Educational gradients in marriage, cohabitation, and fertility

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Abstract

In this paper, I study the choice between marriage and cohabitation joint with fertility decisions. Non-marital cohabitation, living with a partner without getting married, is a common practice in the U.S., and increasingly many children are born to cohabiting parents. Despite this prevalence, the literature on family economics typically ignores cohabitation as a form of household union distinct from marriage or being single. I document that there are educational gradients in fertility and union choices. Less educated women are more likely to cohabit and give birth while cohabiting than are more educated women. I build a lifecycle model of fertility and household union choice, featuring a trade-off between quality and quantity of children in order to be consistent with these observations. In the model, I assume that married couples pay a cost to divorce. Cohabitation provides costless separation, but there is exogenous separation shock. As more educated women choose to have children of higher quality than quantity compared to less educated women, they are more likely to choose marriage, which is more stable than cohabitation. Less educated women start household unions even with low match quality in order to have the economic benefit of living together. The calibrated model generates educational gradients observed in data. Using the calibrated model, I introduce common-law marriage to the economy. I find that the policy leads fewer people to choose cohabitation, and more children are born to married parents. As a result, children receive 20% more investment during their childhood compared to the economy without the policy.

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1 Introduction

Non-marital cohabitation, living with a romantic partner outside of marriage, is a common practice in the United States. According to the National Survey of Family Growth (NSFG) 2013 – 2015, 16% of 18 to 44 years old women in the U.S. are cohabiting, and 61% have ever cohabited in the past. As a result, many children are born to cohabiting parents. Of the NSFG 2013 – 2015 respondents' children who were born after 2005, 27% were born while the respondents were cohabiting. Moreover, using the National Longitudinal Survey of Youth 1979 (NLSY 79) and NSFG 2002, I find that there are educational gradients in fertility, marriage, and cohabitation choices. Less educated women are more likely to cohabit and give birth while cohabiting than are more educated women. In this paper, I study the choice between marriage and cohabitation joint with fertility decisions and explain the educational gradients using the trade-off between quality and quantity of children.

Understanding the choice between marriage and cohabitation is important because it is closely related to child development. Periods of cohabitation are typically shorter than marriage, and cohabitations do not necessarily end with marriage. Therefore, children born to cohabiting parents are much more likely to live in a single-parent household during their childhood than children born to married parents. Many studies find that children who grow up with both biological parents show higher achievement along various dimensions compared to those who grow up with a single parent (e.g., Abbott (2015), Kearney and Levine (2017), Tartari (2015)). Using the combined samples from the NLSY 79 and its accompanying the Children of NLSY (CNLSY), I document that 82% of children live with their father if their mother was married at the time of the child's birth, whereas 58% of children born to a cohabiting mother do. Children born to cohabiting mothers are less likely to have a college education compared to children born to married mothers in the sample even after controlled for mother's education. Furthermore, the educational gradients in cohabitation imply that cohabitation is a channel of the intergenerational persistence of educational attainment.

Some countries have introduced the institution of common-law marriage to protect the vulnerable parties in cohabitation. The details vary across jurisdictions, but cohabiting couples who meet certain criteria face legal obligations, such as alimony payment or property division, which make separation more costly. However, cohabiting couples in the U.S. have no legal regulations.[1] As a consequence, American cohabitation is a particularly short-lived relationship compared to other countries' cohabitations (Heuveline and Timberlake (2004)). To study the effect of introducing a common-law marriage policy similar to what is seen in other countries, I build a lifecycle model of marriage, cohabitation, and fertility decisions.

My model builds on the lifecycle model of imperfect fertility choice from Choi (2017) incorporating the choice between marriage and cohabitation.[2] The model has three key features. First, the model includes both cohabitation and marriage as types of household union. They are different when the relationship ends. I assume that married couples have to pay a cost to divorce, but cohabiting couples separate without any cost. Instead, cohabiting couples are subject to a separation shock. Second, following the insight of Becker and Tomes (1976), the model features the trade-off between quantity and quality of children. A mother receives utility from the number (quantity) and quality of her children. I assume that increasing the quantity of children requires mother's time and increasing the quality requires consumption goods (money). Third, women have imperfect control over fertility. Because cohabitation is more likely to end than marriage, women prefer to postpone fertility until they get married in order to invest more in her child. Women can control the fertility process, but the contraceptive technology is imperfect. As a result, some cohabiting women have children in the model although they do not want to.

My study contributes to the literature by studying the union decision, including cohabitation, joint with fertility and child investment decisions. This allows the model to generate the educational gradients in union and fertility due to the trade-off between quantity and quality of children. This paper is the first to study the choices jointly. The literature on household formation and the

[1] Eleven states and the District of Columbia have 'common-law marriage' in their family law. But to be recognized as a common-law married couple in those states, a couple has to have a written contract or evidence that they hold themselves out as spouses which typically causes lengthy legal disputes in case of their separation. They are different from common-law marriages in other jurisdictions in the sense that no conditions grant the status of common-law marriage automatically. See Dwyer (2012) for details.

[2] Choi (2017) studies the negative correlation between income and fertility. He does not model cohabitation, and the marital status changes exogenously following a stochastic process. I model the choice of household union including cohabitation.

literature on fertility and child investment have little intersection.[3] Moreover, the literature on household formation typically ignores cohabitation as a form of household union distinct from being married or single (Lundberg and Pollak (2013)).[4] Existing studies of cohabitation assume that people have different preferences toward marriage and cohabitation, and the preference is correlated with education to match the observed gradient in union choices.

Using the model, I find that investing in quality of children is an important motive for getting married for high educated women. If I do not allow mothers to invest in children, the fraction of married women decreases by half among high educated. I also find that the closing of the gender earnings gap leads people to delay their marriage. Lastly, I study the effect of introducing a common-law marriage policy that treats cohabiting couples who give birth the same as married couples. I find this policy leads fewer people to cohabit and more children are to be born to married parents. As a result, children receive more investment during their childhood compared to the economy without the policy. The median amount of spending on a child increases by 20% compared to the economy without the policy.

The rest of the paper is organized as follows. Section 2 documents the educational gradients in fertility and household union choices observed in data. Section 3 presents the model, and Section 4 describes the calibration and the fit of the model. Using the calibrated model, I conduct three quantitative exercises in Section 5. And Section 6 concludes.

2 Evidence of educational gradients

In this section, I document the educational gradients in union and fertility choices observed in samples from the NLSY 79, the CNLSY, and the NSFG 2002. The details of the sample selections are in the appendix (A.1). The educational gradients suggest that the choices of union and fertility

[3] Caucutt, Guner and Knowles (2002), Greenwood, Guner and Knowles (2003), Regalia, Rios-Rull and Short (2011) are the few exceptions.

[4] There are studies which consider cohabitation. Brien, Lillard and Stern (2006) study the volatile nature of cohabitation and find that learning about match quality explains the choice between marriage and cohabitation. Gemici and Laufer (2012) build a model of cohabitation that provides a lower level of commitment because of the lower separation cost than marriage. Adamopoulou (2014) studies the relationship between the narrowing gender wage gap and increasing cohabitation. Similar to this paper, Goussé and Leturcq (2017) study the effect of imposing higher separation cost on cohabiting couples in Canada. They find that the policy fosters marriage and deters cohabitation. This paper is different from existing studies as I model the fertility and child investment decisions.

are interdependent. This motivates the trade off between the quality and quantity of children featured in the model, which will be introduced in Section 3. It allows the model to produce these educational gradients (Section 4). Previous studies, which model the choices independently, must assume differential preferences toward marriage and cohabitation to produce these educational gradients.

Table 1 contains the percentage of unmarried mothers at child's birth for each education group using the sample from the NLSY 79. Compared with women with some college or more education (high education), those with less education (low education) are more likely to have had non-marital births.[5] Among those who have given birth, about 30% of women with low education have given birth outside of marriage, and only 11% of women with high education have. The difference is statistically significant.

Table 1: Percentage of unmarried mothers at child's birth

	Low education[1] (1)	High education[2] (2)	Difference (1) - (2)
Any child	30.46	11.18	19.28
			(1.74)
First child	26.95	10.38	16.57
			(1.65)
Second child	15.89	5.19	10.70
			(1.35)
Third child	22.44	4.54	17.89
			(2.62)

From the sample of the NLSY 79; weighted using provided custom weights; robust standard errors of differences are in parentheses
[1] Those who do not have any college education at age 22
[2] Those who have some college education at age 22

A driver of this educational gradient of non-marital birth is cohabitation. Table 2 shows the percentage of women who have ever cohabited by education group using samples from the NSFG 2002. Low educated women are more likely to have ever cohabited before than are high education

[5]These relative differences are not caused by births to teen mothers (19-year-old or younger at child's birth) or by a particular ethnic group. Although the levels change slightly, the relative differences remain the same if the sample excludes births to teen mothers (Table A1). The same is true for race. The levels vary substantially across ethnic groups, but the same relative relationships remain (Table A2).

women. And, low educated are more likely to give birth during cohabitation (Table 3). However, many of the cohabitations end without marriage. Even after giving birth, about half of cohabitation did not end in marriage for the both groups (Table 4).

