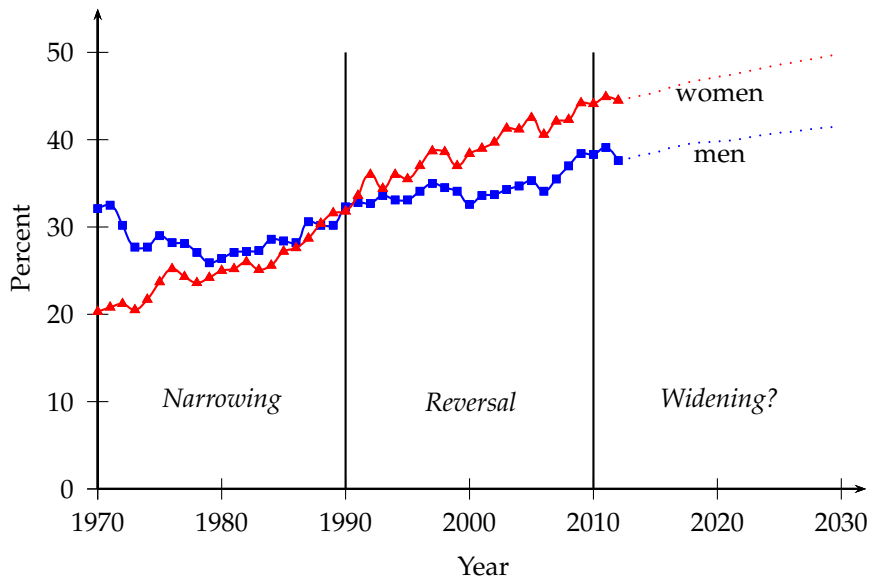


A Marriage-Market Perspective of the College Gender Gap and the Gender Pay Gap

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Friday, April 28, 2017

College Enrollment Rate in the US

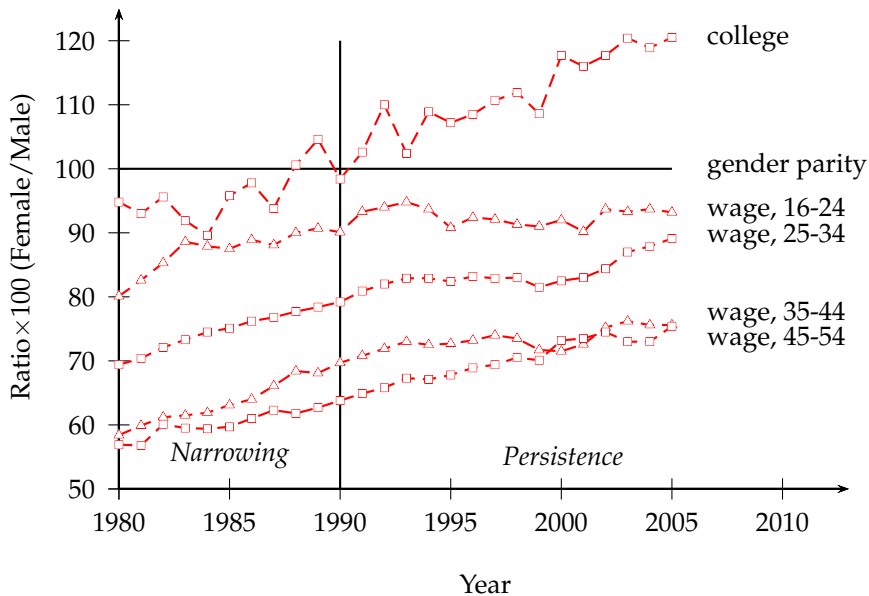


College Gender Gap around the World

The patterns are not uniquely American but rather global.

- ▶ *Narrowing*: Every country in the world has a higher college enrollment rate for women today than in 1970.
- ▶ *Reversal*: 5 countries had a positive college gender gap in 1970; 67 countries across all inhabited continents and 30 out of 34 OECD countries have in 2010.
- ▶ *Widening in the Future?*: OECD (2008) predicts that the percentage of women among all college students in 2030 will be e.g. 71% in UK and 72% in Austria.

Female/Male Pay Ratio in the US



Gender Pay Gap around the World

- ▶ *Narrowing*: The gender pay gap has been *narrowing*.
- ▶ *Persistence*: The gender pay gap has not been closed completely or reversed. Women are earning less than men on average in every country in the world. In 2013, women in OECD countries earned on average 15.5% less than men.
- ▶ *Persistence in the Future?*

This Paper

uses a tractable *equilibrium* investments-and-marriage model to

1. *synthesize* empirically verified labor-market, marriage-market, and social changes that have contributed to *narrowed college gender gap* and *narrowed gender pay gap* in the past,
2. *introduce* a new equilibrium marriage-market channel to explain *reversed college gender gap* and *persistent gender pay gap* when women continue to face family-career tradeoff in the present, and
3. *argue against* the predicted *continued widening college gender gap* and *persistent gender pay gap* in the future.

