

***Multidimensional Life Table  
Estimates of the Total Fertility Rate  
and Its Components, Based  
Alternatively on Actual Birth  
Histories and Reconstructed Birth  
Histories***

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# *What is meant by “TFR and its components”?*

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- TFR
- TMFR (Total Marital Fertility Rate)
- Parity progression ratios (PPRs)
- ASFRs
- Mean and median ages at first marriage
- Mean and median ages at childbearing (both overall and by child’s birth order)
- Mean and median closed birth intervals

# ***All the above measures are estimated, and all are multivariate***

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- The measures are model-predicted measures
- By “multivariate” is meant:
  - Each model-predicted measure can be tabulated by categories of one socioeconomic variable while holding other socioeconomic variables constant

# *The methodology is applicable to birth history data*

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- The birth histories can be actual birth histories or reconstructed birth histories
- **Actual birth histories**
  - E.g., from DHS surveys
- **Reconstructed birth histories**
  - From censuses or household surveys that are collected for other purposes

## *The methodology can be applied to either period data or cohort data*

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- The model-predicted estimates of TFR and its components can be either period measures or cohort measures
  - Depends on how the input data are prepared
- Underlying methodology is complex, but final output is always simple bivariate tables
  - E.g., tabulation of TFR by categories of education, with other socioeconomic variables controlled (i.e., held constant)

# ***Reconstruction of birth histories is done using Norman Luther's method***

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- This method imputes missing births into incomplete birth histories
  - The incomplete birth histories are derived from ages of children who are matched to mothers in the same household
  - Children who are living in some other household or who have died are missing, so their births have to be imputed

# *Data needed for application to censuses and household surveys*

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- Essential data
  - **Number of children ever born (parity)**
  - **Listing of all household members by age, sex, marital status, and relation to head**
- Desirable but not essential data
  - **Number of surviving children** (makes the birth history reconstruction a little more accurate)
  - **Age at first marriage or year of first marriage** (necessary to estimate marriage-related measures, including TMFR)

# *Modeling approach*

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- Discrete-time survival models
  - Either discrete-time logit or complementary log-log
  - They give close to identical results
  - We use the complementary log-log model
- Separate model for each parity transition
  - B-M (birth to first marriage)
  - M-1 (first marriage to first birth)
  - 1-2 (first birth to second birth)
  - And so on (with an open parity interval at the end)
  - B-M and M-1 can be collapsed into 0-1 if needed

# *General features of the model for a particular parity transition*

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- **Response variable:**
  - $P$  (probability of either a first marriage or a next birth in a one-year interval)
- **Predictor variables:**
  - $a$  (woman's age) and  $t$  (duration in parity)
  - socioeconomic predictor variables of interest (e.g., education and urban/rural residence)

***Collectively, the models for the various parity transitions yield predicted transition probabilities  $P_{ait}$***

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- $P_{ait}$ : Set of transition probabilities by age, parity, and duration in parity
  - $a$  denotes age
  - $i$  denotes parity
  - $t$  denotes duration in parity
- A set of probabilities  $P_{ait}$  can be generated for any set of specified values of the socioeconomic predictor variables

***The  $P_{ait}$  are then used to construct a multi-dimensional life table of marriage and fertility***

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- Dimensions of the life table are age, parity, and duration in parity
  - The life table can be either a period life table or a cohort life table, depending on whether the  $P_{ait}$  are generated from period data or cohort data
- In this life table, women are followed one year at a time by age, parity, and duration in parity until they reach age 50
- Events in the life table are first marriages and births by birth order

# *The multi-dimensional life table is multivariate*

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- One can calculate a multidimensional life table for each category of one socioeconomic predictor while holding the other socioeconomic predictors constant
- Since the multidimensional life table is multivariate, all measures calculated from it (TFR and its components) are also multivariate

# *Are results using reconstructed birth histories accurate?*

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- We use Philippines 2003 DHS data to answer this question
- The DHS has a household sample and an individual woman sample
  - We treat the household sample as if it were a census sample
  - Reconstructed birth histories are computed for women in this “census sample”

***We then generate estimates of TFR and its components, first from the actual birth histories and then from the reconstructed birth histories***



- The actual and reconstructed birth histories pertain to exactly the same set of women
- Comparisons of the two sets of estimates are shown in the following slides for selected measures

