Mind The Gap:
What Explains Changes in Relative Timing of Marriage and Fertility ?

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BEROC, March 2017

Since the 1950s...

1. Increase in the age at first **marriage**.
2. Increase in the age at first **birth**.
3. Increase in the **nonmarital fertility**.

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My Paper:

1. Propose a unified approach of studying the three trends.
2. Build a model based on the interaction of the established mechanisms with the observed changes in income dynamics.
3. Establish the quantitative importance of the model.

Unified Approach

1. Increase in the age at first **marriage**.

2. Increase in the age at first **birth**.

3. Increase in the **nonmarital fertility**.

   1. & 2. $\Rightarrow$ "The Gap" **between** timing of first **birth** and timing of first **marriage** decreases. $\Rightarrow$ 3.

Unified Approach

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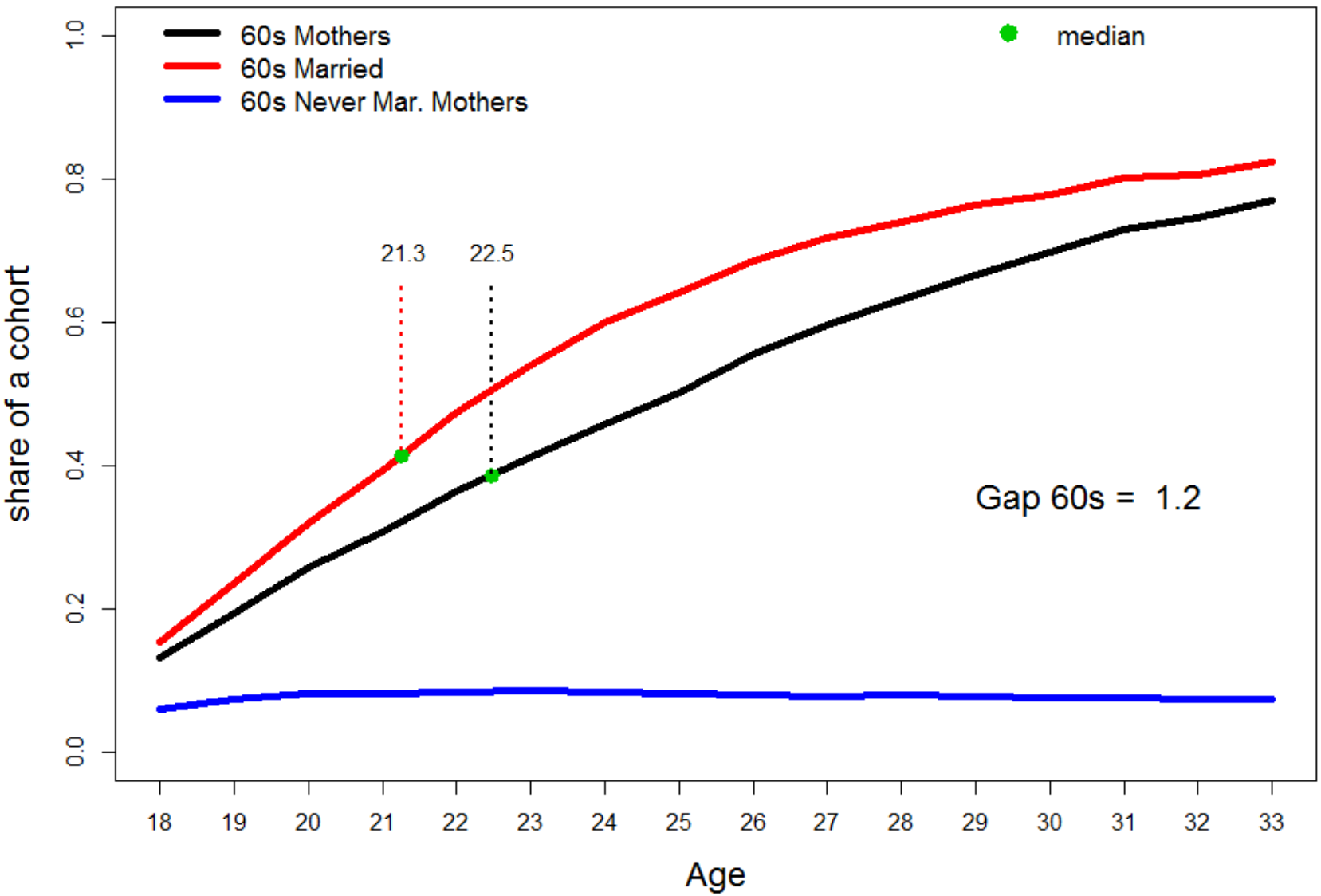
2. Increase in the age at first **birth**.

