An Investment-and-Marriage Model with Differential Fecundity

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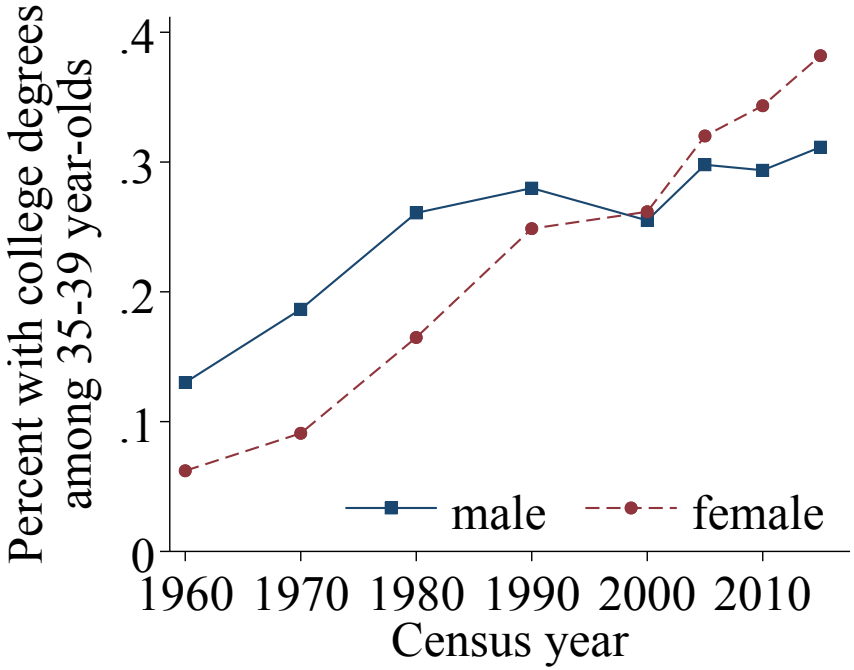
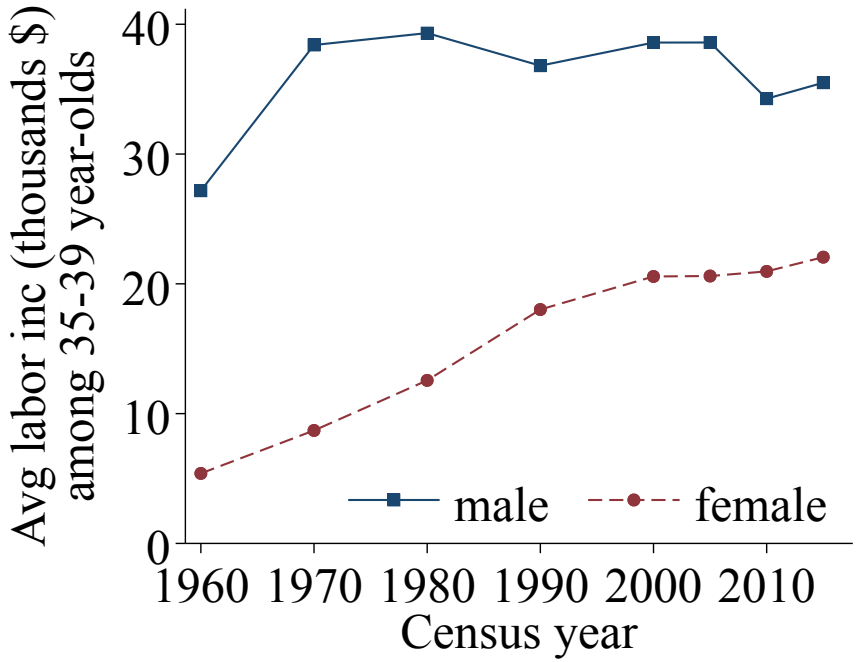
Three Sets of Stylized Facts

1. College and Earnings Gender Gaps

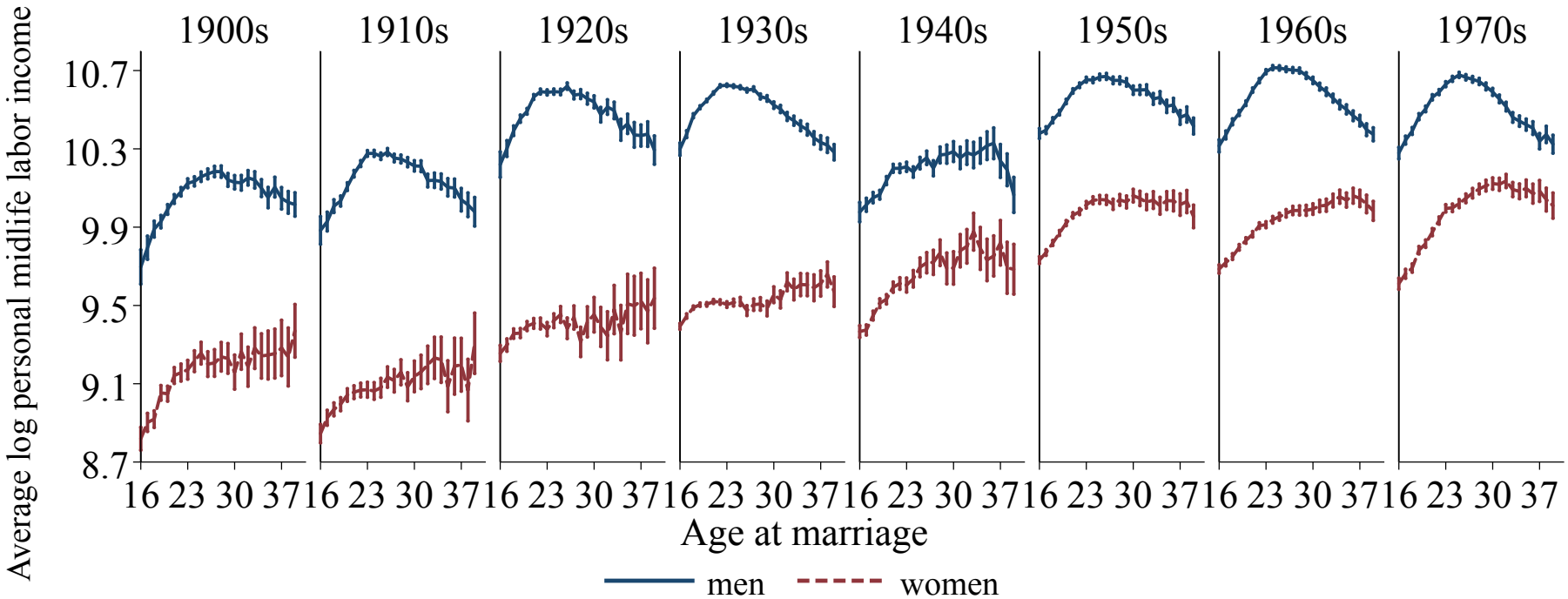
- Reversed college gender gap
- Persistent earnings gender gap





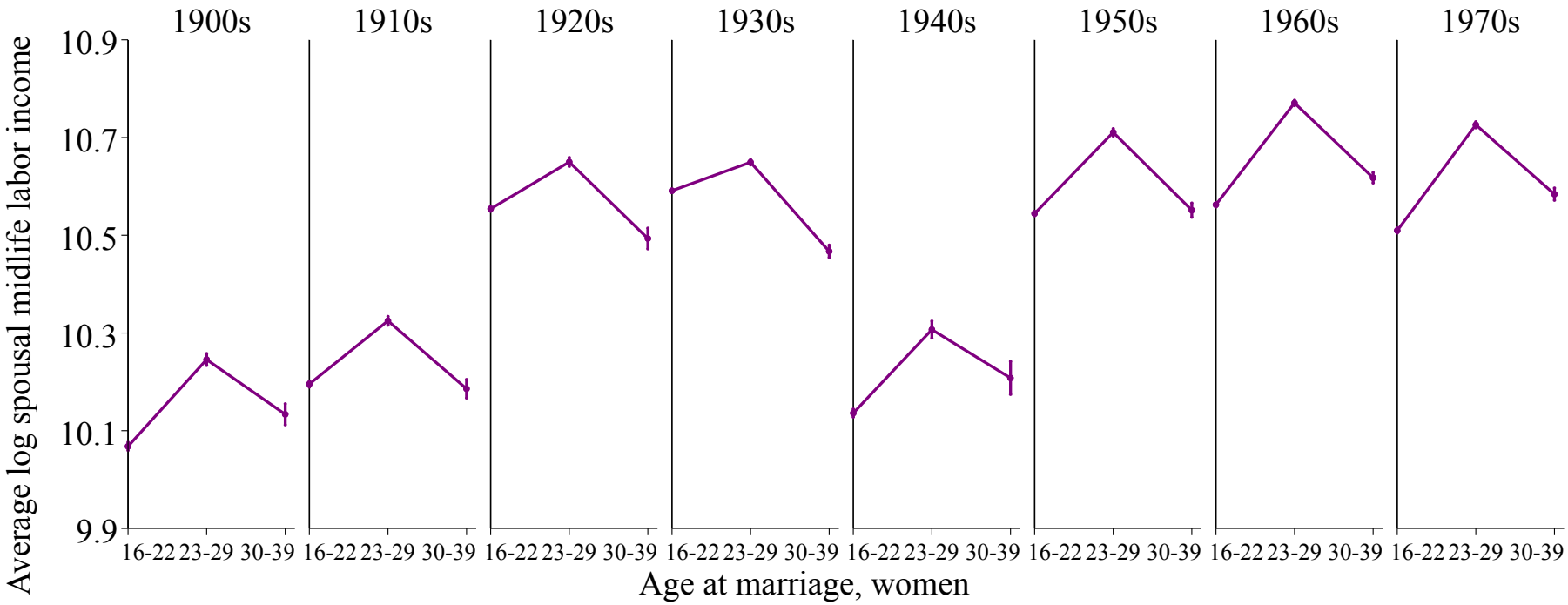
2. Average Midlife Income by Age at Marriage

- 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



Stylized Facts

1. More women than men go to college, fewer women than men earn a high income.
2. Relationship between age at marriage and personal midlife income has been persistently hump-shaped for men and positive for women.
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.

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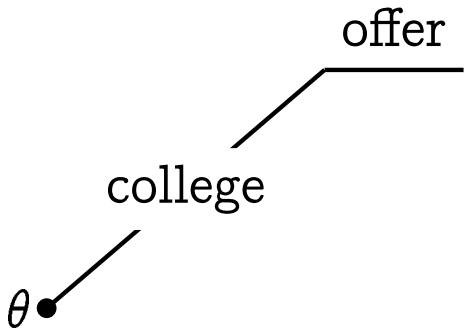
ages 16-22 ages 23-29 ages 30-39

Investments



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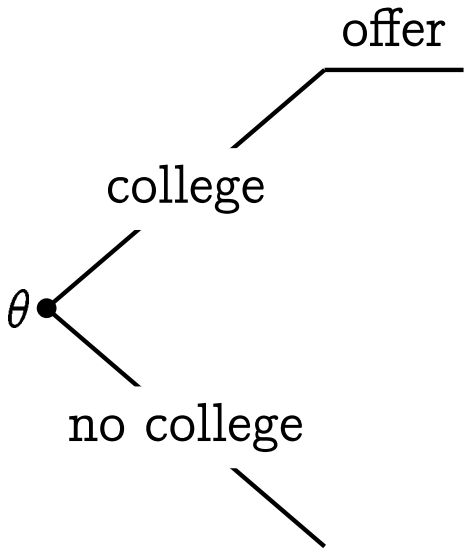

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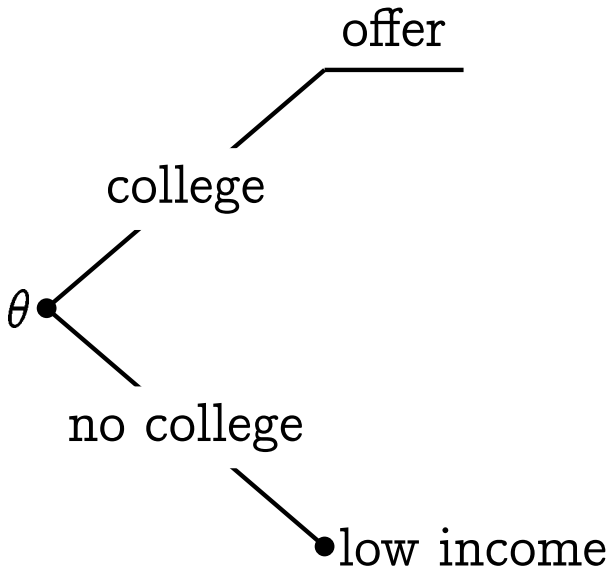

