?
- Mathematics: perturbation analysis of differential equations?
- Two-stage process: entrance into childbearing ("marriage"), and then fertility?

Substantive extensions

- Extending Lee's model: Incorporating variation in α by age and parity.
- New areas of application: Abortion? What are the population consequences of reducing abortion availability? Would more children be born? Or would same number of births just occur earlier?

Leontine's 'harsh' tweet



Monica Alexander @monjalexander · Nov 24

Thinking/writing about formal demography and realize I don't have a good definition for what it is. Definitions in standard books (and people's lecture notes I found on Google) vary quite a bit. #poptwitter any thoughts or references to point to?

10 20

Leontine Alkema @LeontineAlkema · Nov 24

Formal demography: Elegant mathematics to solve a demographic problem under assumptions that never hold true in practice or using data without measurement error

Statistical demography: Formal demography extended to real populations and using data with measurement errors

3 1 18

A gentler conclusion: empirical work and formal work are complementary. Models can help us work through our thinking and point us to what we want to measure.

Measurement Coda: The return of fertility intentions?

- A high frequency birth intentions barometer?
- Extending to cohabitations and marriage?

Thank you