3. Increase in the **nonmarital fertility**.

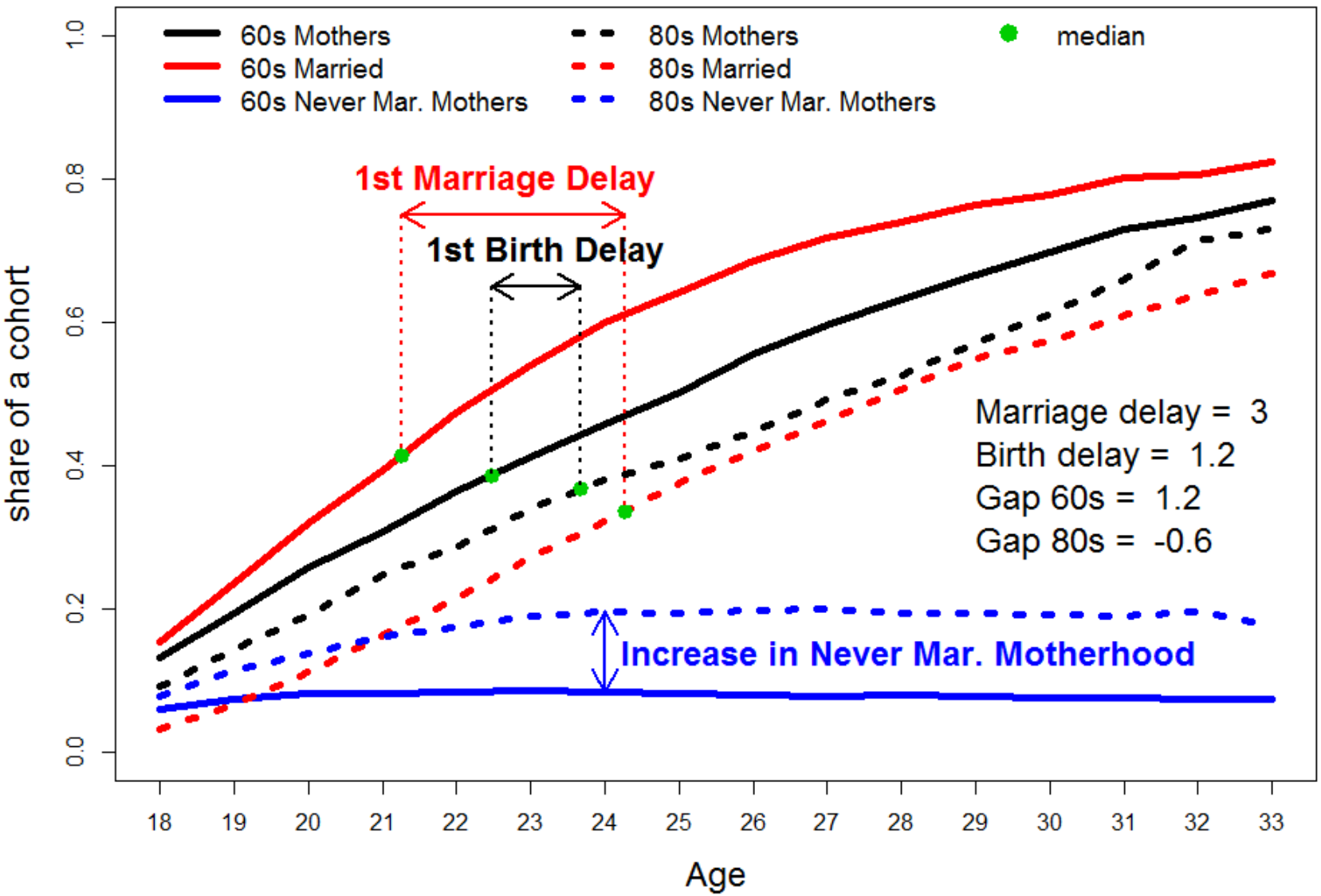
1. & 2. $\Rightarrow$ "The Gap" **between** timing of first **birth** and timing of first **marriage** decreases. $\Rightarrow$ 3.

	1.Age 1st Mar	2.Age 1st Bir	Gap	3. % 1st births to NeverMar
NLSY79 (1960 b.y.)	21.3	22.5	1.2	21
NLSY97 (1980 b.y.)	24.3	23.7	-0.6	54

The Gap


60s Mothers
60s Married
60s Never Mar. Mothers
median
21.3
22.5
Gap 60s = 1.2
share of a cohort
0.0
0.2
0.4
0.6
0.8
1.0
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
Age

Decrease in The Gap



Why Mind The Gap?

- Understanding the Gap $\rightarrow$ better understanding of marriage and fertility timing trends.

- Decrease in the Gap increases share of the out-of-wedlock **first** births.

  > *[...] increases in nonmarital fertility during the last 25 years have been driven largely by dramatic increases in nonmarital first births.*
  >
  > — *Wu, Bumpass & Musick (2001)*

- Decrease in the Gap is a forerunner of the nonmarital first births $\rightarrow$ implications for policy and demographic predictions.

Proposed Explanation

- Mechanism 1: Income inequality $\rightarrow$ marriage timing.
- Mechanism 2: Income mobility/uncertainty $\rightarrow$ fertility timing.
- Assumption 1: Marriage provides partial income insurance.

1. Increase in **income inequality**
   a) Delays **marriage** (Mechanism 1)
   b) Delays **birth** (Assumption 1 $\rightarrow$
   fewer marriages = fewer insured women $\rightarrow$ Mechanism 2)

2. Decrease in **income mobility/uncertainty**
   a) Delays **marriage** (Assumption 1)
   b) Accelerates **birth** (Mechanism 2)

- Hence, 1. delays both marriage and fertility
- While 2. produces decrease in the Gap and increase in the single motherhood.

(related literature)

Assumption 1: Intuition & Literature

- Assumption 1: Marriage provides partial income insurance.
  - Marriage is a long-term commitment.
  - There is at least some degree of income pooling within a union
  - Spousal incomes are not perfectly correlated.
  - *Empirics:* Kotlikoff & Spivak (1981); Rosenzweig & Stark (1989); Ogaki & Zhang (2001); Hess (2004); Chami & Hess (2005)

Mechanism 1: Intuition & Literature

- Mechanism 1: Income inequality affects marriage timing.
  - *Male income* **inequality increased** *:* Katz & Murphy (1991); Heathcote, Perri, & Violante (2010); Debacker et.al. (2013)
  - *Mechanism & Empirics:* **Keeley (1974)**; Oppenheimer Kalmijn Lim (1997); Loughran (2002); Gould Paserman (2003); Coughlin & Drewianka (2011)
  - *This paper:* Extend Keeley's original intuition in a two-sided marriage search problem:

Mechanism 1: Intuition & Literature

- Requirements: assumption 1 & finite horizon.

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    1. Let income of top-earning men (T.E.) rise.

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5. Men whose top-choice are those women delay marriage.
6. repeat 2.-5.

Mechanism 2: Intuition & Literature

- Mechanism 2: Income mobility affects fertility timing.
  - *Income* **mobility/volatility decreased***:* Orzag & Director (2007); Sabelhaus & Song (2010); Guvenen et al. (2014)
  - *Intuition & Empirics:* Wong (2011); Sommer (2014) Kohler & Kohler (2002); Kreyenfeld (2005); Adserà (2004); Vandenbroucke (2012); Goldstein et al. (2013)
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  2. $\exists\ \overline{w}$ s.t. time cost is binding.
  3. $\exists\ \underline{w}$ s.t. monetary cost is binding.
  4. $\uparrow$ Income Mobility / Uncertainty / Volatility
     $\equiv \uparrow Pr(w' \notin [\underline{w}, \overline{w}] | w \in [\underline{w}, \overline{w}]])$

Literature

- Regalia, Rios-Rull & Short (2008):
  - *Objective:* explain increasing out-of-wedlock fertility.
  - *Mechanism:* $\downarrow$ gender-wage gap $\rightarrow$ delays marriage $\rightarrow$ $\uparrow$ out-of-wedlock fertility.
  - *Issue:* $\downarrow$ gender-wage gap $\rightarrow$ delays marriage & $\uparrow$ cost of fertility (authors assume semi-endogenous fertility).
  - *This paper:*
    – endogenous fertility.
    – add effects of the interaction of inequality and mobility to produce decrease in the Gap.

