An Investment-and-Marriage Model with Differential Fecundity

Hanzhe Zhang

Michigan State University

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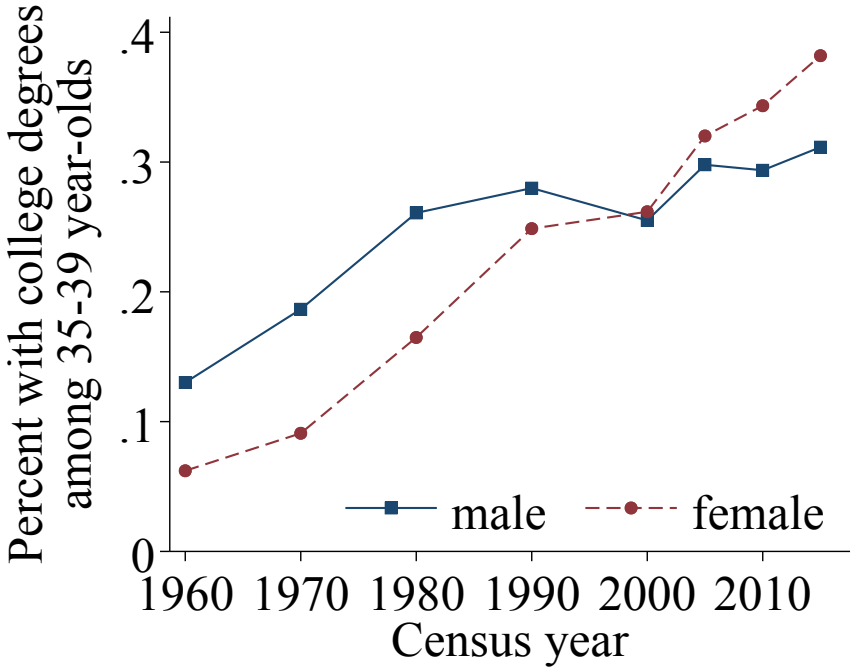
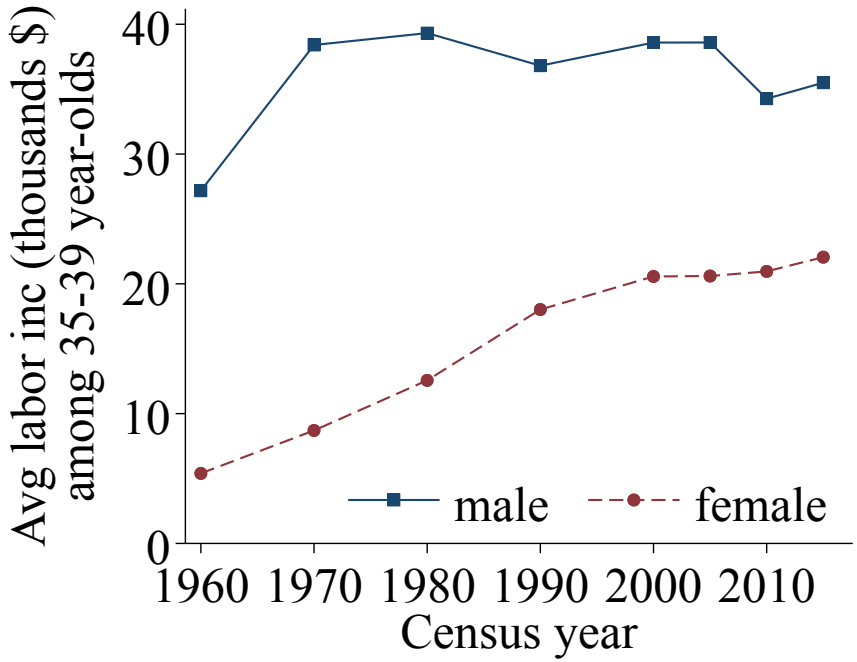
http://www.msu.edu/∼hanzhe/

Three Sets of Stylized Facts

1. College and Earnings Gender Gaps

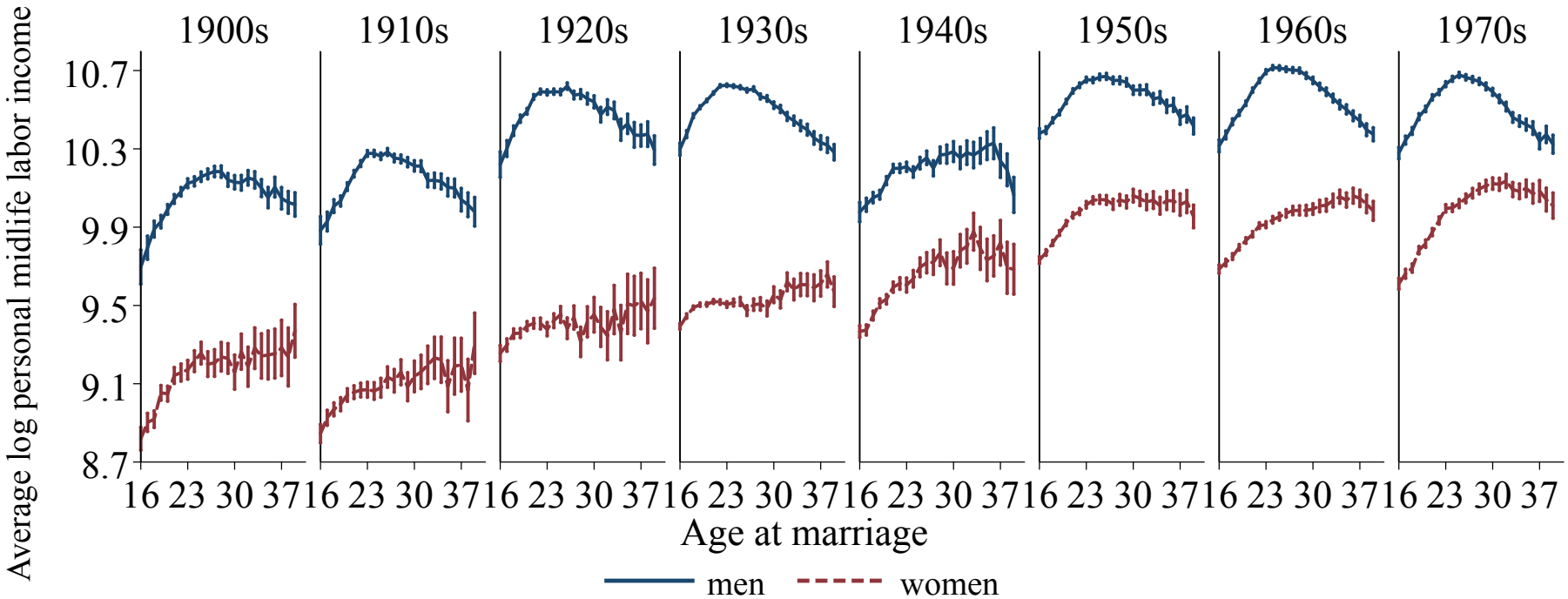
- Reversed college gender gap
- Persistent earnings gender gap





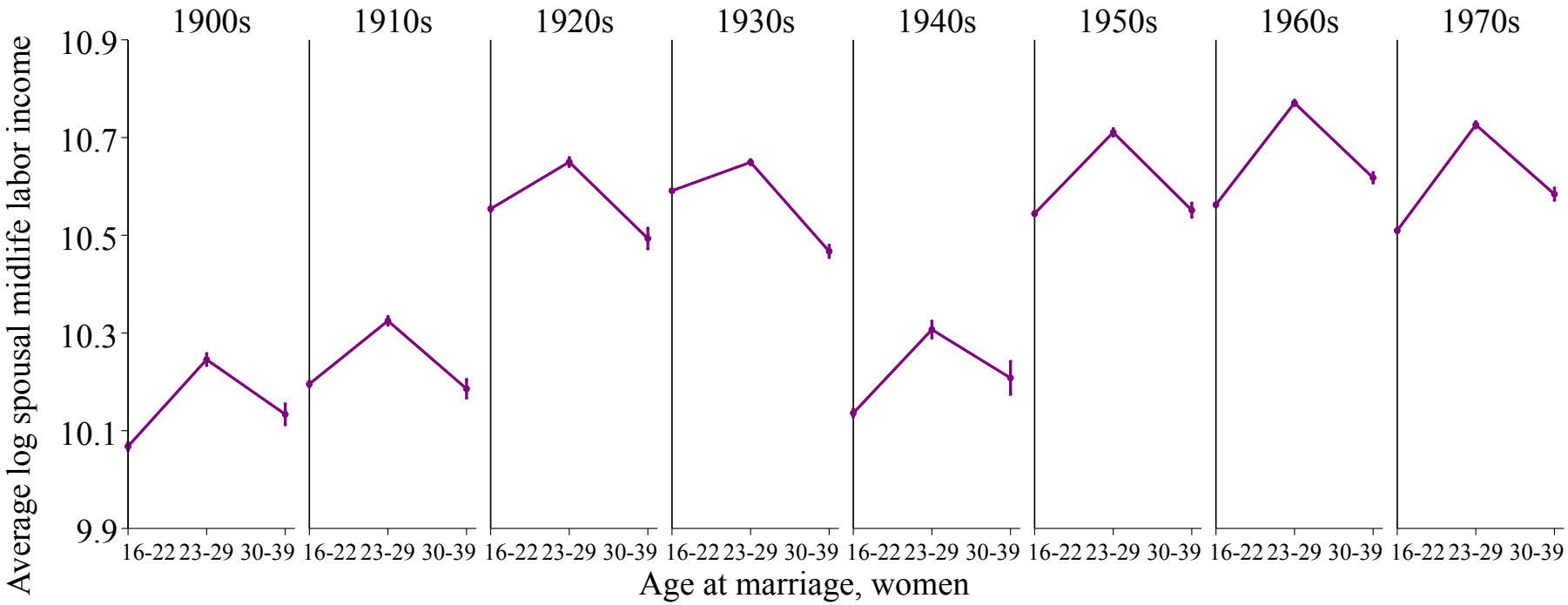
2. Average Midlife Income by Age at Marriage

- Hump-shaped relationship for men
- Positive relationship for women



3. Average Spousal Income by Age at Marriage for Women

- Hump-shaped relationship
- Changing relationship: early versus late brides



Previous Explanations

1. More women than men go to college and fewer women than men earn a high income.
   - One gender difference in the model can generate these two opposite gender gaps; no paper has done that
   - Some empirical studies: Iyigun and Walsh (2007); Chiappori et al. (2009); Ge (2011); Lafortune (2013); Bruze (2015); Greenwood et al. (2016); Chiappori et al. (2017)
2. Relationship between age at marriage and personal midlife income has been persistently hump-shaped for men and positive for women.
   - Becker (1974); Keeley (1979): negative for men and negative for women due to marriage frictions;Bergstrom and Bagnoli (1993): positive for men and no relationship for women due to informational frictions
3. Relationship between age at marriage and spousal income for women has been persistently hump-shaped, with a changing marital outcome for early brides versus late brides.
   - Low (2017): non-assortative matching

Model

Model Overview

- Infinite number of periods.
- A unit mass of men and a unit mass of women become adults each period.
- Individuals are born with heterogeneous abilities of succeeding from investments.
- Investments: they make investment and marriage decisions over three periods.
- Differential fecundity: women stay fertile for a shorter period of time than men.
- Marriage market: division of marriage surplus is determined by supply and demand.

Investments

Investments

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Investments

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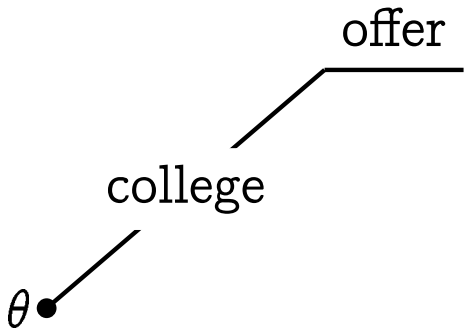
ages 16-22 ages 23-29 ages 30-39

Investments



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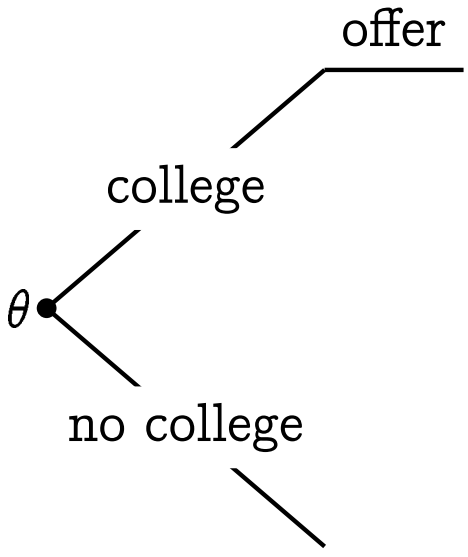

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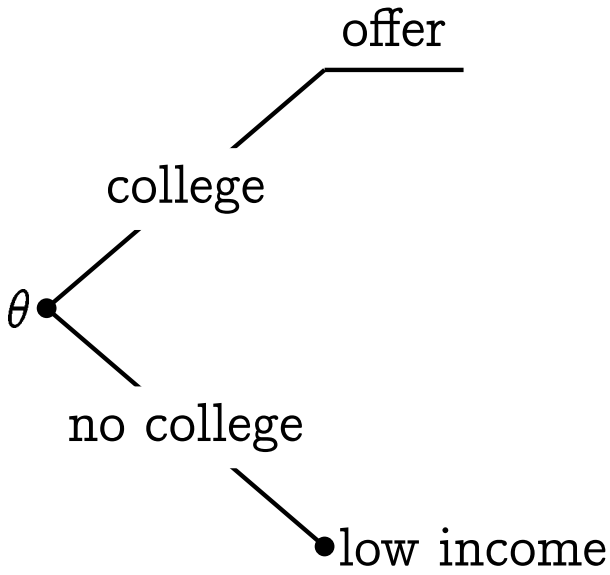