## *Graphs portray estimates of TFR and its components for the whole population*

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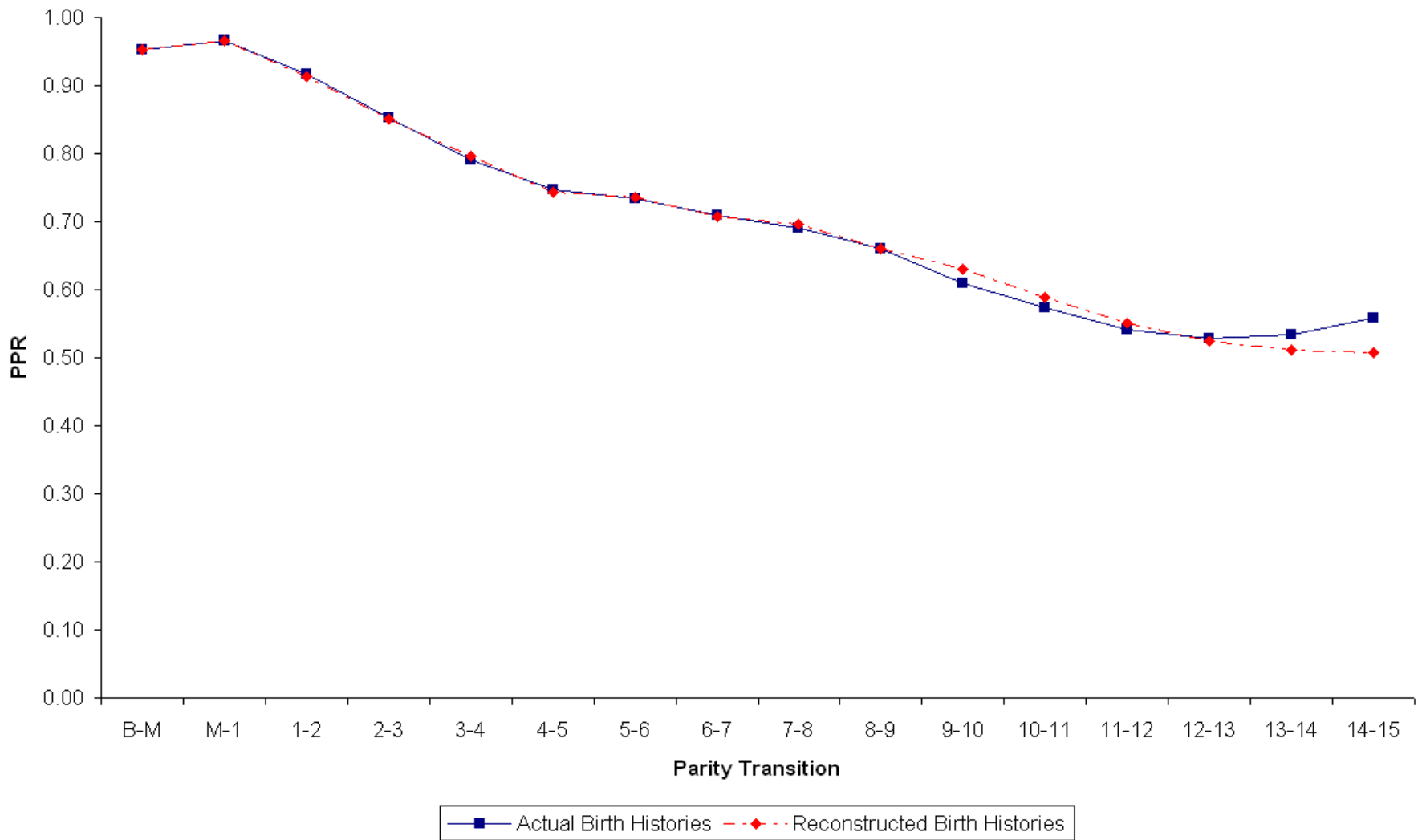
- Models underlying the estimates omit socioeconomic variables
  - Separate model for each parity transition
  - The only predictors in each model are age and duration in parity
- **Period estimates** pertain to the five years before the survey
- **Cohort estimates** pertain to women age 45-49 at time of survey who are followed backward in time to age 10