Literature

- Regalia, Rios-Rull & Short (2008):
  - *This paper:*
    – endogenous fertility.
    – add effects of the interaction of inequality and volatility to produce decrease in the Gap.
- Santos & Weiss (2016):
  - *Objective:* explain delay in marriage and fertility.
  - *Mechanism:* $\uparrow$ volatility $\rightarrow$ delay births $\rightarrow$ delay marriages.
  - Used PSID, where volatility **increases** : Gottschalk,Moffitt, Katz & Dickens (1994); Shin & Solon (2011); Moffitt & Gottschalk (2012).
  - *Issue:* Given decrease in volatility, model's predictions are counterfactual

Model-Related Literature

- Model: Aiyagari, Greenwood & Guner (2000); Greenwood, Guner & Knowles (2002); Caucutt, Guner & Knowles (2002).

- *This paper:*

  - Non-parametric income process similar to De Nardi, Fella & Pardo (2016) allows to decrease the state-space and computation intensity.

  - Model can handle higher level of heterogeneity, with more periods. Simpler calibration without utility shocks and "blisses".

  - Can check for uniqueness of the equilibrium.

Outline and Preview of Results

1. Document that the Gap decrease is relevant to all major socio-economic groups of US women and is robust to other accounting exercises.

Outline and Preview of Results

1. Document the Gap decrease phenomenon.

2. Show how studying marriage, fertility and single motherhood as parts of the Gap lead to a better understanding of the trends.

Outline and Preview of Results

1. Document the phenomenon.
2. Improves understanding of other demographic trends.

3. Propose an explanatory mechanism based on changes in income inequality and mobility.

Outline and Preview of Results

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4. Simple examples to illustrate mechanisms 1 and 2.

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5. Quantitative model

    - Build an equilibrium two-sided matching, life-cycle model with endogenous marriage and fertility decisions.

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    - Calibrate the model to the NLSY 1960s cohort.

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6. Calibration & Simulation

   - Calibrate the model to the NLSY 1960s cohort.
   - Simulation: measured change in inequality and mobility produces: 42 % and 40% of change in the timing of marriage and fertility between 60s and 80s cohorts.

Empirical Investigation: Is the Gap decrease a sub-group phenomenon?

	Gap 60s	Gap 80s	% 1st births to single 60s	% 1st births to single 80s
All women	1.20	-0.65	21	54
White, High-ed.	3.46	2.51	4	14
Black, High-ed.	-1.00	-2.26	48	74
White, Low-ed.	1.86	-0.55	15	56
Black, Low-ed.	-2.46	-4.46	71	88

(related literature) (means)

Empirical Investigation: single mothers & shotgun marriages.

Status at age 33	Gap 60s	Gap 80s	% 1st births to single 60s	% 1st births to single 80s
Married & Mothers	1.76	0.05	9.6	14.5
Married & Mothers median gap	0.64	0.05		
delete shotgun observations	2.30	-0.90	31	67

(related literature) (means)

Quantitative Model

- Finite horizon (all agents live for T periods)
- Two-sided marriage matching
- Distribution of married and single agents evolves endogenously
- There are two types of agents $\{m, f\}$. Genders differ in their income process, and only females can give birth
- There is no saving/no borrowing
- Bargaining powers of spouses are exogenously set to be equal

Income Process

- Income process: similar to De Nardi, Fella & Pardo (2016)
- For every age×gender group, compute mean earnings in N quantiles.
- So every period an agent can have one of N wages: $w \in \{w^g_{t,1}, ..., w^g_{t,N}\}$
- For every age×gender compute transition matrices

	$w^g_{t+1,1}$	$\cdots$	$w^g_{t+1,2}$
$w^g_{t,1}$	$\pi^g_{t,1,1}$	$\cdots$	$\pi^g_{t,1,N}$
$\vdots$	$\vdots$	$\ddots$	$\vdots$
$w^g_{t,N}$	$\pi^g_{t,N,1}$	$\cdots$	$\pi^g_{t,N,N}$

Model Timing

1. Agent observes wage realization.

2. Single agents of the opposite gender are randomly matched. If both agree to marry they continue as a couple. There is no divorce.

3. Single males choose consumption. Couples and single females make fertility and consumption choices.

Marriage Matching Probabilities

- Let $\mu_{t,i} \in [0, 1/N]$ be measure of single males of wage-type i and $\mathcal{M}_t \equiv \{\mu_{t,i}\}_{i=1}^{N}$.

- Single females are heterogeneous in wages and in stock of previous children K_{t-1}. Let measures of single female types be denoted as $\phi_{t,i}(K_{t-1}) \in [0, 1/N]$ and $\Phi_t \equiv \{\{\phi_{t,i}(K_{t-1})\}_{i=1}^{N}\}_{k=0}^{t-1} \equiv \{\phi_{t,j}\}_{j=1}^{N\times t}$

- After each marriage market, distributions of singles are updated.

$$\hat{\mu}_{t,i} = \mu_{t,i} - \sum_j \mu_{t,i}\phi_{t,j}\mathcal{I}(w_{t,j}^f, N_{t-1,j}, w_{t,i}^m, \Phi_{t+1}, \mathcal{M}_{t+1})$$

  where $\mathcal{I}(w_{t,j}^f, N_{t-1,j}, w_{t,i}^m, \Phi_{t+1}, \mathcal{M}_{t+1})$ – marriage indicator function.
- Then $\{\hat{\mu}_{t,i}\}$ evolves according to the earnings transition matrix.