Table 2: Percentage of women who have ever cohabited before

	Any cohabitation[1]			Non-marital cohabitation[2]		
	Low edu.[3] (1)	High edu.[4] (2)	Difference (1) - (2)	Low edu. (3)	High edu. (4)	Difference (3) - (4)
%	62.15	49.55	12.60	26.75	16.78	9.96
(s.e.)	(3.27)	(2.37)	(3.52)	(2.81)	(1.55)	(3.05)
N	715	941		715	941	

From the sample of the NSFG 2002, those who were born between April, 1957 and December, 1967 (comparable to the NLSY79 cohort, 37 – 44 years old at the day of interview); weighted using provided weights and survey design variables
[1] 'Any cohabitation' includes current cohabitation, pre-marital cohabitation (married with the cohabitation partner), and non-marital cohabitation
[2] 'Non-marital cohabitation' includes current cohabitation and cohabitations that end without marriage
[3] Those who have no college education
[4] Those with some college or higher education

Although the NLSY 79 did not collect detailed information on the respondents' cohabitation before 1990, the CNLSY surveys whether the child is living with his or her father. Using the mother's marital status in the NLSY 79, the combined sample reveals the union transition after a child is born. Conditional on living with his or her father when a child is born or one year old, 80% are living with their fathers at age 6 or 7.[6] Table 5 shows the percentage of children living with their father at age 6 or 7 conditional on living with their father at age 0 or 1. Again, there is an educational gradient. About 74% of lower educated mothers' children live with their father at age 6 or 7, while 87% of higher educated mothers' children do. Part of this gradient also comes from the educational gradient in cohabitation. Compared with mothers of high education, more mothers with low education were cohabiting when their child was age 0 or 1. For the both levels of

[6] As CNLSY is a biennial survey, the information is collected every two years. For a child who was born in the year when there was no survey, it is not easy to know whether the father was living with the child. This is especially so if the mother was not married. To increase the sample size and ease the analysis, I group the two years' birth cohorts together. The precentage remains at the similar level if I do not group them.

Table 3: Percentage of women gave birth (pregnancy ended as live birth) during cohabitation among those who have cohabited

	Any cohabitation[1]			Non-marital cohabitation[2]		
	Low edu.[3] (1)	High edu.[4] (2)	Difference (1) - (2)	Low edu. (3)	High edu. (4)	Difference (3) - (4)
%	26.69	14.69	11.99	31.65	21.30	10.35
(s.e.)	(2.90)	(2.49)	(3.51)	(4.22)	(5.18)	(5.97)
N	448	504		448	504	

From the sample of the NSFG 2002, those who were born between April, 1957 and December, 1967 (comparable to the NLSY79 cohort, 37 – 44 years old at the day of interview); weighted using provided weights and survey design variables

[1] 'Any cohabitation' includes current cohabitation, pre-marital cohabitation (married with the cohabitation partner), and non-marital cohabitation

[2] 'Non-marital cohabitation' includes current cohabitation and cohabitations that end without marriage

[3] Those who have no college education

[4] Those who have some college or higher education

mother's education, children of cohabiting mothers are less likely to live with their fathers at age 6 or 7 than are children of married mothers. About 60% of children who were born to cohabiting mothers live with their fathers at age 6 or 7, whereas more than 77% of married mothers' children do.

The literature on child development documents that children living with both biological parents have better outcomes in various measures on average.[7] The correlation is observed in this sample as well.[8] Table 6 shows the percentage of children with some college or higher education at their age 22 or 23 conditional on mother's education. Overall, the children of low educated are less likely to have college education at age 22 or 23 than are the children of high educated. The overall difference between the groups is 20 percentage points. Part of the difference comes from the difference in the parental composition between the two education groups, as the children of the low education mothers are more likely to grow up without their fathers at home (Table 5). This can be seen by conditioning the children's cohabitation status with their fathers. If I restrict the

[7] See Kearney and Levine (2017) for a review of the literature on this point.

[8] Tartari (2015) uses the combined sample of the NLSY 79 and the CNLSY to study the effect of parents' divorce on child's cognitive achievement.

Table 4: Percentage cohabitations that did not end with marriage after giving birth

	Low educatation[1] (1)	High educatation[2] (2)	Difference (1) - (2)
Percentage	56.88	48.81	8.07
Standard error	(7.21)	(7.83)	(11.00)
Observations	235	125	

From the sample of the NSFG 2002, those who were born between April, 1957 and December, 1967 (comparable to the NLSY79 cohort, 37 – 44 years old at the day of interview); weighted using provided weights and survey design variables

[1] Those who have no college education

[2] Those who have some college or higher education

sample to the children who lived with their father at age 0 or 1, the 20 percentage points difference decreases to 16 percentage points. The difference continues to shrink as I restrict the children's cohabitation status with their fathers along with their mothers' marital status. For the children whose mothers were married at birth and lived with their fathers at age 6 or 7, the difference reduces to 14 percentage points.

3 Model

To be consistent with the empirical observations regarding educational gradients, the model features a trade off between quantity and quality of children along with household union transition decisions. The model takes a childless single woman who has finished her education as a utility maximizing decision maker. Over the lifecycle, she meets potential partners and makes union transitions. Her partner provides additional income and match quality. Their utility depends on consumption, match quality, and number and quality of her children. She decides whether or not to have an additional child, but she has imperfect control over her fertility.

3.1 Lifecycle and endowments

At the beginning of her life, the woman has no partner or child. A model period is one year. There are two levels of educational attainment, high and low. I assume that the first model period

Table 5: Children living with biological father at age 6 or 7 conditional on living with father at age 0 or 1

	Low education[1]	High education[2]
All children		
% of children living with father	74	87
number of children	1595	1159
Mother was married at age 0 or 1		
% of children living with father	77	88
number of children	1369	1125
Mother was cohabiting at age 0 or 1		
% of children living with father	59	56
number of children	226	34

From the combined sample of the NLSY 79 and the CNLSY, not weighted.

[1] Those who do not have any college education at age 22

[2] Those who have some college or higher education at age 22

starts at age 18 for a low educated woman and age 21 for a high educated woman. The model life of a woman ends at age 60. She receives labor income each period. Her income depends on her education type and increases exogenously as she ages. As I assume that dependent children imposes time costs on their mother, a woman's income depends on the number of dependent children. Conditional on education, age and number of children, there is no uncertainty in the endowment process. There is no borrowing or saving.

3.2 Preference

A woman's per period utility depends on consumption (c_t), the number of dependent children (k_t), the average quality of dependent children (q_t), the match quality with her partner (γ_t), and her contraceptive effort (x_t).[9] I assume the following functional form for the per period utility:

$$u(c_t, k_t, q_t, \gamma_t, x_t) = (1 - \alpha_k - \alpha_q) \log c_t + \alpha_k \log(1 + k_t) + \alpha_q \log(1 + q_t) + \gamma_t - x_t^2.$$

[9] The value of match quality is zero if she is a single. This match quality can be interpreted as a non-economic benefit (or cost) of living with a partner relative to living alone.

Table 6: Percentage of children having some college or more education at age 22 or 23

	Low education[1]	High education[2]
All children		
% of children with some college or higher	61	81
number of children	1,656	953
Children lived with father at age 0 or 1		
% of children with some college or higher	68	84
number of children	635	571
Mother was married at age 0 or 1		
% of children with some college or higher	70	85
number of children	559	548
Children lived with father at age 6 or 7		
% of children with some college or higher	72	87
number of children	497	493
Mother was married at age 0 or 1, and children lived with father at age 6 or 7		
% of children with some college or higher	73	87
number of children	451	477

From the combined sample of the NLSY 79 and the CNLSY, not weighted.
[1] Those who do not have any college education at age 22
[2] Those who have some college or higher education at age 22

She maximizes the discounted present value of expected lifetime utility with a discount factor β: $U_t = \sum_{j=t}^{T} \beta^{j-t} \mathbb{E}_t u_j$.