# *Color scheme in the graphs*

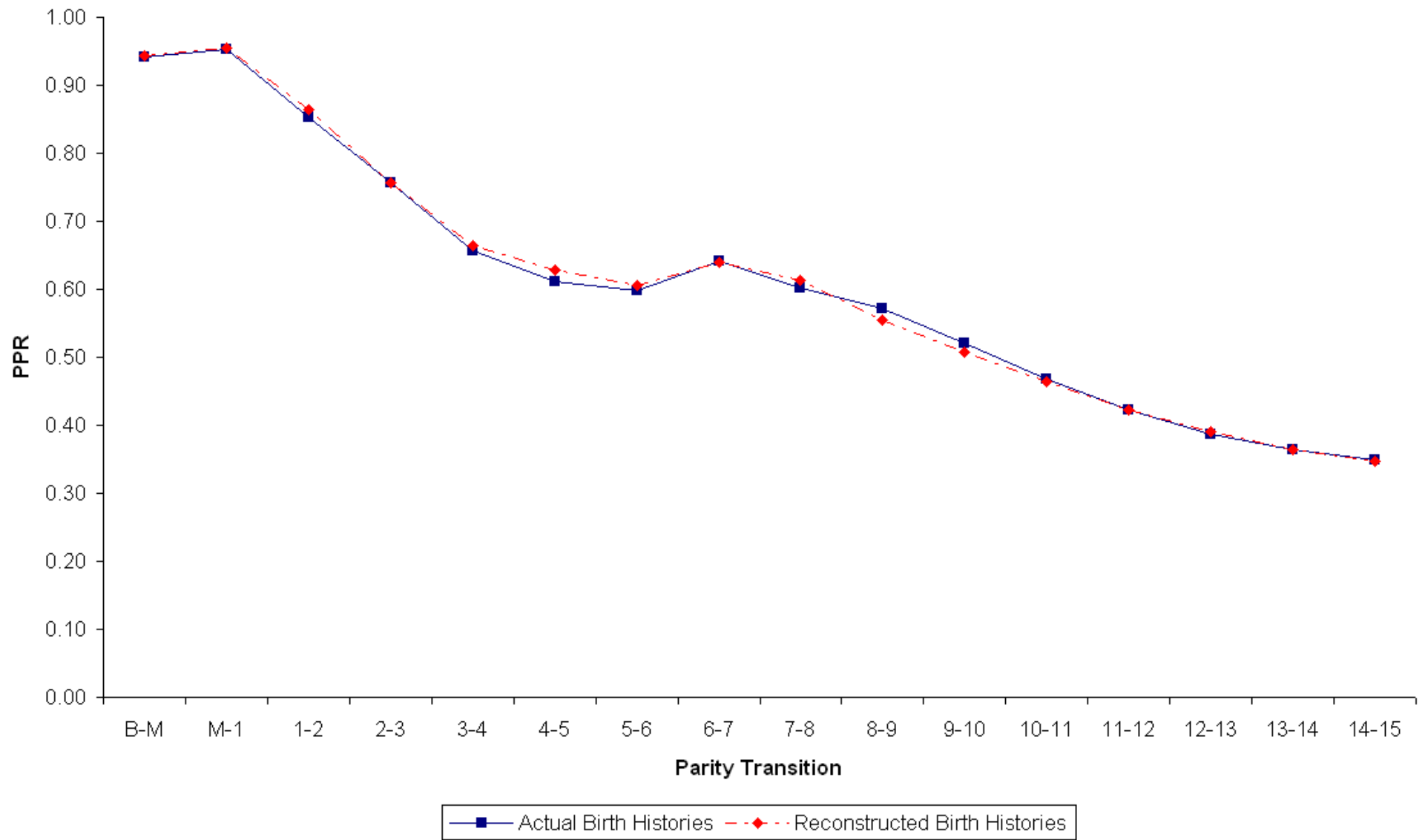
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- Blue curve is based on actual birth histories
- Red curve is based on reconstructed birth histories
- Same women in either case
- All values plotted in the following eight graphs are model-predicted values

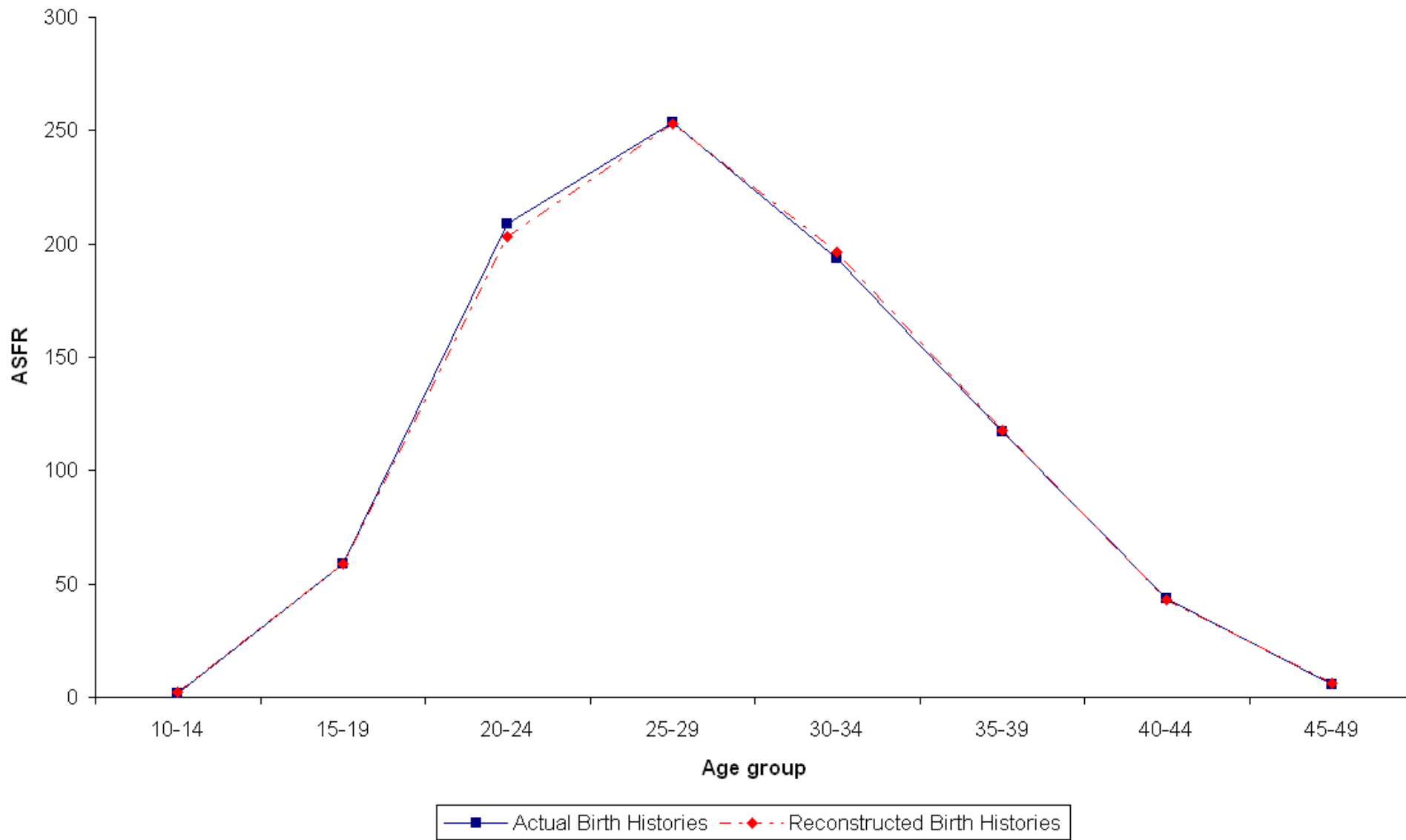
**PPRs derived alternatively from actual and reconstructed birth histories: Cohort analysis,  
Philippines 2003**