Single Male Problem

- Let $M_t(w_t^m, \Phi_{t+1})$ be value of being single male **after** the marriage phase at period t.
- Value of being single male **before** the marriage phase:

$$EM_t(w_t^m, \Phi_t) = \underbrace{\sum_j \phi_{t,j} \mathcal{I}(w_{t,j}^f, K_{t-1,j}, w_t^m) MC_t(w_{t,j}^f, K_{t-1,j}, w_t^m)}_{\text{meet the ``right'' woman and marry her}} +$$

$$\underbrace{\sum_j \phi_{t,j} \left(1 - \mathcal{I}(w_{t,j}^f, K_{t-1,j}, w_t^m)\right) M_t(w_t^m, \Phi_{t+1})}_{\text{meet the ``wrong'' woman and continue as single}} +$$

$$\underbrace{\left(1 - \sum_j \phi_{t,j}\right) \times M_t(w_t^m, \Phi_{t+1})}_{\text{meet nobody and continue as single}}$$

- Male problem:

$$M_t(w_t^m, \Phi_t) = \max_c U(c) + \beta \mathbb{E}_{w_{t+1}^m} \left[EM_{t+1}(w_{t+1}^m, \Phi_{t+1}) | w_t^m \right]$$

$$s.t. \quad c \leq w_t^m$$

Single Female Problem

- Let $F_t(w_t^m, K_t, \mathcal{M}_{t+1})$ be value of being single male **after** the marriage phase at period t.
- Value of being single male **before** the marriage phase:

$$EF_t(w_t^f, K_{t-1}, \mathcal{M}_t) = \sum_i \mu_{t,i} \mathcal{I}(w_t^f, K_{t-1}, w_{t,i}^m) MC_t(w_t^f, K_{t-1}, w_{t,i}^m) + \sum_i \mu_{t,i} \left(1 - \mathcal{I}(w_t^f, K_{t-1}, w_{t,i}^m)\right) F_t(w_t^f, K_{t-1}) + \left(1 - \sum_i \mu_{t,i}\right) F_t(w_t^f, K_{t-1}).$$

- Female problem:

$$F_t(w_t^m, K_{t-1}, \mathcal{M}_t) = \max_{c, k_t \in \{0,1\}} U(c) + V(K_t) + \mathbb{E}_{w_{t+1}^f} \left[EF_{t+1}(w_{t+1}^f, K_t, \mathcal{M}_{t+1}) | w_t^f \right]$$

$$s.t. \quad c + \eta_m K_t \leq (1 - \eta_\tau K_t) w_t^f,$$
$$K_t = K_{t-1} + k_t$$

where η_m, η_τ – monetary and time costs per child

Married Couple's Problem

- Value of life of each spouse is:

$$MC_t(w_t^f, K_{t-1}, w_t^m) = \max_{c,k_t \in \{0,1\}} U\left(\frac{c}{1+\gamma}\right) + V(K_t) + \beta \mathbb{E}_{w_{t+1}^f, w_{t+1}^m}\left[MC_{t+1}(w_{t+1}^f, K_t, w_{t+1}^m) | w_t^f, w_t^m\right],$$

$s.t.$

$$c + \eta_m K_t \leq (1 - \alpha\eta_\tau^{MC} K_t) w_t^f + (1 - (1-\alpha)\eta_\tau^{MC} K_t) w_t^m$$
$$K_t = K_{t-1} + k_t.$$

where $\gamma \in [0,1]$ – family consumption economies of scale.
$\alpha \in [0,1]$ – share of time that female spend on child rearing.

- Note that time cost η_τ^{MC} is bigger than η_τ for a single woman. This accounts for an overlap in time spent with a child.