Key Features of the Model

- ▶ A set of variables is endogenously determined: college and career investments, income distributions, marriage-age distributions, marriage matching, and division of marriage surplus.
- ▶ There is always a unique equilibrium, and comparative statics results can be derived.
- ▶ A key marriage-career tradeoff is captured: women have a shorter reproductive length. In equilibrium,
 - ▶ every male college graduate makes a career investment,
 - ▶ but not every female college graduate does so.

Relation to Chiappori et al. (2009)

This paper advances Chiappori et al. (2009) in three ways:

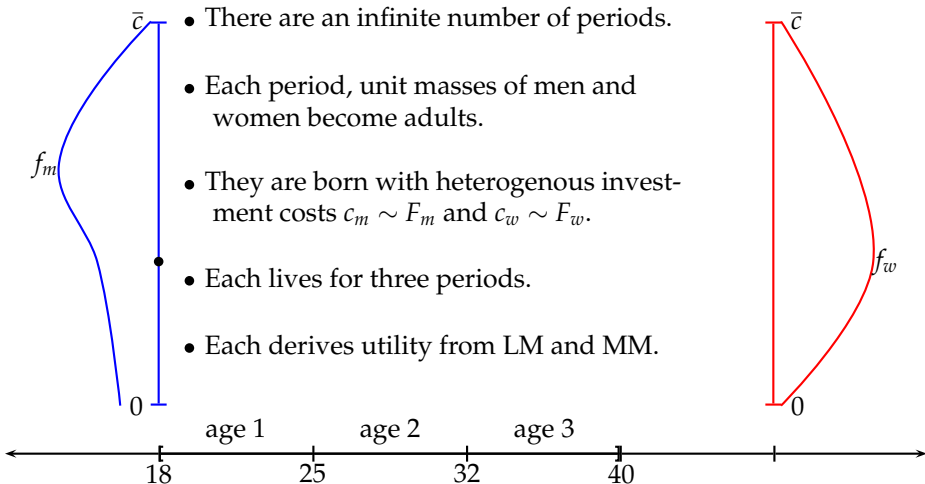
1. extends pre-marriage college investment in Chiappori et al. (2009) by incorporating pre-marriage career investment and bi-dimensional matching in income and reproductive fitness characteristics from Low (2015);
2. advances analytical tractability and derives previously unattainable comparative statics results; and
3. through the equilibrium marriage-market channel, a reversed college gender gap can arise in this model even when women are disadvantaged in the labor market, the marriage market and abilities; in contrast, can only arise in Chiappori et al. (2009) when women have a significant advantage in at least one aspect and no disadvantage in other aspects.

Relation to Literature

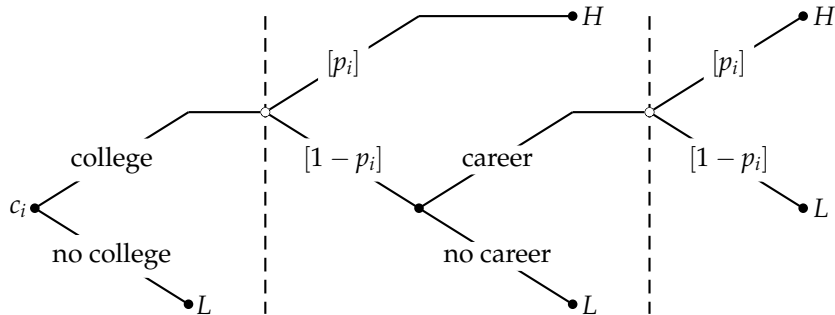
- ▶ synthesizes empirical literature on the college gender gap (Dougherty, 2005; Goldin et al., 2006; Becker et al., 2010a,b), etc.
- ▶ lends theoretical foundation to effects marriage-market incentives on human capital investments (Lafortune, 2013; Iyigun and Lafortune, 2016).
- ▶ derives education consequences of the biological gender difference of reproductive fitness, adding to work exploring its marriage and labor market consequences (Siow, 1998; Low, 2015; Zhang, 2015a,b; Sautmann, 2016).
- ▶ has a unique equilibrium with efficient pre-matching investments (Cole et al., 2001; Peters and Siow, 2002; Iyigun and Walsh, 2007; Bhaskar and Hopkins, 2013; Dizdar, 2013; Nöldeke and Samuelson, 2015).

Simple Model

Extended Model

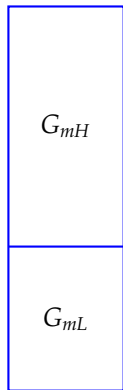


College and Career Investments



Marriage Market

Extended Model



- Overlapping generations in the marriage market each period.
- Men: high-income (H),
low-income (L).
- Women: high-income (H),
low-income (L).
- Surplus $s : \{H, L\} \times \{H, L\} \rightarrow \mathbb{R}_+$.
- strictly supermodular in incomes

Public good provision justifies this assumption

- Career investment costs k for women.