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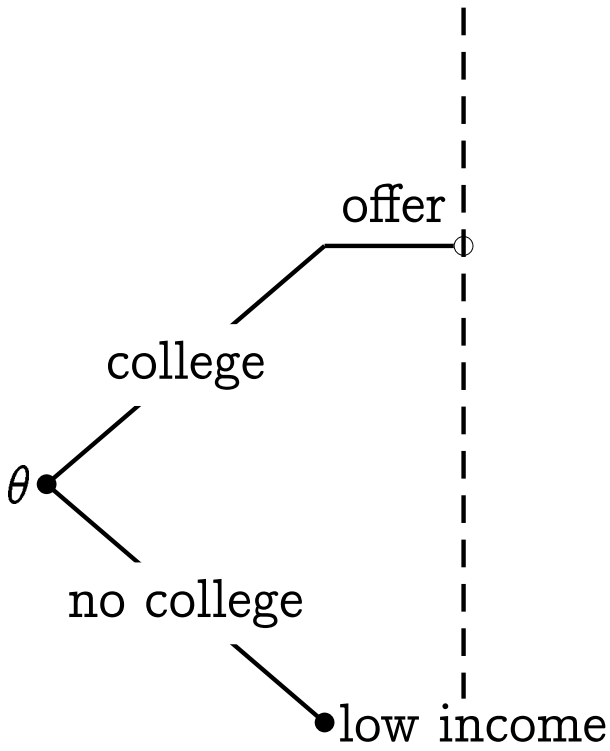

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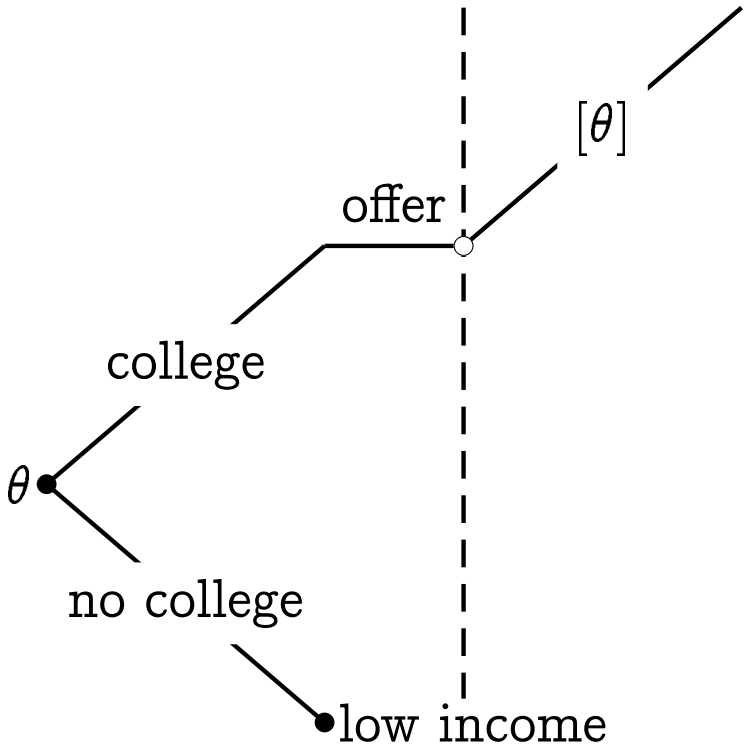

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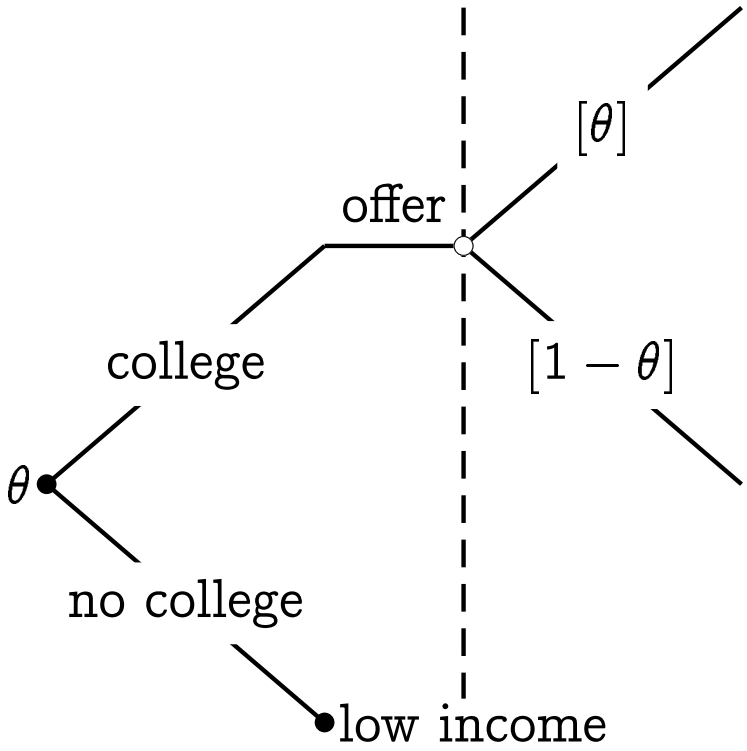

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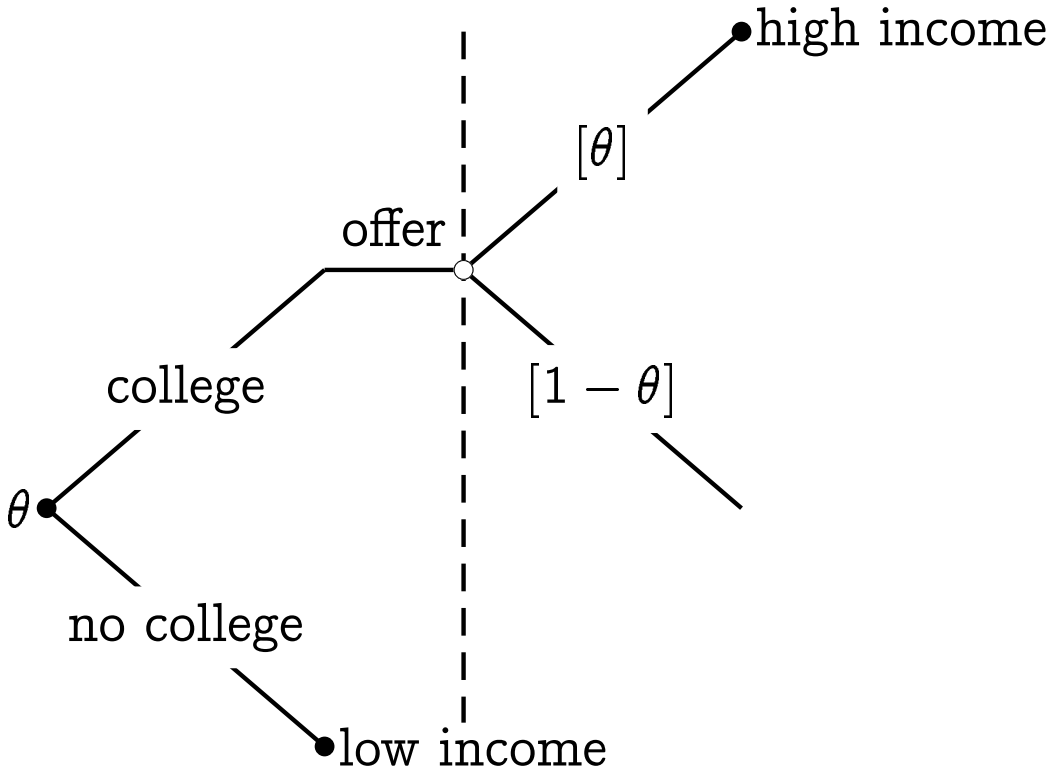

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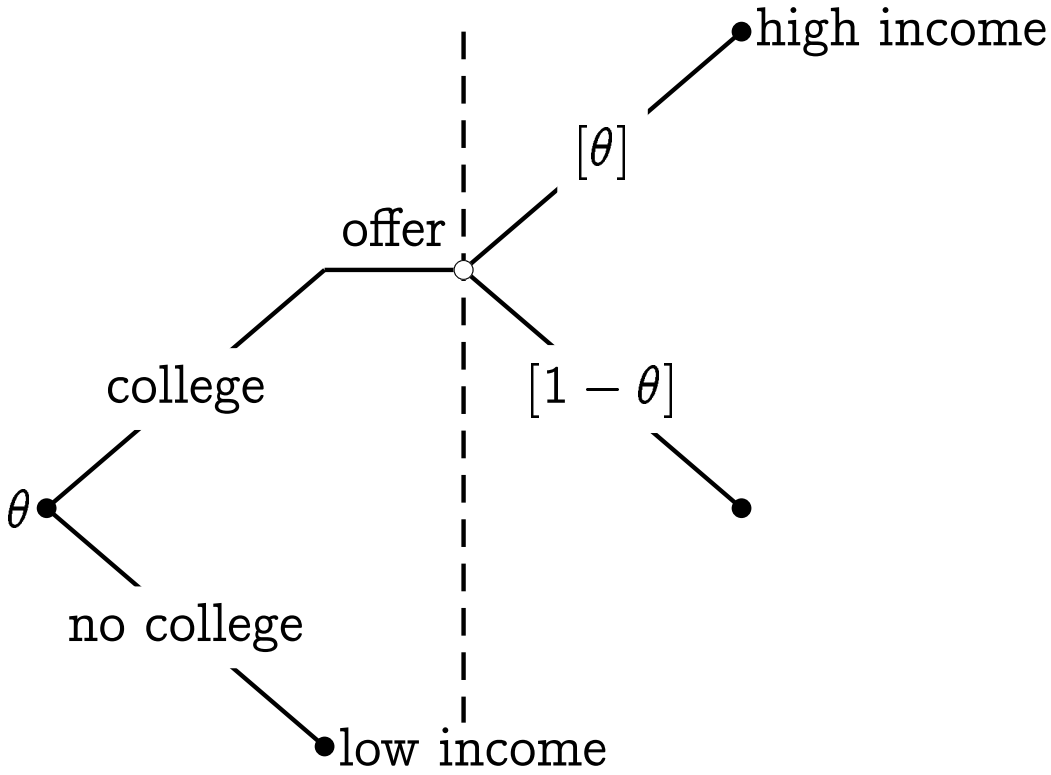

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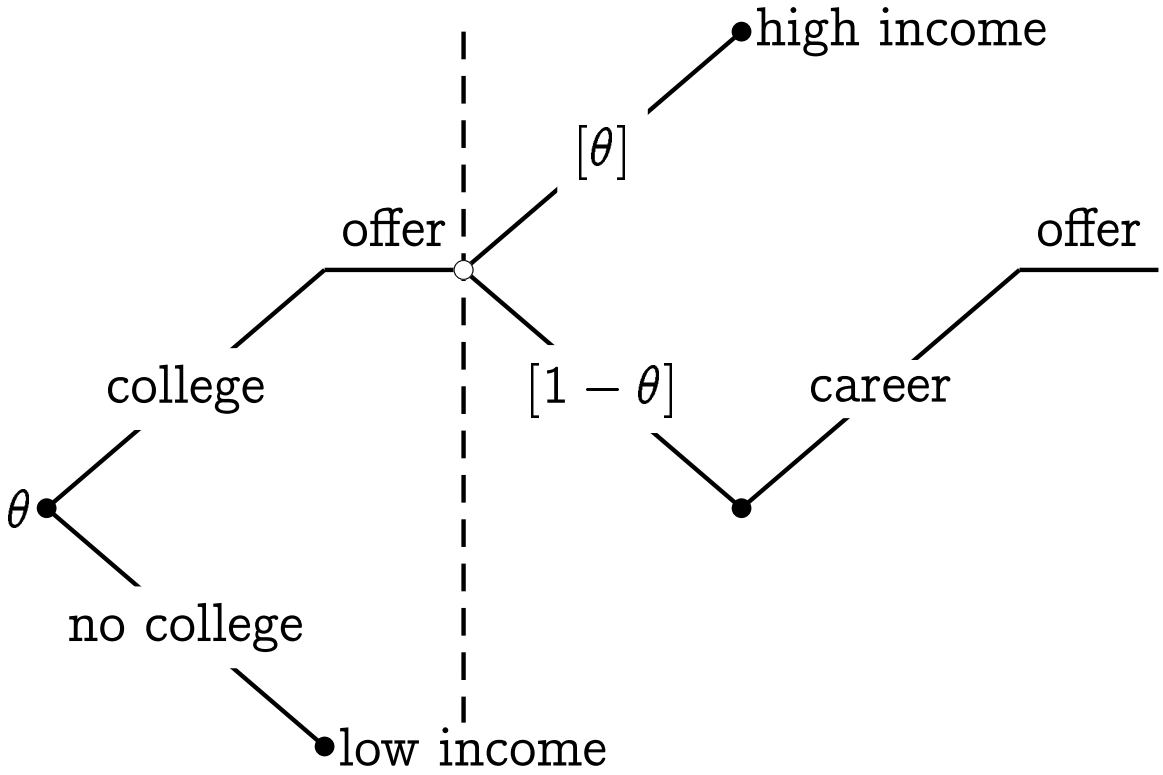