3.3 Children

A woman can have up to K children in her lifetime, at most a child a period (no twins are allowed). She is fertile until age a_f. Once a child is born, the child stays with his/her mother during his/her childhood, regardless of the mother's union transition. Every period, each dependent child grows and leaves his/her mother with probability p_c.

During her fertile periods, a woman decides whether to have an additional child. If she wants to have an additional child, a new baby arrives with some probability. If she does not want to have one, she can exert contraceptive effort to avoid unwanted fertility. However, the contraceptive technology is imperfect. Her contraceptive effort (x_t) affects the probability of an additional child.[10] As a result, mothers may have unwanted children. The efficacy of the contraceptive technology depends on her union status: conditional on exerting the same level of effort, a woman living in a union has a higher chance of having an additional child than a single woman.

While the child is dependent, the mother receives utility from her child. In the spirit of Becker and Tomes (1976), her utility from children depends on the number and the quality of dependent children.[11] I assume that the quality is measured by average spending on dependent children, and it does not accumulate over time (the past history of spending does not affect the quality of children):

$$q_t = \begin{cases} 0 & \text{if no dependent child } (k_t = 0), \\ s_t / k_t & \text{otherwise,} \end{cases}$$

where k_t is the number of dependent children, and s_t is the amount of spending on children.

Children impose direct and indirect costs on their mother. Dependent children affect their mother's income (direct cost), because children reduce their mother's available hours to work. Therefore, compared to non-mothers (women with no dependent children), mothers have lower income. I assume that this direct cost is temporary: her earnings return to the level of non-mothers of the same age after all of her dependent children have grown and left her.[12] Also, in the matching market, mothers have a lower chance of meeting a new partner compared to non-mothers (indirect cost).

[10]Decision of having an abortion is not modeled, but this contraceptive effort can be viewed as a decision including abortion. The model in Choi (2017) has abortion decisions in addition to imperfect control over fertility as the model in this paper.

[11]Her adult children, who have left the household, do not affect her utility.

[12]In the sample from the NLSY 79, there is no significant difference between mother's and non-mother's (those who never had children) earnings in their later lifecycle.

3.4 Union transition

Each period, after the fertility outcome is realized, a single woman meets a potential partner with probability $\lambda(t, k_t)$.[13] Partners have one of two educational types (either low or high) which affect their income profile. A woman's own education type affects the probability distribution of her potential partner's education type: a woman with low education has a greater likelihood of meeting a partner with low education than a woman with high education. Upon meeting, she draws a match quality, γ_t, and decides whether to stay single or to form a union. Living in a union provides her additional income (from the partner's income and economies of scale in consumption) and utility from match quality. There are two types of unions available: marriage and cohabitation. When a marriage ends in divorce, a utility cost of divorce, κ, incurs. Cohabitants can separate costlessly, but there is an exogenous separation shock, δ, which separates a couple regardless of their match quality.[14]

A couple's match quality is stochastic. A woman in a union can change her union status after observing new match quality and fertility outcomes. A cohabiting woman (conditional on not receiving a separation shock) can separate, marry her partner, or continue to cohabit. A married woman can divorce or stay married.[15] Divorced and separated women stay single for the period and enter the matching market the next period.

3.5 Timing of events within a period

Figure 1 summarizes the timing of events within a typical period. They are as follows:

1. Shocks on fertility realize.

   (a) Each of a mother's existing dependent children grow and leave with probability p_c. The shock is independent across each child.

[13] As explained in Section 3.3, the number of children, k_t, affects the probability of meeting a partner (indirect cost of children).

[14] In other words, separation from a cohabiting couple can be either voluntary or involuntary because of this separation shock. All divorces are voluntary.

[15] Starting cohabitation with her husband is feasible, but it is never an optimal choice as it incurs the divorce cost without altering match quality.

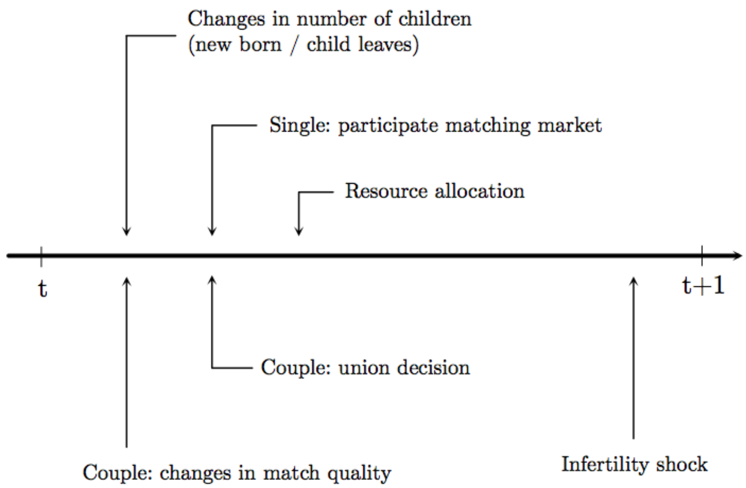

Figure 1: Timeline of the model

   (b) If a woman is fertile, a child may be born based on previous period's contraceptive effort.

2. The woman makes union transition decisions.

   (a) If she was single at the end of the previous period, a potential partner arrives with some probability. She draws a match quality, and makes a union decision.

   (b) If she was cohabiting at the end of the previous period:

      i. The separation shock arrives with probability, δ, or

      ii. If the separation did not happen, a new match quality is drawn and she makes a union transition decision whether to keep cohabiting, marry her partner, or separate.

   (c) If she was married at the end of the previous period, a new match quality is drawn and she makes a union transition decision of whether to stay married, or divorce.

3. A woman allocates resources to consumption, spending on children, and decides how much fertility/contraceptive effort to make.

3.6 Dynamic programs

The problem is solved backwards. Given fertility outcomes and union choices, I solve the resource allocation problem. Define the final period's continuation value, $F_{T+1} = 0$. For a given period t, a t-period-old single woman has state variables of (e, k_t, n_t): her level of educational attainment e, the number of dependent children k_t, and the number of children she has ever had n_t. For a given state, the value function of a single woman at the end of the period (after this period's uncertainties regarding fertility and match quality are resolved and the decision on union allocation is made) is,

$$\begin{aligned} F_t^S(e, k_t, n_t) = \max_{c,s,x} \quad & u(c, k_t, s) - x^2 \\ & + \beta \mathbb{E}_{e^*, \gamma_{t+1}, k_{t+1}, n_{t+1}} \{F_{t+1}(e, e^*, \gamma_{t+1}, k_{t+1}, n_{t+1}, S_t = S) | k_t, x\}, \\ \text{s.t.} \quad & c \leq E(e, t, k_t, n_t) - k_t s, \\ & c > 0, \ s \geq 0. \end{aligned} \tag{1}$$

A single woman decides how much to consume, c, how much to spend on her children, s, if she has children, given her earnings, E. She also decides how much effort to make to affect next period's fertility, x.[16]

The value function of a woman in a union at the end of the period, either cohabiting ($j = C$) or married ($j = M$), is defined similarly with additional state variables of partner's educational attainment, e^*, and match quality, γ_t:

$$\begin{aligned} F_t^j(e, e^*, \gamma_t, k_t, n_t) = \max_{c,s,x} \quad & u(c, k_t, s) - x^2 + \gamma_t \\ & + \beta \mathbb{E}_{\gamma_{t+1}, k_{t+1}, n_{t+1}} \{F_{t+1}(e, e^*, \gamma_{t+1}, k_{t+1}, n_{t+1}, S_t = j) | \gamma_t, k_t, x\}, \\ \text{s.t.} \quad & \frac{c}{\psi} \leq E(e, t, k_t, n_t) + E^*(e^*, t) - k_t s, \\ \text{where} \quad & j \in \{C, M\}. \end{aligned} \tag{2}$$

[16]If she is infertile, the probability of having an additional child is 0, by definition. It does not depend on her effort, x. Therefore, it is optimal to make no effort, $x = 0$, if she is infertile.

A woman enjoys match quality, γ_t, if she lives with her partner. Her available resources are increased by partner's earnings, E^*. Her consumption is adjusted by an economies of scale parameter, ψ.

