

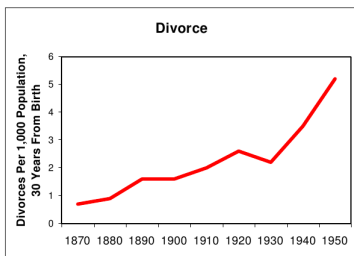
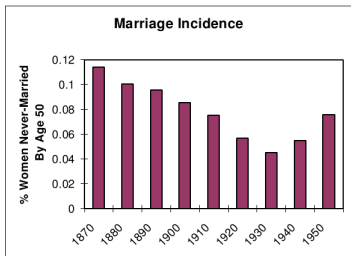
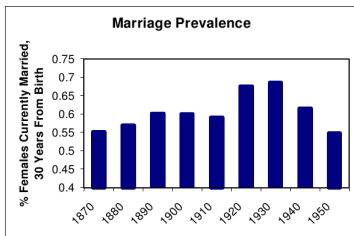
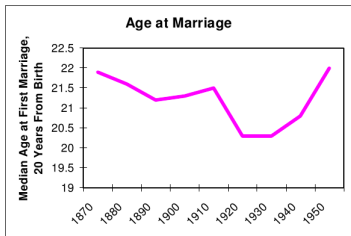
The Demographic Transition and Long-Term Marriage Trends

José-Víctor Ríos-Rull Shannon Seitz Satoshi Tanaka

Minn, Mpls Fed, CAERP, Boston College, Minn

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Trends in Marriage: 1870-79 to 1950-59 Birth Cohorts



Demographic Changes 1870's to 1950's Cohorts

Between the **1870** and **1930's** birth cohorts:

- ① Age at marriage **decreased** by 7.3%.
- ② Fraction never-married by age 50 **decreased** by 55.9%.
- ③ Marriage prevalence **increased** by 28.6%.
- ④ Divorce **increased** by 214.3% for women.

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Between the **1930's** and **1950's** birth cohorts:

- 1 Age at marriage **increased** by 8.4%.
- 2 Fraction never-married by age 50 **increased** by 22.2%.
- 3 Marriage prevalence **decreased** by 20.1%.
- 4 Divorce **increased** by 136.4% for women.

Demographics: Two Transitions

Transition 1: High sex ratio, low life expectancy in 1870's to high sex ratio, high life expectancy in 1930's

Transition 2: High sex ratio, high life expectancy in 1930's to low sex ratio, high life expectancy in 1950's

	Life Expectancy (at age 15)		Men Per 100 Women (aged 15 and above)	
	Men	Women		
1870's	45.6	44.5	104.3	
1930's	56.7 (%Δ 24.3)	52.5 (%Δ 18.0)	98.4 (%Δ - 5.7)	Transition 1
1950's	61.0 (%Δ 7.6)	54.4 (%Δ 3.6)	92.6 (%Δ - 5.6)	Transition 2



What determines marriage structure? Motive and Opportunity.

- There are gains to be together, not necessarily symmetric:
 - ▶ Returns to scale.
 - ▶ Women face biological constraints that may reduce their attractiveness as mates as they age (men do not) (Siow (1998)).
 - ▶ Men have higher resources.
- Some people like more some individuals than others. (Love?)
- Availability. The relative number of men and women in the right age groups. The sex in short supply may be choosier.

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 - ▶ Living alone a superior good. (Salcedo, Schoellman, and Tertilt (2009), Greenwood and Guner (2009))

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 - ▶ Divorce costs.
 - ▶ Living alone a superior good. (Salcedo, Schoellman, and Tertilt (2009), Greenwood and Guner (2009))
 - 3 Have people changed? The rest. (culture?).

Our Paper. We do

- 1 We construct a model of marriage where demographics play several roles:
 - 1 The sex ratio determines the speed at which men and women meet each other.
 - 2 The gains to marriage and costs of investing in marriage change as agents age (in part through life expectancy).
- 2 We estimate our model to match the main facts on marriage and divorce for the cohorts born between 1950-1959.
- 3 We pose the demographic structure faced by those born in 1870's and 1930's and ask what they would have done.
- 4 We look for clues of what accounts for the rest.