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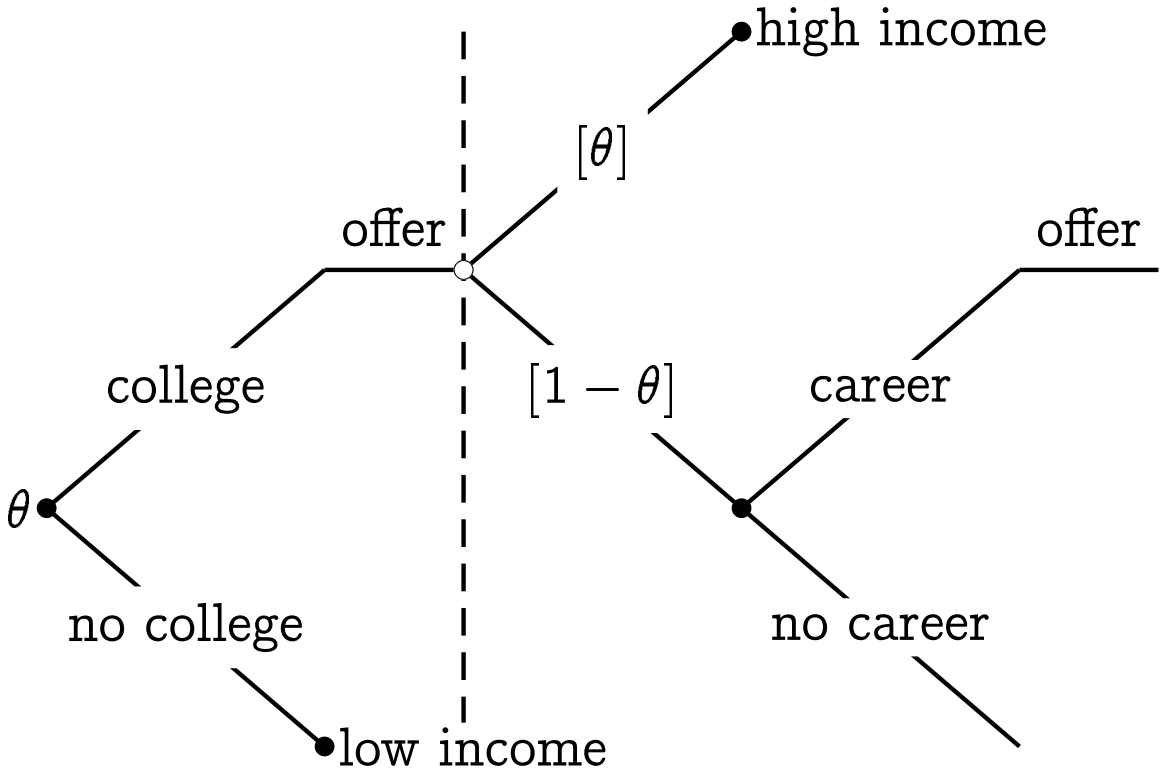

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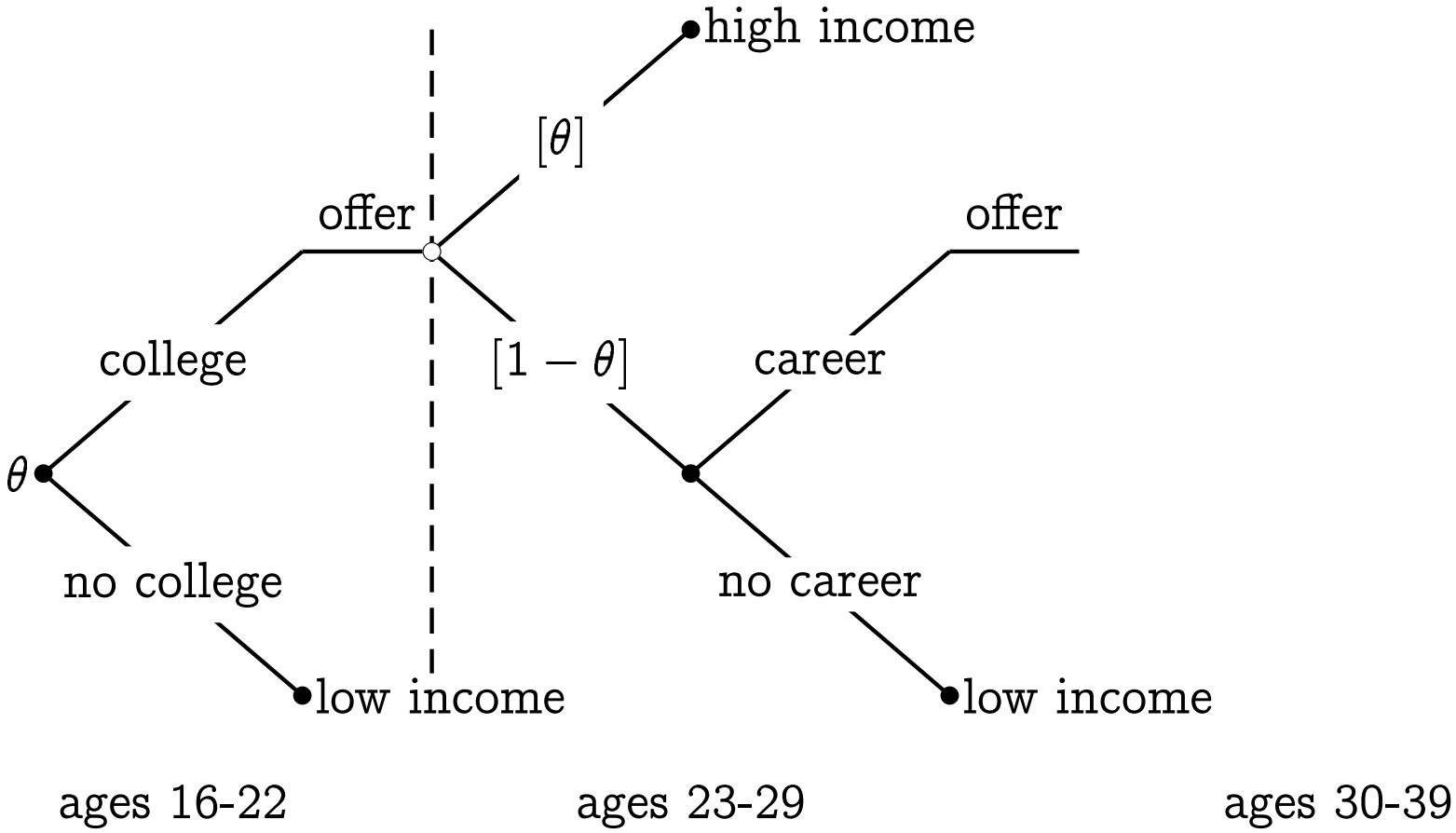

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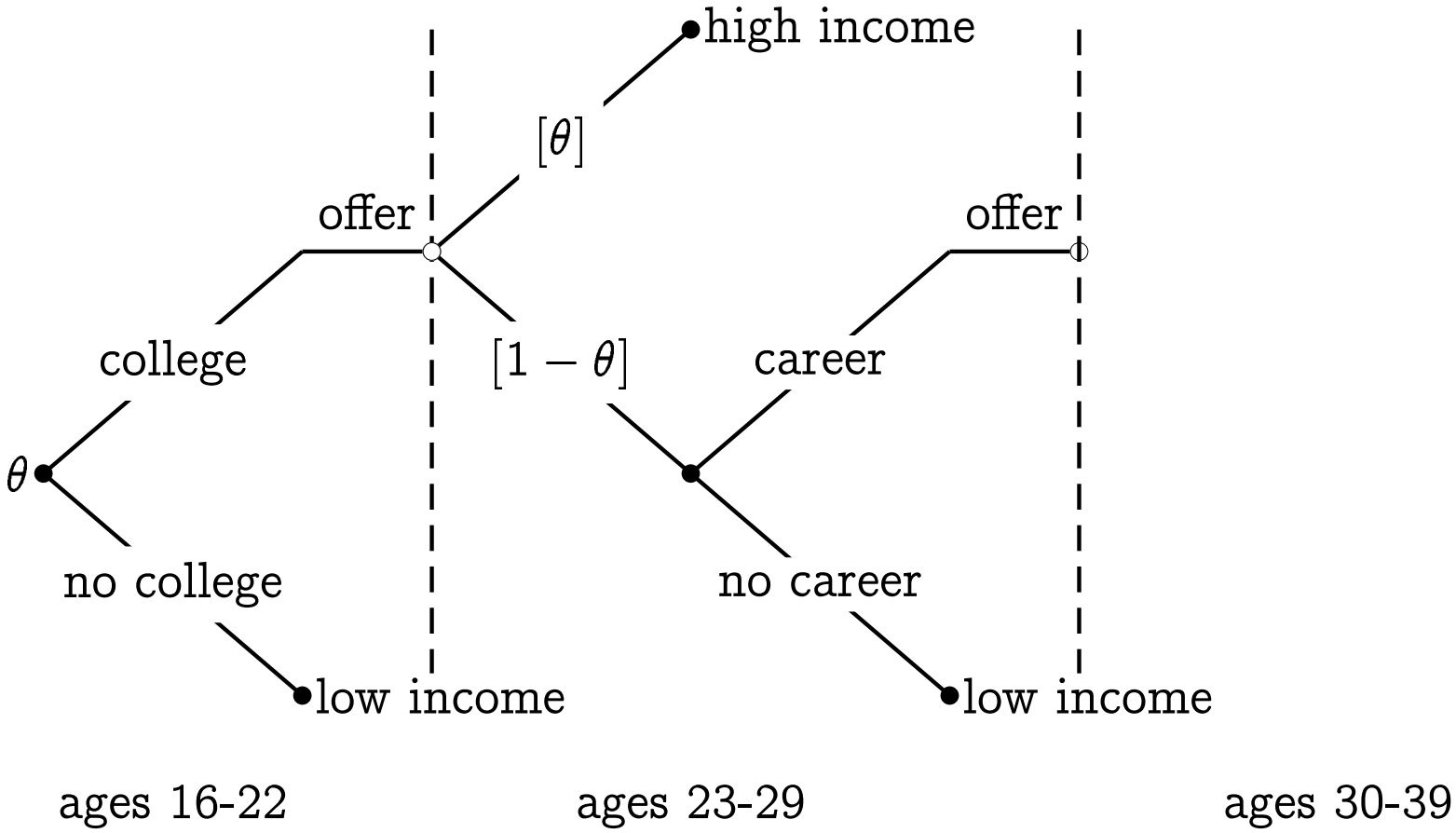

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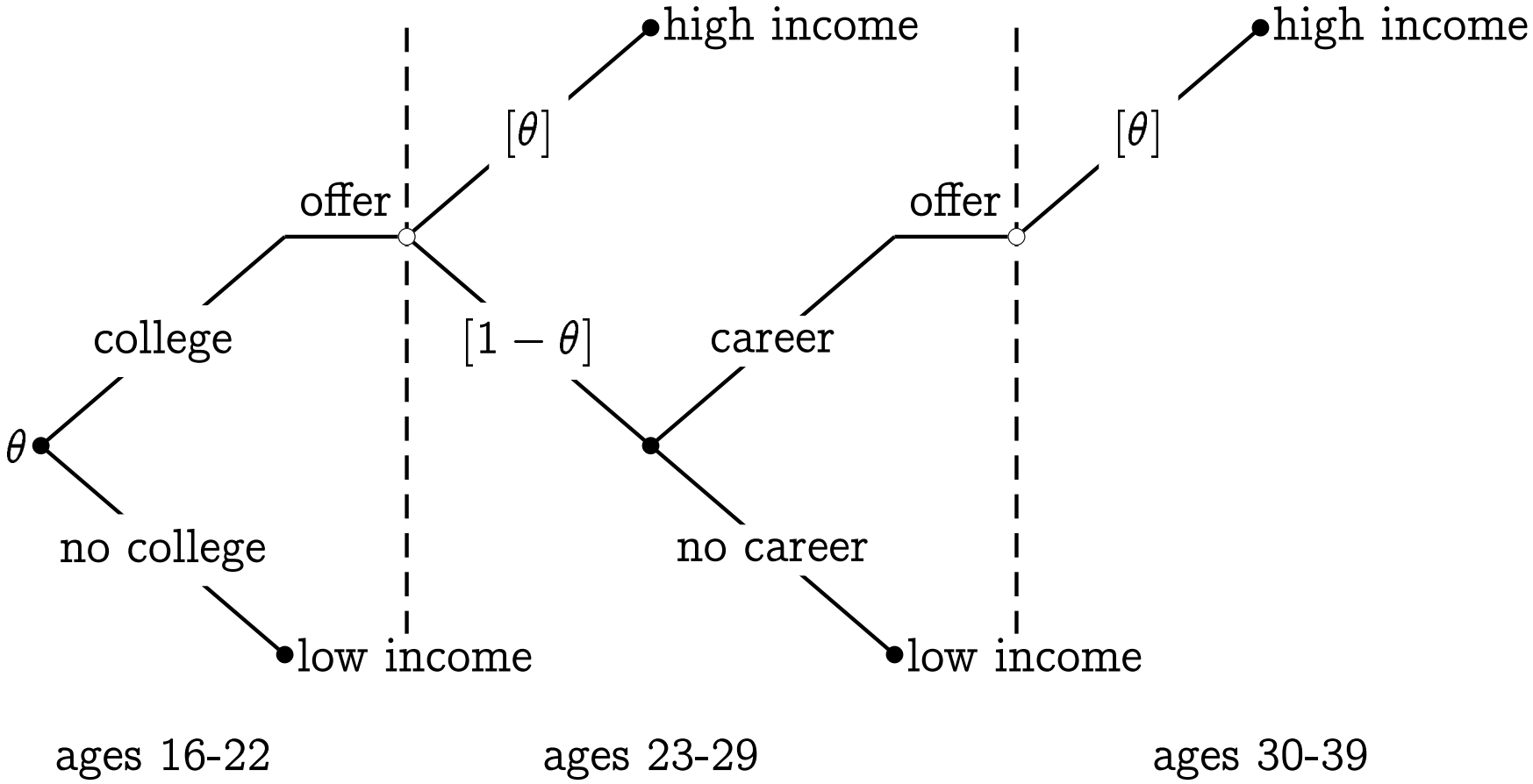