Given the values of each type of union and being single, she makes the union transition that gives her the highest value. This defines the value function at period t (after uncertainties are resolved):

$$F_t(e, e^*, \gamma_t, k_t, n_t, S_{t-1}) = \max \begin{Bmatrix} F_t^M(e, e^*, \gamma_t, k_t, n_t), \\ F_t^C(e, e^*, \gamma_t, k_t, n_t) - \mathbb{1}_{\{S_{t-1}=M\}} \kappa_M, \\ F_t^S(e, k_t, n_t) - \mathbb{1}_{\{S_{t-1}=M\}} \kappa_M \end{Bmatrix}. \tag{3}$$

3.7 Discussion

In the model, living in a union has economic and non-economic impacts on a woman. The economic impact comes from the partner's income and economies of scale in consumption. The household has two earners, and by pooling their income together the disposable resources increase even more than the sum of the two income effectively. The non-economic impact arises from the match quality and the contraceptive technology. A woman in a couple derives direct utility from the match quality with her partner. She also has a higher chance of having an unwanted child compared to a single woman, conditional on having the same level of contraceptive effort.

The divorce cost for marriage and the separation shock for cohabitation give an intuitive relationship between match quality and union choice. All else equal, there is a threshold match quality above which a woman chooses to marry and below which she does not. There is another threshold above which she cohabits and below which she ends a union or stays single.[17] A woman with a high enough match quality chooses marriage over cohabitation to avoid the separation shock. If the match quality is not high enough, it is better to cohabit to avoid the divorce cost. Once

[17]Depending on parameter values and state variables, the thresholds may collapse into one. For example, there is only one threshold for a married woman above which she stays married and below which she divorces.

a woman marries, the threshold of ending the marriage is lower than that of a cohabiting couple due to the divorce cost. The duration of marriage is longer than cohabitation in the model for three reasons. Married couples stay together longer than cohabiting couples because of the selection on match quality (a marriage starts with higher match quality), the divorce cost (a married couple stays in the union with lower match quality), and the exogenous separation shock for cohabitants.

4 Calibration

As analytical expressions of policy functions of the model do not exist, I solve the model numerically. In this section I make parametric assumptions and discuss how to calibrate model parameters. The purpose of calibrating the model is to have model agents behave similar to the U.S. economy observed in data along with the dimensions of interest in order to use the model to analyze the role of quality and quantity trade off on union decision and the impact of introducing common-law marriage policy. Parameters regarding endowment process are set outside of the model, and the remaining parameters are calibrated to match various moments of fertility and union transitions of the NLSY 79 cohort.

4.1 Endowment process

The age profile of endowments and parameters regarding direct costs of children are estimated outside of the model. Using annual earnings data from the NLSY 79, I compute the mean age profile of earnings of men, and fit a fourth order polynomial of age to it, for the two education groups separately. I take the fitted values as model age profiles of men's endowments.

I assume the age profiles of endowments of childless women are the same as the age profile of men with the same level of education with a proportional gap.[18] I label the proportional difference as the 'gender gap.' I estimate the gender gap with a dummy variable of sex in a log earnings regression after controlling for age and race, for the two education groups separately (Table 7).

In the model, women's endowments are affected by the number of dependent children, which reduces their working hours (time cost). I estimate the cost using the NLSY 79 sample. I regress

[18] Mothers bear a direct cost of children in the model, which are separately estimated.

Table 7: Gender earnings gap

	Low education[1]	High education[2]
Gender gap	0.2788	0.2648
Standard error	(0.0351)	(0.0320)

Samples from the NLSY 1979, weighted using custom weights and clustered at the individual level to compute the standard errors
Differences in log wage earnings between men and childless women after controlled for age and race
[1] Those who have no college education at age 22
[2] Those who have some college or higher education at age 22

women's log annual work hours on the number of dependent children. Table 8 reports the estimates. In the calibration, I use the fixed effect point estimates of each group (last two columns of Table 8).

Table 8: Correlation between work hours and number of dependent children k_t

	OLS			FE		
k_t	All	Low edu.[1]	High edu.[2]	All	Low edu.	High edu.
1	−0.1766	−0.1653	−0.1875	−0.2219	−0.1795	−0.2683
	(0.0141)	(0.0183)	(0.0222)	(0.0146)	(0.0185)	(0.0238)
2	−0.2996	−0.2773	−0.3112	−0.3546	−0.3043	−0.3908
	(0.1744)	(0.0223)	(0.0292)	(0.0186)	(0.0229)	(0.0318)
3	−0.4038	−0.3987	−0.3728	−0.4187	−0.3840	−0.4171
	(0.0307)	(0.0405)	(0.0457)	(0.0306)	(0.0379)	(0.0499)

Samples from the NLSY 79; age (and race for OLS) is controlled
Clustered standard errors are in parentheses; all estimates are statistically significantly different from zero at 0.1% confidence level
[1] Those who have no college education at age 22
[2] Those who have some college or higher education at age 22

4.2 Contraceptive technology

The probability of having an additional child next period depends on this period's age (t), the level of contraceptive effort (x), and the current union status (S_t). Compared to exerting no effort, the probability decreases exponentially in the contraceptive effort.[19] The functional form is given by:

$$p_t(x; S_t = j) = p_0(t)\left[\frac{\mathbb{1}_{x>0}}{p_j \exp(p_1 x)} + \mathbb{1}_{x=0}\right], \quad \text{where} \quad p_j = \begin{cases} p_s, & \text{if } j = S, \\ p_u, & \text{if } j \in \{C, M\}, \end{cases} \tag{4}$$

If a woman wants to have a child, she can have one with probability $p_0(t)$, which depends on her age, by exerting no effort ($x = 0$). If she does not want to, she can affect the probability by exerting a strictly positive level of effort ($x > 0$). The parameter p_j determines the base level of contraceptive technology, which depends on current union status. By exerting infinitesimal effort ($x \to 0+$), the probability of childbearing decreases by $1/p_j$ (assuming $p_j \geq 1$) compared to exerting no effort. The parameter p_1 denotes the efficacy of contraceptive technology. For the process of the probability of having a child when exerting zero effort, I assume that it is a continuous function of age, $p_0(t)$. It reaches zero at the end of fertile period, t_f: $p_0(t) = 0$, for $t \geq t_f$. The function is approximated using five points and interpolating between them, and four of them are calibrated. All parameters regarding contraceptive technology are calibrated inside of the model.

4.3 Partner meeting and match quality

The probability a single woman meets a potential partner depends on her age and whether she had children before (indirect cost of children). At a period t, a single childless woman meets a potential partner with probability $\lambda(t)$. A single mother faces the indirect cost of children, so her probability of meeting is $\lambda(t)\lambda_m$, $0 < \lambda_m < 1$. Similar to the probability of having a child, the meeting probability, $\lambda(t)$, is a continuous function of age. The function is approximated using five points and interpolating between them. Four of them are calibrated as I assume that the function reaches zero at the last model period.

The education level of a potential partner, which determines the partner's earnings, depends

[19] Choi (2017) makes the same assumption and uses a similar functional form for the probability.

on a woman's own education level. Conditional on meeting a potential partner, a low type woman meets a low type partner with probability ϕ_l and meets a partner with high education with probability $1 - \phi_l$. Similarly, conditional on a meeting, a high type woman meets a partner with the high type with probability ϕ_h and meets a partner with low type with the complementary probability.

I define an equispaced discrete grid on $[\underline{\gamma}, \bar{\gamma}]$ for match quality exogenously. Initial match quality (match quality for a new partner) is uniformly distributed on the grid. The match quality process of an existing couple (who was married in the previous period, or cohabited in the previous period and did not have the separation shock) is the following:

$$\gamma_t = \begin{cases} \gamma_{t-1}, & \text{if } \gamma_{t-1} = \bar{\gamma}, \\ \gamma_{t-1} + \epsilon, \quad \epsilon \sim N(0, \sigma_\epsilon^2), & \text{otherwise.} \end{cases} \tag{5}$$

I assume that there is an absorbing state of match quality at the highest level. If the previous period's match quality was at the highest grid point ($\bar{\gamma}$), the match quality stays at the point with probability 1. This absorbing state is a reduced-form way of capturing the couple's learning of their match quality over time. If the previous period's match quality was not at the highest level, the match quality follows a random walk with a normal innovation with zero mean which is approximated on the grid following Kennan (2006).

4.4 Moments and parameter values

As a model period is one year, the discount factor (β) is set to 0.96. The match quality is defined between -1 ($\underline{\gamma}$)and 0 ($\bar{\gamma}$). I use 20 points for its support. Parameters set a priori are summarized in Table 9.

There are 18 parameters left to be calibrated: $\alpha_k, \alpha_q, \kappa, p_s, p_1, \delta, \lambda_m, \phi_l, \phi_h, \sigma_\epsilon$ and values at the four grid points of the baseline fertility rate, $p_0(t)$, and the partner meeting rate, $\lambda(t)$.[20] These parameters are set inside of the model by minimizing the distance between data moments and simulated model moments regarding union and fertility choices.