The extended model endogenizes this cost



Stable Outcome

Extended Model

A *stable outcome* of the marriage market consists of

- ▶ a *stable matching* $G = (G_{HH}, G_{HL}, G_{LH}, G_{LL})$
- ▶ *stable marriage payoffs* $v_m = (v_{mH}, v_{mL}), v_w = (v_{wH}, v_{wL})$

1. Everyone gets at least as much as being single,

$$v_{mH}, v_{mL}, v_{wH}, v_{wL} \geq 0.$$

2. Every couple divides the entire marriage surplus,

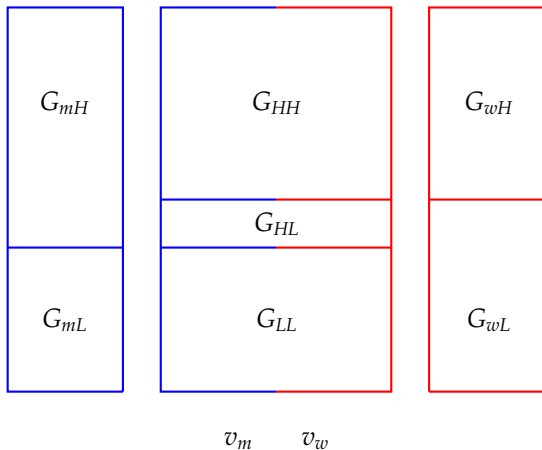
$$v_{m\tau_m} + v_{w\tau_w} = s_{\tau_m\tau_w} \quad \text{if } G_{\tau_m\tau_w} > 0.$$

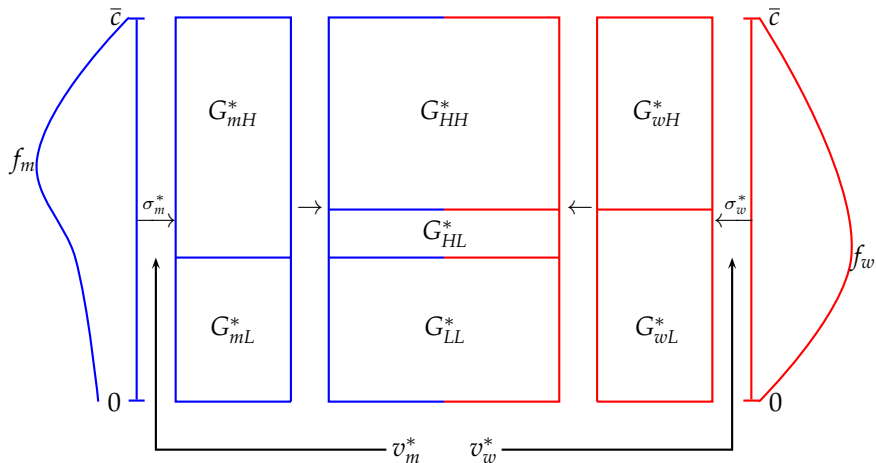
3. No man and woman can benefit from rematching,

$$v_{m\tau_m} + v_{w\tau_w} \geq s_{\tau_m\tau_w} \quad \forall \tau_m, \tau_w.$$

Stable Outcome

Extended Model

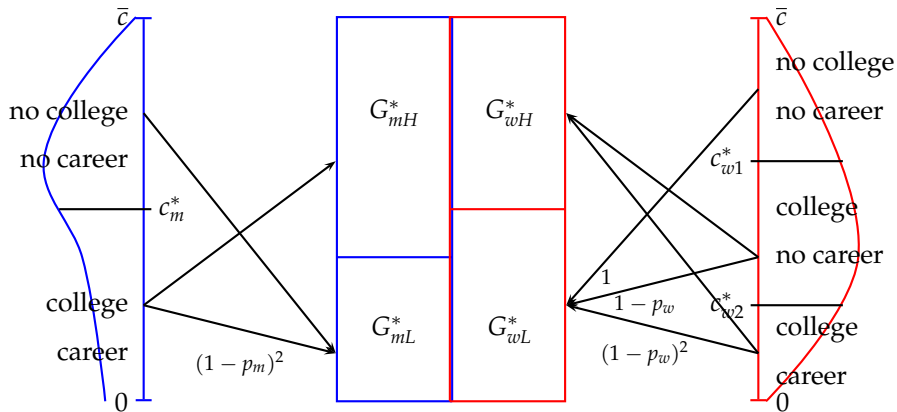




Theorem 1. There always exists a unique equilibrium.