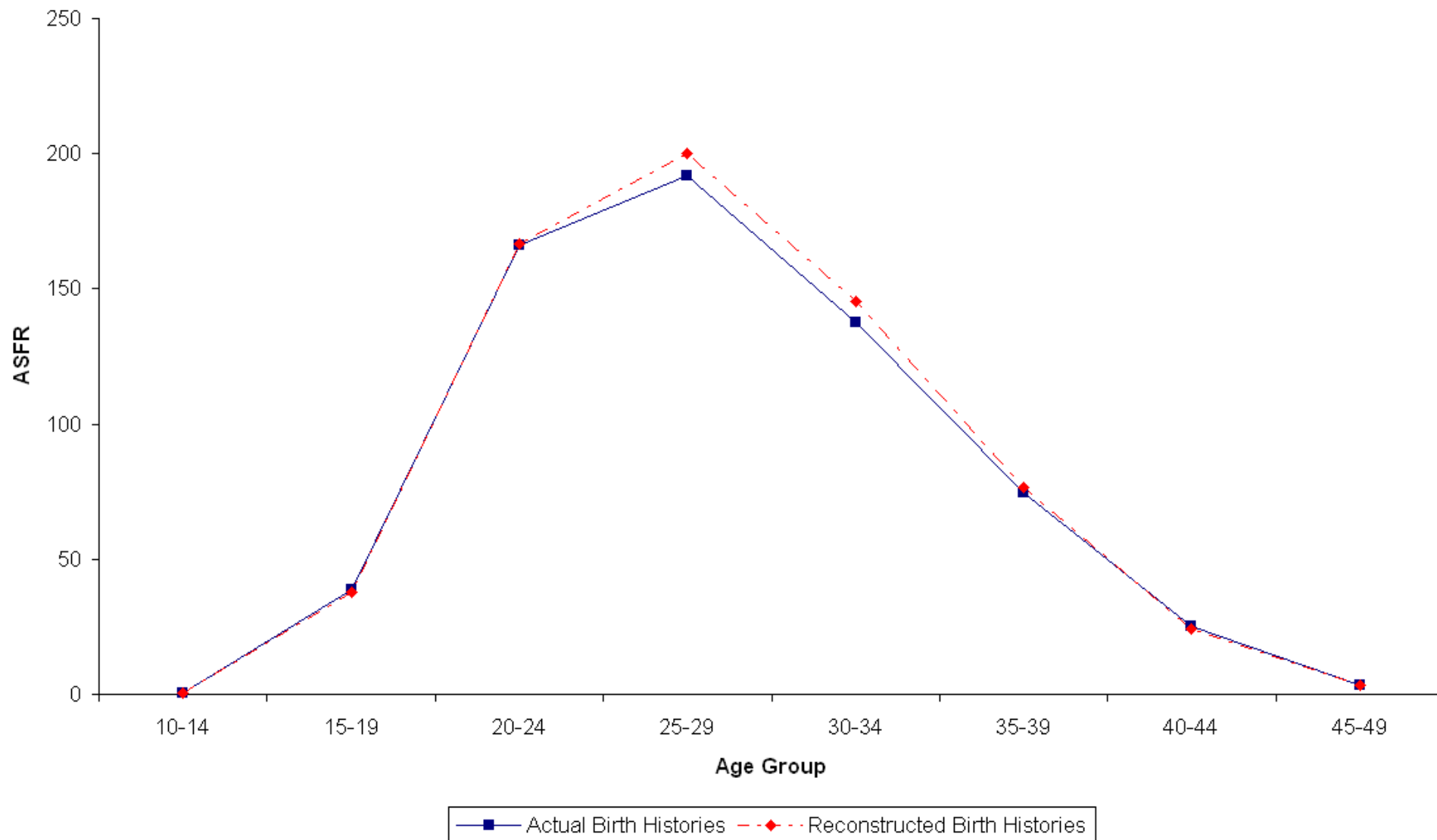
### PPRs derived alternatively from actual and reconstructed birth histories: Period analysis, Philippines 2003