[20] Values at the last point are assumed to be zero.

Table 9: Parameters set a priori

Description		Value
β	0.96	discount factor
ψ	1.7	economies of scale in consumption
K	3	maximum number of children
p_c	1/18	probability of a dependent child growing
p_u	1.0	base level of contraceptive technology for a couple
t_f	44	age at the last fertile period
$\underline{\gamma}$	-1.0	lower bound of match quality
$\overline{\gamma}$	0.0	upper bound of match quality
N_γ	20	number of grid points for match quality

- The age profile of the average number of children ever born from age 21 to age 51 for the low education group, from age 24 to age 51 for the high education group (59 moments, the NLSY 79)
- The age profile of fraction of married women from age 21 to age 51 for the low education group, from age 24 to age 51 for the high education group (59 moments, the NLSY 79)
- The age profile of fraction of single women (neither married nor cohabiting) from age 21 to age 37 for low educated, from age 24 to age 37 for high educated (31 moments, the NSFG 2002)
- The average duration of the first marriage at age 33 for the each group (2 moments, the NSFG 2002)
- The average duration of the first cohabitation at age 33 for the each group (2 moments, the NSFG 2002)
- Annual union transition rates from single to marriage: fraction of singles who get married from age 22 to age 37 for low educated, from age 25 to age 37 for high educated (29 moments, the NSFG 2002)
- Annual union transition rates from cohabitation to single: fraction of cohabiting women who end the cohabitation without marriage from age 22 to age 37 for low educated, from age 25

to age 37 for high educated (29 moments, the NSFG 2002)

- Annual union transition rates from marriage to single: fraction of marriages that ended from age 22 to age 37 for low educated, from age 25 to age 37 for high educated (29 moments, the NSFG 2002)

- The fraction of women with low educated partners at age 30 for the each education group (2 moments, the NSFG 2002)

- The average difference in meeting rate of mothers and non-mothers (2 moments, the NSFG 2002)

In total, there are 244 moments. Many parameters influence many moments simultaneously. For example, parameters regarding the fertility processes affect union choices as well as number of children, and vice versa. Because of the simultaneity of the relationship, it is not easy to provide a formal identification proof. Instead, I provide heuristic arguments of the relationship between parameters and target moments.

The preference weights on children, α_k and α_q, affect the number of children at the end of the fertile period. The relative size between the two (α_k is the weight on the number of children, and α_q is the weight on quality of children) affects the difference in the number of children between the low and the high education group. The distribution of partner type, ϕ_l and ϕ_h, is related to the fraction of women living with each type of partner. The dispersion of match quality innovation, σ_ϵ, determines transition between union statuses. The average duration of marriage and cohabitation provide information about the divorce cost, κ, and the exogenous separation shock, δ, respectively.

The efficacy of the contraceptive technology, p_1, determines the growth of the average number of children. Combined with the age profile of union, the age profile of the number of children ever had gives information about the base level of fertility of a single woman relative to a woman in a union, p_s.[21]

The partner meeting rate shapes the age profile of union statuses (fractions of married, cohabiting women). The difference in meeting rates between mothers and non-mothers helps set the

[21] The base level of fertility of a woman in a union, p_c, is normalized to 1.

value of the indirect cost of children in the matching market, λ_m. Table 10 summarizes calibrated values of the parameters.

Table 10: Calibrated parameter values

	Value	Description
α_k	0.1030	utility weight on number of children
α_q	0.3550	utility weight on quality of children
κ	1.1317	divorce cost
$p_0(18)$	0.1636	base fertility rate at age 18
$p_0(25)$	0.1535	base fertility rate at age 25
$p_0(30)$	0.1117	base fertility rate at age 30
$p_0(35)$	0.0547	base fertility rate at age 35
p_s	1.5645	base fertility rate shifter for single
p_1	6.8189	efficacy of contraceptive effort
δ	0.0500	prob. of exogenous cohabitation separation
$\lambda(18)$	0.5254	partner meeting rate at age 18
$\lambda(31)$	0.6711	partner meeting rate at age 31
$\lambda(41)$	0.0508	partner meeting rate at age 41
$\lambda(51)$	0.0294	partner meeting rate at age 51
λ_m	0.6877	relative prob. of meeting a partner for mothers
ϕ_l	0.0607	prob. of meeting H partner for low edu. woman
ϕ_h	0.3549	prob. of meeting H partner for high edu. woman
σ_ϵ	0.1382	standard deviation of match quality shock

4.5 Results

The calibrated model captures the educational gradients in cohabitation and non-marital fertility: low educated are more likely to cohabit and give birth as unmarried compared to high educated. However, the model does not match the educational gradient in marriage. In the data, the fraction of married women in the high education group surpasses the fraction of married women in the low education group as they age. The model cannot generate the reversal between the two groups.

Number of children Table 11 and Figure 2 compare the model's age profiles of the average number of children ever had to the data. The model replicates the age profile relatively well.

Union choice Table 12 summarizes age profiles of union status. Figures 3 and 4 plot the age profiles of the fraction of married and cohabiting women, respectively. The model generates the

Table 11: Average number of children ever had

	Low education[1]		High education[2]	
Age	Data	Model	Data	Model
21	0.52	0.33	0.07	0.00
26	1.11	0.95	0.35	0.54
31	1.51	1.46	0.92	1.06
36	1.71	1.74	1.34	1.36
41	1.76	1.85	1.49	1.48
46	1.77	1.86	1.51	1.50

Data estimates are from the sample of the NLSY 79

[1] Those who have no college education

[2] Those who have some college or higher education

educational gradients in cohabitation.

The model matches the high group's fraction of married women closely. However, there are more married women in the low education group in the model compared to the data. In the data, low educated's fraction of married women remains stable around 0.6 after age 30, but high educated's fraction exceeds 0.6 at age 30 and reaches 0.7 around age 35. The model does not generate the reversal: there are more married women in the low education group than the high education group throughout the lifecycle in the model.

Although the model has difficulty in matching the level of the fraction of cohabiting women, it captures the educational gradient in cohabitation: there are more cohabiting women in the low group than the high group.

Non-marital childbearing Table 13 summarizes mothers' union status at child's birth by birth order. These are non-targeted moments. The model can generate the educational gradient in non-marital fertility. Low educated are more likely to give birth as non-married than are high educated both in data and the model. There are more cohabiting mothers among low educated than high educated.

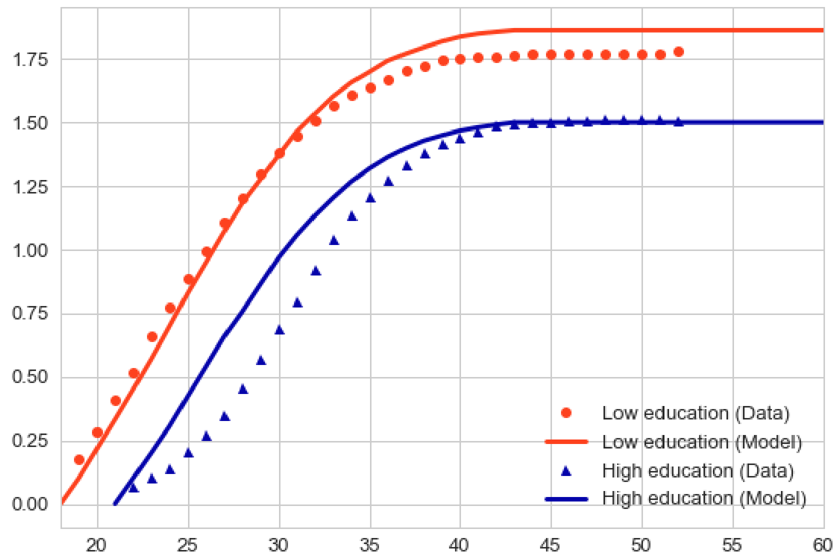

Figure 2: Average number of children ever had

Table 12: Union status

	Married (%)				Cohabiting (%)			
	Low education[1]		High education[2]		Low education		High education	
Age	Data	Model	Data	Model	Data	Model	Data	Model
21 – 25	48	32	36	18	12	20	8	15
26 – 30	58	55	58	47	12	13	8	10
31 – 35	60	71	68	62	13	7	7	7
36 – 40	60	79	71	69	12	3	6	4
41 – 45	62	81	71	70		1		1
46 – 50	60	81	69	70		1		1

Estimates for marriage are from samples of NLSY 79; estimates for cohabitation are from samples of NSFG 2002
Estimates are averaged over the specified age
[1] Those who have no college education
[2] Those who have some college or higher education