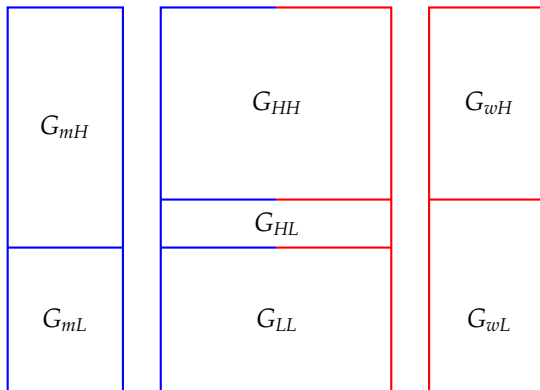
Equilibrium Investments and Income Distributions

Extended Model



Equilibrium Matching 1

Extended Model

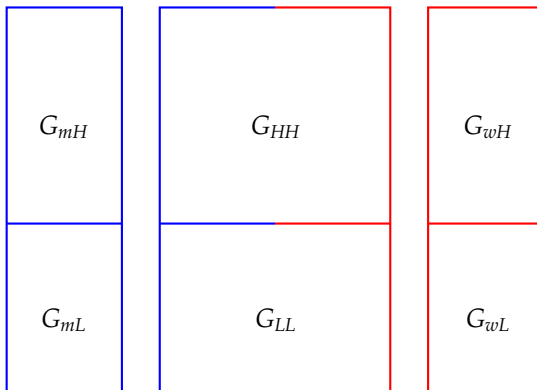


$$v_{mH} - v_{mL} = s_{HL} - s_{LL}$$

$$v_{wH} - v_{wL} = s_{HH} - s_{HL}$$

Equilibrium Matching 2

Extended Model

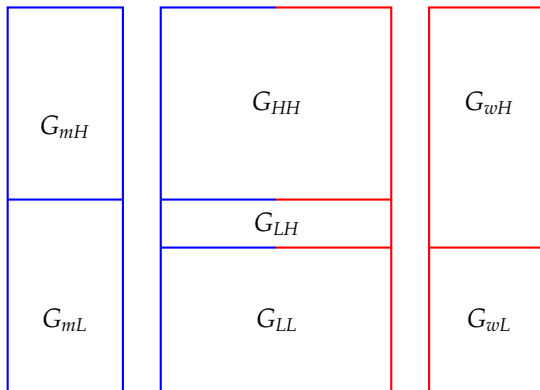


$$S_{HL} - S_{LL} \leq v_{mH} - v_{mL} \leq S_{HH} - S_{LH}$$

$$S_{LH} - S_{LL} \leq v_{wH} - v_{wL} \leq S_{HH} - S_{HL}$$

Equilibrium Matching 3

Extended Model



$$v_{mH} - v_{mL} = s_{HH} - s_{LH}$$

$$v_{wH} - v_{wL} = s_{LH} - s_{LL}$$

Narrowed College Gender Gap and Gender Pay Gap

Proposition 1

Suppose that there are strictly fewer high-income women than high-income men. The college gender gap and the gender pay gap shrink when

- (a) (societal changes) Women's ability distribution F_w decreases to a first-order stochastically dominated distribution F'_w ,*
- (b) (labor-market changes) Women's investment success probability p_w increases, women's income gain $y_{wH} - y_{wL}$ increases, and/or*
- (c) (marriage-market changes) The marriage surplus gain from having a high-income wife relative to a low-income wife for a high-income man, $s_{HH} - s_{HL}$, increases.*

Supporting Evidence

- (a) (societal improvements) Decrease in investment cost and social stigma and a shifted demand favoring brain rather than brawn: Goldin (1990), Goldin et al. (2006); Behrman et al. (2010).
- (b) (labor-market improvements) Increase in labor market opportunities (discrimination, “the pill”): Goldin (1990); Goldin and Katz (2002); Bailey (2006); and increase in income gain: Dougherty (2005); Katz and Murphy (1992); Mulligan and Rubinstein (2008).
- (c) (marriage-market improvements) Increase in high-income and highly educated women’s value at home, or positive-assortative matching: Greenwood et al. (2014).

Proposition 2

When the setting is gender-symmetric ($F_m = F_w$, $y_{mH} - y_{mL} = y_{wH} - y_{wL}$, $p_m = p_w$, $s_{HL} = s_{LH}$) but women face a positive career cost ($k > 0$), strictly more women than men go to college.

Intuition

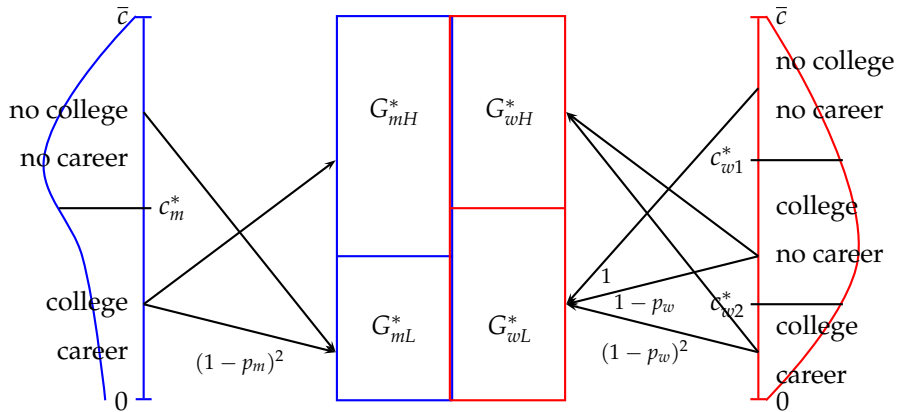
- ▶ All college men make a career investment.
- ▶ Not all college women make a career investment.
- ▶ Fewer women than men end up with a high income in LM.
- ▶ Fewer women than men end up with a high income in MM.
- ▶ High-income women are scarcer than high-income men.
- ▶ Women have an endogenously higher MM return to college.