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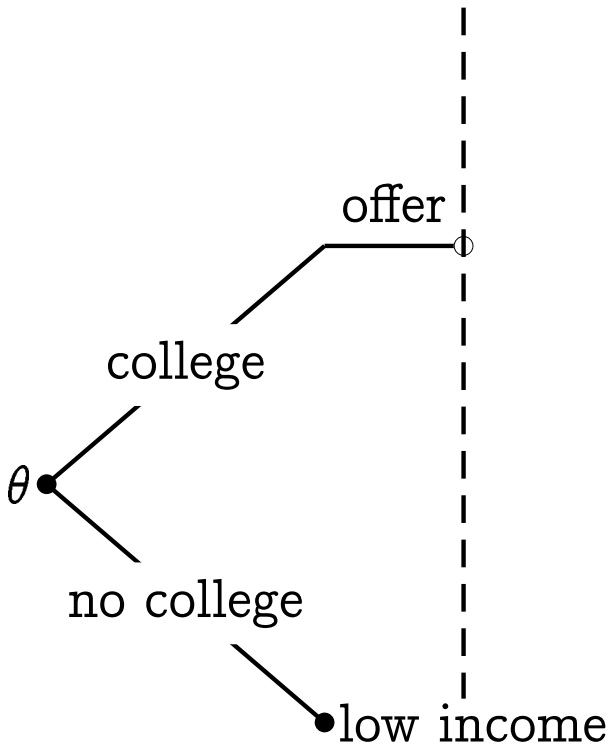

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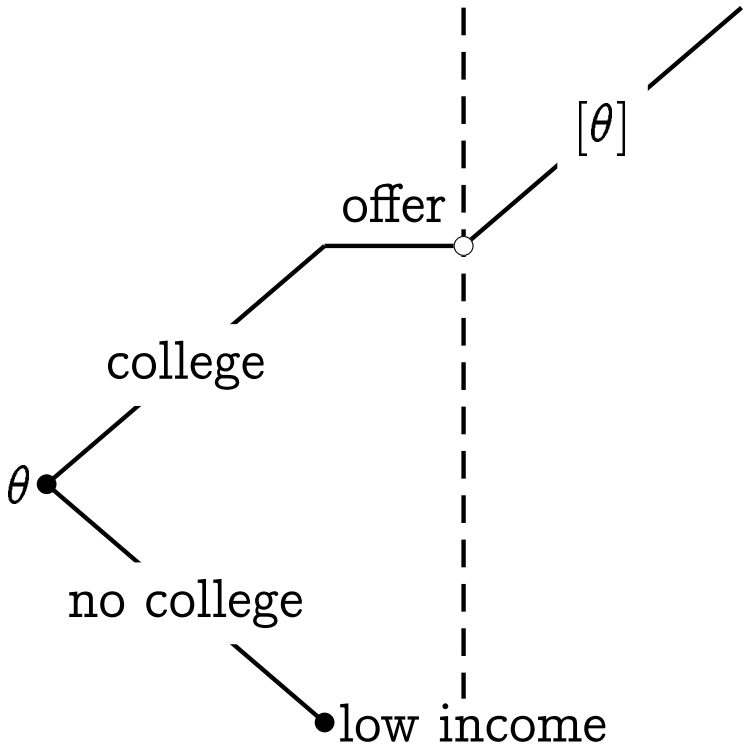

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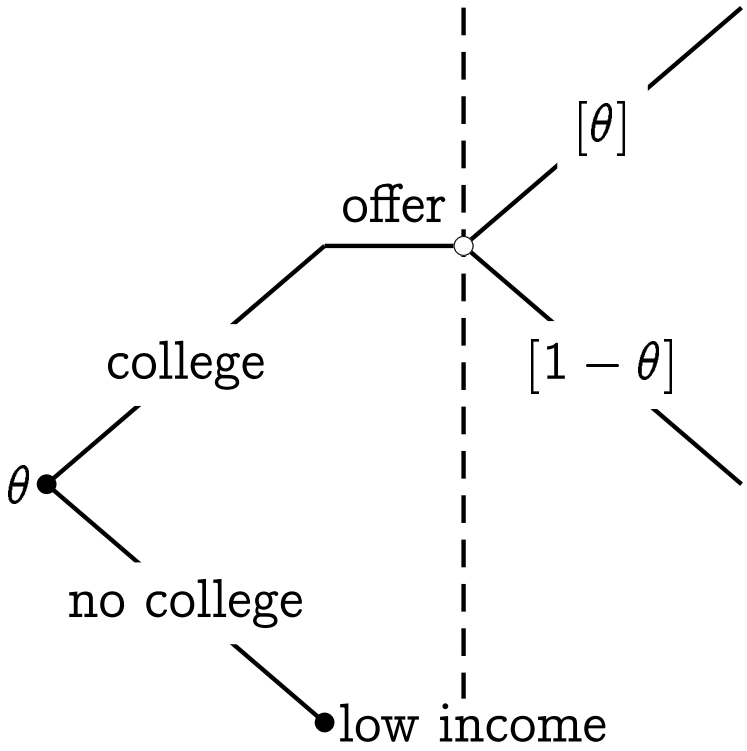

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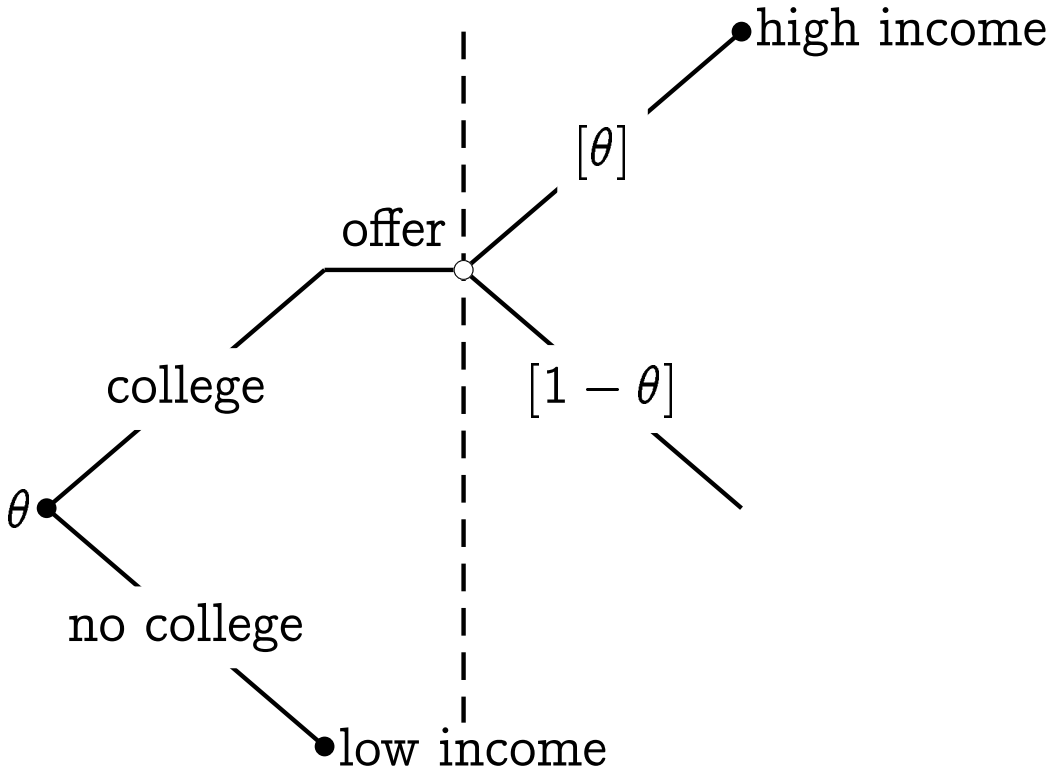

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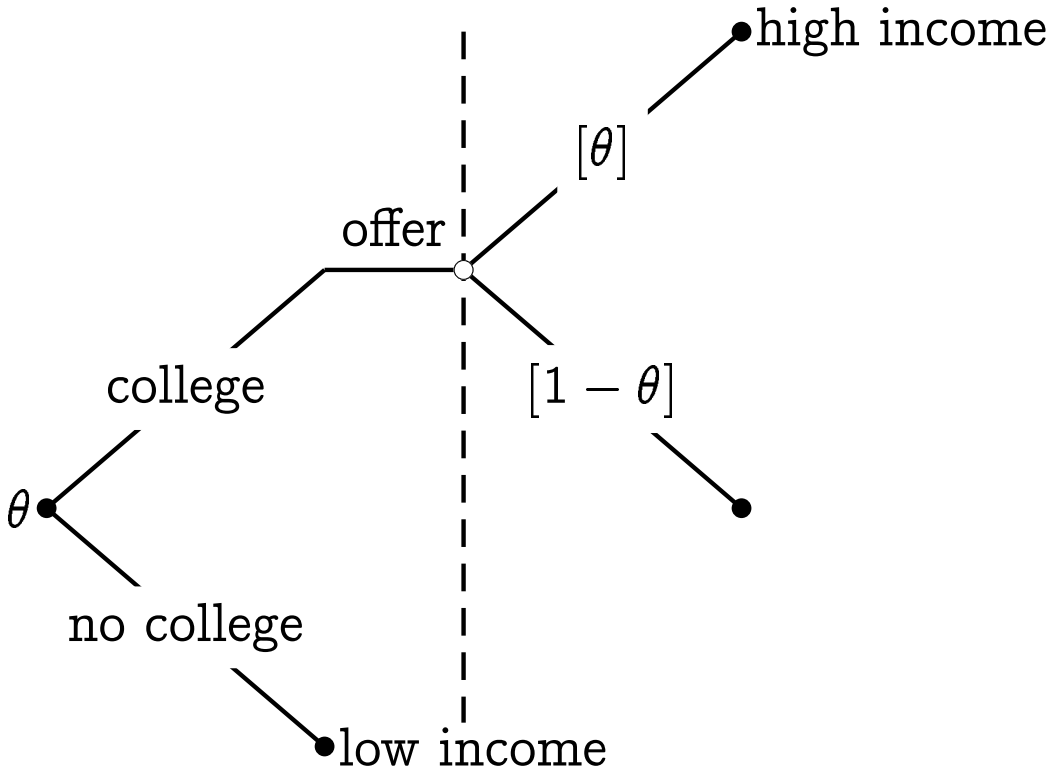

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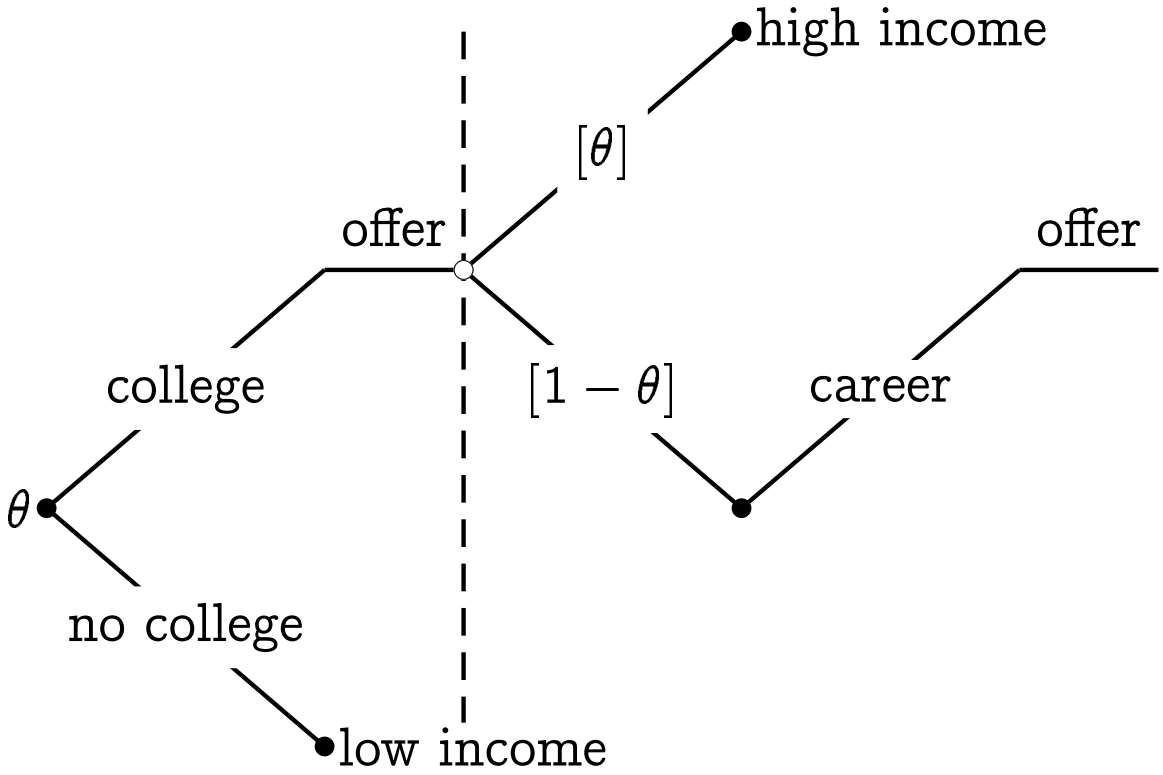