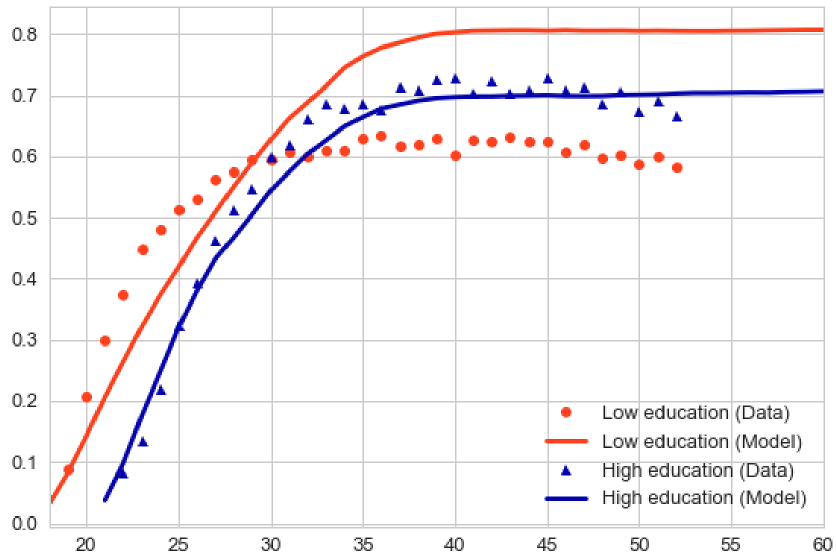

Figure 3: Fraction of married women

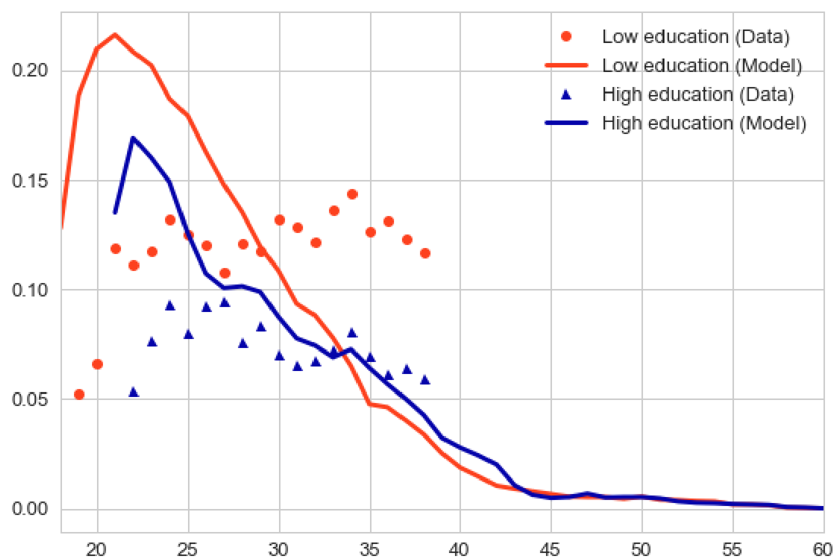

Figure 4: Fraction of cohabiting women

Table 13: Union status at child's birth

		Low education[1]		High education[2]	
		Data	Model	Data	Model
First child	Single	40	38	16	41
	Cohabit	11	21	4	15
	Married	49	40	80	44
Second child	Single	28	28	11	30
	Cohabit	8	14	4	8
	Married	64	58	85	62
Third child	Single	30	19	14	25
	Cohabit	13	11	5	6
	Married	57	70	81	69

Data estimates are from the sample of the NSFG 2002

[1] Those who have no college education

[2] Those who have some college or higher education

5 Quantitative exercises

In this section, I conduct three quantitative exercises using the calibrated model. First, I remove the quality dimension of children to highlight its importance for the union choice. With no quality dimension, fewer people marry compared to the baseline, and both groups have more children. Second, I investigate whether decreasing the gender earnings gap can explain the trend of delaying marriages and increasing cohabitation. The closing of the gender gap leads to marriage delay and increased cohabitation in the model. Third, I investigate the effect of introducing common-law marriage policy treating cohabiting parents as married couples. In the counterfactual economy, fewer people cohabit, and fewer children are born to unmarried parents. As a result, children receive more investment from parents during childhood compared to children in the baseline economy.

5.1 Removing the quality dimension of children

In this exercise, I remove the quality dimension of children to illustrate the effect of the trade-off between quality and quantity of children on union choices in the model. In the experimental economy, both groups have more children on average compared to the baseline. There are fewer married couples in both groups, but the decrease is greater in the high group.

In the baseline economy, the utility of the mother depends on the number of dependent children (k_t) and the quality of her children (q_t) as well as own consumption (c_t):

$$(1 - \alpha_k - \alpha_q) \log c_t + \alpha_k \log(1 + k_t) + \alpha_q \log(1 + q_t).$$

In contrast to the quantity dimension, which gives constant utility to mother once a child is born until the child has left, mothers choose how much to spend on their children. As the union decision affects the household's disposable income, the union decision affects the mother's utility from the quality of her children. I set the utility weight on the quality to zero and increase the weights on the number of children:

$$(1 - \alpha_k - \alpha_q) \log c_t + (\alpha_k + \alpha_q) \log(1 + k_t).$$

Keeping the value of parameters the same with the baseline model, I solve the model again.

Table 14: Average number of children ever had without quality dimension of children

	Low education		High education	
Age	Baseline[1]	Experiment[2]	Baseline	Experiment
21	0.33	0.49	0.00	0.00
26	0.95	1.22	0.54	0.78
31	1.46	1.75	1.06	1.38
36	1.74	2.01	1.36	1.69
41	1.85	2.11	1.48	1.80
46	1.86	2.12	1.50	1.82

[1] Columns 'Baseline' are the results of baseline economy, where the mother receives utility from the quantity and quality of her children.
[2] Columns 'Experiment' are the results with zero weight on mother's utility from the quality of her children.

Table 15: Union status without quality dimension of children

	Married (%)				Cohabiting (%)			
	Low education		High education		Low education		High education	
Age	Base[1]	Exp.[2]	Base	Exp.	Base	Exp.	Base	Exp.
21 – 25	32	30	18	5	20	16	15	21
26 – 30	55	51	47	18	13	11	10	24
31 – 35	71	66	62	29	7	8	7	19
36 – 40	79	73	69	36	3	4	4	13
41 – 45	81	75	70	38	1	1	1	7
46 – 50	81	76	70	38	1	0	1	4

[1] Columns 'Base' are the results of baseline economy, where the mother receives utility from the quantity and quality of her children.
[2] Columns 'Exp.' are the results with zero weight on mother's utility from the quality of her children.

Table 14 compares the average number of children a woman ever had in the baseline and the economy with no quality dimension (columns 'Experiment'). Not surprisingly, women in both groups have more children on average if they do not care about the quality of children compared to the baseline economy. Table 15 summarizes the union allocation over the lifecycle in the baseline (columns 'Base') and in the economy without quality dimension (columns 'Exp.'). Both marriage and cohabitation show little change for the low group. However, the fraction of married women in the high group decreased by about half compared to the baseline, and the fraction of cohabiting women has more than doubled compared to the baseline.

This exercise highlights the different set of functions that marriage is serving for the two groups. Living in a union provides additional income, economies of scale in consumption, and utility from match quality. Marriage is a way of keeping a partner longer compared to cohabitation in the model. The security of union is a reason for marriage in the baseline. It allows women to invest more and longer in children due to increased household income. As mothers do not invest in their children in the experimental economy, the benefit of marriage decreases. However, investing in children is not a primary reason of getting married for the low group because they chose the quantity over the quality of children in the baseline. As a result, the union allocation of low educated changes little in this experiment.

5.2 Increasing cohabitation and the decline of gender gap

This exercise studies the relationship between the decreasing gender earnings gap and changes in the union choices. Over the past few decades, people have delayed marriage and have cohabited more. Table 16 compares union experiences of the NLSY 79 cohort (estimates are from the NSFG 2002 sample) and the NLSY 97 cohort. They are about 20 years apart.[22] More than 80% of the earlier cohort married by age 33, whereas less than half of the later cohort married by the same age (the last row of Table 16). More of the younger cohort cohabited by the age 33 (the third row of Table 16).

In their study of the increasing fraction of single households from the early 1970s to the late 2000s, Regalia *et al.* (2011) find that the closing of the gender wage gap alone can explain more than

[22]The NLSY 79 cohort is born between 1957 – 1964, and the NLSY 97 cohort is born between 1980 – 1984.

