Sex Ratios and Long-Term Marriage Trends

José-Víctor Ríos-Rull, Shannon Seitz, Satoshi Tanaka

UMN, Mpls Fed, NBER, CAERP, Analysis Group, UQ

June 14, 2013

Introduction

- We construct a model to help us think about what accounts for the changes in family structure over the last century (marriage and divorce statistics)
- Ingredients that may matter are
  - Demographics
  - Legal environment (marriage divorce)
  - Technology (making or not making babies)
  - Attractiveness of alternative family arrangements

Demographic changes 1870s to 1950s Cohorts in the U.S.

- People now live longer (especially women)
- The number of men has become relatively smaller

Birth Cohort	Life Expectancy (at age 15) Women	Men	Men per 100 Women (aged 15 and above)
1870s	43.9	43.4	104.0
1930s	54.9 (%Δ 25.0)	51.4 (%Δ 18.04)	99.7 (%Δ - 4.1)
1950s	60.4 (%Δ 10.0)	54.4 (%Δ 5.8)	93.9 (%Δ - 5.8)

- How do these changes affect people's marriage behaviors?

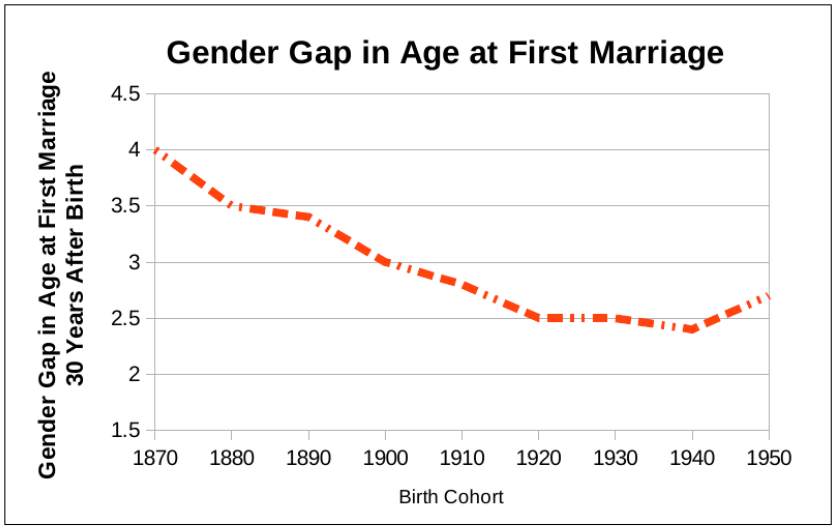
Demographics Alone May Shape Family Structure

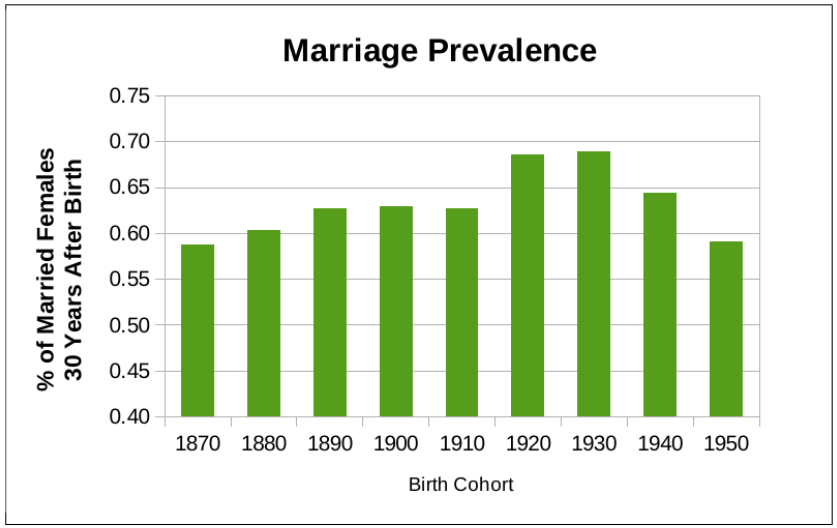
An older population facing a smaller population of men may imply:

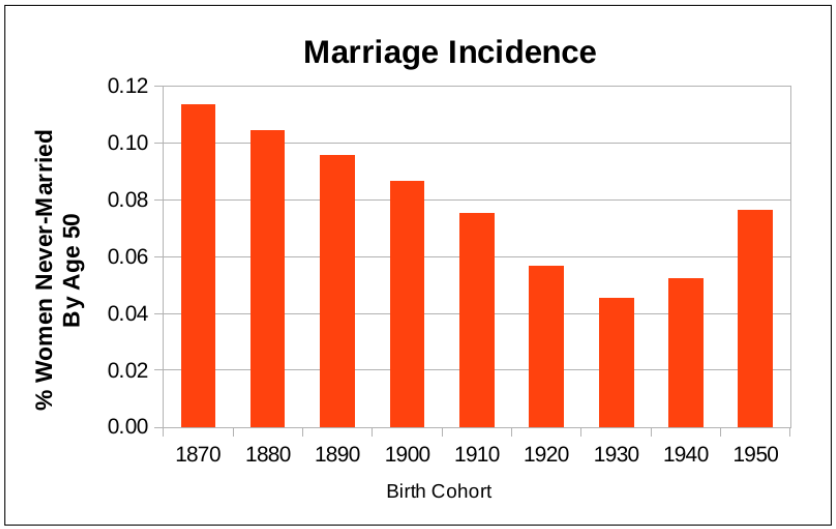
1. Men start getting married ealier (gender gap of age narrows).
2. Greater incidence of marriage (more time at risk).
3. Higher divorce rates (the gains to marriage fall as wives age).
    - Women face biological constraints that may reduce the gains to marriage as they age. Men do not.

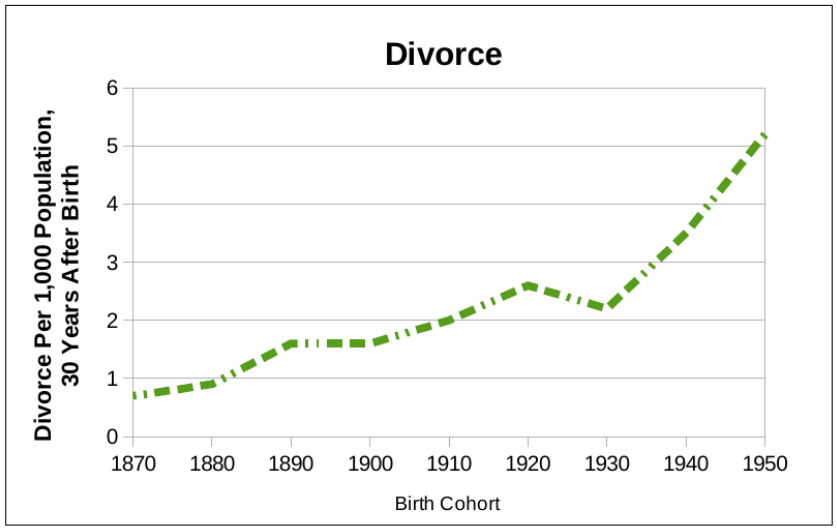
How much does demographics matter?

Trends in Marriage: 1870s to 1950s Birth Cohorts









What This Paper Does

Our Question: To what extent does demographic change shape the historical trends in marriage?

1. Construct a model of marriage where demographics plays several roles.
    - The sex ratio determines meeting rates.
    - The utility from marriage depends partner's age (Siow, 1998).
    - The life expectacy affects the long-term gains of marriage.
2. Calibrate the model's parameters to match the main marriage and divorce facts for the 1950s birth cohort.
3. Pose the demographic structure faced by the 1870s birth cohort, and ask how much the model can explain the data.