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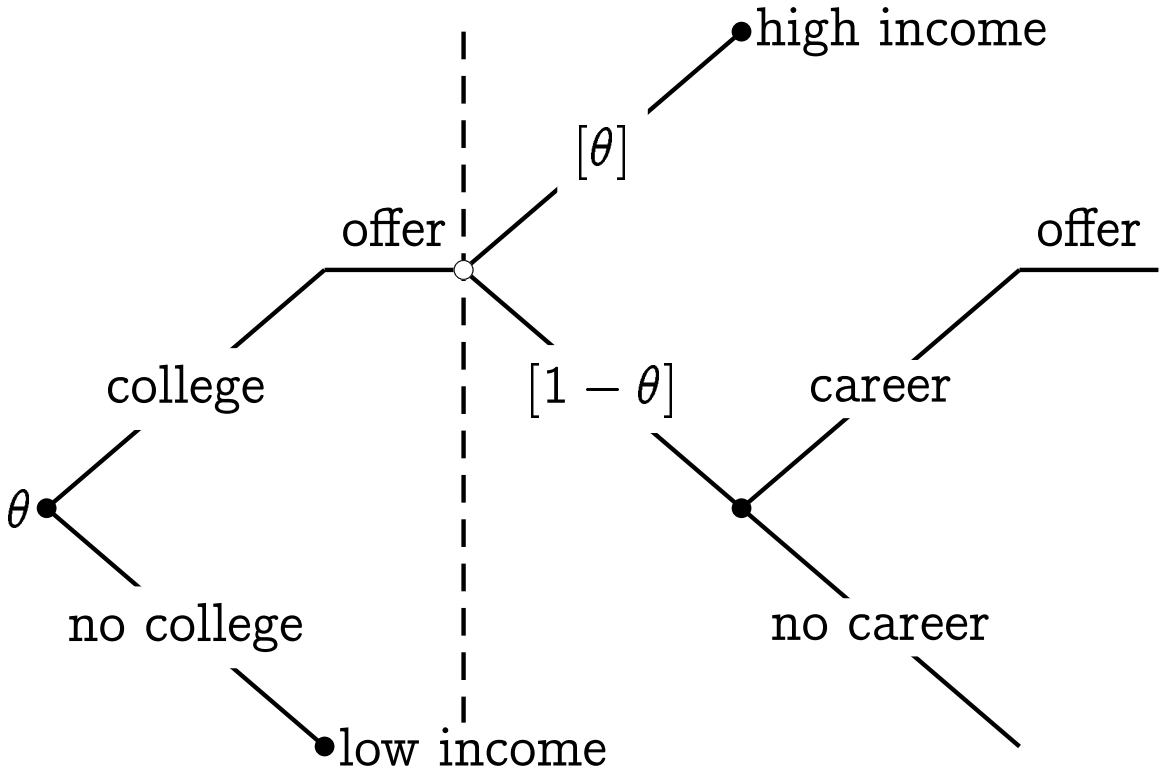

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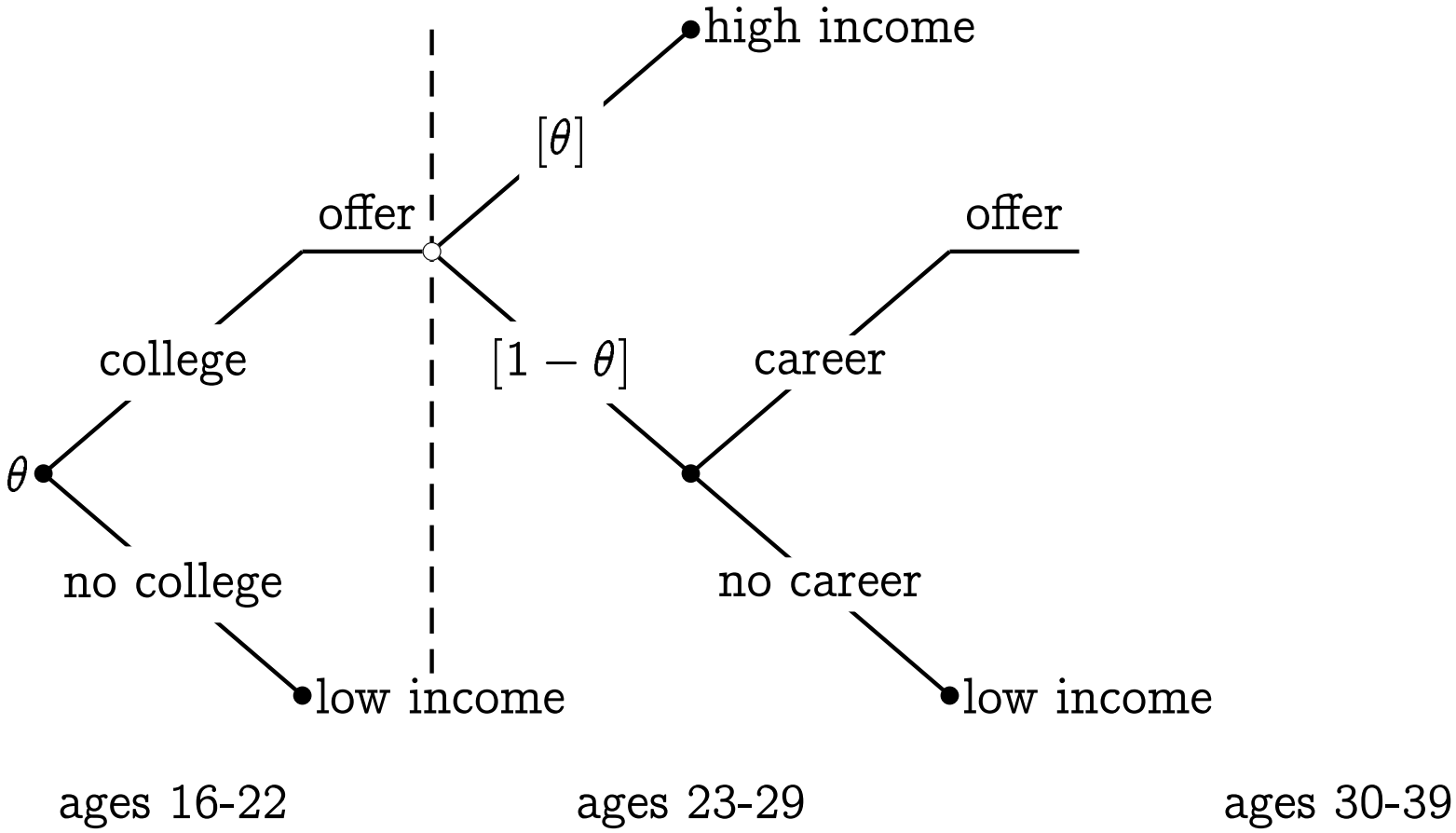

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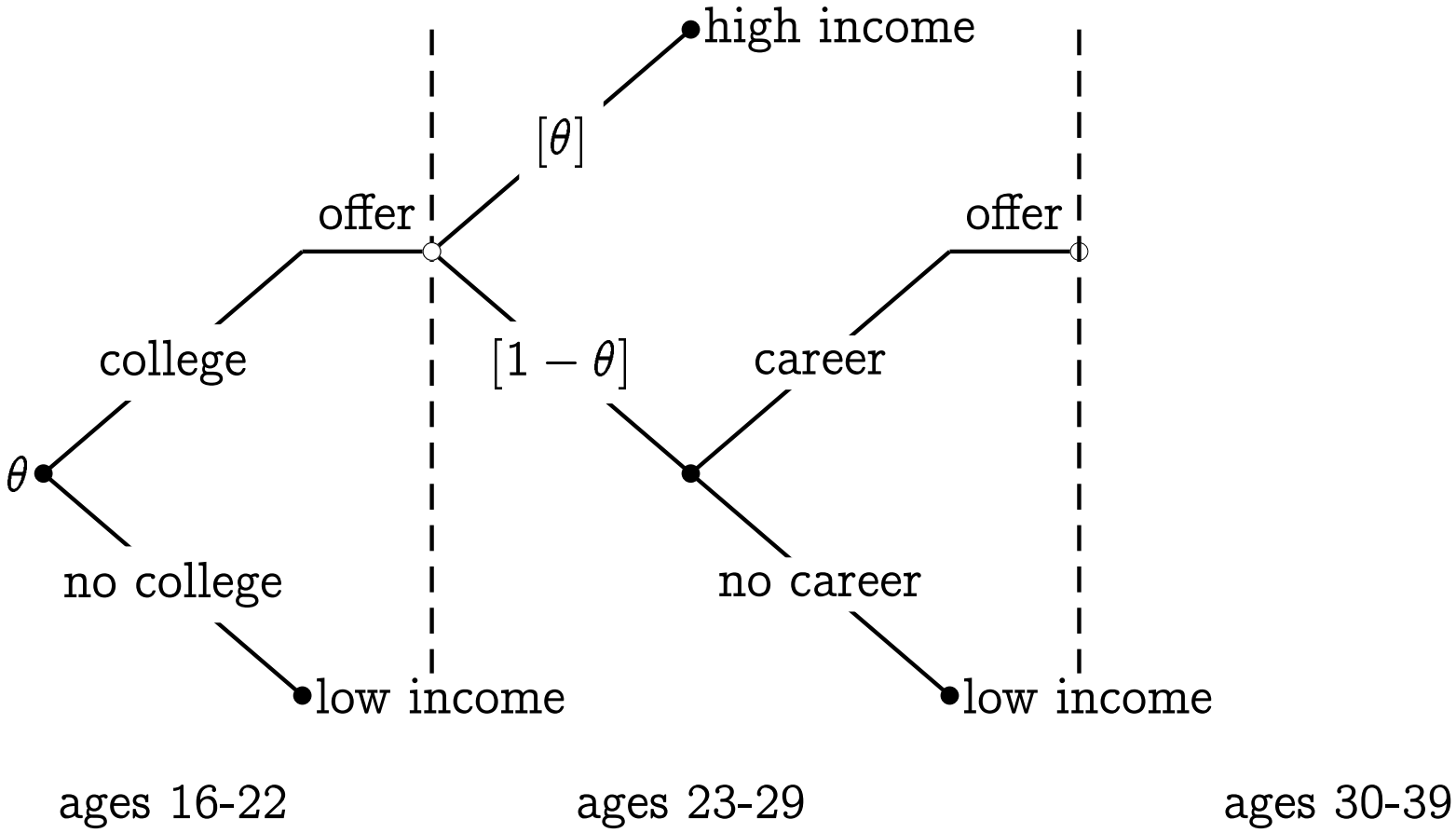