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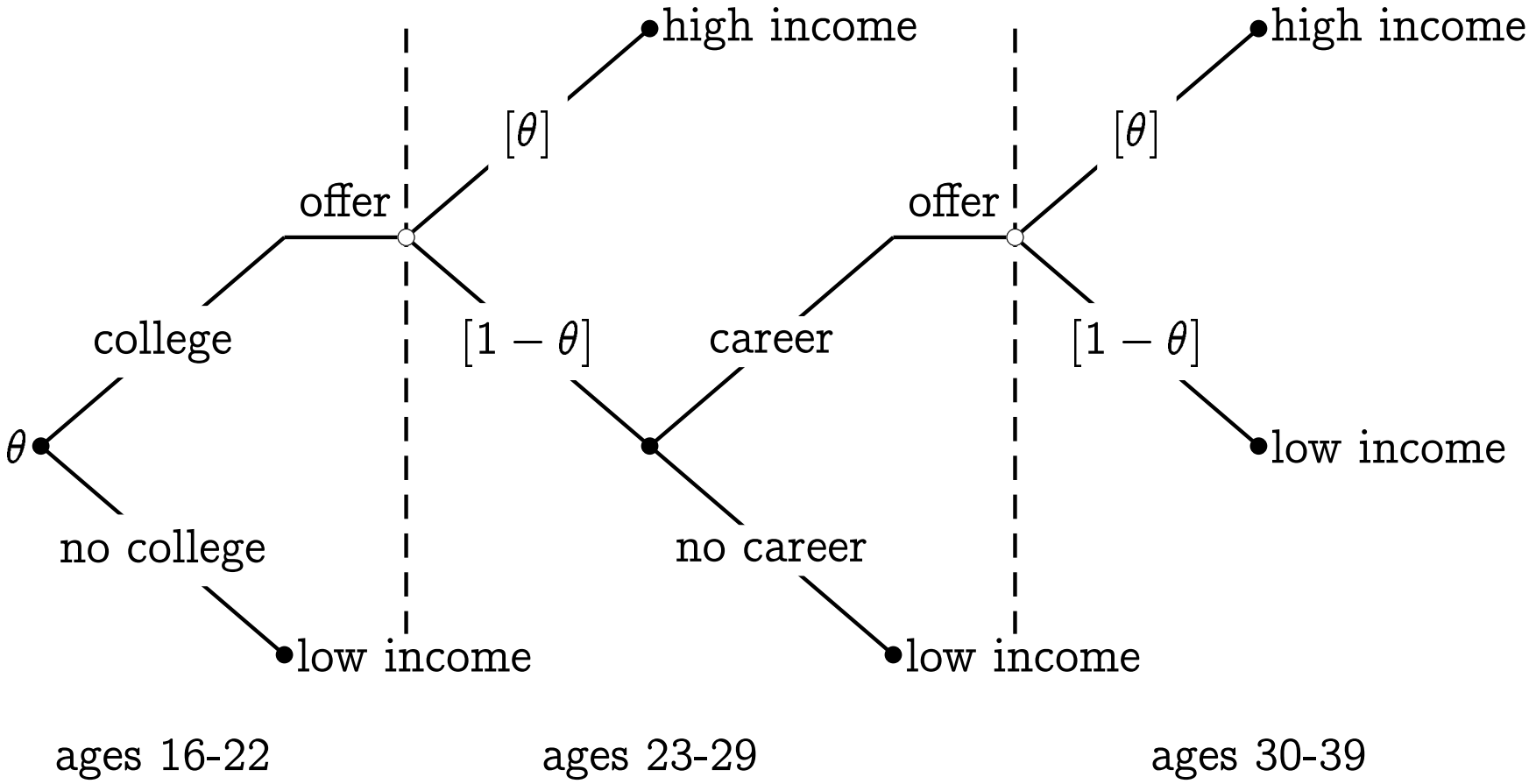


Differential Fecundity

$$y + v - c$$

income + marital payoff (income, fertility) − investment costs

- Men who marry in any of the three periods have the same fertility level.
- Women who marry in the third period may have a lower fertility level than those who marry in the first two periods.
- Husband's income and wife's income and fertility determine marriage surplus: $s(y_m, y_w, \phi_w) \equiv s(\tau_m, \tau_w)$.
  - Surplus is increasing in each argument, supermodular in incomes, and supermodular in income and fertility.

Marriage Market

- Division of the marriage surplus is endogenously determined: $v_{m\tau_m} + v_{w\tau_w} = s(\tau_m, \tau_w)$ for any married couple τ_m and τ_w.
- Marriages are stable: $v_{m\tau_m} + v_{w\tau_w} \geq s(\tau_m, \tau_w)$ for any pair.

Equilibrium

Investment strategies (σ_m^*, σ_w^*) and marriage payoffs (v_m^*, v_w^*) form an equilibrium if

- $\sigma_m^*(\theta), \sigma_w^*(\theta)$ maximizes each ability-θ individual's expected payoff.
- (v_m^*, v_w^*) are the stable marriage payoffs in the marriage market (G_m^*, G_w^*) induced by (σ_m^*, σ_w^*).

Equilibrium Existence and Uniqueness

Theorem

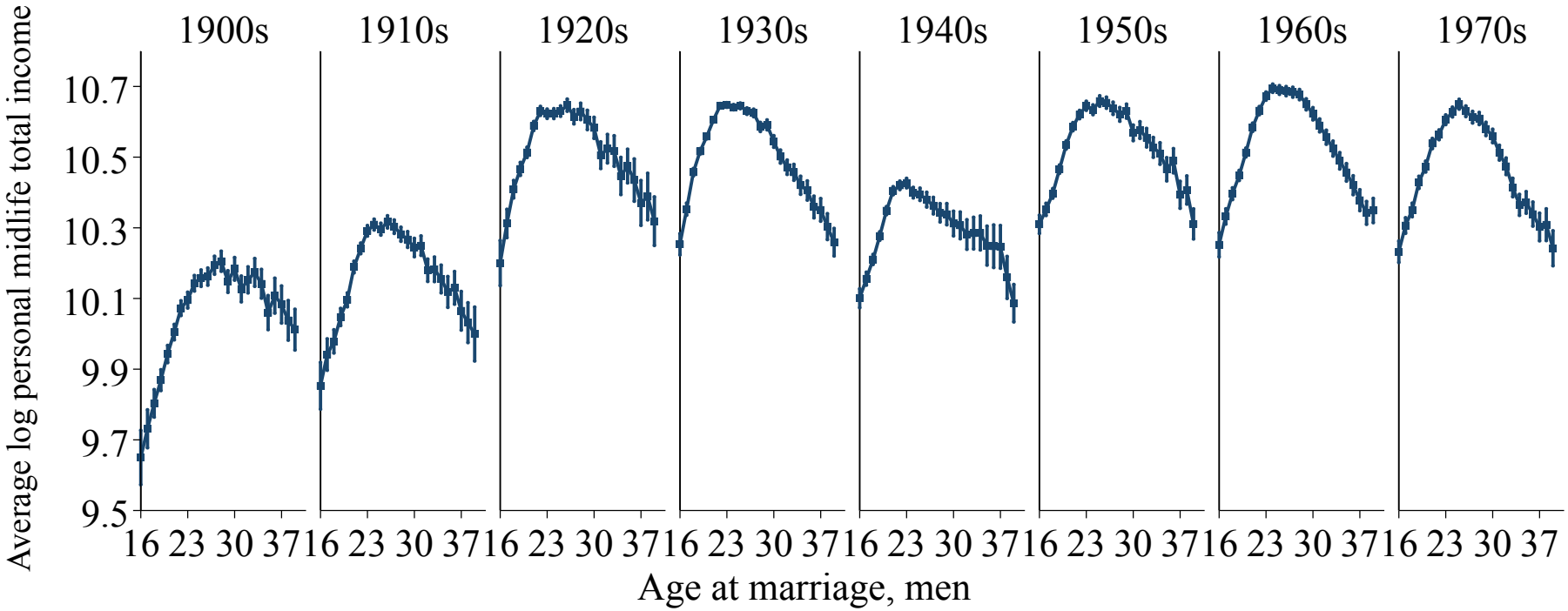
There exists an equilibrium. Equilibrium investment strategies (σ_m^*, σ_w^*) are uniquely determined. Equilibrium marriage payoffs (v_m^*, v_w^*) are uniquely determined up to a constant.

Proof Steps

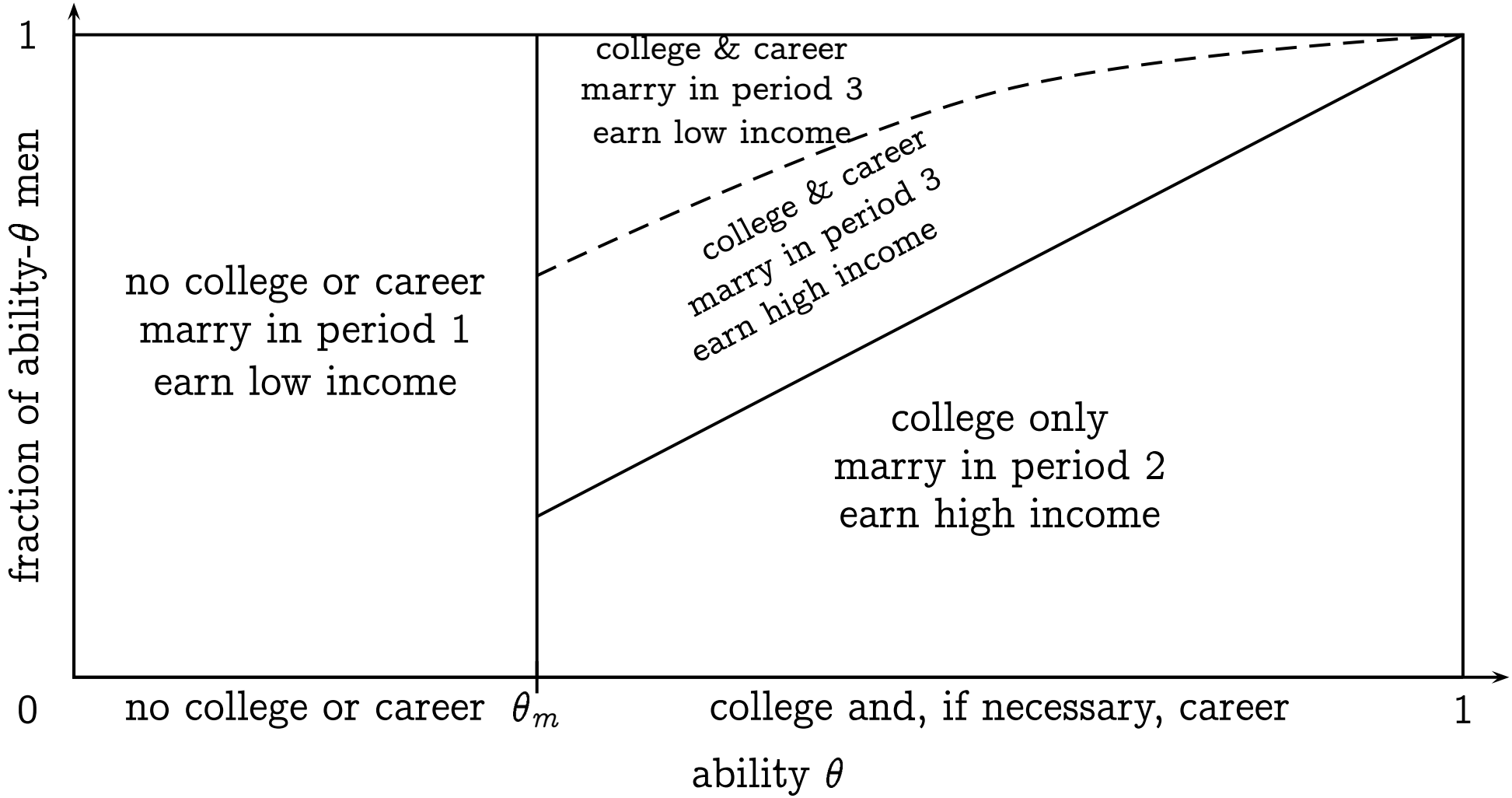
0. Marriage payoffs are determined by payoff difference $\pi_m \equiv v_{mH} - v_{mL}$.
   The mapping in consideration is $\pi_m \xrightarrow{f_\sigma} \sigma \xrightarrow{f_G} G \overset{f_\pi}{\rightrightarrows} \pi_m$.
1. Construct supply function $S(\pi_m) = f_G(f_\sigma(\pi_m))$.
2. Construct demand correspondence $D(\pi_m) = \{G : \pi_m \in f_\pi(G)\}$.
3. Show that supply is increasing and demand is decreasing.