Proposition 3

When the setting is gender-symmetric ($F_m = F_w$, $y_{mH} - y_{mL} = y_{wH} - y_{wL}$, $p_m = p_w$, and $s_{HL} = s_{LH}$) but women face a positive career cost ($k > 0$), fewer women than men earn a high income.

Reversed College Gender Gap and Persistent Gender Pay Gap

Extended Model



Robustness of the Main Result

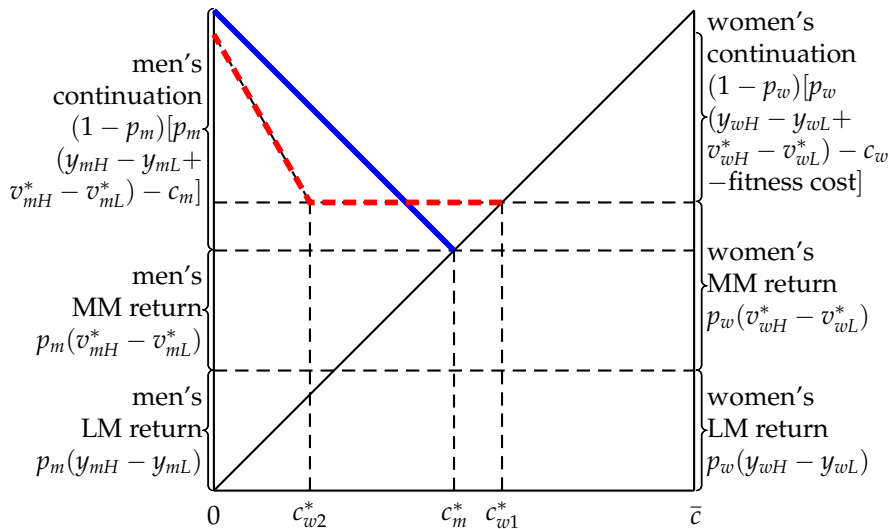
- ▶ **Equilibrium marriage-market effect** drives the result.
- ▶ Income-income super-modularity is necessary for reversed college gender gap.
- ▶ Three-period investments, bi-dimensional matching characteristics, balanced sex ratio and no discounting in the setup are not crucial.
 - ▶ In the equilibrium of a two-period investment-and-matching model, more women than men may invest when men succeed with probability 1 and women succeed with probability $p < 1$.

Implication on Returns to College

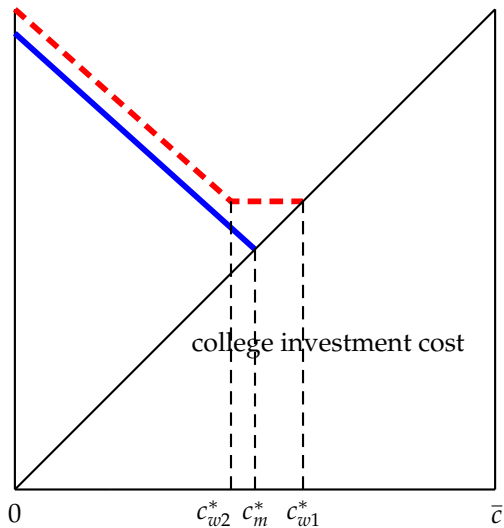
Proposition 4

- (a) *The equilibrium net returns to college differ by gender and by ability within a gender.*
- (b) *The equilibrium net returns to college of marginal college-investing women are always higher than those of the men of the same abilities.*
- (c) *The average equilibrium net returns to college of women could be higher or lower than those of men.*

Proposition 4a: Returns to College differ by gender and by ability within a gender.

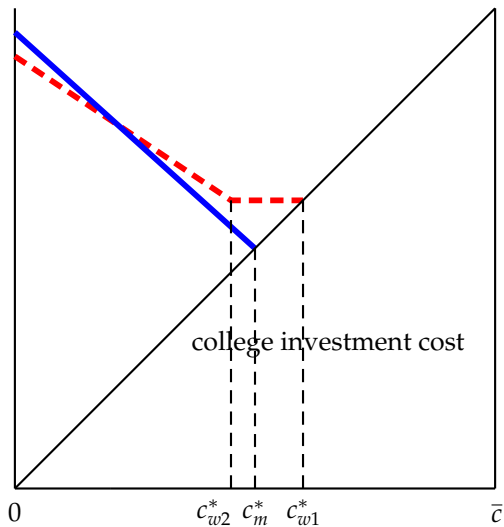


Marginal versus Average Returns to College, Case (A)