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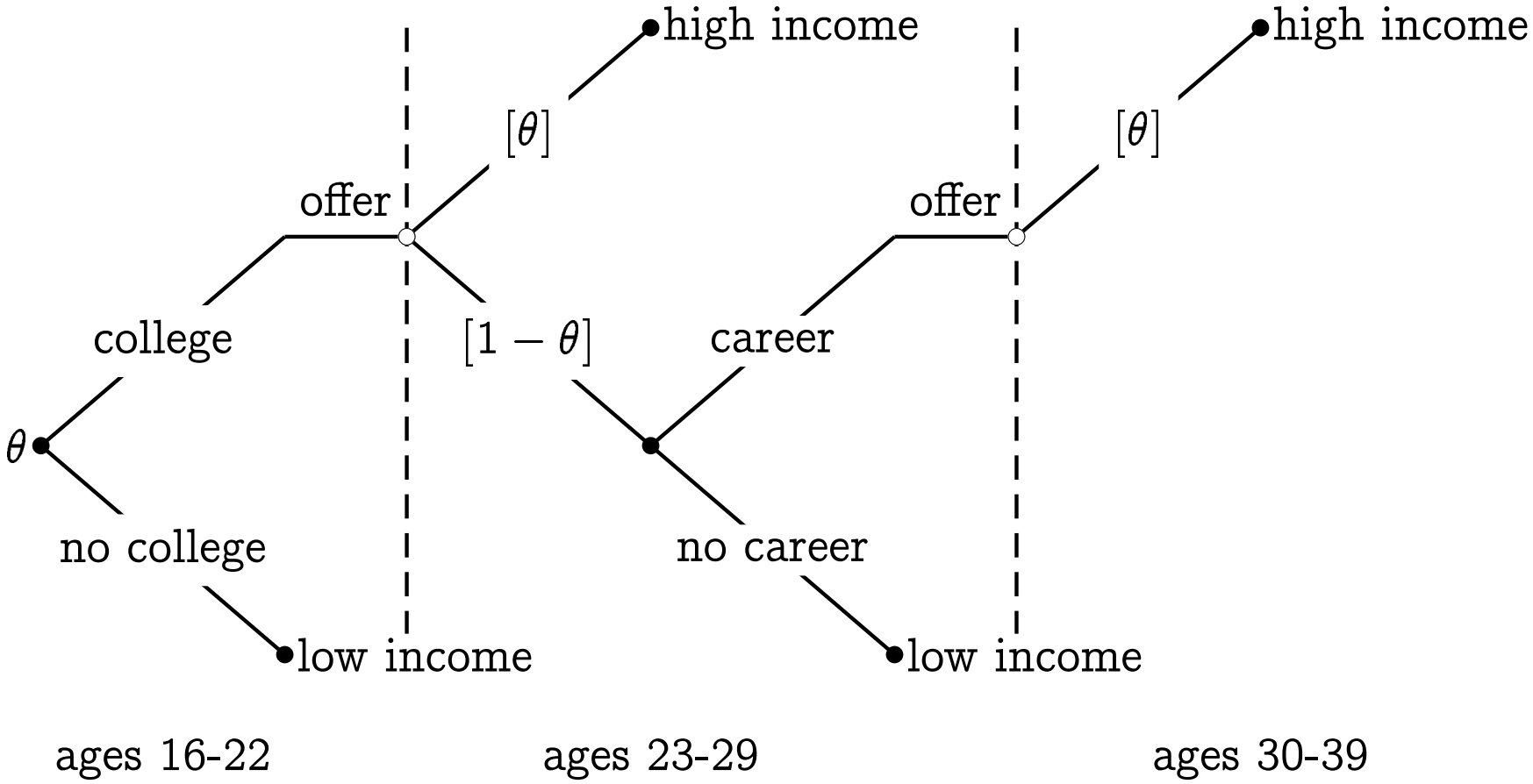

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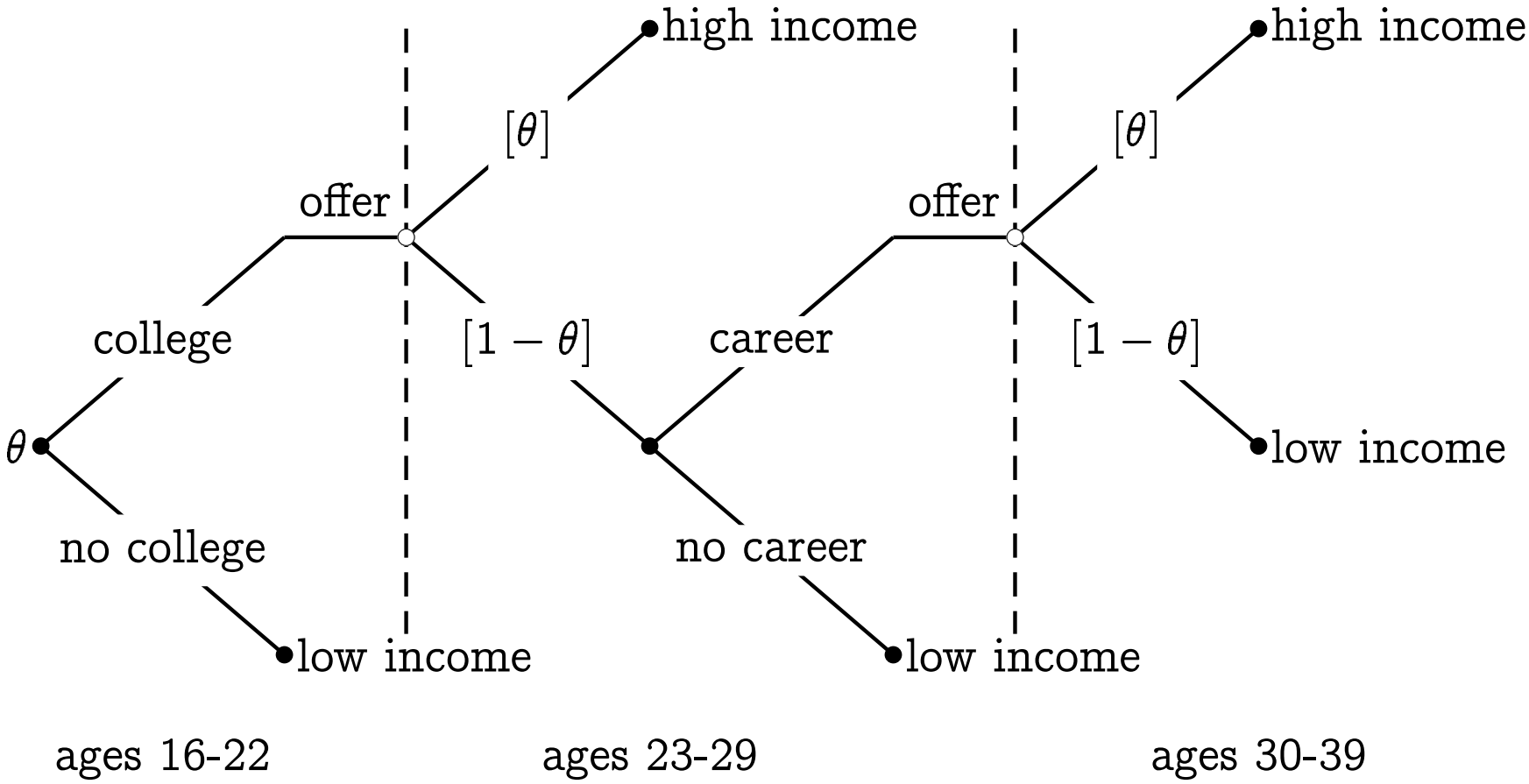


Differential Fecundity

$$y + v - c$$

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

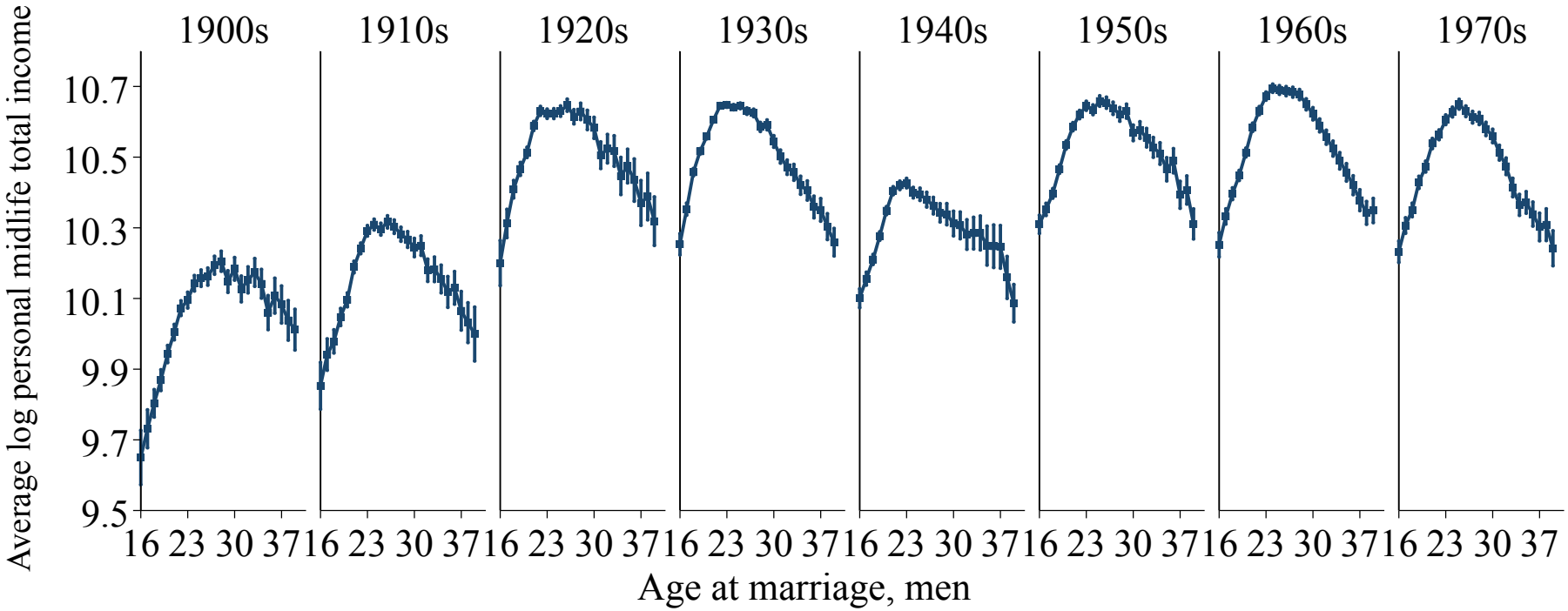
There exists an equilibrium. Equilibrium investment strategies (σ_m^*, σ_w^*) are uniquely determined. Equilibrium marriage payoffs (v_m^*, v_w^*) are uniquely determined up to a constant.

Proof Steps

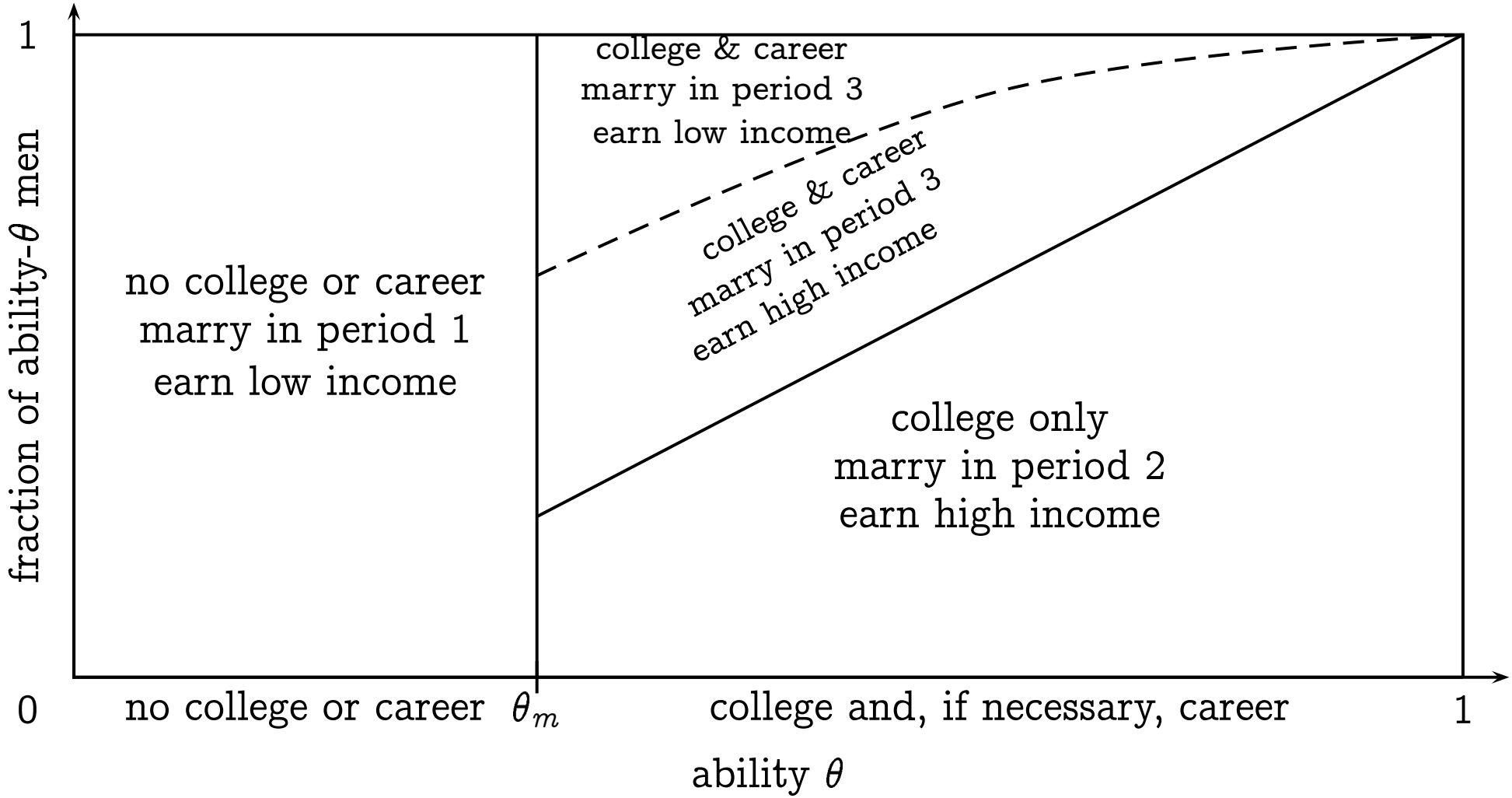
0. Marriage payoffs are determined by payoff difference $\pi_m \equiv v_{mH} - v_{mL}$.
   The mapping in consideration is $\pi_m \xrightarrow{f_\sigma} \sigma \xrightarrow{f_G} G \overset{f_\pi}{\rightrightarrows} \pi_m$.
1. Construct supply function $S(\pi_m) = f_G(f_\sigma(\pi_m))$.
2. Construct demand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