Table 16: Union experience at age 33

	Low education[1]		High education[2]	
	1990[3]	2010[4]	1990	2010
Currently cohabiting (%)	14	14	8	11
Currently married (%)	62	27	68	44
Ever cohabited (%)	55	67	46	57
Ever married (%)	82	42	84	49

[1] Those who have no college education
[2] Those who have some college or higher education
[3] Estimates in columns '1990' are for the birth cohort of 1957 – 1964 (the NLSY 79 cohort) using the NSFG 2002 sample. The respondents in the sample were age 33 around year 1990.
[4] Estimates in columns '2010' are from the NLSY 1997. The respondents were age 33 around year 2010.

half of the observed changes. Adamopoulou (2014) also finds that the decreasing gender wage gap leads to fewer marriages and more cohabitations. Following this literature, I reduce the size of the gender gap in the model. The baseline was calibrated to match the fertility and union transitions of the NLSY 79 cohort, where the gender gap is estimated as 25% (Table 7). The estimated gap is reduced to 10% in the NLSY 97 sample. I solve the model by keeping the value of other parameters the same as the baseline and changing the parameter for gender gap to 10%.

Table 17 summarizes the union experiences in the baseline economy and the economy with the smaller gender gap. Compared to the baseline, fewer model agents have married, and more of them have cohabited by age 33. Compared to the changes observed in data, the model predicts qualitatively accurate changes of the outcomes (compare the last two columns of Table 17). Table 18 summarizes union allocations over the lifecycle. There are fewer married women in both groups. In this economy, compared to the baseline, women have higher income, or potential partners' have relatively lower income. As the economic benefit of a union has decreased (thus match quality becomes more important), women wait longer to meet a partner with higher match quality. Some of those who cohabited in the baseline economy will now stay single waiting for a partner with a higher match quality. Similarly, some of those who married before now cohabit instead.

As people stay single for a longer period and cohabit more, there are more children born to

Table 17: Union experience at age 33 with smaller gender gap

		Model (%)		% change	
		Baseline[1]	Smaller gap[2]	Model	Data
Low edu.	Currently cohabiting	8	8	0	0
	Currently married	71	68	-4	-56
	Ever cohabited	77	74	-4	+22
	Ever married	72	68	-6	-15
High edu.	Currently cohabiting	7	9	+29	+38
	Currently married	63	49	-22	-35
	Ever cohabited	61	62	+2	+24
	Ever married	65	51	-22	-42

[1] Around year 1990, 25% of gender gap.
[2] Around year 2010, 10% of gender gap.

unmarried mothers. Table 19 tabulates mothers' union statuses at child's birth by the order in the baseline calibration and the calibration of the smaller gap. As people delay marriage and cohabit more (Table 17), more mothers are unmarried at child's birth. For example, 58% of the low type women and 64% of the high type women are married at their first child's birth in the baseline, 49% of the low type and 46% of the high type are married with the smaller gap. Although the fraction of children born to unmarried mothers has increased, children receive more investment than children in the baseline do as mothers have higher income. Compared to the baseline, the median spending of the low education mothers on children increases by 29% and the mean increases by 13%. The median spending of the high education mothers also increases by 15% and the mean increases by 11%.

5.3 Introducing common-law marriage

Next, I study the effect of introducing a policy that treats certain cohabitants as married couples on fertility and union decisions. In many European countries and Canada (excluding Québec), cohabitants are deemed as *de facto* married couples if they meet certain criteria ('common-law marriage' or 'civil union'). The criteria vary across jurisdictions, but they are typically the length of cohabitation period or existence of children between the couple. For example, by the Family

Table 18: Union status with smaller gender gap

	Married (%)				Cohabiting (%)			
	Low edu.		High edu.		Low edu.		High edu.	
Age	Base[1]	Exp.[2]	Base	Exp.	Base	Exp.	Base	Exp.
21 – 25	32	30	18	5	20	16	15	21
26 – 30	55	51	47	18	13	11	10	24
31 – 35	71	66	62	29	7	8	7	19
36 – 40	79	73	69	36	3	4	4	13
41 – 45	81	75	70	38	1	1	1	7
46 – 50	81	76	70	38	1	0	1	4

[1] Columns 'Base' are the results of baseline economy, where the gender earnings gap is 25%.
[2] Columns 'Exp.' are the results with 10% of the gender earnings gap.

Law Act in Ontario (1978), a cohabiting couple is treated as a married couple if they have lived together longer than three years or have had children together.[23] However, cohabitants become *de facto* married couples in no states of the U.S.[24]

In the baseline economy, no cohabiting woman becomes married unless she wants to. In this counterfactual economy, simulating a feature of the common-law marriage in other jurisdictions, I treat a cohabiting woman who gave birth in the cohabitation as a married woman: once a child is born, she faces no separation shock and has to pay the divorce cost to end the union. Parameter values remain the same as the baseline calibration.

Table 20 tabulates the average number of children a woman ever had by educational group. Both groups have more children on average. Table 21 compares the union allocation in the baseline economy to the economy with common-law marriage. There are more married women, especially early in their lifecycle, in the counterfactual economy, if we count common-law married women as well. Also, there are fewer cohabiting women.

Cohabitation serves as an intermediate form of union in the model. Due to the separation shock

[23]By exploiting different timing of introduction of common-law marriage in different Canadian provinces, Lafortune, Chiappori, Iyigun and Weiss (2016) examines the impact of introduction on various cohabiting couples' decisions, and how the impact differs between pre-existing couples and couples formed after the changes.

[24]See Footnote 1 for details.

Table 19: Union status at child's birth with smaller gender gap

		Low education		High education	
		Baseline[1]	Smaller gap[2]	Baseline	Smaller gap[1]
First child	Single	38	44	41	51
	Cohabit	21	17	15	14
	Married	40	39	44	34
Second child	Single	28	32	30	37
	Cohabit	14	11	8	9
	Married	58	57	62	54
Third child	Single	19	21	25	31
	Cohabit	11	11	6	6
	Married	70	68	69	63

[1] Around year 1990, 25% of gender gap.
[2] Around year 2010, 10% of gender gap.

and costless exit, a couple whose match quality is not good enough to marry choose to cohabit as they are likely to pay the divorce cost if they marry. The risk involving cohabitation in the baseline economy is losing a partner due to the separation shock. In the counterfactual economy, as people have imperfect control over fertility, there is an additional risk of being forced into marriage if she gives birth, even if the match quality is not high enough to choose to get married. If there were no divorce cost, most of these new couples would divorce immediately. However, due to the divorce cost, some of these couples married by the common-law stay in the relationship. As a result, there are more married couples and fewer cohabitants in the counterfactual economy compared to the baseline.

These changes affect the union allocation, and more children are born to married mothers. Table 22 reports mothers' union statuses at child's birth. Compared to the baseline, almost no children are born to cohabiting mothers, and more children are born to married mothers, including those who married by common-law. As more children born to married mothers, the amount of spending on children has increased compared to the baseline. The median amount of spending on children has increased by 21% for the mothers of both groups. The mean amount has increased by 8% for the low group and 12% for the high group.

Table 20: Average number of children ever had with common-law marriage

	Low education		High education	
Age	Baseline	Common-law[1]	Baseline	Common-law
21	0.33	0.38	0.00	0.00
26	0.95	1.10	0.54	0.66
31	1.46	1.69	1.06	1.28
36	1.74	2.08	1.36	1.72
41	1.85	2.26	1.48	1.92
46	1.86	2.29	1.50	1.95

[1] The counterfactual economy with common-law marriage; cohabiting couples who had children while cohabiting are treated as married couples.

Table 21: Union status with common-law marriage

	Married (%)[1]				Cohabiting (%)			
	Low education		High education		Low education		High education	
Age	Base	Exp.[2]	Base	Exp.	Base	Exp.	Base	Exp.
21 – 25	32	36	18	36	20	14	15	12
26 – 30	55	60	47	60	13	8	10	7
31 – 35	71	76	62	72	7	4	7	4
36 – 40	79	83	69	75	3	2	4	2
41 – 45	81	83	70	74	1	1	1	1
46 – 50	81	83	70	74	1	0	1	0

[1] Including those who married by common-law (cohabitants who gave birth while cohabiting).
[2] The counterfactual economy with common-law marriage; cohabiting couples who had children while cohabiting are treated as married couples.