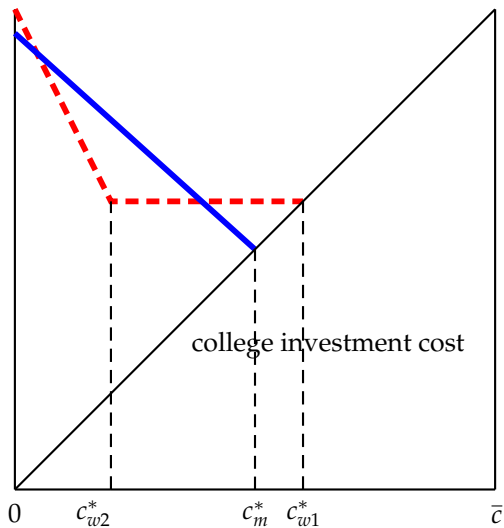
(A)

Marginal versus Average Returns to College, Case (B)



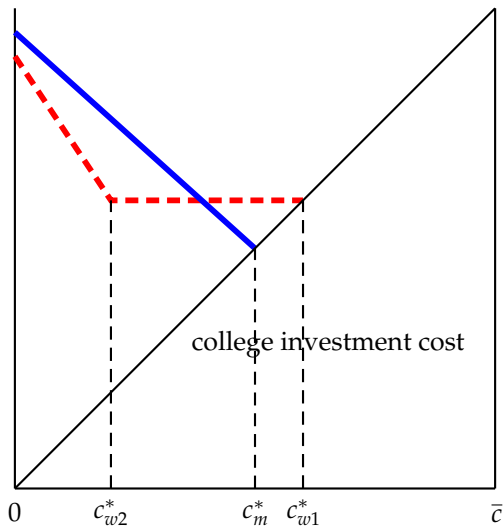
(B)

Marginal versus Average Returns to College, Case (C)



(C)

Marginal versus Average Returns to College, Case (D)



(D)

Widening College Gender Gap and Widening Gender Pay Gap?

Extended Model

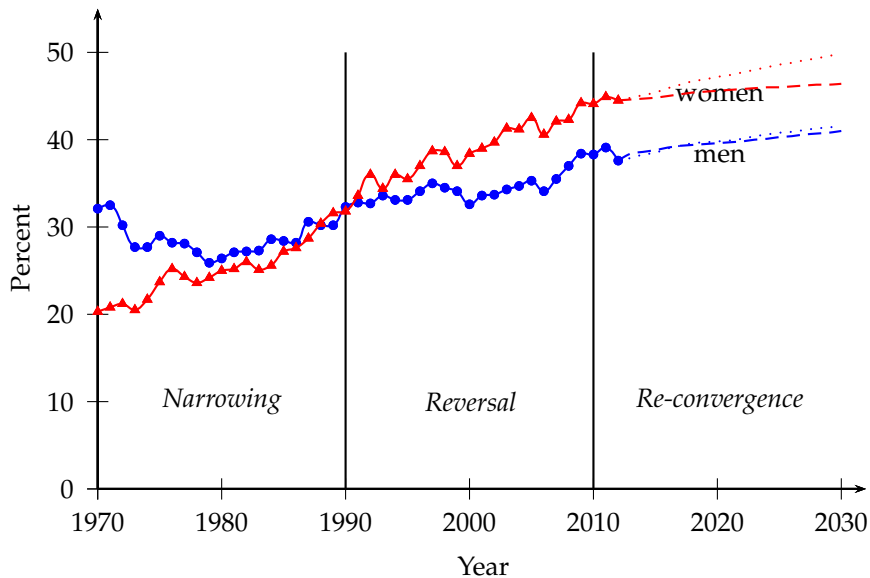
Proposition 5

When the setting is completely gender-symmetric ($F_m = F_w$, $y_{mH} - y_{mL} = y_{wH} - y_{wL}$, $p_m = p_w$, $s_{HL} = s_{LH}$ and $k = 0$), the same number of women and men go to college and the same number of women and men earn a high income.

Implications: When the reproductive fitness is no longer a constraint for women's career advancement,

- ▶ An increasing number of women end up with high-income jobs.
- ▶ High-income women's bargaining power in the marriage market declines.
- ▶ Women's college investment incentive decreases.
- ▶ Fewer women go to college.

Re-convergence of the College Gender Gap



Conclusion

1. Constructs an equilibrium investments-and-marriage model with endogenous college and career investments, income distributions, marriage-age distributions, marriage matching, and divisions of marriage surplus.
2. Explains and predicts changes in the college gender gap and the gender pay gap in the United States and around the world.
 - 2.1 Past: narrowed college gender gap and narrowed gender pay gap.
 - 2.2 Present: reversed college gender gap and persistent gender pay gap.
 - 2.3 Future: widening (?) college gender gap and widening (?) gender pay gap.
3. Provides a framework to study other patterns: non-assortative matching and relationships between marriage-age and income (Zhang, 2016), as well as career choices (Zhang, 2017).