Explanations

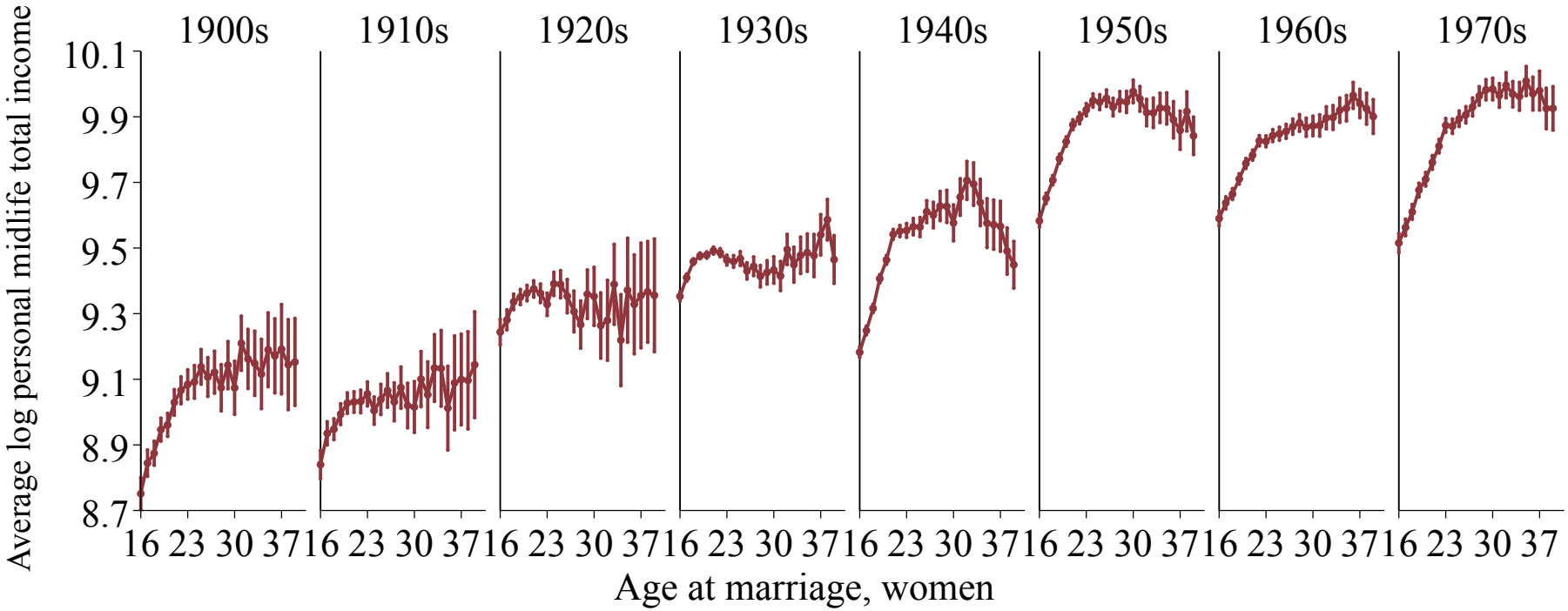
Men's Midlife Income by Age at Marriage



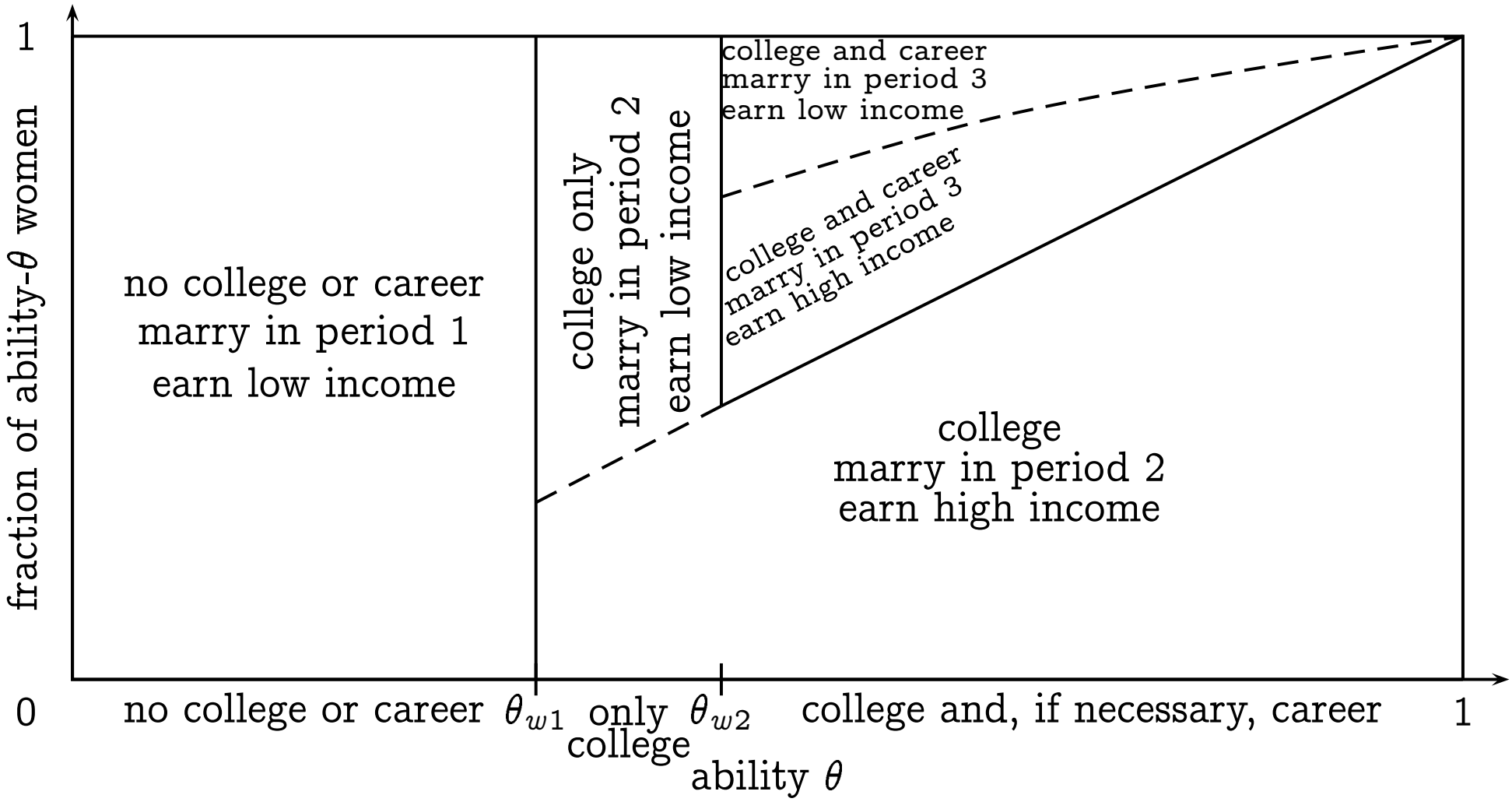
$$\theta_m = \frac{c_m}{(y_{mH} - y_{mL}) + (v_{mH} - v_{mL})} \equiv \frac{c_m}{\Delta z_m + \pi_m}$$



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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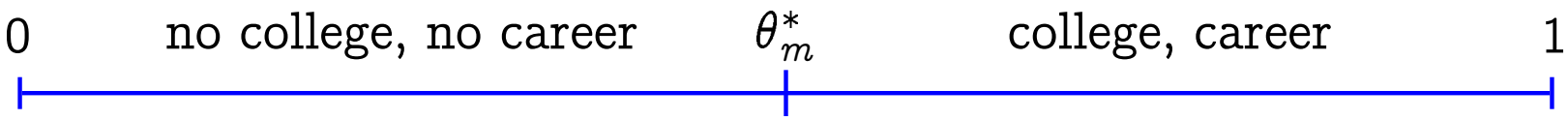

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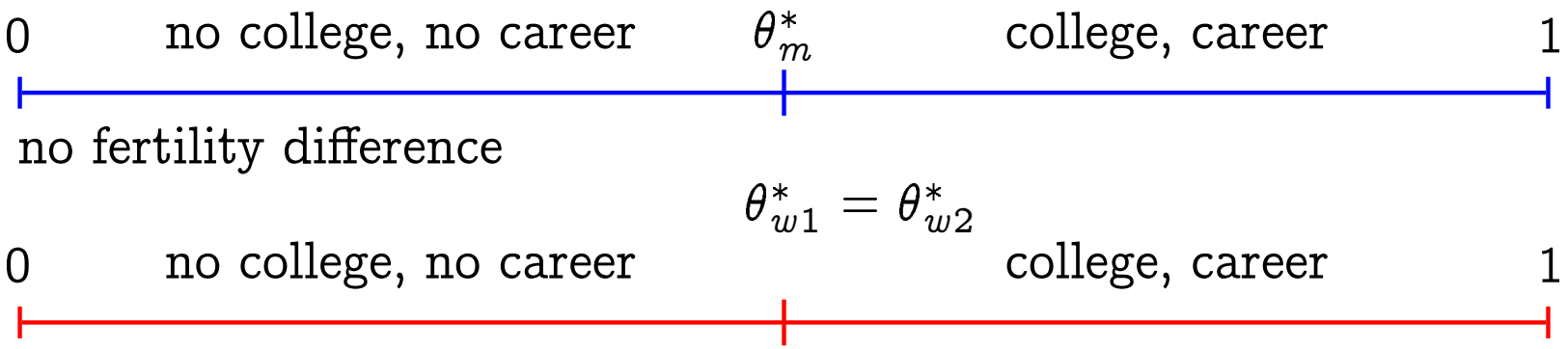

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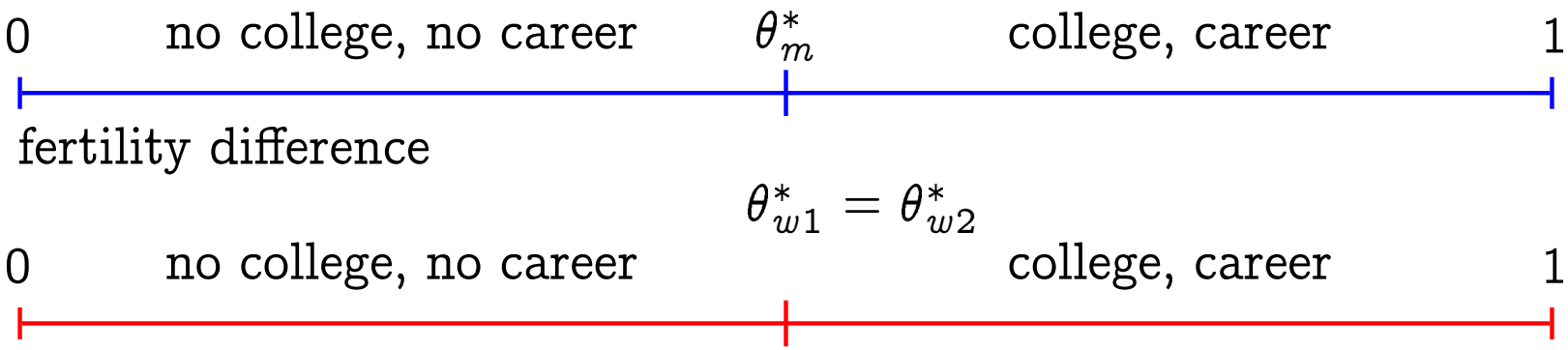