Explanations

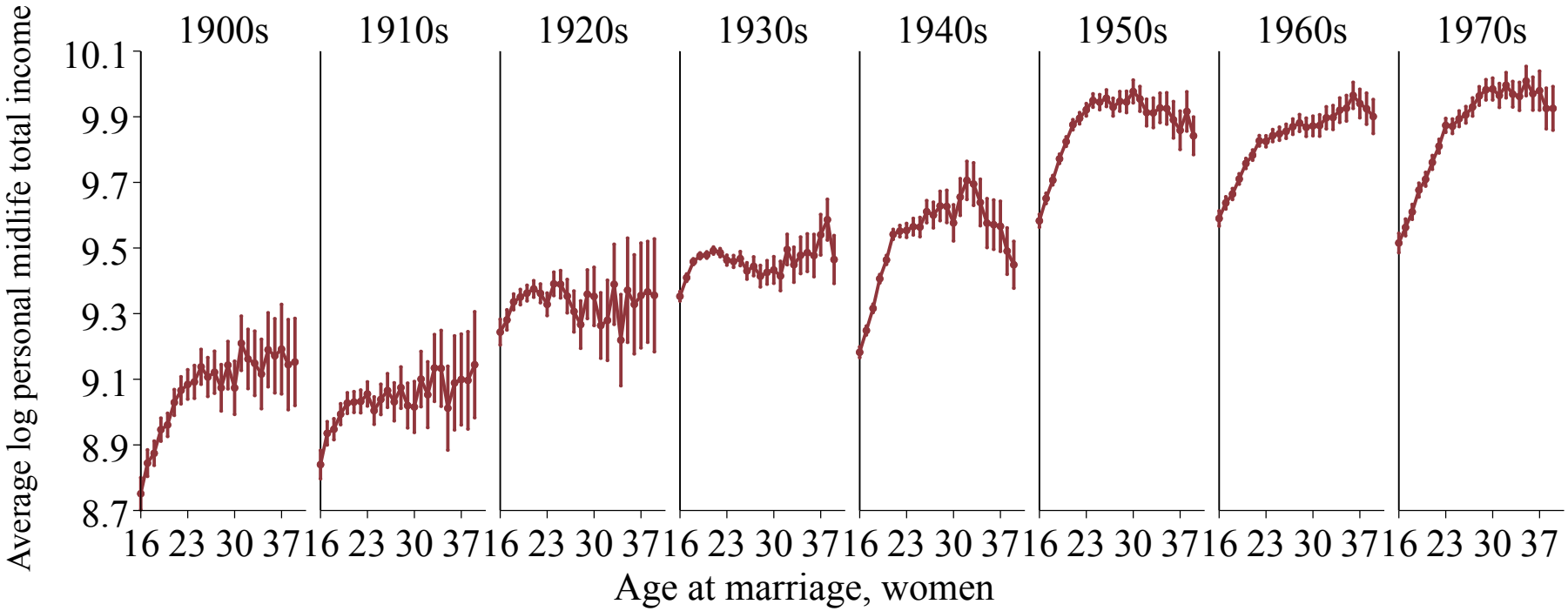
Men's Midlife Income by Age at Marriage



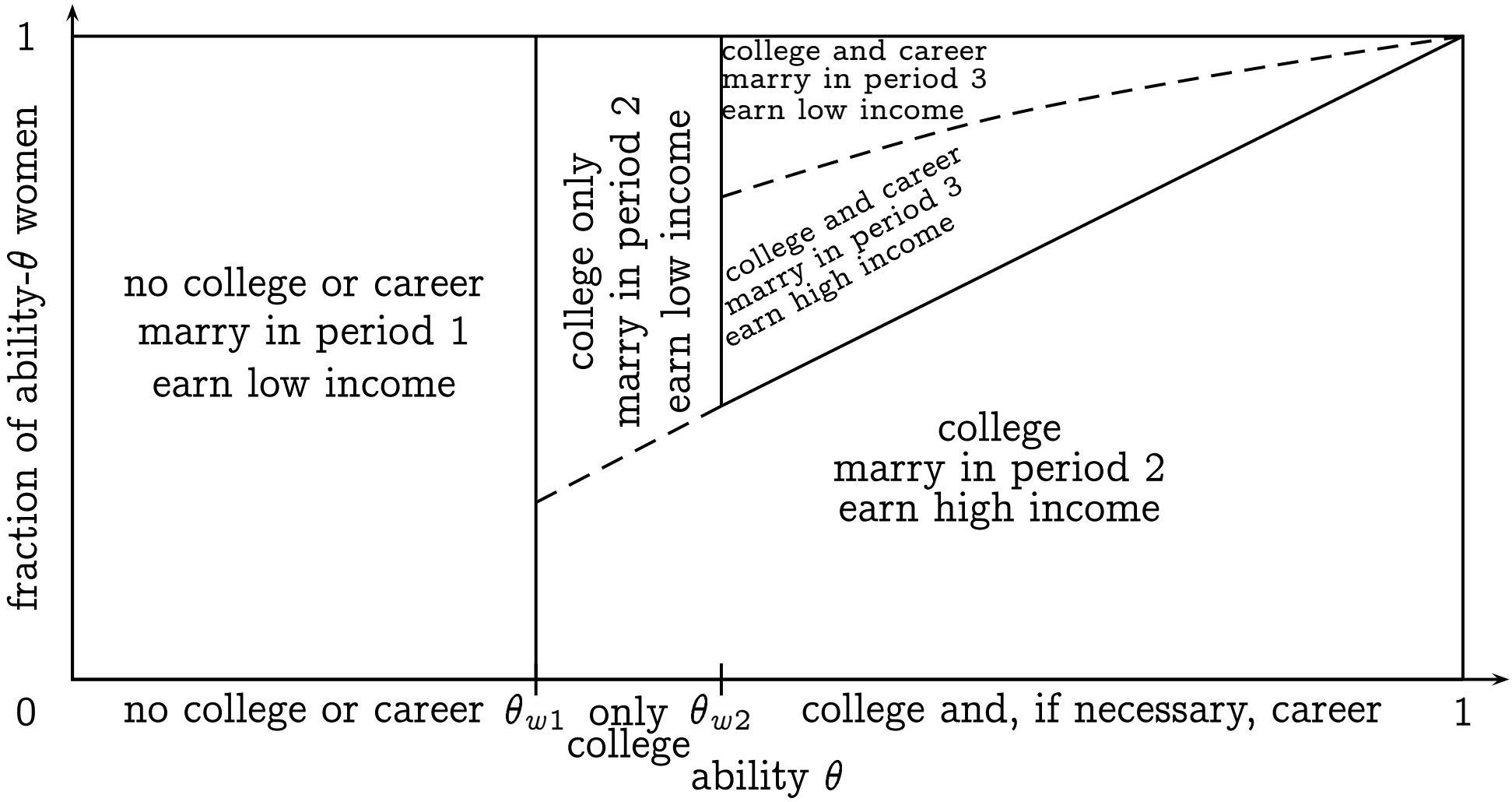
$$\theta_m = \frac{c_m}{(y_{mH} - y_{mL}) + (v_{mH} - v_{mL})} \equiv \frac{c_m}{\Delta z_m + \pi_m}$$



Women's Midlife Income by Age at Marriage



$$\theta_{w1} = \frac{c_w}{\Delta y_w + \pi_w} < \theta_{w2} = \frac{c_w + v_{wL} - v_{wl}}{\Delta y_w + v_{wh} - v_{wl}}$$



College and Earnings Gender Gaps

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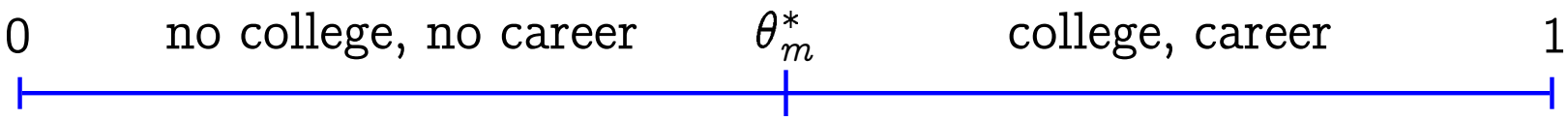

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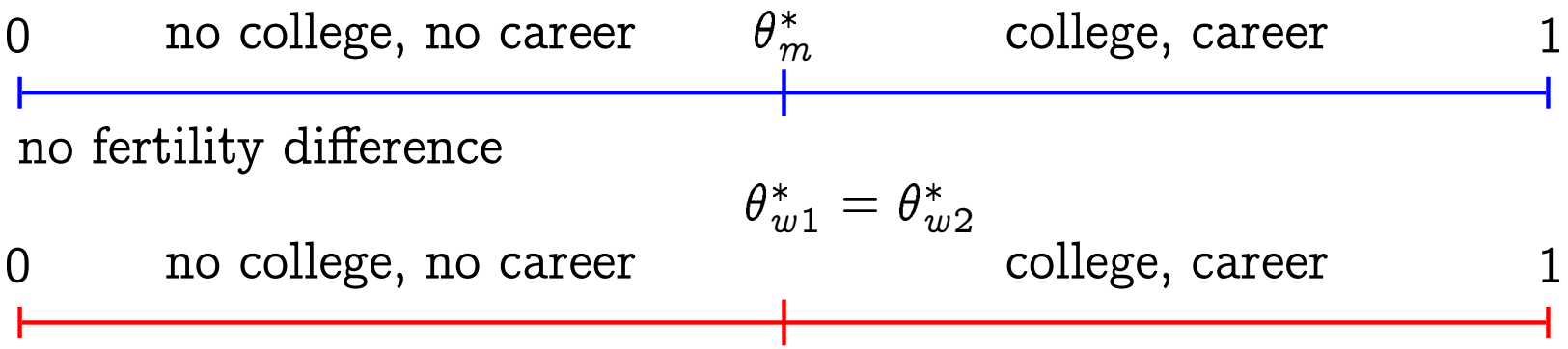

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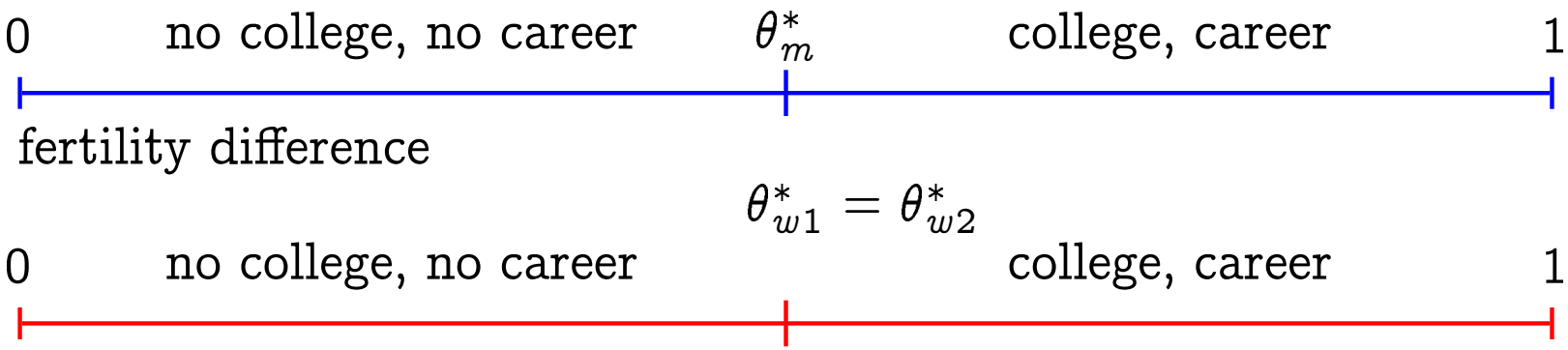

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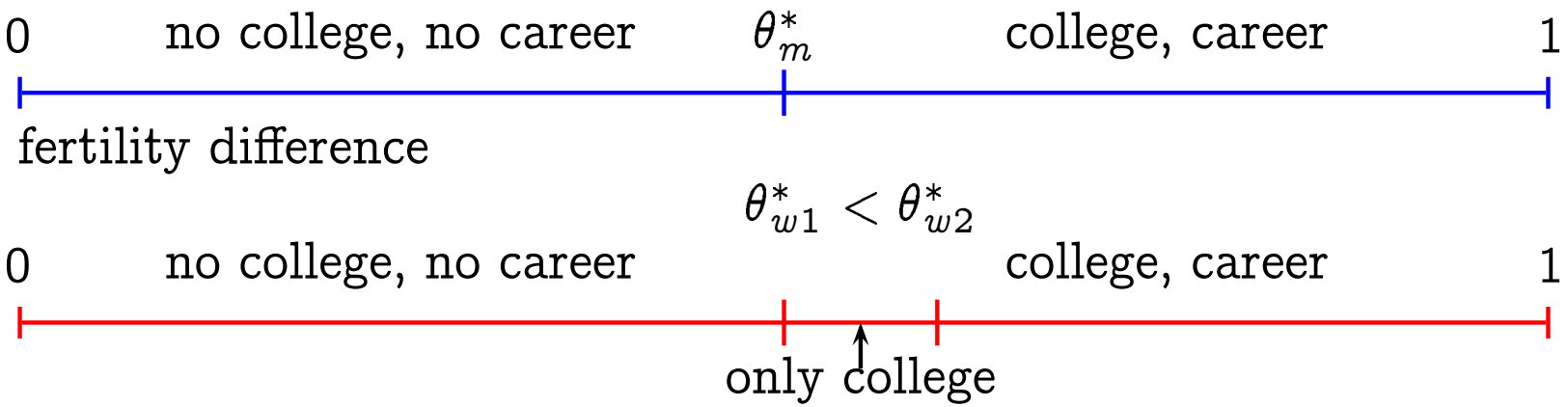

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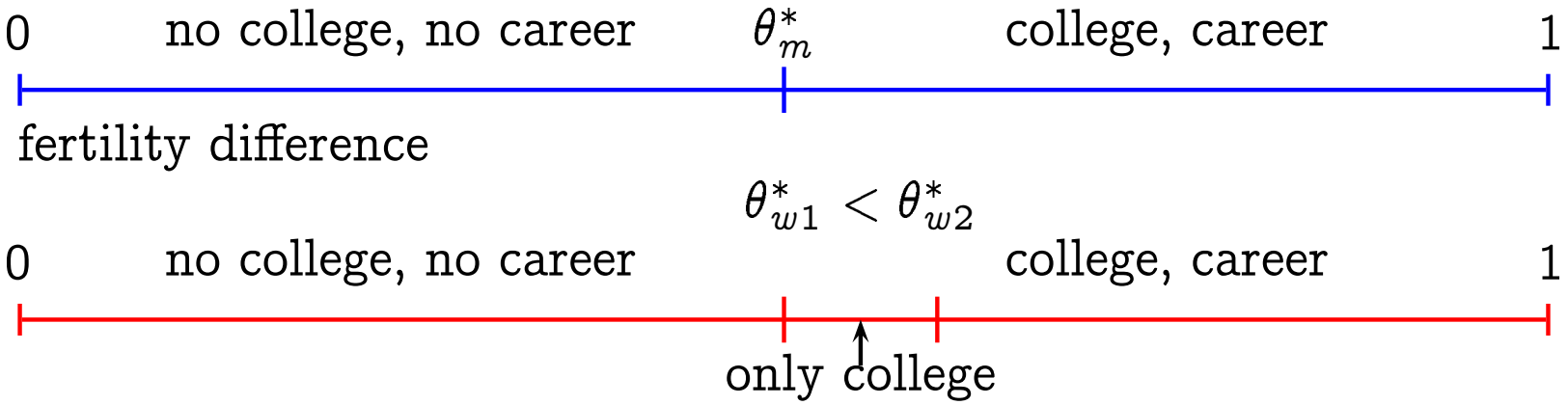

- All college-educated men make a career investment.
- Only some college-educated women make a career investment.
- Fewer women than men earn a high income.