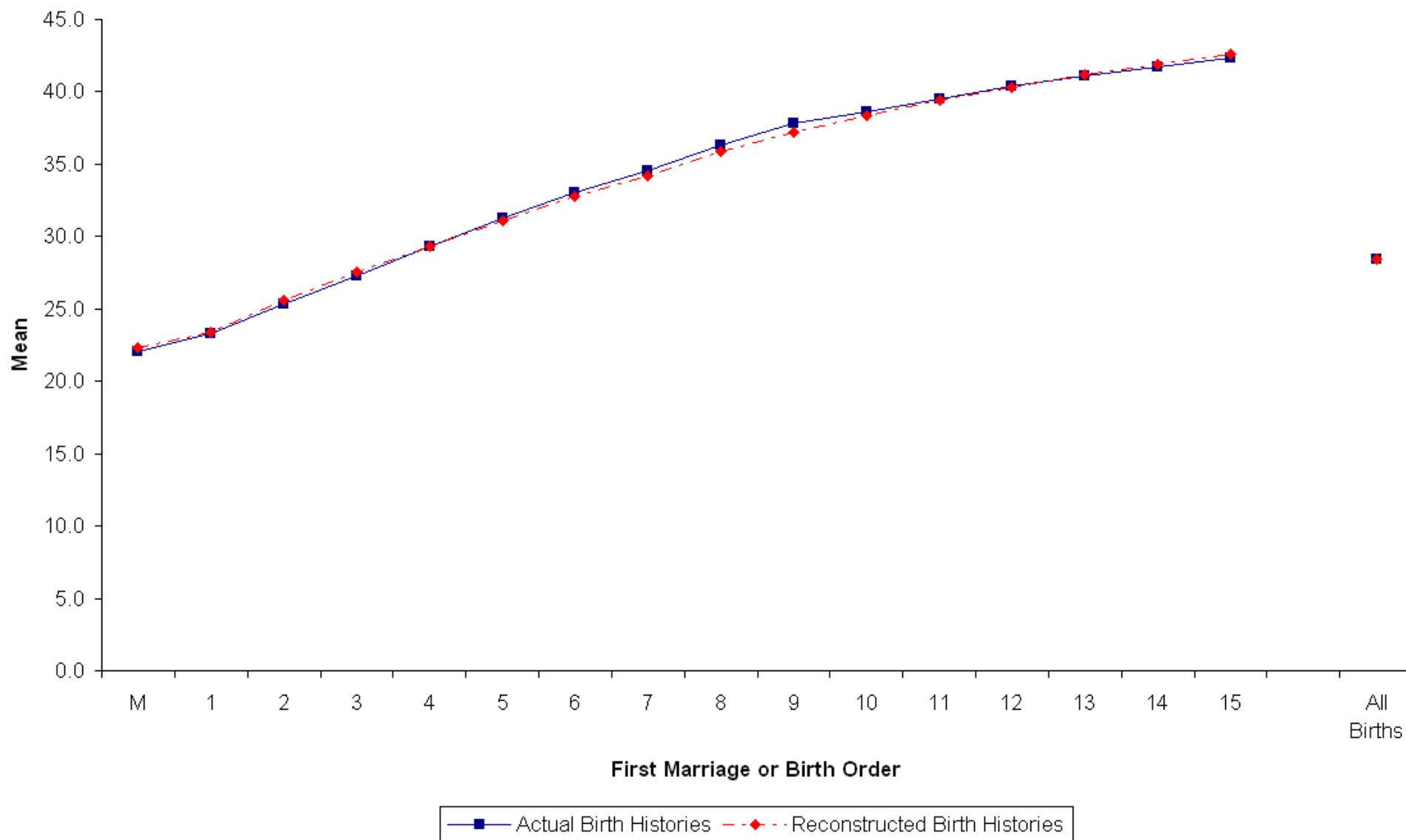
### ASFRs derived alternatively from actual and reconstructed birth histories: Cohort analysis, Philippines 2003