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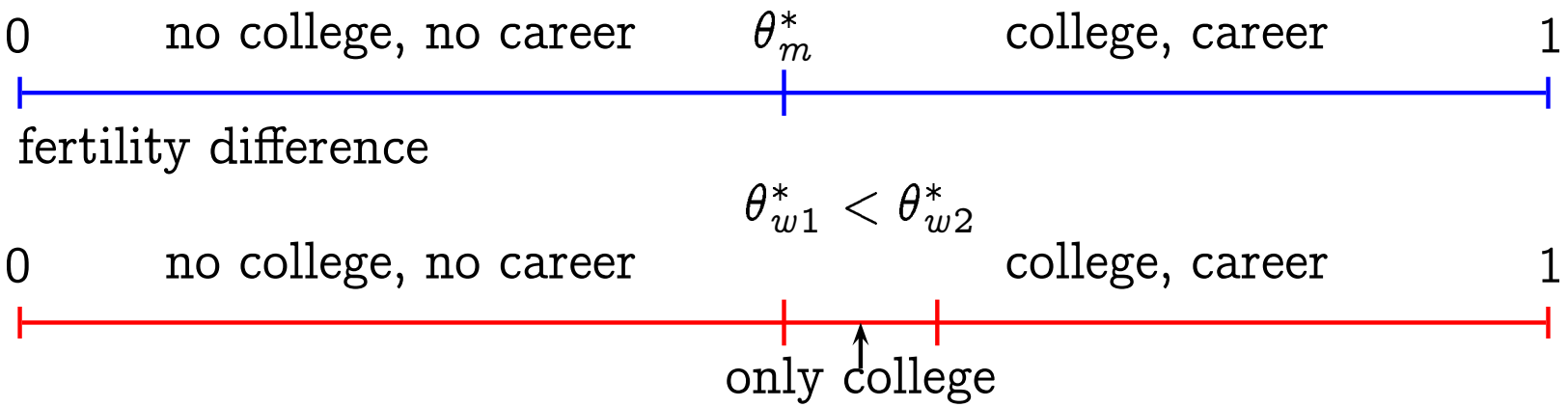

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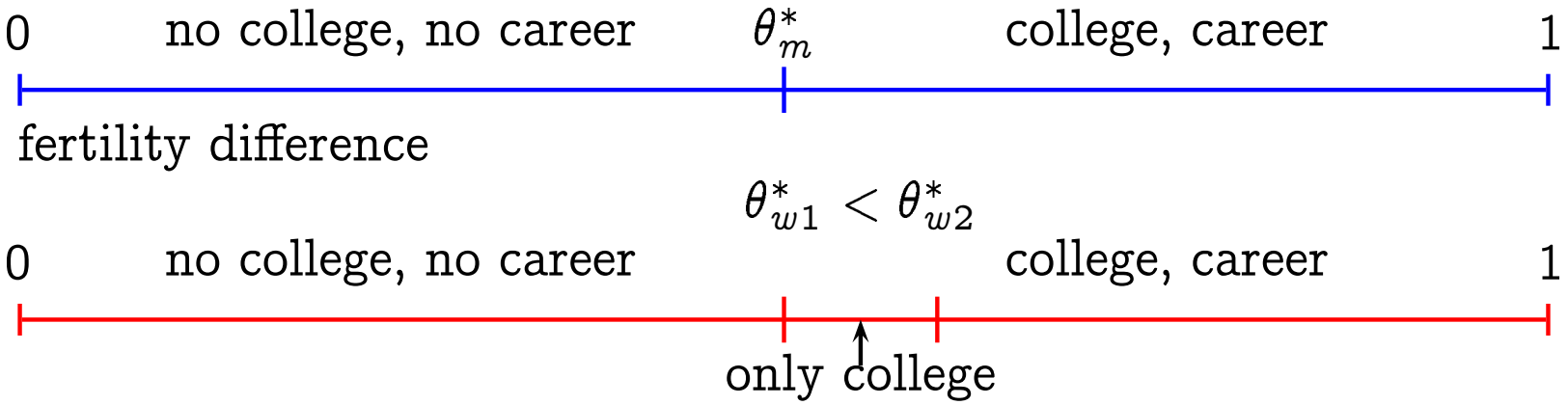

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- Only some college-educated women make a career investment.
- Fewer women than men earn a high income.

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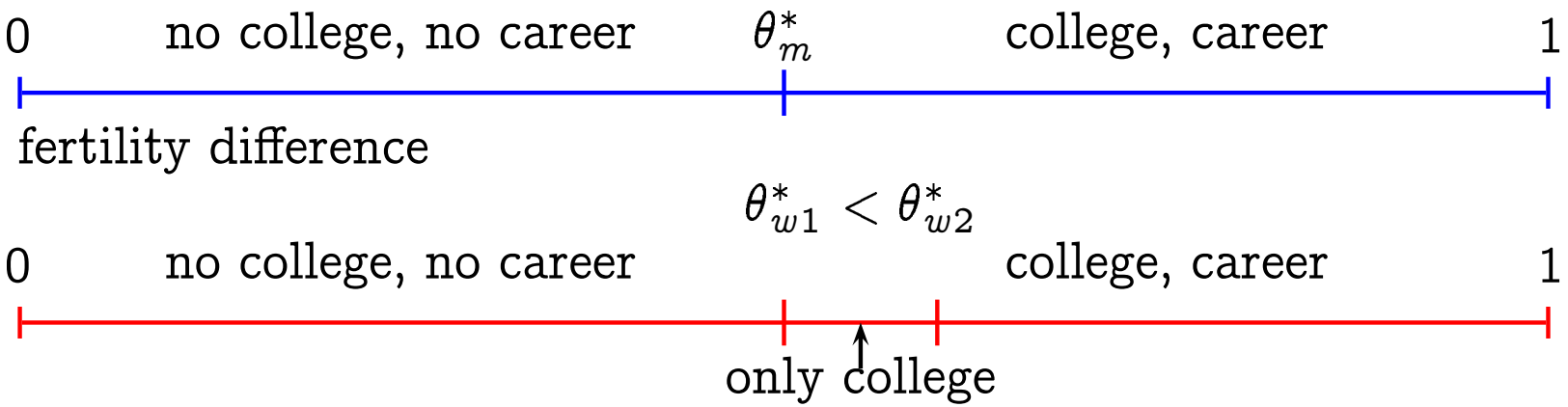

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- Only some college-educated women make a career investment.
- Fewer women than men earn a high income.
- High-income women are more scarce than high-income men in MM.

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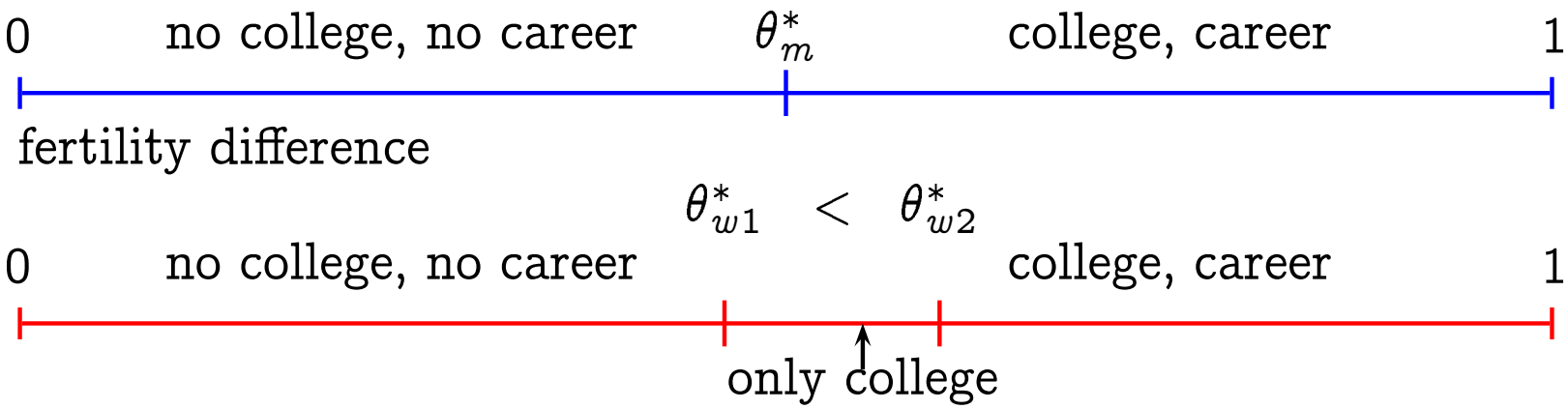
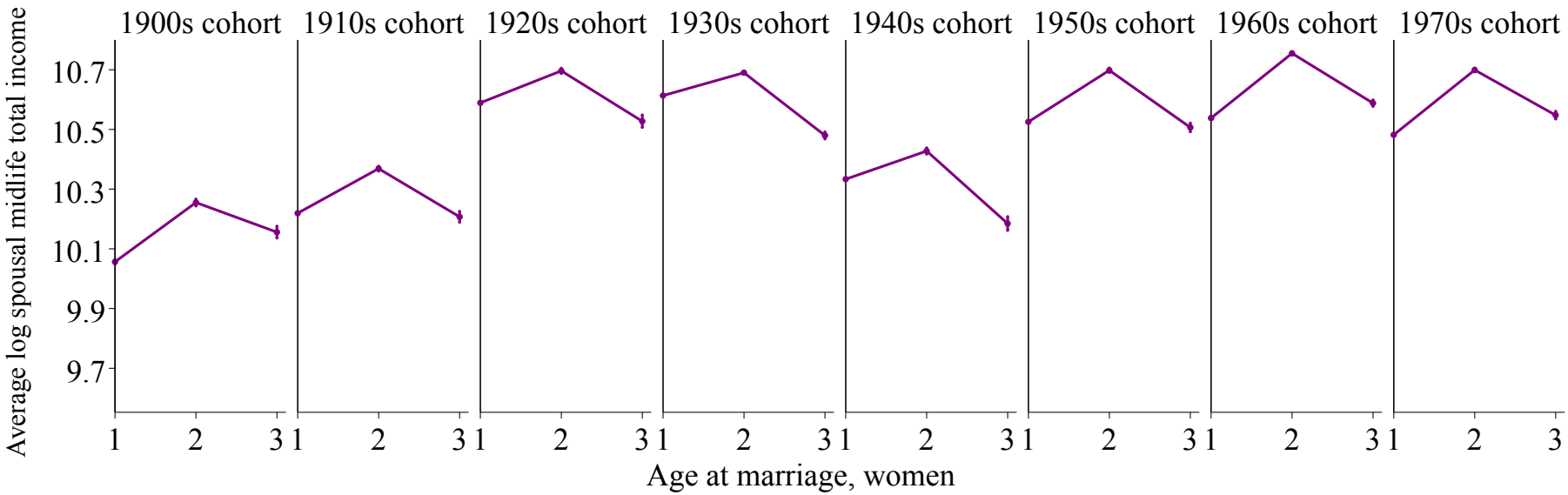
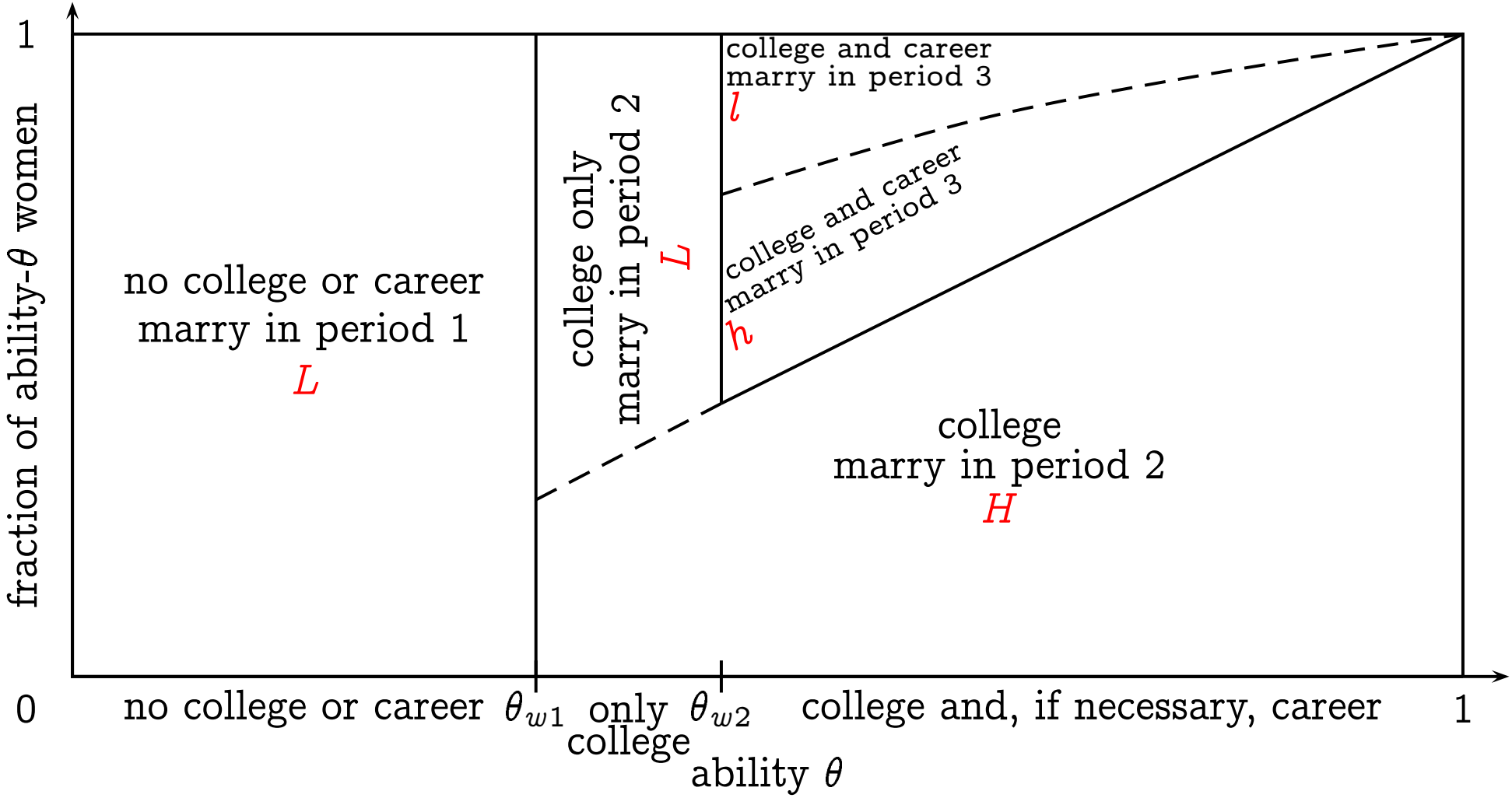