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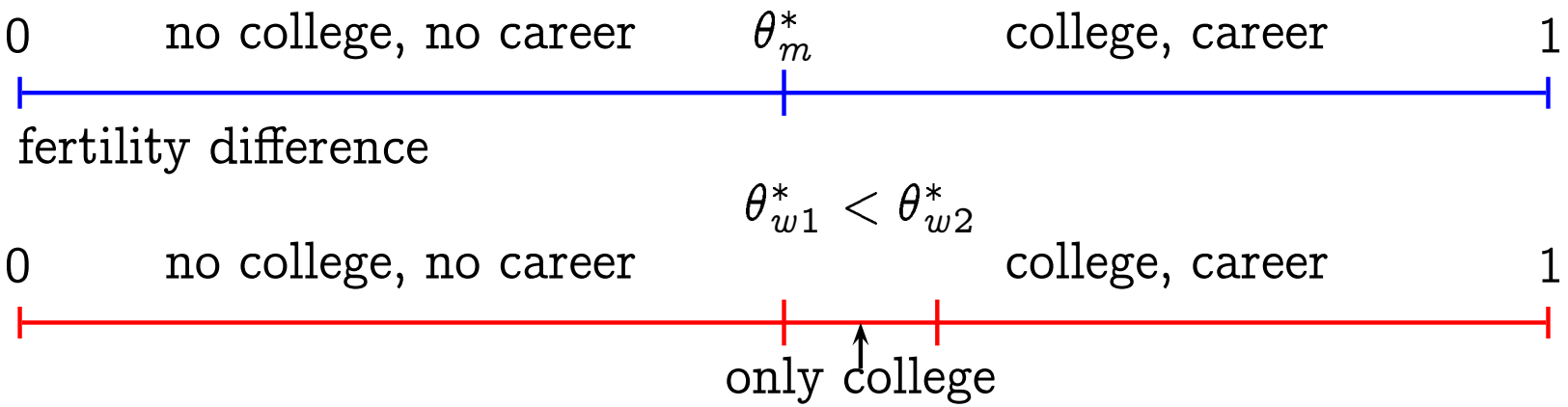

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- Only some college-educated women make a career investment.
- Fewer women than men earn a high income.
- High-income women are more scarce than high-income men in MM.

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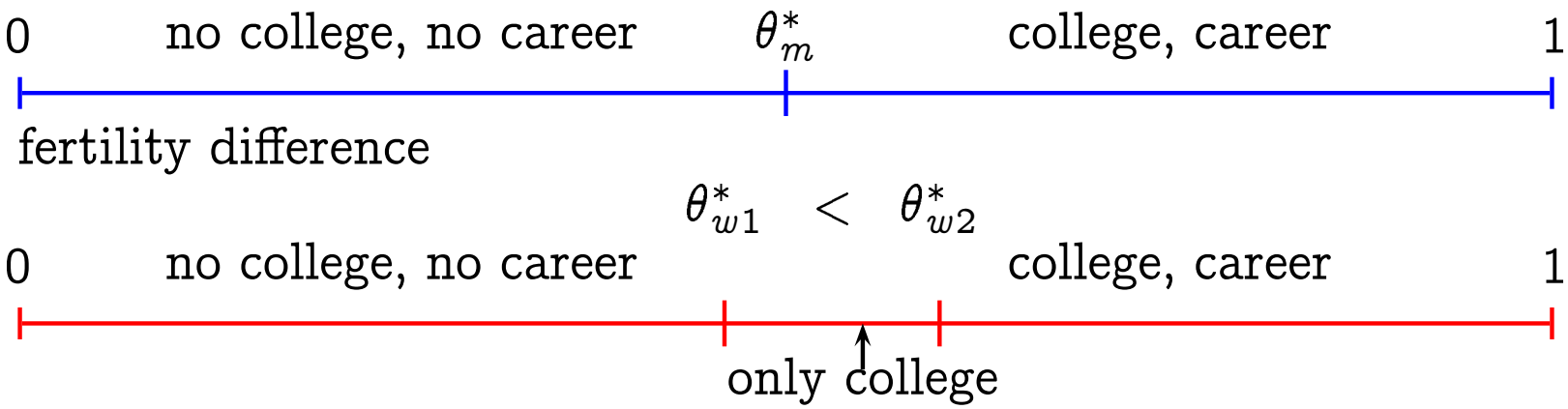
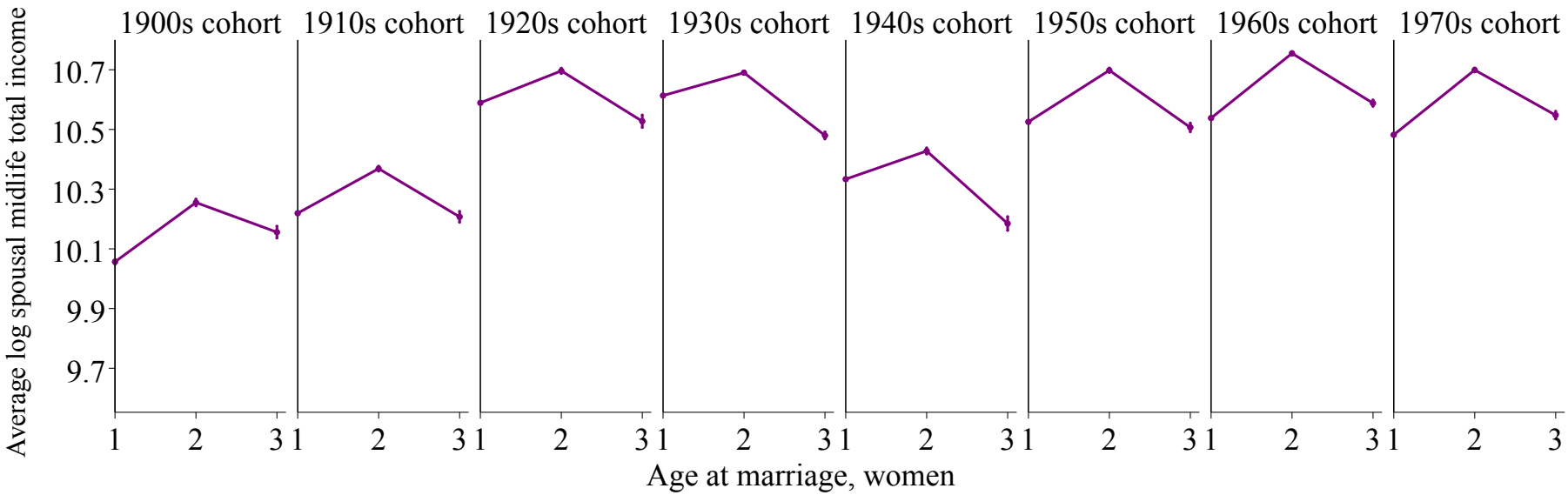
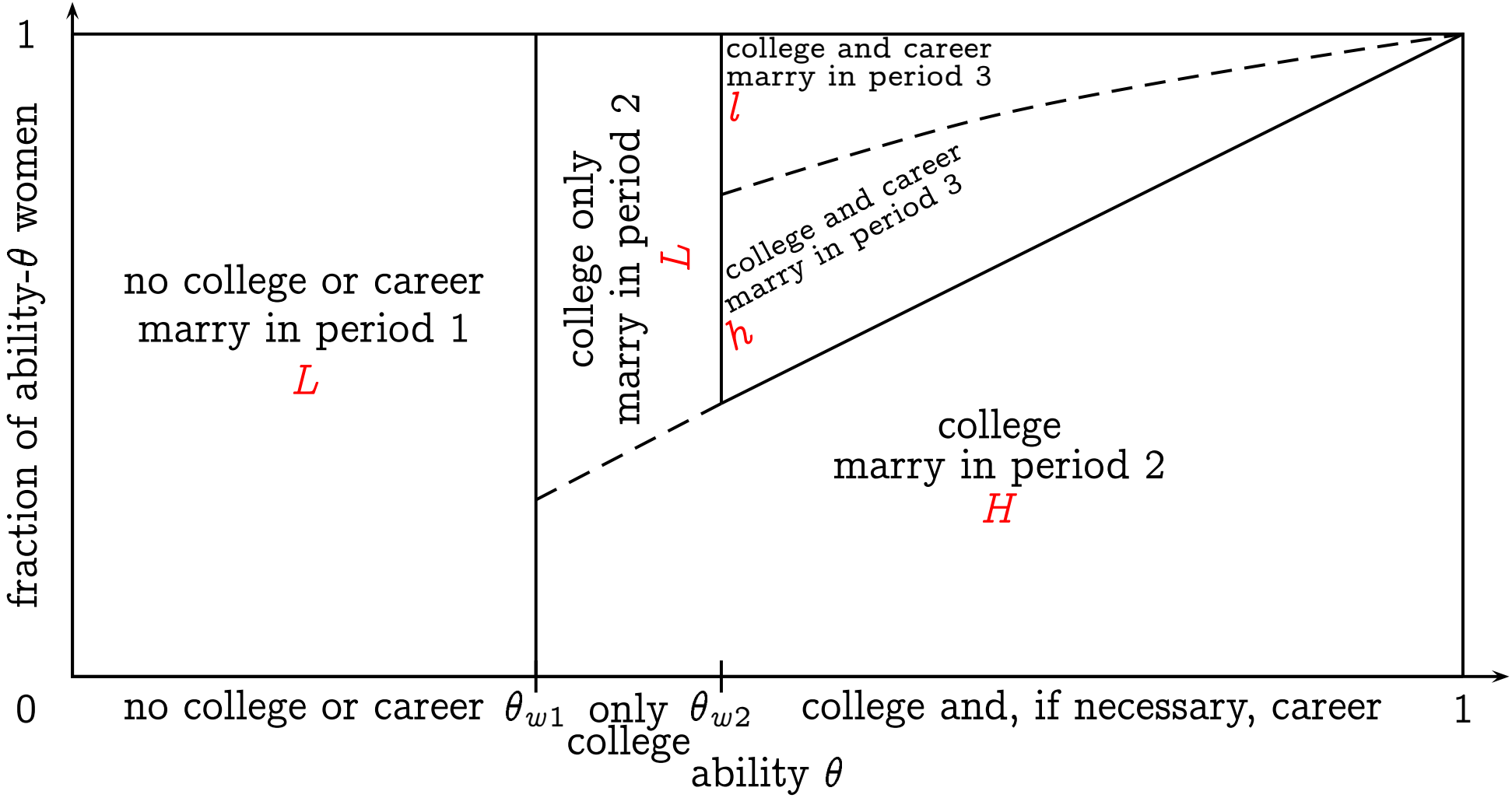


- All college-educated men make a career investment.
- Only some college-educated women make a career investment.
- Fewer women than men earn a high income.
- High-income women are more scarce than high-income men in MM.
- College generates higher MM returns for women than for men.

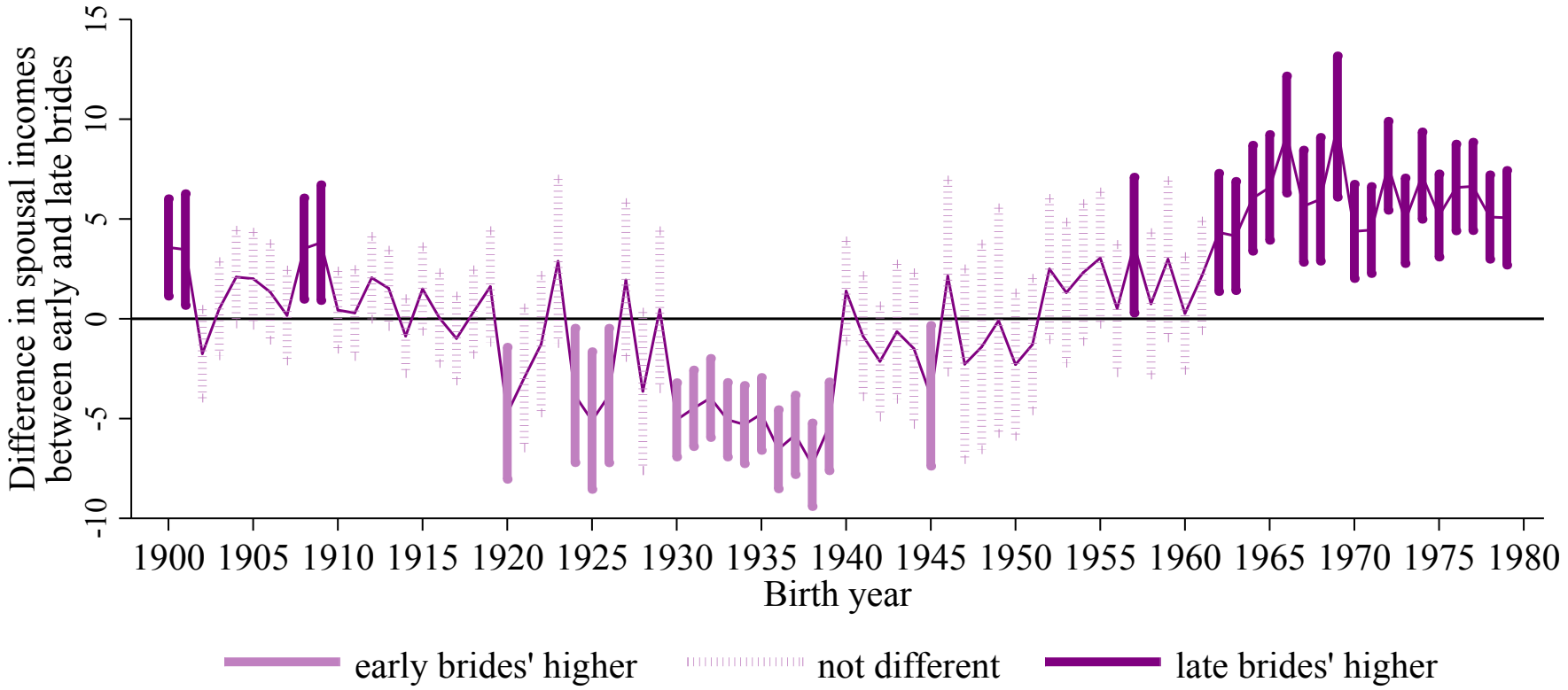
Women's Spousal Income by Age at Marriage