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 - ▶ Women age faster
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- Across time the 1870's cohorts is similar in some ways to the the 1950's cohorts.
- A lot less so the 1930's. cohorts.

The 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 $\Gamma_{i,j'}^f$ and $\Gamma_{i,j'}^m$,
- ▶ Mortality $\{\pi_i^m, \pi_i^f\}_{i \in \{a, y, o\}}$.
- ▶ n^g newborns are born every period.

- 2 Age is in the eye of the beholder:

- ▶ **Biological age** (adolescent, young, or old) is not observed in the data but determines how attractive one is to the opposite sex.
- ▶ **Calendar age**, the number periods since birth is observed but does not determine attractiveness. We compile statistics with it.

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

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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 $\Phi(\hat{\epsilon}) = \text{Prob}(\epsilon < \hat{\epsilon})$.

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



The Model: Women (adolescent, young and old)

Unpaired (single) woman of age i . Her state is

$$V^f(i, 0, 0, 0, 0) = \beta (1 - \pi^f) \sum_{i'} \Gamma_{i, i'}^f \left\{ (1 - \psi^f) V^f(i', 0, 0, 0, 0) + \psi^f \sum_{j', \mu^f, \mu^m} \frac{x^{m, j'}}{x^m} \lambda(\mu^f) \lambda(\mu^m) V^f(i', 1, j', \mu^f, \mu^m) \right\}$$

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

$$V^{f,i}(q, j, \mu^f, \mu^m) = \left\{ V^{f,i}(0, 0, 0, 0) - \omega 1_{[q=2]} \right\} \Phi(\epsilon_{f,i}^*) \Phi(\epsilon_{m,j}^*) + \int_{\epsilon_{f,i}^*}^{\infty} \int_{\epsilon_{m,j}^*}^{\infty} \left\{ \alpha_j^f + \mu^f + \epsilon^f + \beta(1 - \pi^f) \left[(1 - \pi^m) \sum_{i', j', \mu^{f'}, \mu^{m'}} \Gamma_{i,i'}^f \Gamma_{j,j'}^m \Lambda_{\mu^f, \mu^{f'}}^{i'} \Lambda_{\mu^m, \mu^{m'}}^{j'} V^{f,i'}(2, j', \mu^{f'}, \mu^{m'}) + \beta \pi^m \sum_{i'} \Gamma_{i,i'}^f V^{f,i'}(0, 0, 0, 0) \right] \right\} d\Phi(\epsilon^f) d\Phi(\epsilon^m)$$

Mapping the model to data: 24 Parameters

Name	Parameter
Immigration Rate (1)	i_m
Mortality Rate (2)	π_f, π_m
Preferences (6)	$\alpha_a^f, \alpha_y^f, \alpha_o^f, \alpha_a^m, \alpha_y^m, \alpha_o^m$
Aging Transition (4)	$\Gamma_{ay}^f, \Gamma_{yo}^f, \Gamma_{ay}^m, \Gamma_{yo}^m$
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

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)

- Record keeping starts (agents become adolescent) at age 16

Mortality Rate:

- For 1950's, we have an age independent mortality rate.
- For 1870's and 1930's, we have age specific mortality rate for women. This feature captures the data fact that one of the big gain of life expectancy for women comes from the improvement of **maternal health**.

Immigration Rate:

- This rate is constructed to match the sex ratio given mortality rates of men and women

Exactly Identified. Block 1: Mortality and Immigration

- 1 For 1950's mortality rates are age independent and are to match the life expectancy in the data.
- 2 For the years, 1870's and 1930's, we set $\pi^f(a)$ and $\pi^f(o)$ so that the rate of the change of the mortality to 1950's is same as men's.
- 3 We adjust $\pi^f(y)$ for 1870's and 1930's to match women's life expectancy in those years.
- 4 Immigration sets the sex ratio.