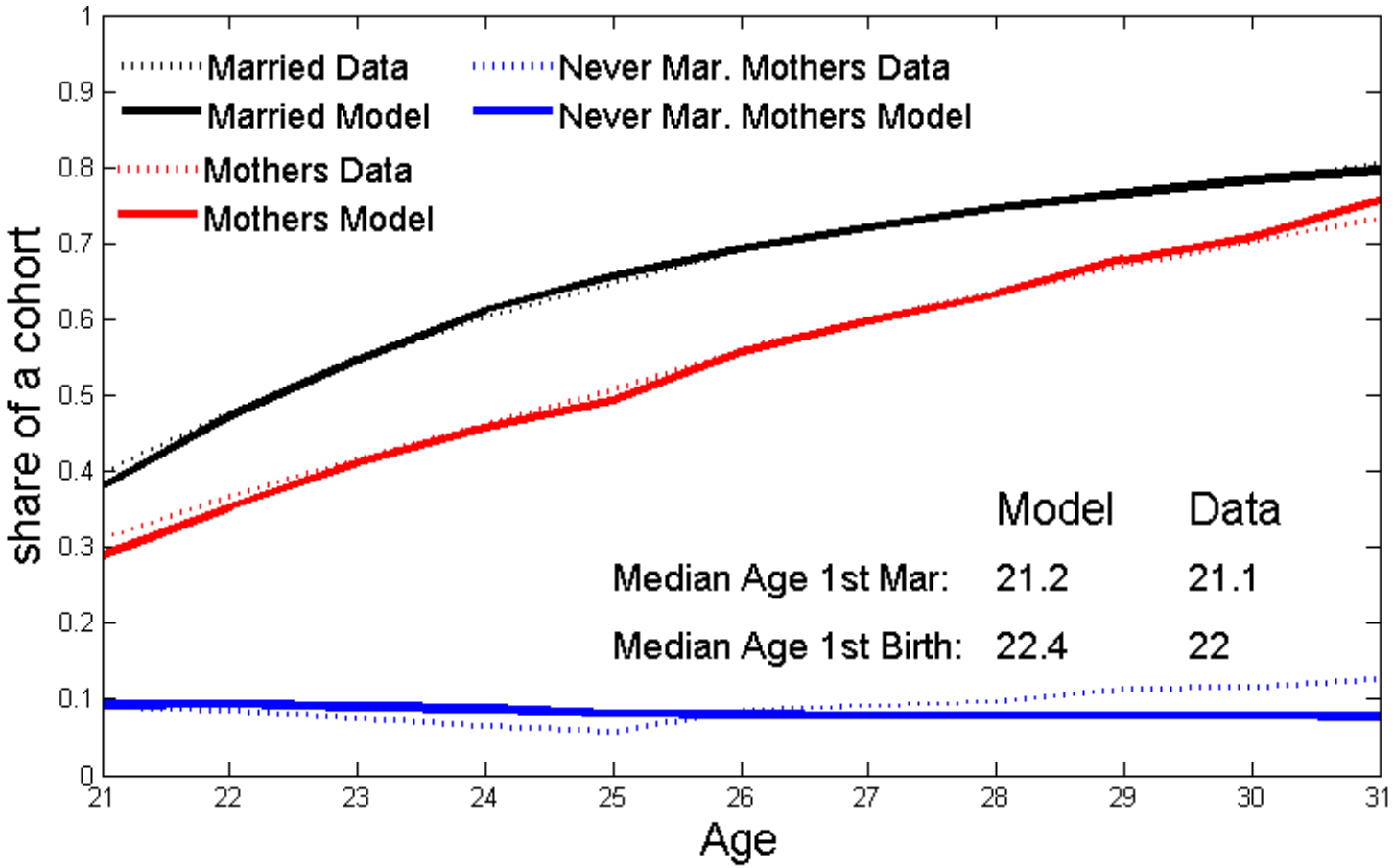
Equilibrium

- Fertility, consumption and marriage choices are optimal conditional on $\{\mathcal{M}_t\}_{t=1}^T, \{\Phi_t\}_{t=1}^T$.
- $\{\mathcal{M}_t\}_{t=1}^T, \{\Phi_t\}_{t=1}^T$ are consistent with marriage and fertility choices.
- $\{\mathcal{M}_t\}_{t=1}^T, \{\Phi_t\}_{t=1}^T$ are solutions to the following fixed point problem:
  - Given $\{\mathcal{M}_t\}_{t=1}^T, \{\Phi_t\}_{t=1}^T$ optimal choices of consumption, fertility, and marriage are computed by backwards induction.
  - Given marriage and single fertility decisions, $\{\mathcal{M}_t\}_{t=1}^T, \{\Phi_t\}_{t=1}^T$ are updated for every period through the forward induction.

Calibration

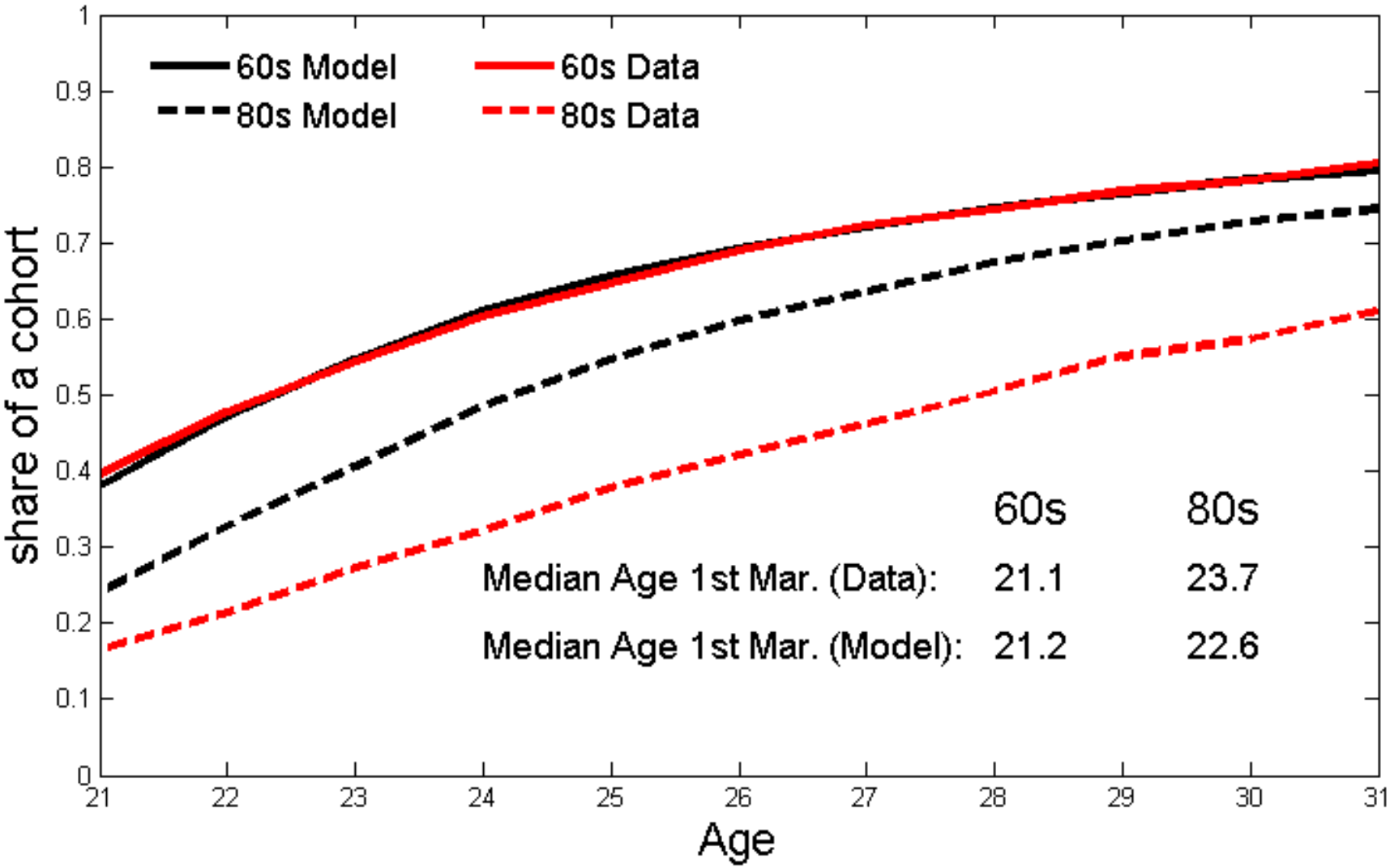
- Time cost $\eta_\tau = 0.185$ – Schoonbroodt (2016)
- Parenting time overlap $\eta_\tau^{mar} = 1.26\eta_\tau$ – Folbre et al. (2005)
- Share of parenting time due to a wife $\alpha = 0.7$ – Schoonbroodt (2016)
- Discounting $\beta = 0.98$ – standard
- Income process - own estimation of a 10-quantile process from the NLSY.