Literature

- Abramitzky, Delavande, and Vasconcelos (2011)
  - Used the variation in male's mortality rate in French during WWI.
  - Found that a decrease in sex ratio (men/women) narrowed the age gap at first marriage between men and women.
- Angrist (2001)
  - Used immigration data in the U.S.
  - Found a rise in sex ratio (men/women) increases female marriage prospect.

Model

Model: Demographics

1. OLG with stochastic aging. Three ages $i \in \{a, y, o\}$, Adolescent (a), Young (y), and Old (o). Two sexes $g \in \{m, f\}$.
    - Aging transitions $\Gamma^f_{i,i'}$ and $\Gamma^m_{i,i'}$.
2. New entrants due to birth (in equal amounts) and men's migration
    - n^g newborns are born every period.
    - Immigration rate i^m.
3. Differential mortality rates by age and sex. $\{\pi^m_i, \pi^f_i\}_{i \in \{a,y,o\}}$.

The Model: Notation, Meeting and Marriage

Marital Status: Single, dating or married $q \in \{0, 1, 2\}$.

Random dating: Probability $\psi^f = min\{1, \frac{x^m}{x^f}\}$. x^g measure of singles.

Preferences: If single or dating $u_i^g(0) = 0$. If married, utility depends on the age of partner plus a match quality. $u_i^g(i^*) = \alpha_{i^*}^g + z$.

Match Quality z^g: It has two components a Markov component and an iid component. $z = \mu + \epsilon$, where $\mu \in \{\mu_G, \mu_B\}$ has transition Λ^i and λ is the initial probability of $\mu = \mu_G$. $\epsilon \sim (0, \sigma^2)$, with $\Phi(\hat{\epsilon}) = Prob(\epsilon < \hat{\epsilon})$.

Marriage If both agree they get married, $q = 2$. Else $q = 0$.

Divorce is Costly. Agents pay a cost, ω upon divorce.

State before draw of ϵ. $\{i, q, i^*, \mu, \mu^*\}$

Model: Women (Adolescent, Young and Old)

Unpaired (single) woman of age i.

$$V^f(i,0,0,0,0) = u_i^f(0) + \beta\,(1-\pi^f)\sum_{i'}\Gamma^f_{i,i'}\Big\{(1-\psi^f)\,V^f(i',0,0,0,0) + \psi^f\sum_{j',\mu^f,\mu^m}\frac{x^{m,j'}}{x^m}\,\lambda(\mu^f)\lambda(\mu^m)\,V^f(i',1,j',\mu^f,\mu^m)\Big\}$$

Paired (married or dating, $q \in \{1,2\}$) women ($\epsilon^*_{f,i}$ and $\epsilon^*_{m,j}$ are cutoff values)

$$V^{f,i}(q,j,\mu^f,\mu^m) = \Big\{V^{f,i}(0,0,0,0) - \omega 1_{[q=2]}\Big\}\,\Phi(\epsilon^*_{f,i})\,\Phi(\epsilon^*_{m,j}) + \int_{\epsilon^*_{f,i}}^{\infty}\int_{\epsilon^*_{m,j}}^{\infty}$$

$$\Big\{\alpha^f_j+\mu^f+\epsilon^f+\beta(1-\pi^f)\Big[(1-\pi^m)\sum_{i',j',\mu^{f\prime},\mu^{m\prime}}\Gamma^f_{i,i'}\Gamma^m_{j,j'}\Lambda^{i'}_{\mu^f,\mu^{f\prime}}\Lambda^{j'}_{\mu^m,\mu^{m\prime}}V^{f,i'}(2,j',\mu^{f\prime},\mu^{m\prime}) + \beta\pi^m\sum_{i'}\Gamma^f_{i,i'}V^{f,i'}(0,0,0,0)\Big]\Big\}\,d\Phi(\epsilon^f)\,d\Phi(\epsilon^m)$$