Mortality Rate	$\pi^f(a)$	$\pi^f(y)$	$\pi^f(o)$	π^m
1950's	0.0166	0.0166	0.0166	0.0187
1930's	0.0173	0.0228	0.0173	0.0194
1870's	0.0205	0.0338	0.0205	0.0230

Properties of the Estimates: Block 2 Preferences

Parameter	Value
Mean of match quality in good regime, μ_G	8.28
Mean of match quality in bad regime, μ_B	-20.5
Variance of match quality, σ	7.01
Initial dist. of good match, λ	0.000
Transition probability of regimes, $\Lambda_{G,G}^a$, for adolescent	0.996
Transition probability of regimes, $\Lambda_{B,B}^a$, for adolescent	0.066
Transition probability of regimes, $\Lambda_{G,G}^y$, for young	0.980
Transition probability of regimes, $\Lambda_{B,B}^y$, for young	0.011
Transition probability of regimes, $\Lambda_{G,G}^o$, for old	1.000
Transition probability of regimes, $\Lambda_{B,B}^o$, for old	0.647
Cost of divorce	2.36

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- Probability of switching 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.

Estimated Parameters: Block 2: Preferences

- Women like marriage less than men.
- 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)	-14.08
Female's preferences over young spouse (α_y^f)	-2.29
Female's preferences over old spouse (α_o^f)	-3.50
Male's preferences over adolescent spouse (α_a^m)	-14.96
Male's preferences over young spouse (α_y^m)	11.15
Male's preferences over old spouse (α_o^m)	-1.71
Average age at which women become young	21.5
Average age at which women become old	25.3
Average age at which men become young	21.4
Average age at which men become old	27.7

Model Performance: 1. Marriage Statistics

	Women		Men	
	Data	Model	Data	Model
Marriage Rates by Age, per 1,000 Unmarried				
16-19 in 1965	127.7	135.9	57.8	74.2
20-24 in 1970	220.6	206.1	184.4	167.7
25-29 in 1975	129.4	151.1	145.6	156.4
30-34 in 1980	105.6	95.5	124.1	120.4
35-40 in 1985	68.9	61.5	80.9	90.0
40-44 in 1990	60.1	43.8	75.3	69.7
Marriage Incidence				
% Never-Married by Age 50 in 1990	5.5	5.4	6.5	6.5



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	19.9	22.8	29.8	29.6
20-24 in 1970	19.3	15.8	17.3	18.8
25-29 in 1980	18.1	15.1	16.4	14.5
30-34 in 1980	17.4	15.9	15.1	13.3
35-39 in 1990	15.4	16.6	11.7	13.0
40-44 in 1990	15.4	17.0	11.2	13.0
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	4.4
Percent aged 16 to 49 that are Married		
Women	56.7	50.9
Men	52.8	50.7
Sex Ratio at Birth	105.4	104.1

Now to use the model

- Are the marriage patterns of earlier generations a product of different demographics (age ratio and life expectancy)?
- If not, are there some other simple changes that tell us something about what else has changed?

Demographic Experiment 1: What would the 1950's birth cohorts do if they faced the population structure of 1870's?

To answer this question, we choose mortality and immigration rates to match the age and sex structure for the 1870's birth cohorts, holding all other parameters constant at their 1950's values.

	1870's	1950's
Life expectancy of women (at age 15)	45.6	61.0
% Change		+33.8
Life expectancy of men (at age 15)	44.5	54.4
% Change		+22.7
Men per 100 women (aged 15 and above)	104.3	92.9
% Change		-10.9

Results: Age at Marriage

	Data		Model	
	1870's	1950's	1870's	1950's
Age at Marriage				
Women	21.9	22.0	21.9	22.0
% Change		(+0.5)		(+0.5)
Men	25.9	24.7	26.1	24.7
% Change		(-4.6)		(-6.4)

Results: Marital Statistics

	Data		Model	
	1870's	1950's	1870's	1950's
% Aged 16 to 49 that are Married				
Women	55.2	56.7	40.8	50.9
% Change		(+2.7)		(+24.8)
% of Never-Married by Age 50				
Women	10.2	5.5	5.9	5.4
% Change		(-46.1)		(-8.5)
Men	14.4	6.5	13.4	6.5
% Change		(-54.9)		(-51.5)

Results: Divorce Rate

	Data		Model	
	1870's	1950's	1870's	1950's
Divorce Rate, per 1,000				
	0.7	5.2	4.4	4.4
% Change		(+742.9)		(+0.0)

Results: Summary

- The demographic transition from 1870's to 1950's can explain *much* of the transition in marital status:
 - ① The decrease in age at marriage for men (139.1%), and no change on age at marriage for women.
 - ② Thus, the decrease of the gap in age at marriage.
 - ③ The increased incidence of marriage for women (18.4%) and for men (93.8%).
- The model predicts a too large increase in prevalence of marriage, which is not observed in the data (918.5%).
- The model explains none of the rise in divorce.