- All college-educated men make a career investment.
- Only some college-educated women make a career investment.
- Fewer women than men earn a high income.
- High-income women are more scarce than high-income men in MM.
- College generates higher MM returns for women than for men.

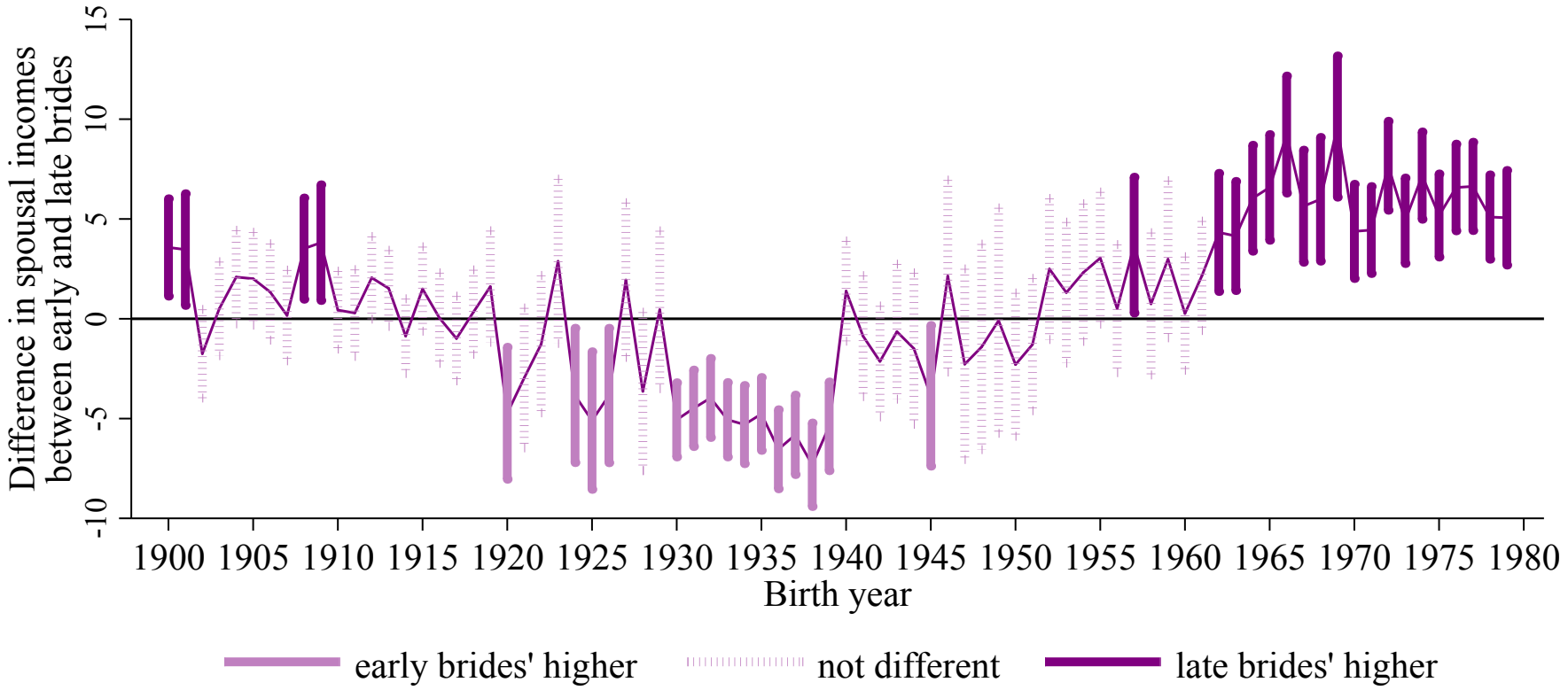
Women's Spousal Income by Age at Marriage



Fertility-Income Tradeoff



Early versus Late Brides

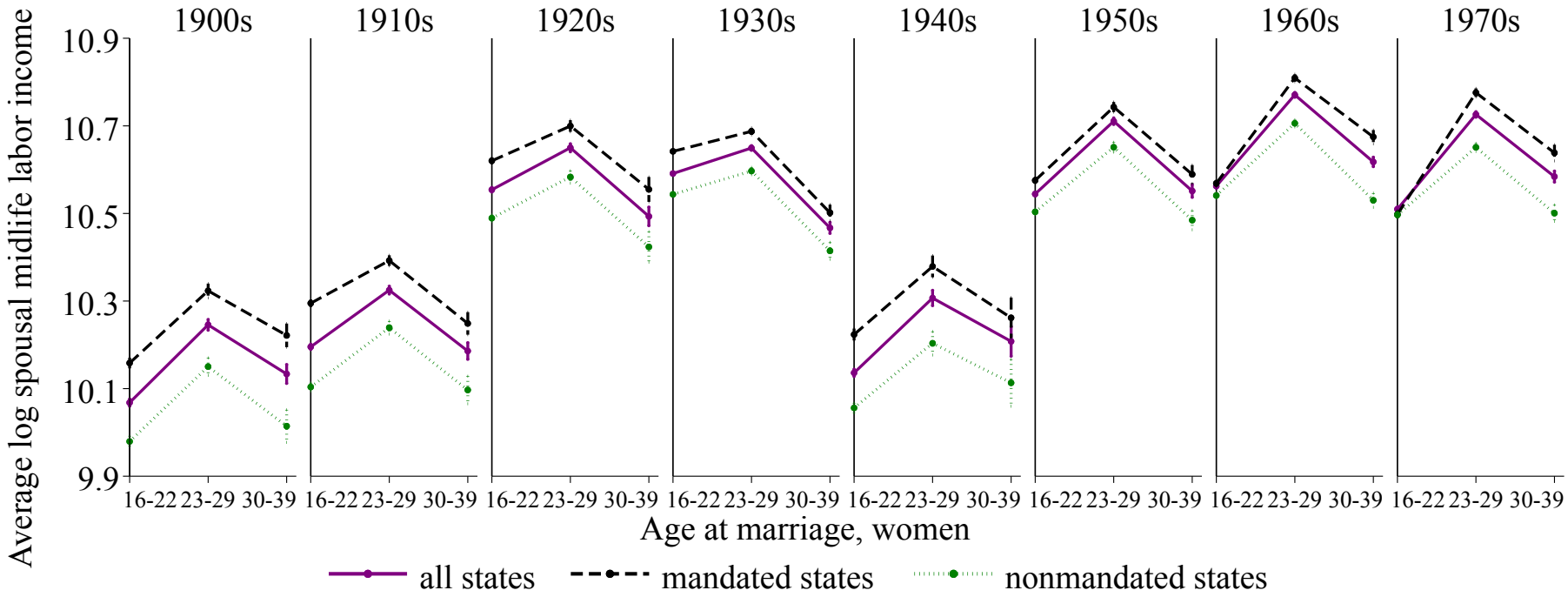


Mandates to Cover/Offer Infertility Treatments in Insurances

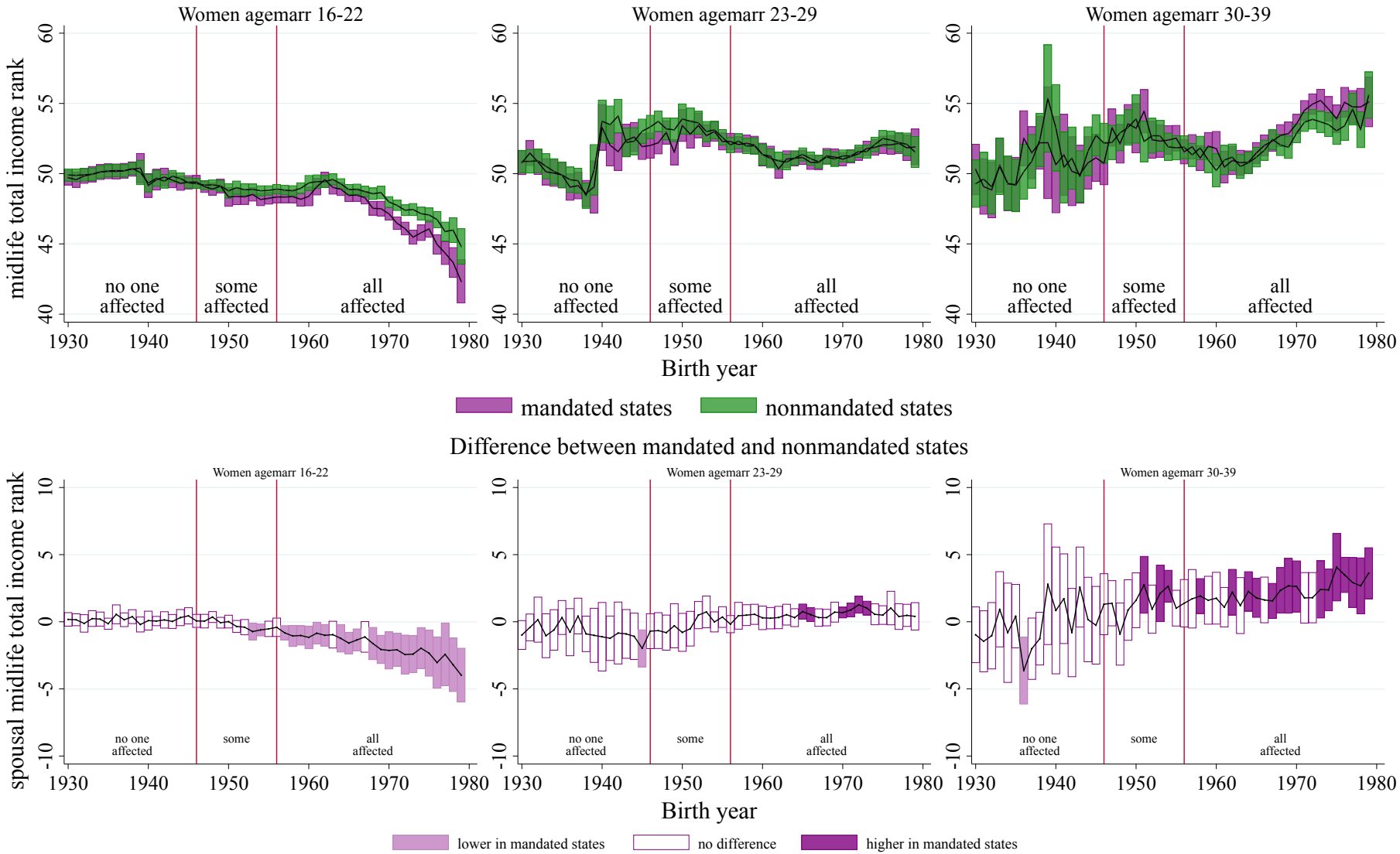
Between 1985 and 1995, thirteen states passed mandates to cover/offer infertility treatments in insurances