Estimation

Mapping the Model to Data: 24 Parameters

Name	Parameter
Immigration Rate (1)	i_m
Mortality Rate (2)	π_f, π_m
Preferences (6)	α_a^f, α_y^f, α_o^f, α_a^m, α_y^m, α_o^m
Aging Transition (4)	Γ_{ay}^f, Γ_{yo}^f, Γ_{ay}^m, Γ_{yo}^m
Mean and Variance of Match Quality (3)	μ_G, μ_B, σ
Initial Dist. of Match Quality (1)	$\lambda(\mu_G)$
Transition of Match Quality (6)	$\Lambda_{G,G}^a$, $\Lambda_{G,G}^y$, $\Lambda_{G,G}^o$, $\Lambda_{B,B}^a$, $\Lambda_{B,B}^y$, $\Lambda_{B,B}^o$
Cost of Divorce (1)	ω

Mapping the Model to Data: 31 Moments

Target's Name

First Block

Life Expectancy for Men and Women (2)
Sex Ratio (1)

Second Block

Marriage Rate by 6 Age Groups for Men and Women (12)
Divorce Rate by 6 Age Groups for Men and Women (12)

Number of Never Married by Age 50 (2)

Age at First Marriage (2)

Properties of the Estimates: Block 2

- Women become old at earlier age than men.
- Women's attractiveness falls sharply from young to old age.
- Men's aging is less dramatic than women's.

Parameter	**Value**
Female's preferences over adolescent spouse (α_a^f)	-5.14
Female's preferences over young spouse (α_y^f)	1.17
Female's preferences over old spouse (α_o^f)	1.02
Male's preferences over adolescent spouse (α_a^m)	-2.00
Male's preferences over young spouse (α_y^m)	2.86
Male's preferences over old spouse (α_o^m)	-0.07
Average age at which women become young	21.4
Average age at which women become old	26.1
Average age at which men become young	21.8
Average age at which men become old	28.1

Properties of the Estimates: Block 2 Cont.

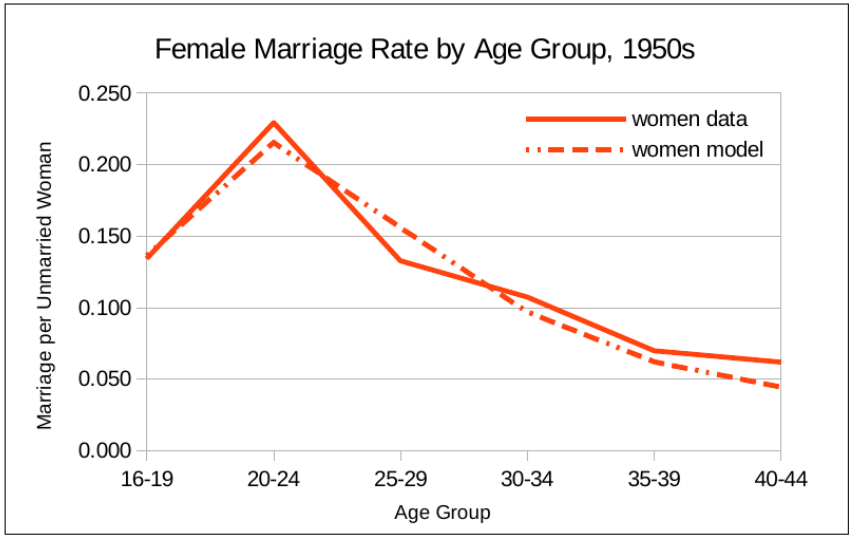
Match Quality:

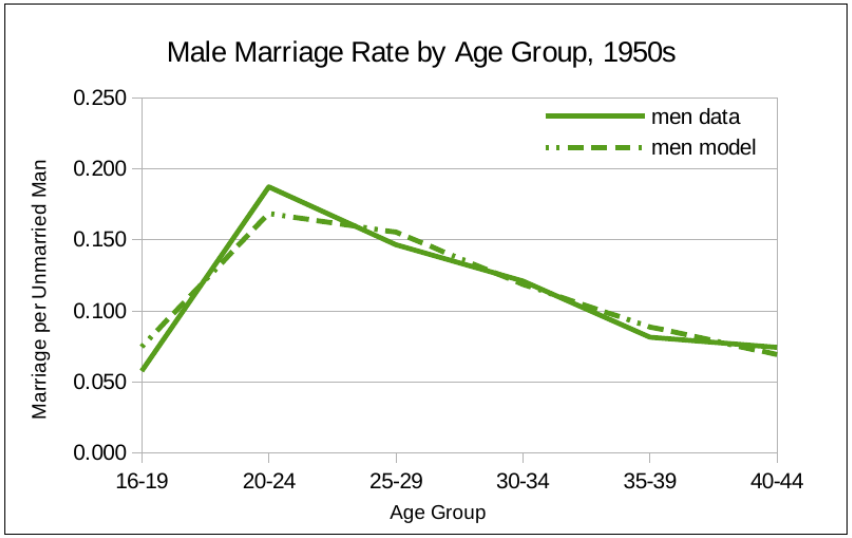
- Everyone starts with bad regime when dating.
- Transition probability of switching to a good match (μ_G) from a bad match (μ_B) is higher for the adolescent and for the young.
- Probability of swithcing to a bad match (μ_B) from a good match (μ_G) is higher for the young.
- These properties of the match quality captures the patterns of marriage and divorce in the data; both the marriage rate and the divorce rate are higher for the young.

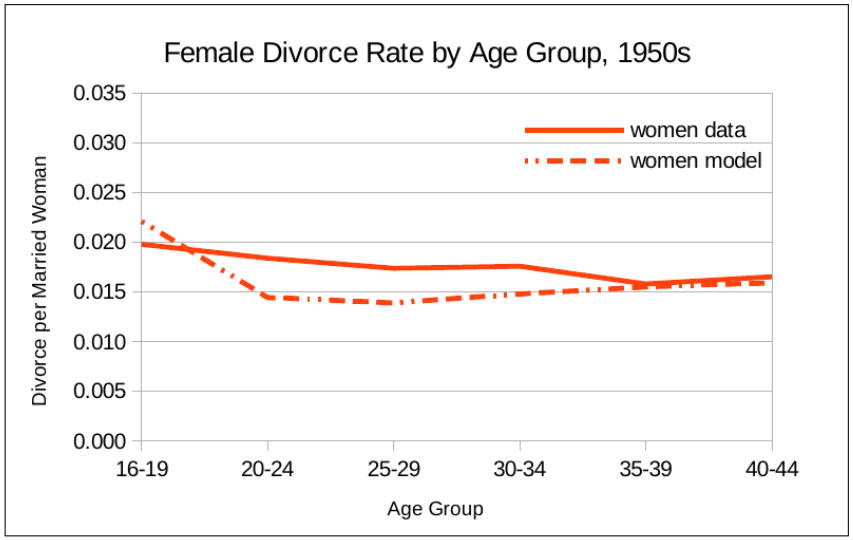
Properties of the Estimates: Block 2 Cont.