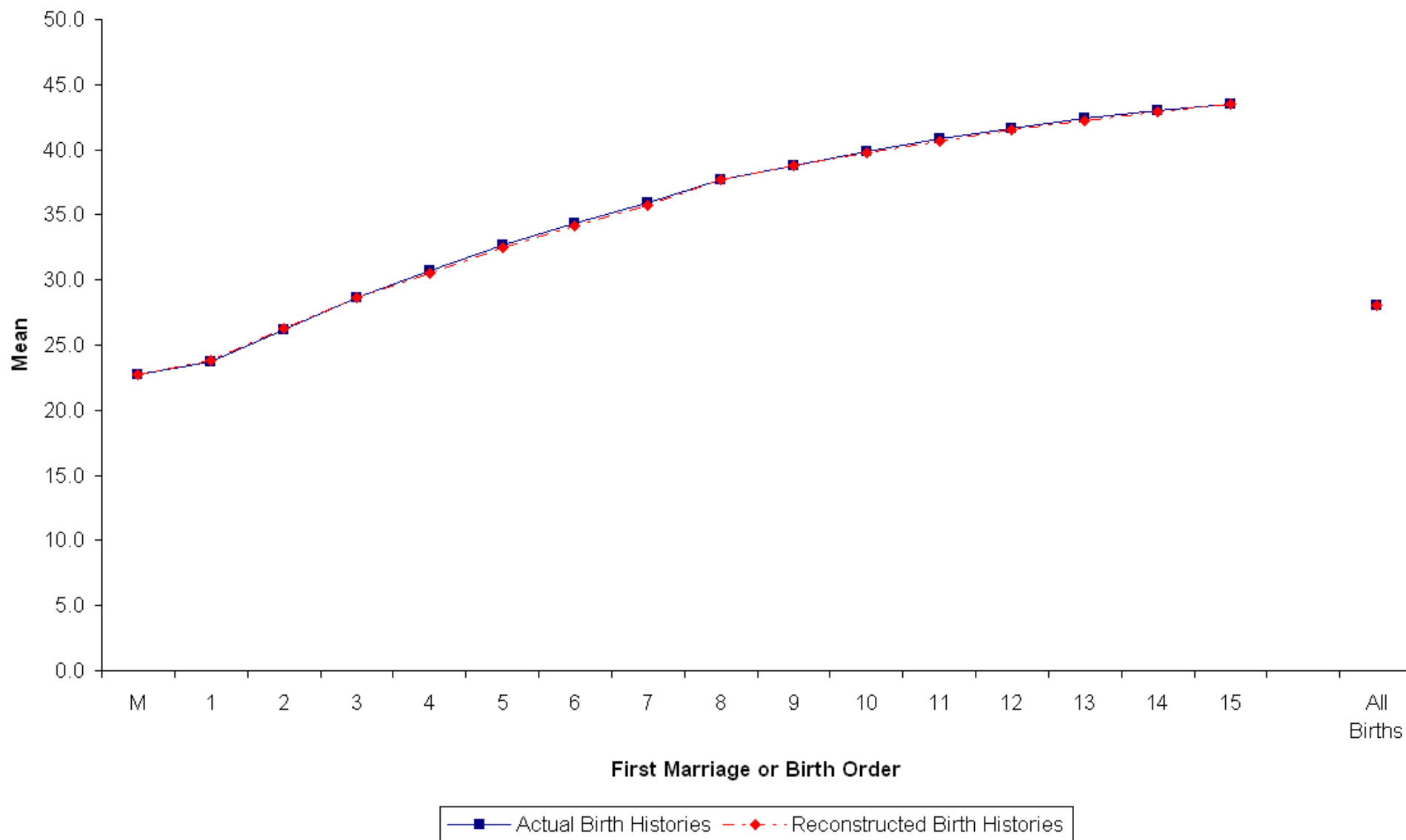
### ASFRs derived alternatively from actual and reconstructed birth histories: Period analysis, Philippines 2003