THANK YOU!

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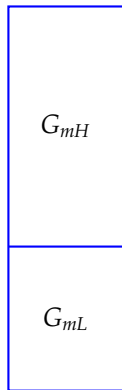
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- ▶ In the extended model, women's reproductive fitness is modeled as a separate dimension in the marriage market to endogenize women's additional career cost k .
- ▶ All the propositions continue to hold.
- ▶ The college and career investments are the same as in the simple model. The difference starts from the description of the marriage market.

Marriage Market

Simple Model



- Age 3 women are reproductive fit w.p. r .
- All others are fit with probability 1.
- Overlappin' generat'ns in MM each period.
 - Men: high-income (mH), low-income (mL).
 - Women: high-income fit (wH), high-income less-fit (wh), low-income fit (wL), low-income less-fit (wl).
- Surplus $s : \{H, L\} \times \{H, h, L, l\} \rightarrow \mathbb{R}_+$.
 - supermodular in incomes, in income & fitness.



Stable Outcome

Simple Model

A *stable outcome* of the marriage market consists of

- ▶ a *stable matching* $G_{\tau_m \tau_w}$: mass of (τ_m, τ_w)
- ▶ *stable marriage payoffs* $v_m = (v_{mH}, v_{mL})$ and $v_w = (v_{wH}, v_{wL}, v_{wh}, v_{wl})$

1. Everyone gets at least as much as being single,

$$v_{mH}, v_{mL}, v_{wH}, v_{wL}, v_{wh}, v_{wl} \geq 0.$$

2. Every couple divides the entire marriage surplus,

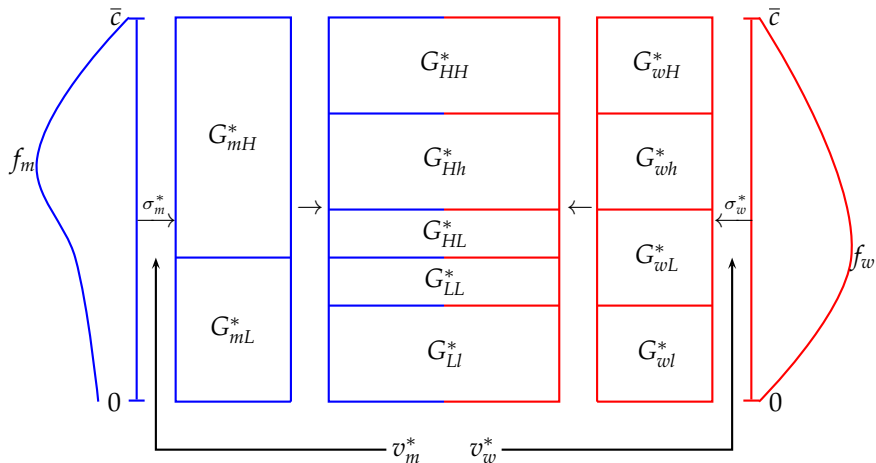
$$v_{m\tau_m} + v_{w\tau_w} = s_{\tau_m \tau_w} \quad \text{if } G_{\tau_m \tau_w} > 0.$$

3. No man and woman can benefit from rematching,

$$v_{m\tau_m} + v_{w\tau_w} \geq s_{\tau_m \tau_w} \quad \forall \tau_m, \tau_w.$$

Equilibrium

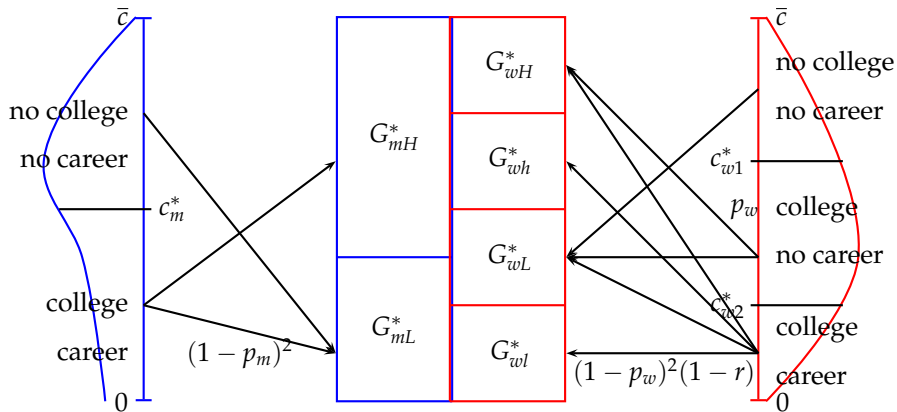
Simple Model



Theorem 1. There always exists a unique equilibrium.