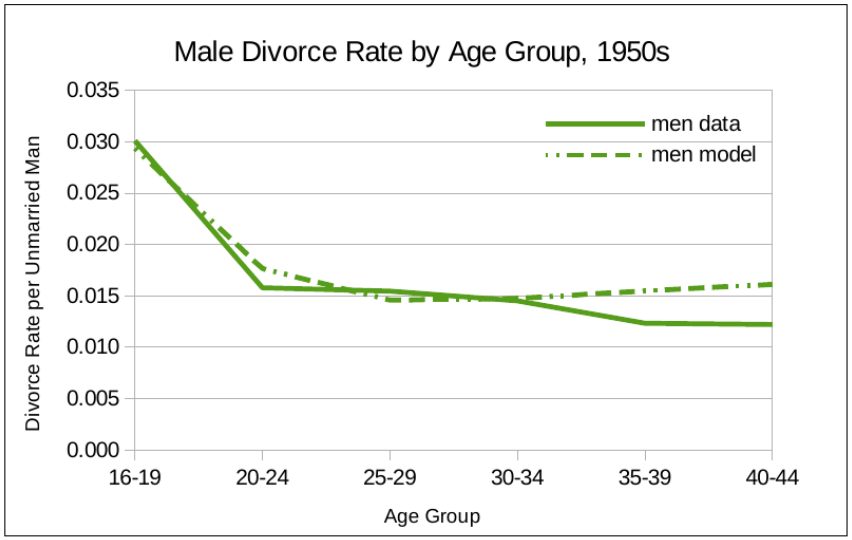
Parameter	**Value**
Mean of match quality in good regime, μ_G	1.66
Mean of match quality in bad regime, μ_B	-4.36
Variance of match quality, σ	2.88
Initial dist. of good match, λ	0.007
Transition probability of regimes, $\Lambda^a_{G,G}$, for adolescent	0.665
Transition probability of regimes, $\Lambda^a_{B,B}$, for adolescent	0.521
Transition probability of regimes, $\Lambda^y_{G,G}$, for young	0.839
Transition probability of regimes, $\Lambda^y_{B,B}$, for young	0.202
Transition probability of regimes, $\Lambda^o_{G,G}$, for old	0.978
Transition probability of regimes, $\Lambda^o_{B,B}$, for old	0.842
Cost of divorce	8.99

Model Performance: Marriage and Divorce Rates









Model Performance: 1. Marriage Statistics

	Women		Men	
	Data	**Model**	**Data**	**Model**
Marriage Rates by Age, per 1,000 Unmarried				
16-19 in 1965	134.1	136.2	57.8	74.7
20-24 in 1970	229.1	215.2	187.3	168.5
25-29 in 1975	132.8	155.9	146.6	155.4
30-34 in 1980	107.4	96.9	121.0	118.7
35-40 in 1985	69.9	62.1	81.3	88.7
40-44 in 1990	61.8	44.5	74.4	69.2
Marriage Incidence				
% Never-Married by Age 50 in 1990	5.2	5.1	6.2	6.2

Model Performance: 2. Divorce Rates by Age

	Women		Men	
	Data	**Model**	**Data**	**Model**
Divorce Rates by Age, per 1,000 Married				
16-19 in 1965	19.7	22.1	30.0	29.3
20-24 in 1970	18.4	14.4	15.7	17.6
25-29 in 1975	17.3	13.9	15.4	14.5
30-34 in 1980	17.6	14.8	14.5	14.7
35-39 in 1985	15.8	15.5	12.3	15.4
40-44 in 1990	16.5	15.9	12.1	16.1
Age at Marriage				
	22.0	22.0	24.7	24.7

Model Performance: 3. Overall Picture

	Data	Model
Divorce Rate, per 1,000 in Population		
	5.2	4.0
Percent of Married Age 16+		
Women	59.1	51.5
Men	64.4	54.8
Percent of Married Age 16-49		
Women	60.8	63.6
Men	56.0	56.5

Now to Use the Model

Demographic Experiment 1

- What would the 1950s birth cohorts do if they faced the population structure of 1870s?
- Choose mortality and immigration rates to match the age and sex structure for the 1870s birth cohorts.

	1950s	**1870s**
Life expectancy of women (at age 15)	60.4	43.9
% Change		(-27.3)
Life expectancy of men (at age 15)	54.4	43.4
% Change		(-20.2)
Men per 100 women (aged 15 and above)	93.9	104.0
% Change		(+10.7)

Result 1: Age at Marriage and Never-Married

	1950s		1870s	
	Data	**Model**	**Model**	**Data**
Age at Marriage				
Women	22.0	22.0	21.9	22.3
% Change			(-0.4)	(+1.3)
Men	24.7	24.7	25.9	25.6
% Change			(+4.8)	(+3.6)
% of Never-Married by Age 50				
Women	5.2	5.1	10.3	6.1
% Change			(+98.0)	(+19.6)
Men	6.2	6.2	12.9	9.7
% Change			(+108.0)	(+56.4)