Fitting the Initial Cohort

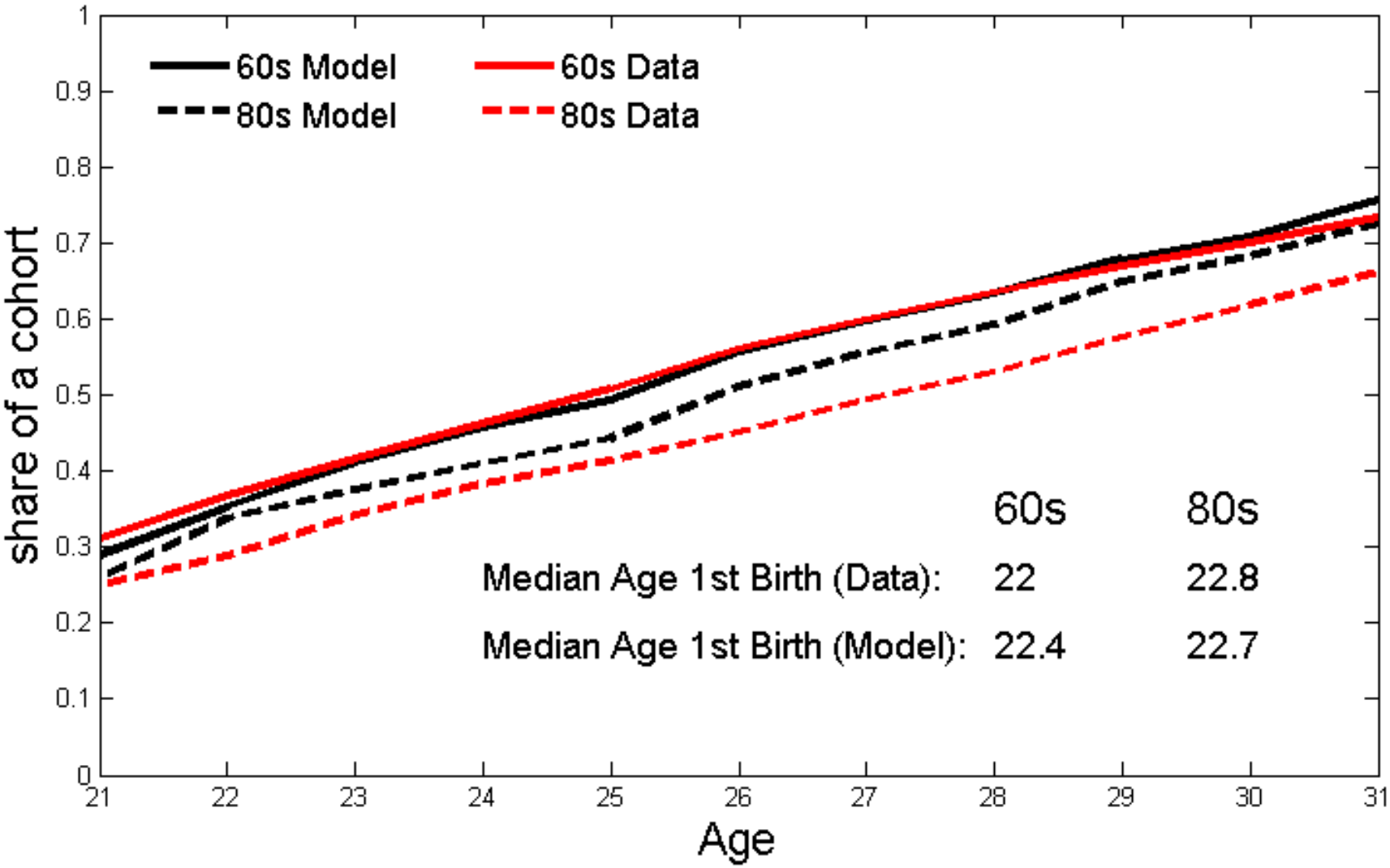


σ_c	σ_k	ψ	η_m	γ
risk aversion	r. a. in K	C/K	monetary cost	ec. scale
0.27	0.98	4.34	4,890 (in 2012\$)	0.73

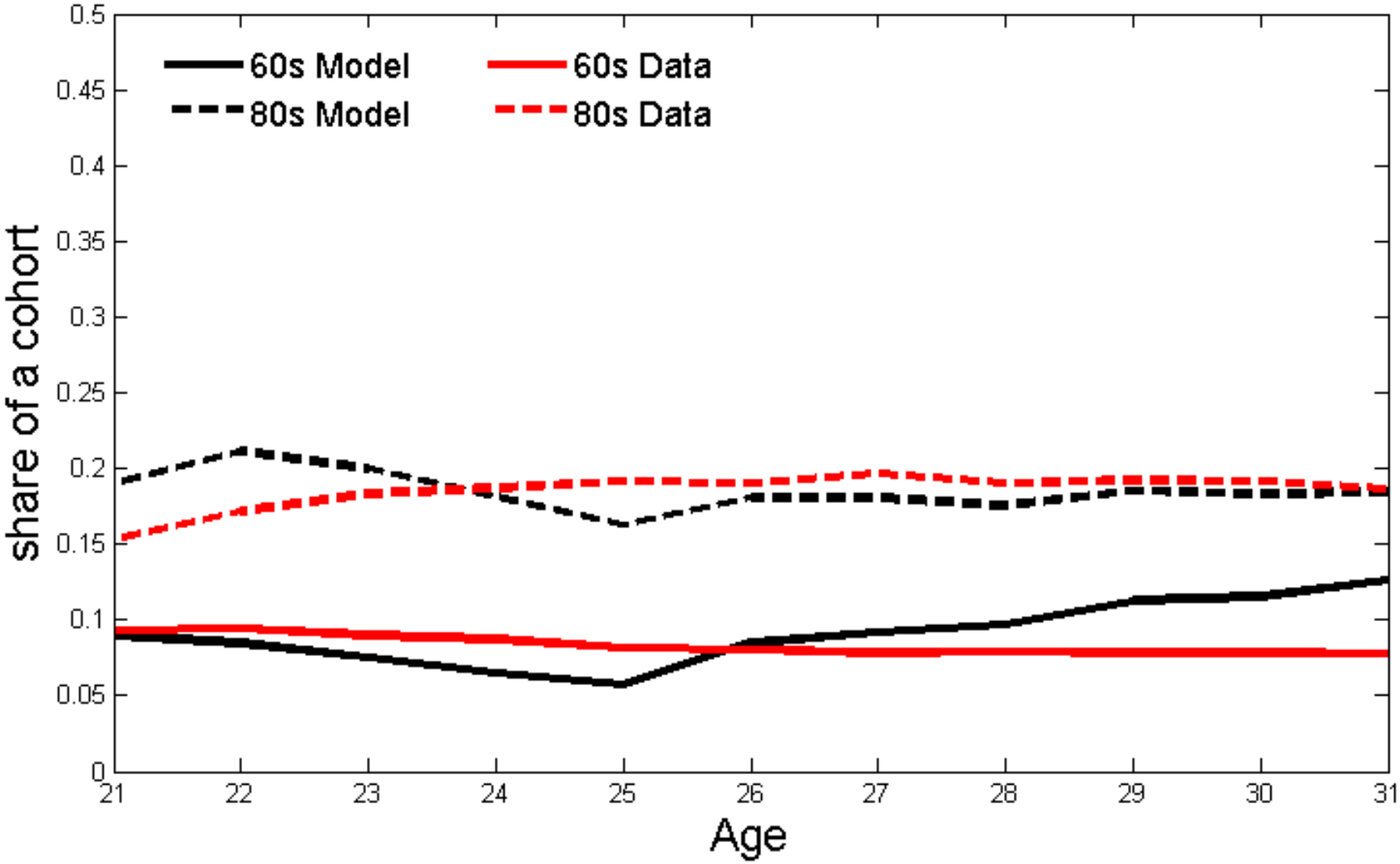
Model Accounts for 42% of Change in Marriage