Equilibrium Investments and Marriage-Type Distributions

Simple Model

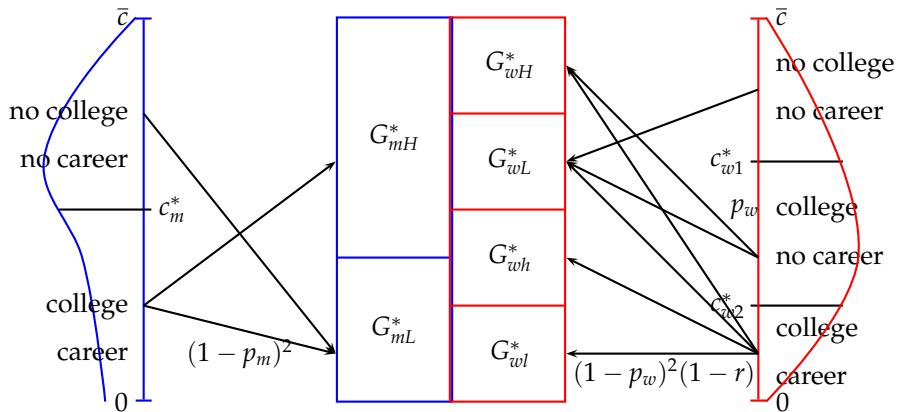


Equilibrium Matching

Simple Model 1

Simple Model 2

Simple Model 3



Proposition 2

When the setting is gender-symmetric ($F_m = F_w$, $y_{mH} - y_{mL} = y_{wH} - y_{wL}$, $p_m = p_w$, $s_{HL} = s_{LH}$) but women still face reproductive constraint ($r < 1$), strictly more women than men go to college.

Intuition

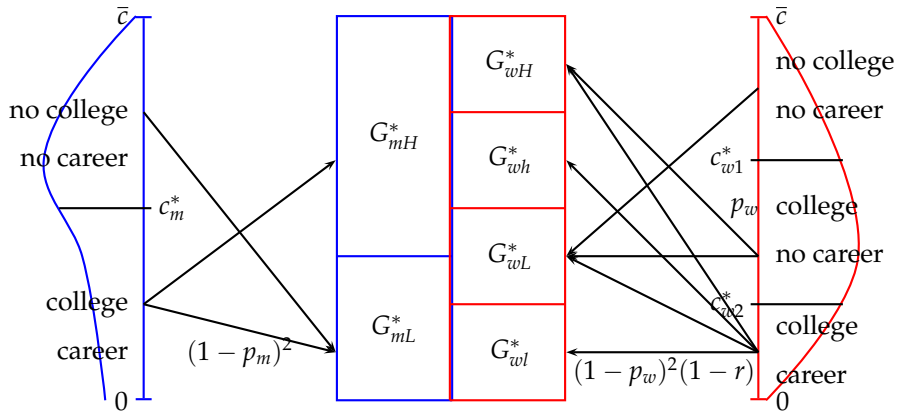
- ▶ All college men make a career investment.
- ▶ Not all college women make a career investment.
- ▶ Fewer women than men end up with a high income in LM.
- ▶ Fewer women than men end up with a high income in MM.
- ▶ High-income women are scarcer than high-income men.
- ▶ Women have an endogenously higher MM return to college.

Proposition 3

When the setting is gender-symmetric ($F_m = F_w$, $y_{mH} - y_{mL} = y_{wH} - y_{wL}$, $p_m = p_w$, and $s_{HL} = s_{LH}$) but women face a reproductive constraint ($r < 1$), fewer fit women than men earn a high income.

Reversed College Gender Gap and Persistent Gender Pay Gap

Simple Model



Widening College Gender Gap and Gender Pay Gap?

Simple Model

Proposition 5

When the setting is completely gender-symmetric ($F_m = F_w$, $y_{mH} - y_{mL} = y_{wH} - y_{wL}$, $p_m = p_w$, $s_{HL} = s_{LH}$, and $r = 1$), the same number of women and men go to college and the same number of women and men earn a high income.

Implications: When the reproductive fitness is no longer a constraint for women's career advancement,

- ▶ An increasing number of women end up with high-income jobs.
- ▶ Young and successful women's bargaining power in the marriage market declines.
- ▶ Women's college investment incentive decreases.
- ▶ Fewer women go to college.

Public good provision justifies supermodularity

back to marriage market

Consider an income y_m man and an income y_w woman who allocate income between a private good q and a public good Q . The marriage surplus is

$$\begin{aligned} & \max_{q_m+q_w+Q \leq y_m+y_w} q_m Q + q_w Q - \max_{q_m+Q \leq y_m} q_m Q - \max_{q_w+Q \leq y_w} q_w Q \\ = & \frac{(y_m + y_w)^2}{4} - \frac{y_m^2}{4} - \frac{y_w^2}{4} \\ = & \frac{y_m y_w}{2}. \end{aligned}$$

The marriage surplus is increasing in incomes, strictly supermodular in incomes, and any division of marriage surplus can be achieved through perfect transfers between the couple.