Result 2: Percent of Married and Divorce Rate

	1950s		1870s	
	Data	**Model**	**Data**	**Model**
% of Married Age 16+				
Women	59.1	51.5	58.8	47.6
% Change			(-0.5)	(-7.5)
% of Married Age 16-49				
Women	60.8	63.6	59.7	59.2
% Change			(-1.8)	(-6.9)
Divorce Rate, per 1,000				
Women	5.2	4.0	0.7	3.8
% Change			(-86.5)	(-5.0)

Results: Summary

The demographic transition from 1870s to 1950s *can explain many* of the transition in marital status:

1. Can explain the **decrease in age at marriage** for men (75%), and no change on age at marriage for women.
    - Thus, the decrease of the gap in age at marriage.
2. Can explain the **increase in incidence of marriage** for women (20%) and for men (52%).
3. Over-predicts the **increase in prevalence of marriage**, which is not observed in the data (183%).
4. Explains **none of the rise in divorce**.

Underlying Mechanism

(1) Only life expectancy changes. (2) Only sex ratio changes.

	% Change in Data (1950s to 1870s)	% Change in Model (1950s to 1870s)		
		(1) Life Exp. Only	**(2) Sex Ratio Only**	**Both**
		Age at Marriage		
Women	-0.4	+3.1	-2.7	+1.3
Men	+4.8	+3.6	+0.0	+3.6
		% of Never-Married by Age 50		
Women	+98.0	+70.5	-41.1	+19.6
Men	+108.0	+38.7	+12.9	+56.4

Intuition

- The population shifted;
  - From a high sex ratio/low life expectancy regime in 1870's
  - To a low sex ratio/high life expectancy regime in 1950's
- As a result, the model predicts:
  1. Earlier age at marriage for men
     - Easy to find a wife
  2. A rise in marriage incidence for women and men
     - Larger average gains of marriage because of longer life expectancy

What Else Could Have Happened?

- The model failed to explain the increase of divorce rate, and over-predicted the rise in the prevalence of marriage.
- Divorce liberalization may be the answer to these two changes.
  1. Decrease of the cost of divorce increases divorce rate.
  2. Increase of divorce rate reduces the prevalence of marriage.
- Re-estimate **cost of divorce** (ω)
  - Target: the divorce rate in 1870's

Divorce Law Liberalization: Result 1

	1950s		1870s		
	Data	**Model**	**Data**	**Model**	**Model (D)**
			Age at Marriage		
Women	22.0	22.0	21.9	22.3	23.8
% Change			(-0.4)	(+1.3)	(+8.6)
Men	24.7	24.7	25.9	25.6	25.7
% Change			(+4.8)	(+3.6)	(+4.0)
			% of Never-Married by Age 50		
Women	5.2	5.1	10.3	6.1	11.0
% Change			(+98.0)	(+19.6)	(+115.6)
Men	6.2	6.2	12.9	9.7	12.4
% Change			(+108.0)	(+56.4)	(+100.0)

Divorce Law Liberalization: Result 2

	1950s		1870s		
	Data	Model	Data	Model	Model (D)
% of Married Age 16+					
Women	59.1	51.5	58.8	47.6	51.9
% Change			(-0.5)	(-7.5)	(+0.7)
% of Married Age 16-49					
Women	60.8	63.6	59.7	59.2	65.2
% Change			(-1.8)	(-6.9)	(+2.5)
Divorce Rate, per 1,000					
	5.2	4.0	0.7	3.8	0.7
% Change			(-86.5)	(-5.0)	(-82.5)

Results: Summary

With divorce law liberalization;

- The demographic transition from 1870s to 1950s *can explain most* of the transition in marital status:
  1. Can explain the **decrease in age at marriage** for men (83%).
  2. Can explain the **increase in incidence of marriage** for women (117%) and for men (92%).
  3. Consistent with the little change **in prevalence of marriage**.