- 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)

Women's Spousal Income by Age at Marriage



Spousal Total Income Percentile Rank



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

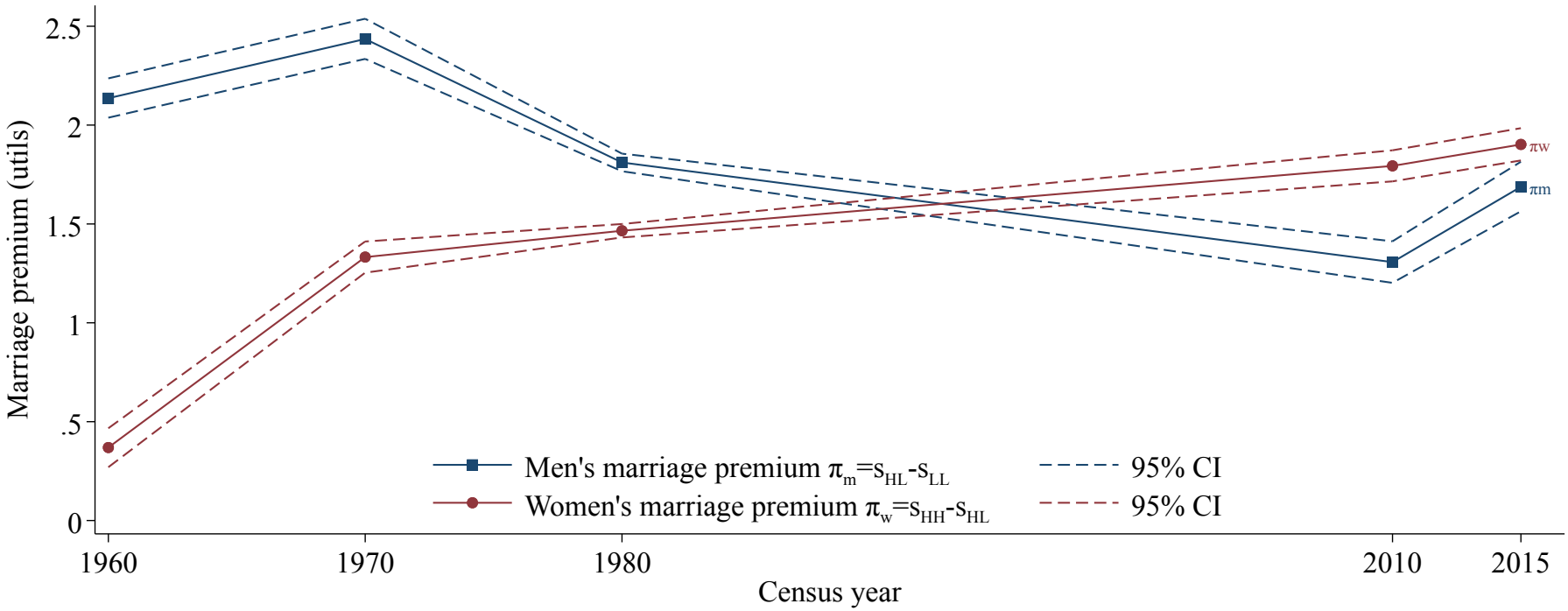
Fertility more important

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

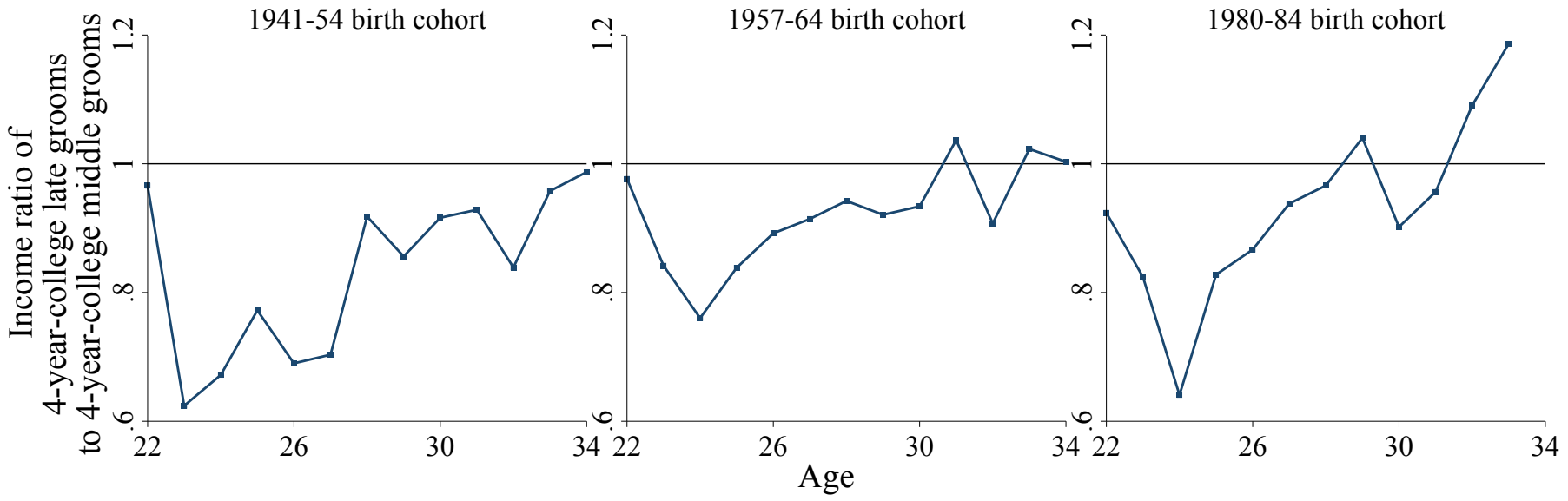
Income more important

Supporting Evidence and Calibration

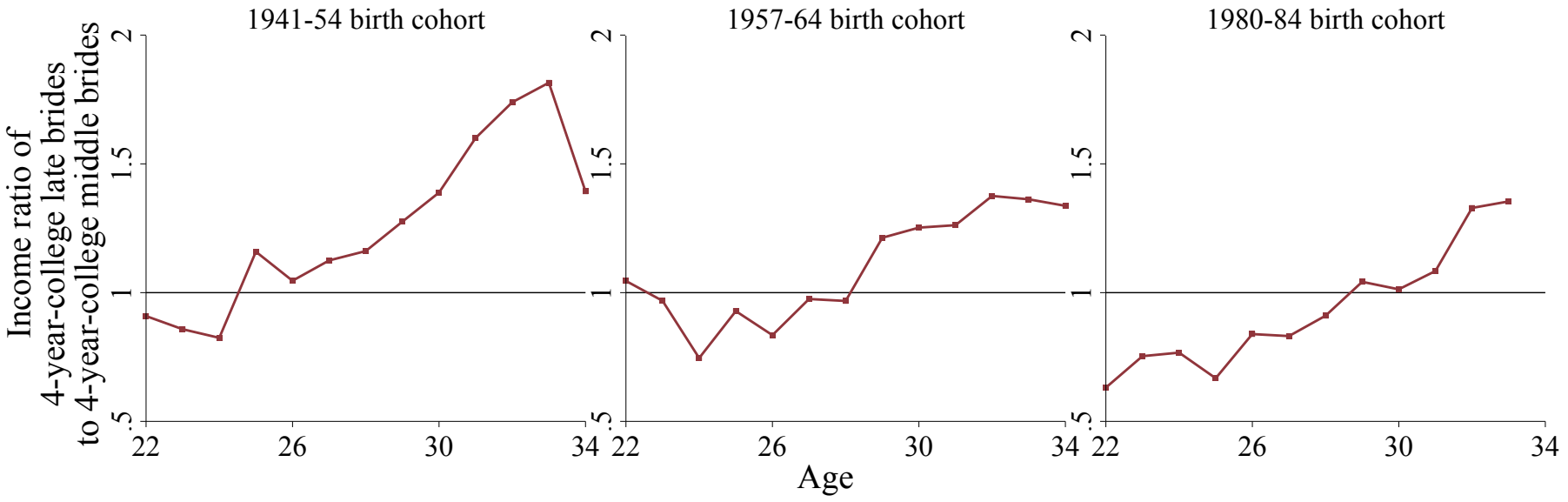
Evolution of the Marriage Premium



Age-Income Profiles for Men



Age-Income Profiles for 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

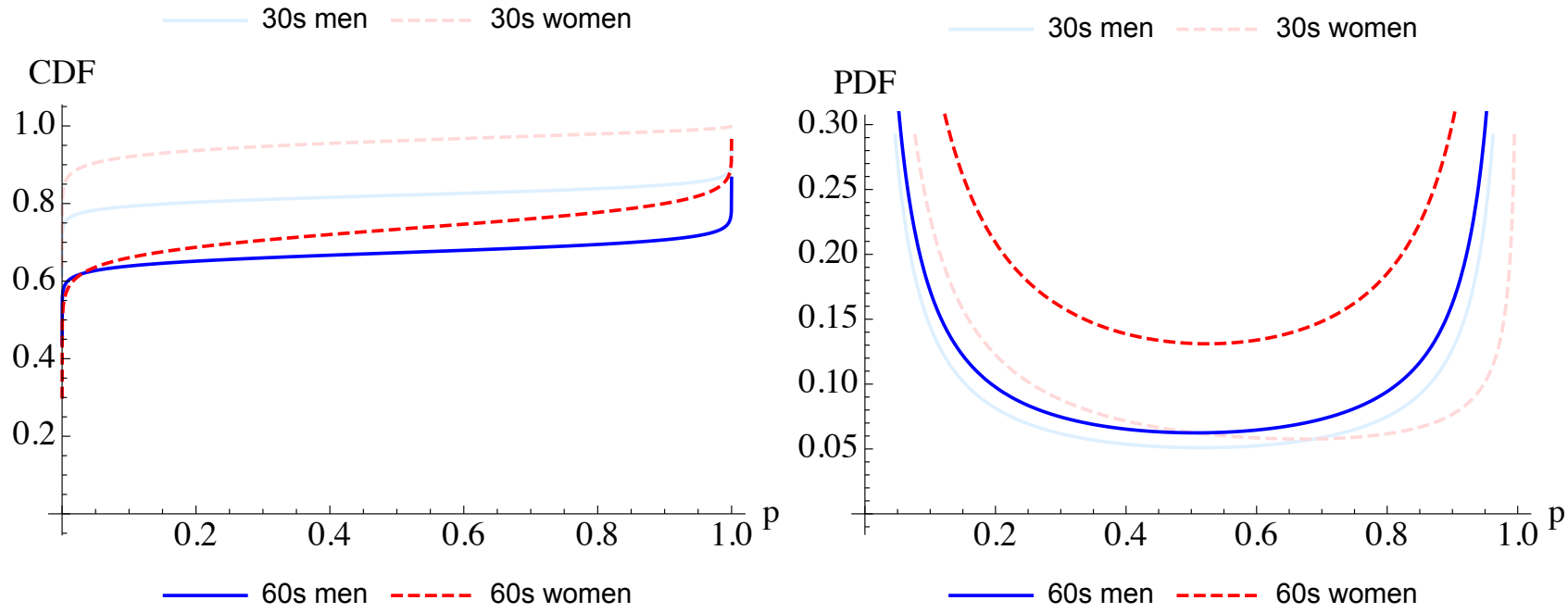
- Ability distributions are Beta(α_m, β_m) and Beta(α_w, β_w).
- Low income is average income of the non-college-educated.
- High income is average income of the college-educated.
- Total investment cost is two years of low incomes; annual cost is total cost divided by 40.
- Surplus in monetary terms 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 increase by 2.97 percent.
  - The average spousal income of late brides would decrease 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, due to the equilibrium marriage market, leads to many observed economic and social gender differences.

THANK YOU!