Model Accounts for 40% of Change in Fertility



Share of Never Married Mothers



Counterfactual 1: If Only Inequality has Changed

- Experiment: only update wage arrays w_t^g but not transition matrices.

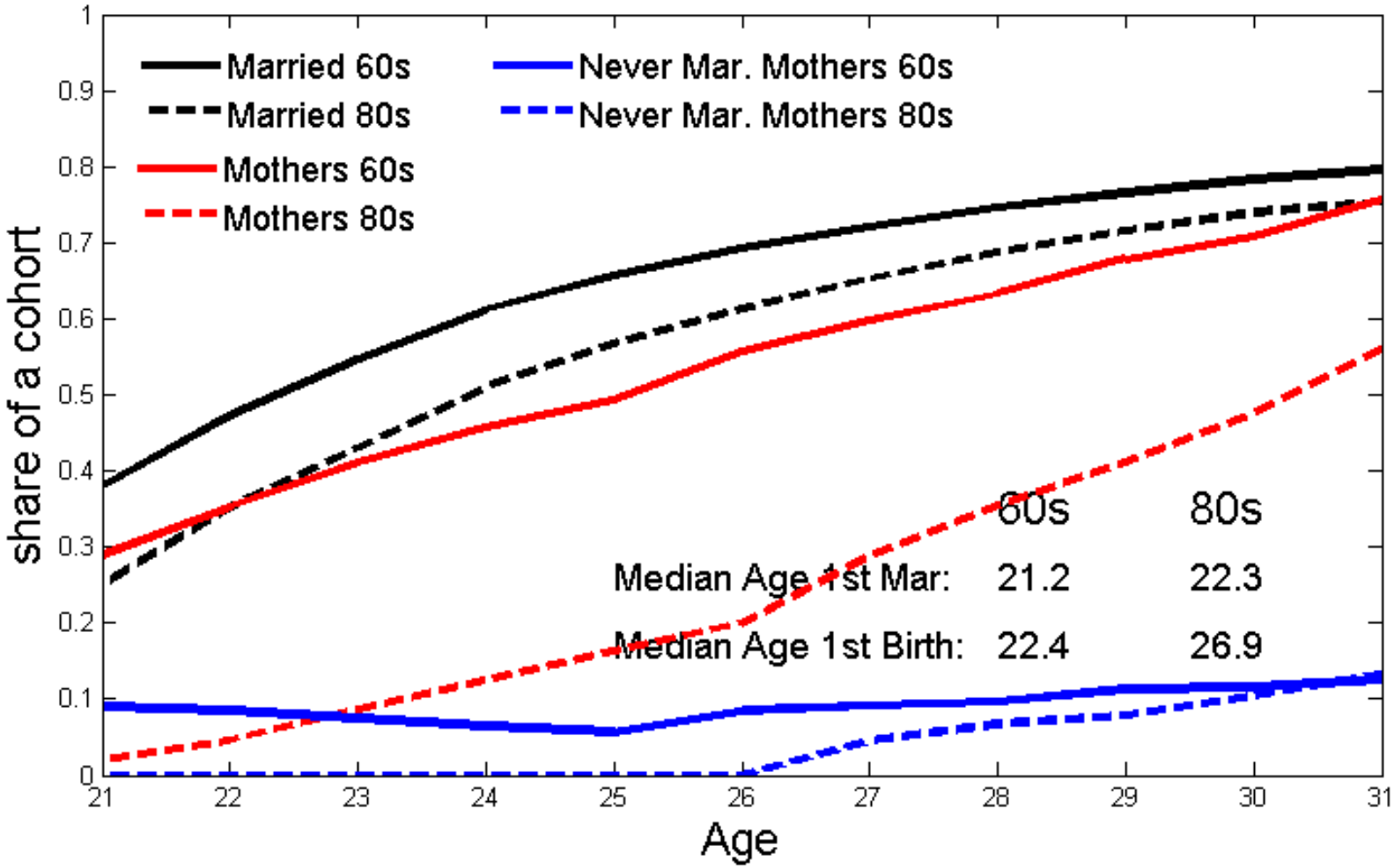
1. Increase in **income inequality**
   a) Delays **marriage** (Mechanism 1)
   b) Delays **birth** (Assumption 1 $\rightarrow$
      fewer marriages = fewer insured women $\rightarrow$ Mechanism 2)

2. Decrease in **income mobility/uncertainty**
   a) Delays **marriage** (Assumption 1)
   b) Accelerates **birth** (Mechanism 2)

- Prediction: increase in inequality = increase in volatility (keeping transition matrix constant)

  $\Rightarrow$ Delay in birth $>$ Delay in marriage.
  $\Rightarrow$ Decrease in single motherhood.