Preliminary Conclusion

- From 1870's to 1950's (Long Run) the demographics can account for;
  - The fall in age at marriage for men.
  - The increased incidence of marriage both for men and for women.
- With divorce liberalization, most of the marriage statistics in the model move consistently with the data.

Future Work

Near Future:

- What other explanations might account for the trends?
- Changes in the gains to marriage.

Distant Future:

- To what extent can changes in the age and sex structure of the population account for:
  - The Baby Boom?
  - The fertility cycle following the Baby Boom?

1930s

Demographic Experiment 2

- What would the 1950s birth cohorts do if they faced the population structure of 1930s?
- Choose mortality and immigration rates to match the age and sex structure for the 1870s birth cohorts.

	1950s	**1930s**
Life expectancy of women (at age 15)	60.4	54.9
% Change		(-9.1)
Life expectancy of men (at age 15)	54.4	51.4
% Change		(-5.5)
Men per 100 women (aged 15 and above)	93.9	99.7
% Change		(+6.1)

Result 1: Age at Marriage and Never-Married

	1950s		1930s	
	Data	**Model**	**Data**	**Model**
Age at Marriage				
Women	22.0	22.0	20.3	21.8
% Change			(-7.7)	(-0.9)
Men	24.7	24.7	22.8	24.8
% Change			(-7.6)	(+0.4)
% of Never-Married by Age 50				
Women	5.2	5.1	5.6	4.0
% Change			(+7.6)	(-21.5)
Men	6.2	6.2	6.6	6.7
% Change			(+6.4)	(+8.0)

Result 2: Percent of Married and Divorce Rate

	1950s		1930s	
	Data	**Model**	**Data**	**Model**
% of Married Aged 16+				
Women	59.1	51.5	68.9	52.6
% Change			(+16.5)	(+2.1)
Divorce Rate, per 1,000				
	5.2	4.0	2.2	4.0
% Change			(-57.6)	(+0.0)

Results: Summary

The demographic transition from 1930s to 1950s *cannot explain much* of the transition in marital status:

1. Can't explain the delay in marriage for women and men.
2. Can't explain the fall in incidence of marriage for women.
3. Can't explain the decreased prevalence of marriage.
4. None of the rise in divorce.

Divorce Law Liberalization + Schooling

Two social changes might explain the transition:

1. Divorce law liberalization
2. Rise of college enrollment

Re-estimate;

1. The cost of divorce (ω).
2. The value of being single for adolesents ($u_a^f(0)$ and $u_a^m(0)$).

Targets are the divorce rate and the age at first marriage for women and men in the 1870s.

Divorce Law Liberalization + Schooling: Result 1

	1950s		1930s			
	Data	Model	Data	Model	Model (D)	Model (D+S)
Age at Marriage						
Women	22.0	22.0	20.3	21.8	22.4	20.6
% Change			(-7.7)	(-0.9)	(+1.8)	(-6.3)
Men	24.7	24.7	22.8	24.8	24.8	22.5
% Change			(-7.6)	(+0.4)	(+0.4)	(-8.9)
% of Never-Married by Age 50						
Women	5.2	5.1	5.6	4.0	5.6	4.2
% Change			(+7.6)	(-21.5)	(+9.8)	(-17.6)
Men	6.2	6.2	6.6	6.7	7.1	5.8
% Change			(+6.4)	(+8.0)	(+14.5)	(-6.4)

Divorce Law Liberalization + Schooling: Result 2

	1950s		1930s			
	Data	Model	Data	Model	Model (D)	Model (D+S)
% of Married Age 16+						
Women	59.1	51.5	68.9	52.6	56.3	57.4
% Change			(+16.5)	(+2.1)	(+9.3)	(+11.4)
Divorce Rate, per 1,000						
	5.2	4.0	2.2	4.0	2.2	2.2
% Change			(-57.6)	(+0.0)	(-45.0)	(-45.0)