Fertility-Income Tradeoff



Early versus Late Brides



Mandates to Cover/Offer Infertility Treatments in Insurances

Between 1985 and 1995, thirteen states passed mandates to cover/offer infertility treatments in insurances

- Mandate to cover: Maryland (1985), Arkansas, Hawaii, and Massachusetts (1987), Rhode Island (1989), Illinois (1991), Montana (1987), New York (1990), Ohio (1991), West Virginia (1995)
- Mandate to offer: Texas (1987), California (1989), Connecticut (1989)

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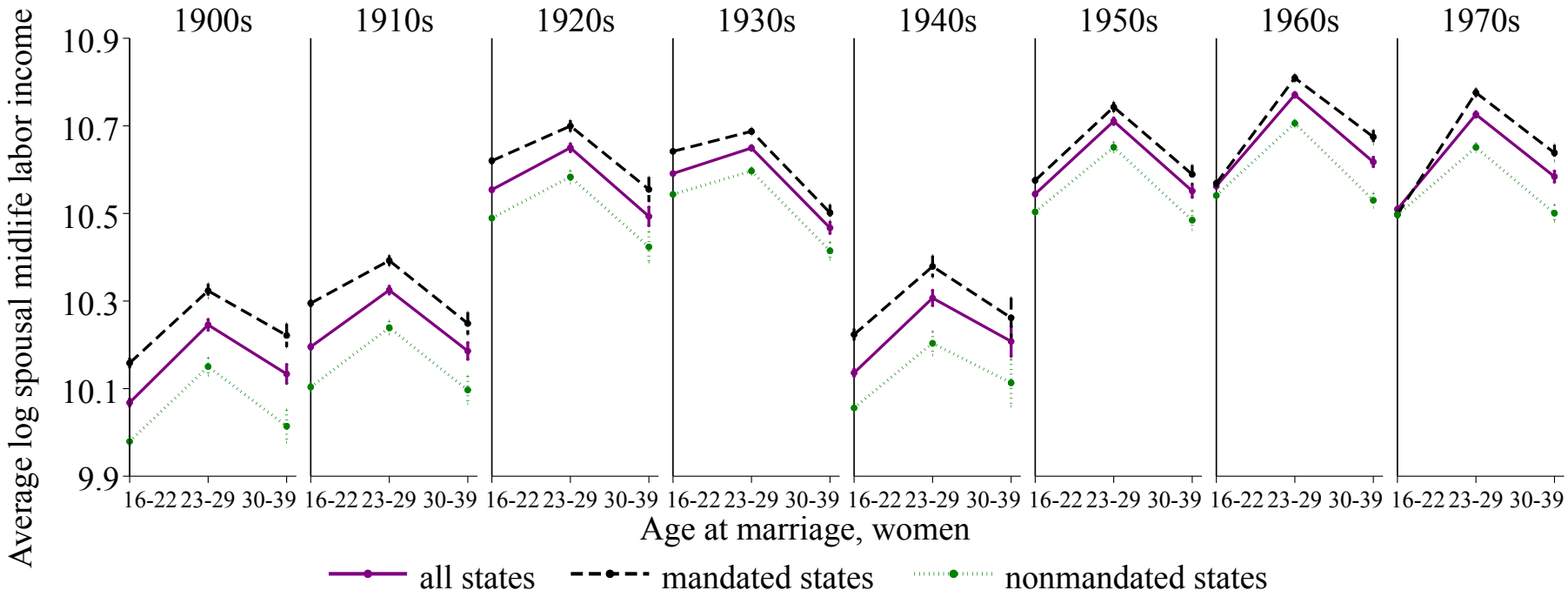
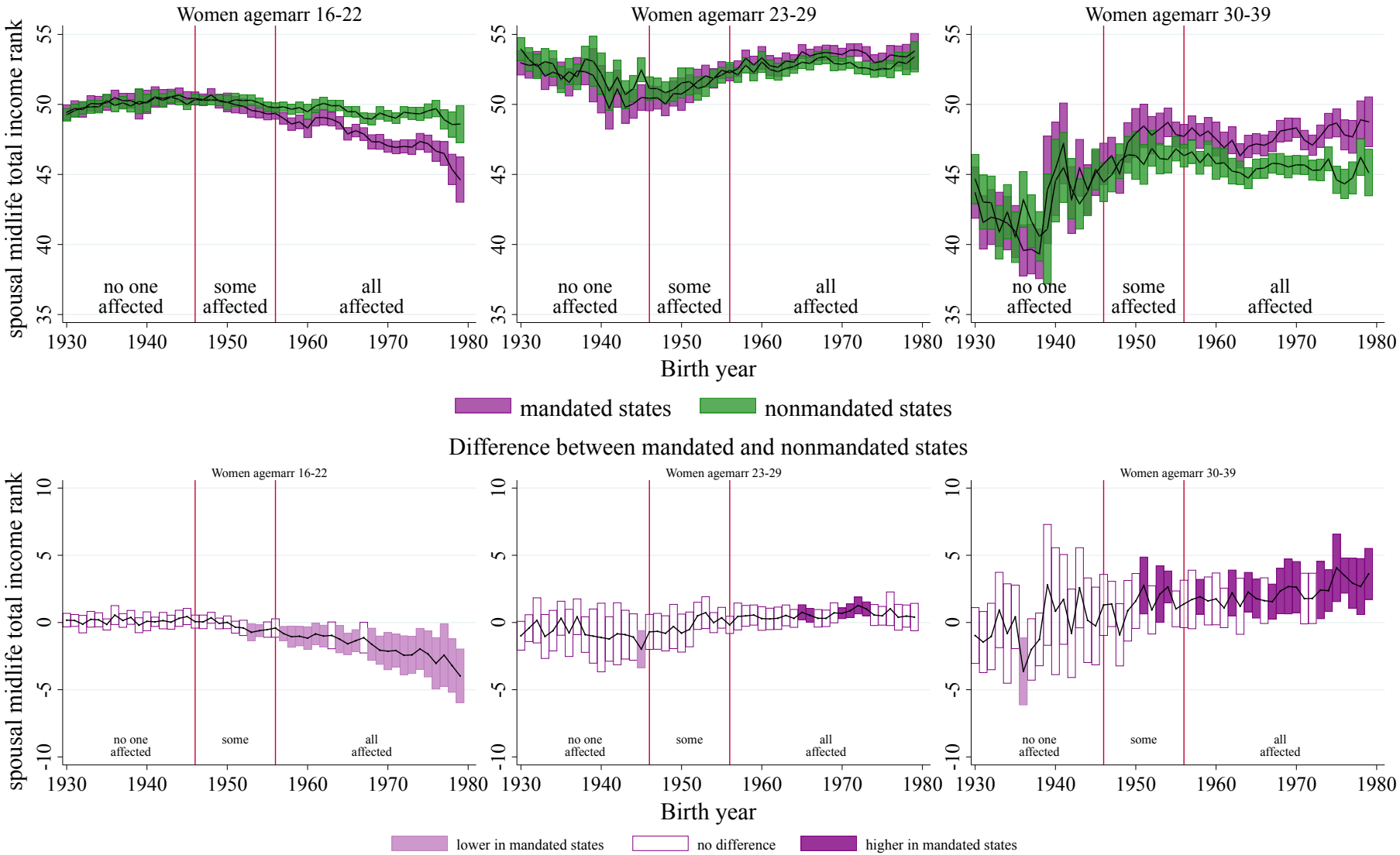