Counterfactual 1: If Only Inequality has Changed



("elasticity")

Counterfactual 2: If Only Mobility has Changed

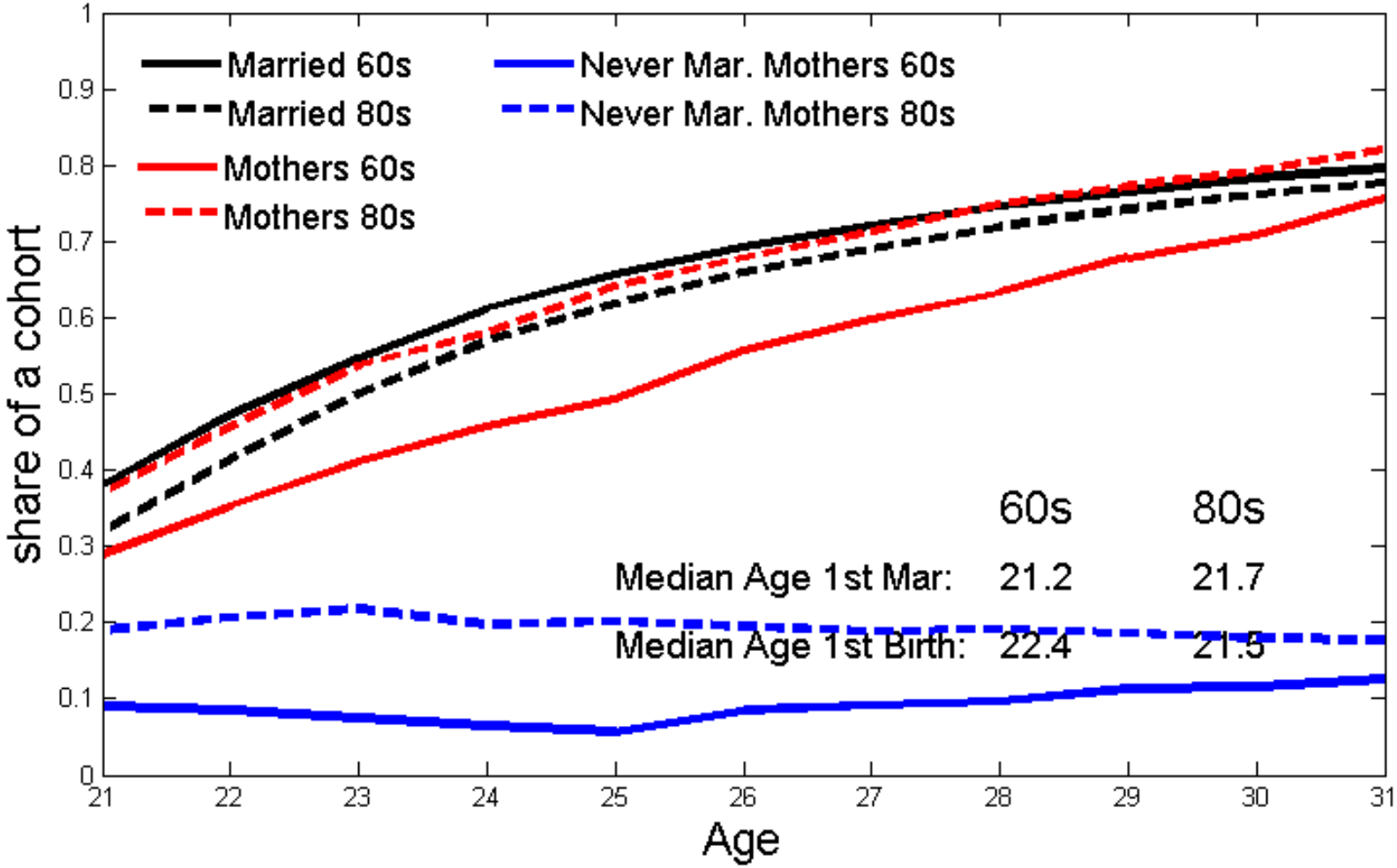
- Experiment: only update transition matrices Π_t^g but not wage arrays w_t^g.

1. Increase in **income inequality**
   a) Delays **marriage** (Mechanism 1)
   b) Delays **birth** (Assumption 1 $\rightarrow$ fewer marriages = fewer insured women $\rightarrow$ Mechanism 2)

2. Decrease in **income mobility/uncertainty**
   a) Delays **marriage** (Assumption 1)
   b) Accelerates **birth** (Mechanism 2)

- Prediction:
  Delay in marriage, acceleration of births, increase in single motherhood.

Counterfactual 2: If Only Mobility has Changed



("elasticity")

Conclusion

1. The Gap perspective:
   - Marriage, fertility and single-motherhood need to be studied together.
   - Decrease in the Gap is not a sub-group phenomenon.
2. Mechanism:
   - **Changes in inequality and income mobility** are able to produce decrease in the Gap.
   - Model can **account for 42% and 40% of change** in the timing of marriage and fertility
3. Secondary contributions:
   - Explain the intuition behind the **income inequality – marriage delay** relationship in a two-sided framework.
   - Provide an algorithm which is able to establish uniqueness of such type of the equilibrium.
   - Introduction of the non-parametric income process allows to improve applicability and tractability of this type of models.

Discussion

Better understanding of demographic trends is important:

- Out-of-Wedlock childbearing:
  - Health: Waldfogel et. al. (2010)
  - Human capital formation: Mclanahan & Sandefur (2009)
- Marriage:
  - Economies of scale: Browning, Chiappori & Lewbel (2013)
  - Savings behavior: Knoll, Tamborini & Whitman (2012)
  - Home ownership: Fisher & Gervais (2011)

Future Work & Policy Implications

- Decrease in the Gap is relevant to all major groups of women – social policy implications.

- Study the long run (overlapping generations) equilibrium of the model.
  [need to allow child quality investment]

  - Study inter-generational evolution of inequality.
  - Policy implications – effects of policies on the balanced growth path. [e.g. education policies, redistributive policies]
  - Quantitative evaluations of redistributional policies.

THANK YOU!