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.

This represents a move towards an environment where;

- the average gains to marriage rise for women and fall for men,
- and, men drive the marriage decisions.

As a result, the model predicts:

- 1 **Earlier age at marriage** for men (easy to find a wife)
- 2 **Rise in marriage prevalence and incidence** (larger average gains of marriage for women)

What Else Could Have Happened? Divorce was Easier in 1950's than in 1870's

The model failed to explain the increase of divorce rate, and over-predicted the rise in the prevalence of marriage (918.5%).

- **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.

To test our conjecture, we re-estimate **cost of divorce** (ω) in order to match the divorce rate in 1870's.

Divorce Law Liberalization: Result 1

	Data		Model	
	1870's	1950's	1870's	1950's
Age at Marriage				
Women	21.9	22.0	21.67	22.0
% Change		(+0.5)		(+1.5)
Men	25.9	24.7	27.3	24.7
% Change		(-4.6)		(-9.5)
% Aged 16 to 49 that are Married				
Women	55.2	56.7	47.6	50.9
% Change		(+2.7)		(+6.9)

Divorce Law Liberalization: Result 2

	Data		Model	
	1870's	1950's	1870's	1950's
% of Never-Married by Age 50				
Women	10.2	5.5	6.3	5.4
% Change		(-55.9)		(-16.3)
Men	14.4	6.5	13.7	6.5
% Change		(-56.9)		(-53.5)
Divorce Rate, per 1,000				
% Change	0.7	5.2	0.7	4.4
		(+742.9)		(+642.9)

Divorce Law Liberalization: Results Summary

- With divorce liberalization, the demographic transition from 1870's to 1950's can account for *most* of the transition in marital status:
 - 1 The decrease in age at marriage for men (206.5%) and almost no change on age at marriage for women.
 - 2 The increased incidence of marriage for women (29.1%) and for men (94.0%).
 - 3 The increase in prevalence of marriage (255.5%).
- The results look better with divorce liberalization.

Demographic Experiment 2: What would the 1950's birth cohorts do if they faced the population structure of 1930's?

To answer this question, we choose mortality and immigration rates to match the age and sex structure for the 1930's birth cohorts, holding all other parameters constant at their 1950's values.

	1930's	1950's
Life expectancy of women (at age 15)	56.7	61.0
% Change		7.6
Life expectancy of men (at age 15)	52.5	54.4
% Change		3.6
Men per 100 women (aged 15 and above)	98.4	92.9
% Change		-5.6

Results: Age at Marriage

	Data		Model	
	1930's	1950's	1930's	1950's
Age at Marriage				
Women	20.3	22.0	21.8	22.0
% Change		(+8.4)		(+1.3)
Men	22.8	24.7	24.8	24.7
% Change		(+8.3)		(-0.5)

Results: Marital Statistics

	Data		Model	
	1930's	1950's	1930's	1950's
% Aged 16 to 49 that are Married				
Women	71.0	56.7	49.2	50.9
% Change		(-20.1)		(+3.5)
% of Never-Married by Age 50				
Women	4.5	5.5	4.2	5.4
% Change		(+22.2)		(+28.6)
Men	6.2	6.5	7.2	6.5
% Change		(+4.8)		(-9.7)

Results: Divorce Rate

	Data		Model	
	1930's	1950's	1930's	1950's
Divorce Rate, per 1,000				
	2.2	5.2	4.6	4.4
% Change		(+136.4)		(-4.4)

Results: Summary

The demographic transition from 1930's to 1950's can explain *some* of the transition in marital status for women and *none* of the transition in marital status for men.