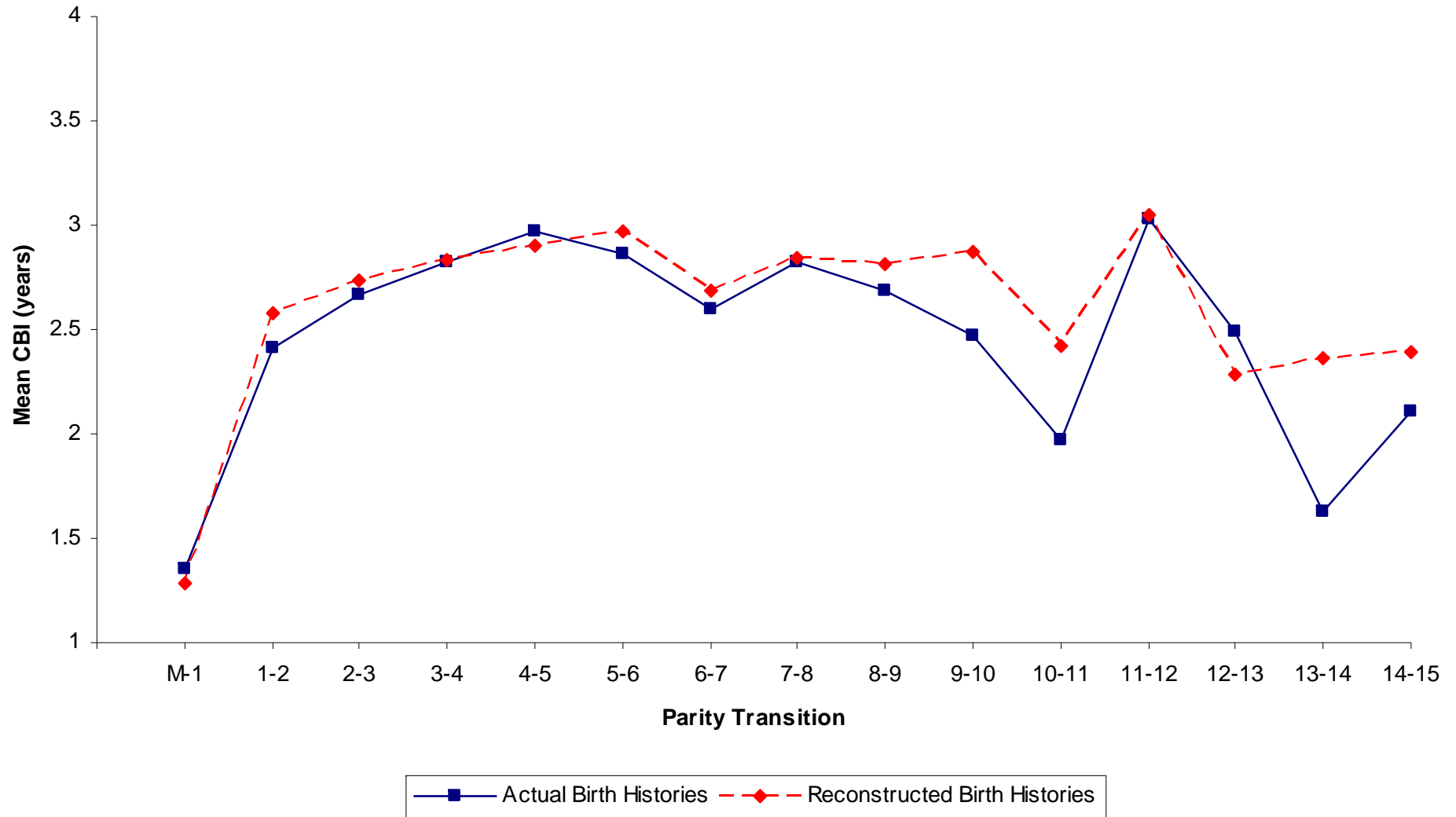
**Mean age at first marriage, first birth, or next birth derived alternatively from actual and reconstructed birth histories: Cohort analysis, Philippines 2003**



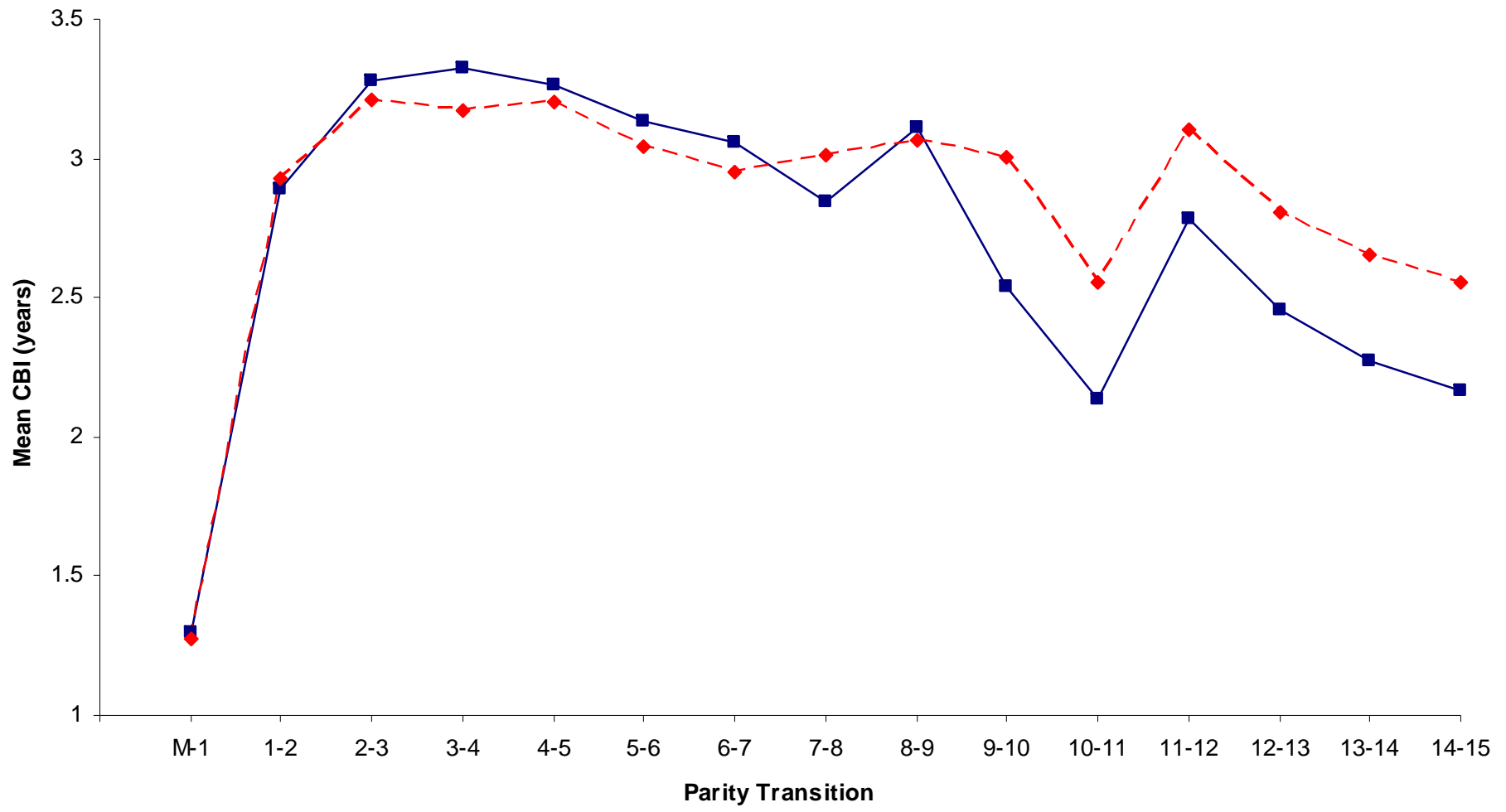
### Mean age at first marriage, first birth, or next birth derived alternatively from actual and reconstructed birth histories: Period analysis, Philippines 2003