Spousal Total Income Percentile Rank



men	match	women
H	HH	H
	HL	$L\uparrow$
	Hh	$h\downarrow$
	Lh	
L	Ll	l

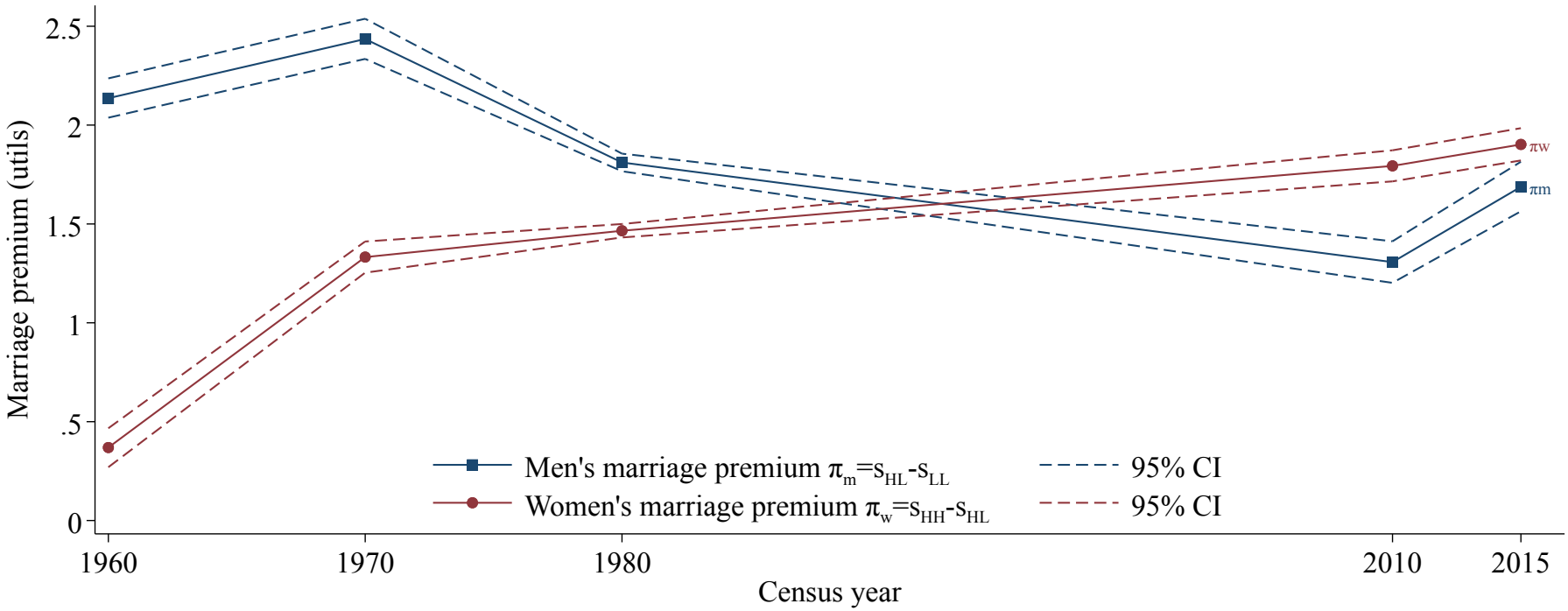
Fertility more important

men	match	women
H	HH	H
	Hh	$h\uparrow$
	HL	$L\downarrow$
	LL	
L	Ll	l

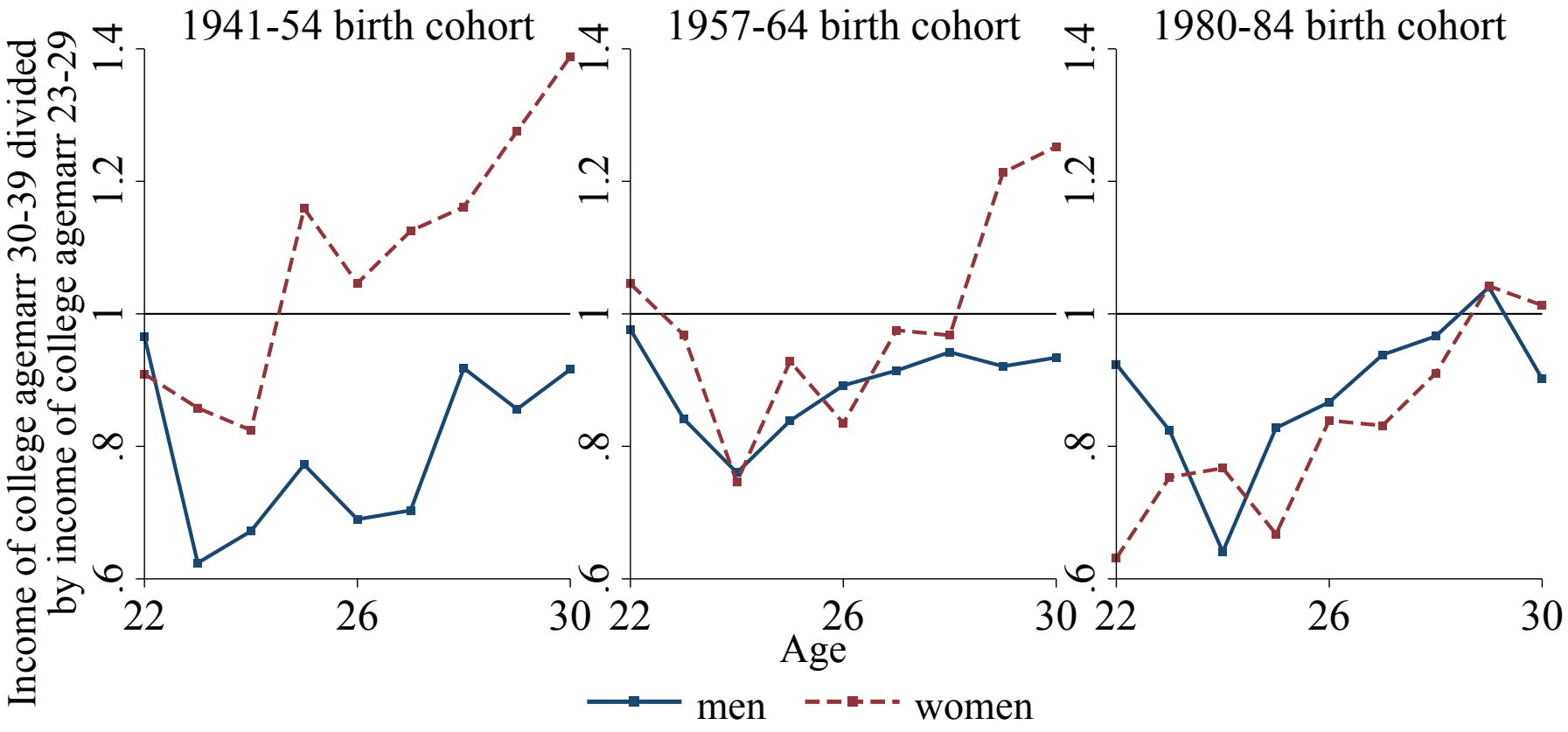
Income more important

Supporting Evidence and Calibration

Evolution of the Marriage Premium



Age-Income Profiles for Men and Women



More Career Investments for Low Incomes

Relation between career investment and logincome, men

	(1) ols79	(2) logit79	(3) probit79	(4) ols97	(5) logit97	(6) probit97
logincome	-0.0969***	-0.447***	-0.261***	-0.0947***	-0.406***	-0.250***
	(0.0142)	(0.0647)	(0.0370)	(0.0161)	(0.0723)	(0.0439)
age	-0.000539	0.00561	-0.000519	-0.0244***	-0.108***	-0.0664***
	(0.00741)	(0.0308)	(0.0188)	(0.00719)	(0.0324)	(0.0199)
N	1659	1659	1659	1638	1638	1638

Marginal effects; Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Calibration

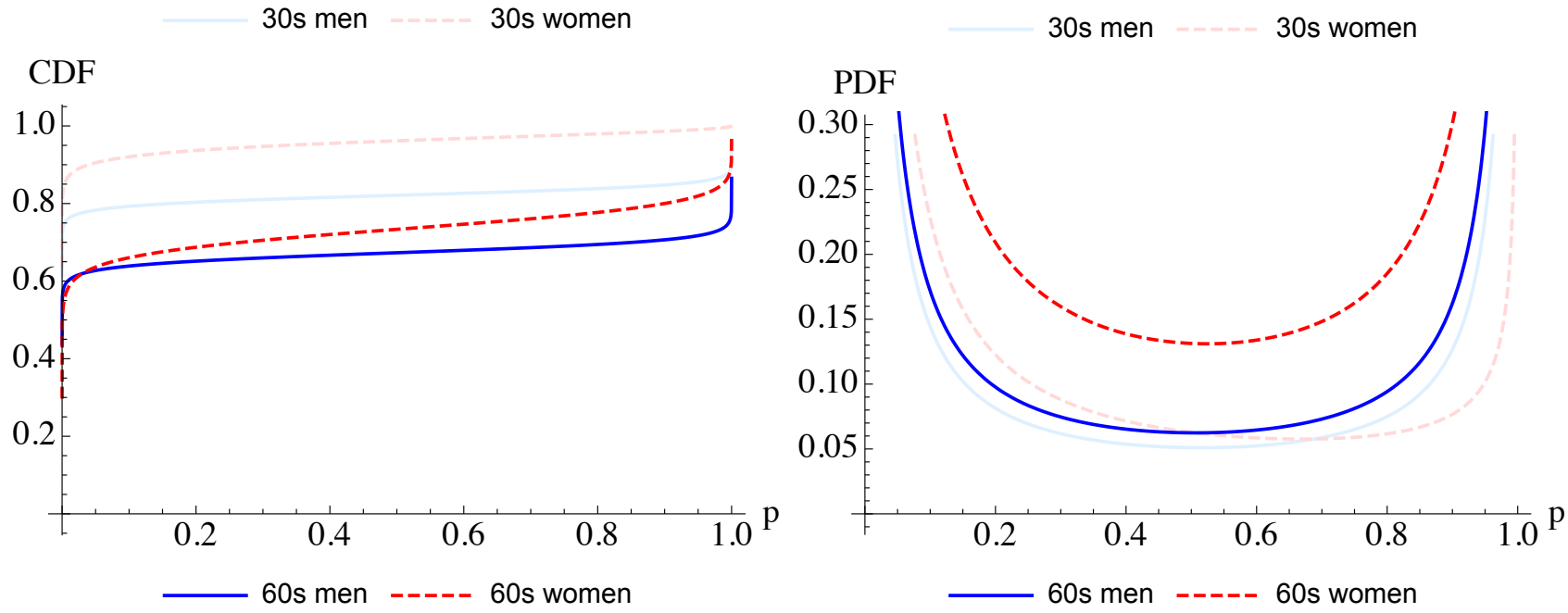
- Ability distributions are Beta(α_m, β_m) and Beta(α_w, β_w).
- Low income is average income of the non-college-educated.
- High income is average income of the college-educated.
- Total investment cost is two years of low incomes; annual cost is total cost divided by 40.
- Surplus in monetary terms is k times estimated surplus in utils.
- Add marriage frictions (possibility of not marrying upon entering MM).
- 19 targeted moments.
  - Percentages of early, middle, late grooms/brides (6).
  - Average personal income of early, middle, late grooms (3).
  - Average personal income of early, middle, late brides (3).
  - Average spousal income of early brides (3).
  - College enrollment rates of men and women (2).

Fit of the Model

moments	30s target	30s model	difference	60s target	60s model	difference
G_{m1}	0.48476	0.484451	-0.0637%	0.30756	0.307372	-0.0613%
G_{m2}	0.411344	0.412559	0.295%	0.451633	0.452309	0.15%
G_{m3}	0.103896	0.102989	-0.872%	0.240807	0.24032	-0.202%
G_{w1}	0.740591	0.740591	0.000051%	0.4494	0.449534	0.0299%
G_{w2}	0.206928	0.206847	-0.0393%	0.381204	0.380081	-0.295%
G_{w3}	0.0524809	0.0525618	0.154%	0.169396	0.170385	0.584%
$G_{m,\mathrm{col}}$	0.218733	0.220363	0.745%	0.379722	0.380819	0.289%
$G_{w,\mathrm{col}}$	0.119257	0.119255	-0.00131%	0.390058	0.389479	-0.148%
y_{m1}	40209.7	39603.7	-1.51%	44571.6	44730.5	0.357%
y_{m2}	43820.8	43915.8	0.217%	56434.2	56524.6	0.16%
y_{m3}	37442.	38350.9	2.43%	48376.5	48589.3	0.44%
y_{w1}	12049.	11696.3	-2.93%	20091.	20510.	2.09%
y_{w2}	12457.2	12739.2	2.26%	24627.8	25169.9	2.2%
y_{w3}	12886.1	12421.	-3.61%	26080.1	24207.1	-7.18%
x_{w1}	41269.2	41155.8	-0.275%	46138.3	47051.6	1.98%
x_{w2}	45269.5	42290.6	-6.58%	58701.2	55594.8	-5.29%
x_{w3}	35537.5	38066.9	7.12%	48666.8	50699.8	4.18%
average			1.71%			1.51%

Quantifying Labor-Market Shocks on Marriage Timing

- Estimated ability distributions (labor-market opportunities).



- Labor-market shocks (due to the possibility that one does not receive a high-income offer after college) contribute to 42.7% of college-educated men and 24% of college-educated women born in the 1960s delaying marriage (the rest are explained by marriage-market frictions).

Fit of the Model, Mandated States

moments	30s target	30s model	difference	60s target	60s model	difference
G_{m1}	0.451869	0.451556	-0.0693%	0.271852	0.271602	-0.092%
G_{m2}	0.430358	0.431748	0.323%	0.462758	0.463643	0.191%
G_{m3}	0.117773	0.116697	-0.914%	0.26539	0.264754	-0.239%
G_{w1}	0.712169	0.714571	0.337%	0.40867	0.415509	1.67%
G_{w2}	0.227668	0.221022	-2.92%	0.403811	0.390709	-3.24%
G_{w3}	0.0601629	0.0644064	7.05%	0.187518	0.193783	3.34%
$G_{m,\mathrm{col}}$	0.240621	0.242344	0.716%	0.392051	0.393502	0.37%
$G_{w,\mathrm{col}}$	0.131002	0.12084	-7.76%	0.400299	0.370931	-7.34%
y_{m1}	42549.9	41471.4	-2.53%	45833.3	46347.3	1.12%
y_{m2}	46013.6	46116.	0.223%	59531.3	59658.5	0.214%
y_{m3}	38934.8	40058.4	2.89%	52070.5	52371.7	0.579%
y_{w1}	12664.9	12918.8	2.01%	20453.6	21866.4	6.91%
y_{w2}	13050.4	15802.5	21.1%	25514.7	28767.5	12.7%
y_{w3}	13429.7	12946.1	-3.6%	27373.5	25741.2	-5.96%
x_{w1}	43941.9	42819.1	-2.56%	48004.4	47777.3	-0.473%
x_{w2}	47304.5	45972.1	-2.82%	62317.6	60849.6	-2.36%
x_{w3}	37059.8	39648.9	6.99%	52485.	54120.2	3.12%
average	->	->	3.81%	->	->	2.94%

Fit of the Model, Nonmandated States

moments	30s target	30s model	difference	60s target	60s model	difference
G_{m1}	0.50978	0.509501	-0.0549%	0.334886	0.334418	-0.14%
G_{m2}	0.39688	0.397736	0.216%	0.443119	0.444872	0.396%
G_{m3}	0.0933392	0.0927631	-0.617%	0.221995	0.220711	-0.578%
G_{w1}	0.762457	0.762457	0.000022%	0.480704	0.485707	1.04%
G_{w2}	0.190972	0.190905	-0.0353%	0.363829	0.354892	-2.46%
G_{w3}	0.0465706	0.0466378	0.144%	0.155467	0.159401	2.53%
$G_{m,\mathrm{col}}$	0.202083	0.203549	0.725%	0.370287	0.373063	0.75%
$G_{w,\mathrm{col}}$	0.11022	0.110219	-0.000626%	0.382188	0.36033	-5.72%
y_{m1}	38631.7	38140.6	-1.27%	43787.7	43444.2	-0.785%
y_{m2}	42012.	42087.2	0.179%	53959.1	54176.3	0.402%
y_{m3}	36009.2	36372.9	1.01%	44997.	45506.	1.13%
y_{w1}	11606.5	11253.5	-3.04%	19854.	20950.	5.52%
y_{w2}	11913.	12196.3	2.38%	23871.3	26551.5	11.2%
y_{w3}	12345.8	11857.2	-3.96%	24881.1	22856.7	-8.14%
x_{w1}	39414.	39452.6	0.0979%	44926.9	43993.5	-2.08%
x_{w2}	43434.5	40533.2	-6.68%	55639.5	55561.4	-0.14%
x_{w3}	34045.4	36624.4	7.58%	45155.8	47599.5	5.41%
average	->	->	1.65%	->	->	2.85%

Mandate Counterfactual Analyses

Infertility Treatment Insurance Mandate

- If mandated states were not mandated:
  - The fraction of late brides in the mandated states would decrease from 19.4 percent to 17.0 percent.
  - The average spousal income of early brides would increase by 2.92 percent.
  - The average spousal income of late brides would decrease by 0.12 percent.
- If nonmandated states were mandated:
  - The fraction of late brides in the mandated states would increase from 15.9 percent to 18.2 percent.
  - The average spousal income of early brides would decrease by 2.97 percent.
  - The average spousal income of late brides would increase by 0.07 percent.

Gender Equality Counterfactual Analysis 1

Gender Equality in Fecundity

- 4.96 percent of women would delay their marriage age from between 23 and 29 to between 30 and 39
- Middle brides' average spousal income would increase by 5.43 percent
- Late brides' average spousal income would increase by 3.61 percent
- The average personal income of late brides would not increase, because intermediate-ability women delay marriages

Gender Equality Counterfactual Analysis 2

- Women's college enrollment rate would decrease from 38.9 percent to 38.3 percent
- Fraction of
  - early brides (16-22): would increase by 0.35 percent
  - middle brides (23-29): would decrease by 2.94 percent
  - late brides (30-39): would increase by 5.64 percent
- Average spousal income of
  - early brides would decrease by 0.43 percent
  - middle brides would increase by 0.68 percent
  - late brides would increase by 0.37 percent

Gender Equality Counterfactual Analysis 3

Gender Equality in Investment Opportunities

- Women's college enrollment rate would decrease from 38.9 percent to 38.5 percent
- Fraction of
  - early brides (16-22): would increase by 0.23 percent
  - middle brides (23-29): would increase by 1.73 percent
  - late brides (30-39): would decrease by 4.46 percent
- Average spousal income of
  - early brides would decrease by 0.43 percent
  - middle brides would increase by 0.68 percent
  - late brides would increase by 0.37 percent

Conclusion

- College and earnings gender gaps.
- Relationships between age at marriage and personal income for men and women.
- Relationship between age at marriage and spousal income for women.
- Differential fecundity, coupled with the equilibrium marriage market, leads to many observed economic and social gender differences.

THANK YOU!

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