- The model with changes in the age and sex structure between the 1930's and 1950's birth cohorts is consistent with:
 - 1 The delay in marriage for women (15.4%).
 - 2 The fall in the incidence of marriage for women (128.8%).
- Can't explain the delay in marriage and the fall in incidence of marriage for men.
- Can't explain the decreased prevalence of marriage.
- None of the rise in divorce.

The population shifted from a **high sex ratio/high life expectancy regime** in 1930's to a **low sex ratio/high life expectancy** regime in 1950's.

- In both regimes, the average gains to marriage are high for women and low for men.
- There is a shift from an environment where women are choosy to one where men are choosy.

As a result:

- Women marry later (it is difficult to find a spouse).
- Marriage incidence falls for women.

We also tested whether the changes of **divorce costs** and **marriage gain** can improve our results.

With Divorce Costs and Marriage Gains: Result 1

	Data		Model		
	1930's	1950's	1930's (D)	1930's (M)	1950's

Age at Marriage

Women	20.3	22.0	22.0	21.8	22.0
% Change		(+8.4)			(+0.0), (+1.3)
Men	22.8	24.7	25.1	24.2	24.7
% Change		(+8.3)			(-1.6), (+2.0)

% Aged 16 to 49 that are Married

Women	71.0	56.7	57.9	54.2	50.9
% Change		(-20.1)			(-12.1), (-6.1)

With Divorce Costs and Marriage Gains: Result 2

	Data		Model		
	1930's	1950's	1930's (D)	1930's (M)	1950's
% of Never-Married by Age 50					
Women	4.5	5.5	3.8	2.9	5.4
% Change		(+22.2)			(+42.1), (+86.2)
Men	6.2	6.5	4.4	3.8	6.5
% Change		(+4.8)			(+47.7), (+71.0)
Divorce Rate, per 1,000					
% Change	2.2	5.2	2.2	5.0	4.4
		(+136.4)			(+104.5), (-12.0)

With Divorce Costs and Marriage Gains: Summary

Result: Even if we adjust the costs of divorce and the gain of marriage, the model cannot account for the data from 1930's to 1950's.

- Especially, the model cannot match the following at the same time:
 - 1 Increase of age at marriage both for men and for women.
 - 2 Decrease of prevalence of marriage.
 - 3 Not so much change in the incidence of marriage.

From 1870's to 1950's (Long Run):

- Demographics can account for the fall in age at marriage for men, the shrink of the gap in age at marriage, and 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.

From 1930's to 1950's (Short Run):

- Demographics alone are NOT able to account for the delay in age at marriage and the decreased prevalence of marriage.
- The changes of divorce costs and marriage gain are NOT answers.

Near Future:

- A more systematic approach to track changes across cohorts. Perhaps thinking of (non-linear) economies of scale.

References

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Contingent Slides

What Else Could Have Happened? Decline of the Gains from Marriage from 1870(-79) to 1950(-59)

The gains from marriage might have declined from 1870 to 1950.

- **Decline of the Gain from Marriage** will induce;
 - 1 Decrease of the incidence of marriage.
 - 2 Decrease of the prevalence of marriage.

We tested if the result will be improved when we add a **gain from marriage** (ζ) to the model, and adjust ζ targeting on 1) the number of never-married by age 50 and 2) the number of the married in 1870 data.

- **Answer:** No improvement.

Decline of the Gain from Marriage: Result 1

	Data		Model	
	1870	1950	1870	1950
Age at Marriage				
Women	21.9	22.0	21.9	22.0
% Change		(+0.5)		(+0.5)
Men	25.9	24.7	26.3	24.7
% Change		(-4.6)		(-6.1)
% Aged 16 to 49 that are Married				
Women	55.2	56.7	39.7	50.9
% Change		(+2.7)		(+28.2)

Decline of the Gain from Marriage: Result 2

	Data		Model	
	1870	1950	1870	1950
% of Never-Married by Age 50				
Women	10.2	5.5	6.5	5.4
% Change		(-55.9)		(-16.9)
Men	14.4	6.5	14.8	6.5
% Change		(-56.9)		(-56.1)
Divorce Rate, per 1,000				
	0.7	5.2	4.3	4.4
% Change		(+742.9)		(2.3)