Mean closed birth intervals by child's birth order (CBI) derived alternatively from actual and reconstructed birth histories: Cohort analysis, Philippines 2003



**Mean closed birth intervals by child's birth order (CBI) derived alternatively from actual and reconstructed birth histories: Period analysis, Philippines 2003**



Actual Birth Histories — Reconstructed Birth Histories

## ***Meaning of “unadjusted” and “adjusted” in following two slides***

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- “Unadjusted” means that the underlying models include only one socioeconomic predictor variable
  - Can tabulate a model-predicted TFR by categories of the sole socioeconomic predictor variable (no controls)
- “Adjusted” means that the underlying models include all the socioeconomic predictor variables
  - Tabulate model-predicted TFR by categories of one socioeconomic predictor while controlling for the other socioeconomic predictors by holding them constant

**Unadjusted and adjusted TFRs by socioeconomic characteristics derived alternatively from actual and reconstructed birth histories: Cohort analysis, Philippines 2003**

	Unadjusted		Adjusted	
	Actual	Reconstructed	Actual	Reconstructed
TFR	Birth History	Birth History	Birth History	Birth History
	<b>COHORT ANALYSIS</b>			
<b>Residence</b>				
Urban	3.8	3.8	3.8	3.7
Rural	5.2	5.1	4.6	4.5
<b>Education</b>				
Low	5.4	5.4	5.3	5.3
Medium	4.2	4.2	4.2	4.2
High	2.9	2.9	3.0	3.0
<b>All</b>	4.4	4.4		

**Note: In the adjusted estimates, differentials by residence control for education, and differentials by education control for residence.**

Unadjusted and adjusted TFRs by socioeconomic characteristics derived alternatively from actual and reconstructed birth histories: Period analysis, Philippines 2003

	Unadjusted		Adjusted	
	Actual Birth History	Reconstructed Birth History	Actual Birth History	Reconstructed Birth History
TFR				
	<b>PERIOD ANALYSIS</b>			
<b>Residence</b>				
Urban	2.7	2.8	2.7	2.8
Rural	3.9	4.0	3.4	3.5
<b>Education</b>				
Low	4.5	4.7	4.3	4.5
Medium	3.3	3.4	3.2	3.3
High	2.4	2.5	2.5	2.5
<b>All</b>	3.2	3.3		

Note: In the adjusted estimates, differentials by residence control for education, and differentials by education control for residence.

# *Why do this?*

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- Get closer to the true effects of predictor variables
  - Potentially confounding variables are controlled
- As fertility comes down, there will be less money for fertility surveys
  - Increasing need to utilize censuses/household surveys that collect data for other purposes
  - New methodology yields a great deal of information about marriage and fertility levels, trends, and determinants, without the huge cost of new data collection

## *Why do this? (continued)*

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- With large census samples, one can also do separate analyses for local areas (e.g., provinces or states)
  - This is policy-relevant, because population policies are often administered at the province or state level

# *Household surveys*

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- E.g., labor force surveys, income and expenditure surveys, American Community Survey
- Need to add a few extra questions
  - **Complete household listing** by age, sex, marital status, and relation to head (essential)
  - **Children ever born** (essential)
  - Age at first marriage (highly desirable)
- Don't need these extra questions every survey round
  - Once every 5 or 10 years would be enough

## *Computer programs will be placed in the public domain*

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- They will be documented and in some cases we hope to be able to package them with an easy-to-use graphic interface
- They will be downloadable from the East-West Center website (about one year from now)
- We hope that national census and statistical offices will use the programs!

# *Further details on methodology*

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- Retherford, R. D., H. Eini-Zinab, M. K. Choe, N. Ogawa, and R. Matsukura. 2010. *Further Development of Methodology for Multivariate Analysis of the Total Fertility Rate and Its Components Based on Birth History Data*. East-West Center Working Papers, Population and Health Series, No. 122. Honolulu: East-West Center.
- Downloadable at <http://www.eastwestcenter.org/fileadmin/store/d/pdfs/popwp122.pdf>.