Table 22: Union status at child's birth with common-law marriage

		Low education		High education	
		Baseline	Common-law[1]	Baseline	Common-law
First child	Single	38	31	41	29
	Cohabit	21	6	15	5
	Married	40	64	44	66
Second child	Single	28	17	30	16
	Cohabit	14	2	8	1
	Married[2]	58	81	62	83
Third child	Single	19	8	25	11
	Cohabit	11	1	6	1
	Married[2]	70	91	69	88

[1] The counterfactual economy with common-law marriage; cohabiting couples who had children while cohabiting are treated as married couples.
[2] Including those who married by common-law

6 Conclusion

Despite its increasing prevalence and its tight linkage to non-marital childbearing, the literature of family economics typically overlooks cohabitation as a distinct form of union. From the samples from NLSY 79 and NSFG 2002, I find that there are educational gradients in fertility and union choices: the less educated are more likely to cohabit and more likely to give birth while cohabiting than the more educated. Based on the observations, I build a lifecycle model of union and fertility choices to understand them jointly. The model features a partial equilibrium partner search and quantity-quality trade-off of children with imperfect control over fertility. The calibrated model can capture observed educational gradients in cohabitation and non-marital fertility.

Using the calibrated model, I conduct three quantitative exercises. Removing the quality dimension of children increases the number of children lower education women have. It also results in lower marriage rates of high education women, which highlights the interdependence of fertility and union choices. The decline of the gender earnings gap leads to a delay of marriage, as observed in data in the past two decades. According to the model, the changes in the gender gap alone can explain about a third to one half of the changes in union allocation observed in the data. Lastly, I study the effect of introducing a common-law marriage policy on fertility and union decisions. By treating cohabiting couples who gave birth while cohabiting as married couples, union allocations change substantially in the model. There are more married couples and fewer cohabitants. As a result, almost no children are born to cohabiting mothers, and more children are born to married mothers, as compared to the baseline where no common-law marriage exists.

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A Appendix

A.1 Data

NLSY 79 The National Longitudinal Survey of Youth 1979 (NLSY 79) consists of 12,686 individuals who are born between January 1, 1957, and December 31, 1964. The survey began in 1979 and interviewed the cohort annually until 1994 and biennially since then through 2013. I made several sample restrictions to use in this paper. I exclude the military subsample; respondents who missed interviews more than one time to reduce issues of imputation; respondents who had more than three children. These restrictions produce the sample of 2,775 females and 2,297 males.

I divide the sample by their level of educational attainment. I group respondents with some college experience, regardless whether they have degree, at age 22 and label them as 'high group,' and group the rest and label them as 'low group.'

CNLSY The National Longitudinal Survey of Youth 1979 Children and Young Adults (CNLSY) is a biennial survey that follows all of the biological children of the women in the NLSY 79 since 1986. As of 2014, there are 11,521 children are born to the NLSY 79 mothers. I combine the CNLSY sample with the sample of NLSY 79. I exclude children whose mothers are dropped in the sample restriction described above. The CNLSY provides information whether the child lived with his/her biological father. As the information is provided since 1984, I drop children born before 1983 from the sample. These restrictions leave the sample of 4,741 children. For Table 6, as I need information on the education at the age 22 or 23, the sample is further reduced to those who born before 1992 (who turned age 22 in the 2014 survey).

NSFG The National Survey of Family Growth (NSFG) gathers information on family life, marriage and divorce, pregnancy, infertility, use of contraception, and general and reproductive health. It is designed to be nationally representative of 15-44 years of age in the civilian, noninstitutionalized population of the United States (household population). I use the survey of the year 2002 (Cycle 6) to have the comparable birth cohorts of the NLSY79, born between 1957 and 1964.[25] The survey includes 7,643 females and 4,928 males.

I use the female sample and restrict to the sample of respondents who born before December 31, 1964, a comparable birth cohorts to the NLSY79[26]. The sample contains 1,951 respondents. Although it is a cross-sectional survey,[27], it asks questions regarding past union experiences including cohabitation and pregnancy. I exploit this retrospective aspect of the survey.

The survey includes survey design variables and weights to provide estimates at the national level. The estimates in tables of the main body are computed using those variables.

A.2 Additional tables

[25]The sample from Cycle 5, which is surveyed in 1995, also contains the birth cohorts of the NLSY79. However, I do not use the sample as they are relatively young in the Cycle 5.

[26]The oldest respondent in NSFG 2002 is born on April 1957.

[27]The respondents in different survey cycles are not connected.

Table A1: Percentage of unmarried mothers at child's birth: mothers are at least 20 years old at child's birth

	Low education[1] (1)	High education[2] (2)	Difference (1) - (2)
Any child	24.46	10.01	14.45
			(1.66)
First child	20.68	8.60	12.08
			(1.73)
Second child	15.06	5.18	9.88
			(1.37)
Third child	22.05	4.54	17.50
			(2.62)

Samples from the NLSY 79; weighted using provided custom weights; robust standard errors of differences are in parentheses

[1] Those who have no college education

[2] Those who have some college or higher education

Table A2: Percentage of unmarried mothers at child's birth by race

		All			20+ olds[1]		
		Low edu[2] (1)	High edu[3] (2)	Difference (1) - (2)	Low edu (1)	High edu (2)	Difference (1) - (2)
White	Any child	21.29	4.03	17.26	16.96	3.60	13.36
				(1.85)			(1.75)
	First child	17.69	3.55	14.14	14.71	3.18	11.53
				(1.72)			(1.81)
	Second child	7.48	1.35	6.13	7.53	1.36	6.17
				(1.29)			(1.32)
	Third child	15.08	1.69	13.39	14.72	1.69	13.03
				(2.99)			(2.98)
Black	Any child	77.97	54.35	23.63	65.91	50.08	15.83
				(4.08)			(4.43)
	First child	75.00	51.19	23.81	62.51	45.45	17.06
				(4.14)			(5.15)
	Second child	58.66	34.84	23.82	56.47	35.12	21.34
				(4.93)			(5.09)
	Third child	51.75	23.96	27.79	51.47	23.96	27.51
				(7.27)			(7.30)
Hispanic	Any child	34.90	19.31	15.59	28.59	17.06	11.52
				(5.08)			(4.90)
	First child	31.15	19.31	11.85	28.92	16.89	12.03
				(4.99)			(5.28)
	Second child	16.80	3.33	13.47	16.53	2.38	14.16
				(3.46)			(3.38)
	Third child	17.75	2.04	15.71	17.75	2.04	15.71
				(4.90)			(4.90)

Samples from the NLSY 79; weighted using provided custom weights
[1] Counts child births to 20 or older mothers
[2] Those who have no college education
[3] Those who have some college or higher education

Table A3: Percentage of women ever cohabited before by race

	Any cohabitation[1]			Non-marital cohabitation[2]		
	Low edu.[3] (1)	High edu.[4] (2)	Difference (1) - (2)	Low edu. (3)	High edu. (4)	Difference (3) - (4)
White	63.95	49.37	14.58	21.71	15.92	5.79
	(4.23)	(2.88)	(4.34)	(3.65)	(1.87)	(3.77)
	344	633		344	633	
Black	65.13	54.69	10.44	41.50	28.32	13.18
	(5.26)	(7.36)	(9.46)	(5.15)	(4.64)	(7.68)
	175	168		175	168	
Hispanic	55.17	55.20	−0.03	31.28	15.61	15.67
	(6.79)	(5.23)	(9.82)	(3.99)	(4.09)	(5.90)
	178	106		178	106	

Samples from NSFG 2002, born between April, 1957 and December, 1967 (comparable to NLSY79 cohort, 37 – 44 years old at the day of interview); weighted using provided weights and survey design variables; standard errors are in parentheses

[1] 'Any cohabitation' includes current cohabitation, pre-marital cohabitation (married with the cohabitation partner), and non-marital cohabitation

[2] 'Non-marital cohabitation' includes current cohabitation and cohabitations that end without marriage

[3] Those who have no college education

[4] Those who have some college or higher education

Table A4: Percentage of women gave birth (pregnancy ended as live birth) during cohabitation

		Any cohabitation[1]			Non-marital cohabitation[2]		
		Low edu.[3] (1)	High edu.[4] (2)	Difference (1) - (2)	Low edu. (3)	High edu. (4)	Difference (3) - (4)
White	Percentage	17.90	9.87	8.03	19.03	16.95	2.08
	Standard error	(4.26)	(2.79)	(4.79)	(8.95)	(8.13)	(9.25)
	Observations	214	342		214	342	
Black	Percentage	50.46	25.93	24.53	49.05	33.91	15.14
	Standard error	(7.56)	(4.25)	(7.89)	(6.82)	(6.97)	(12.41)
	Observations	116	93		116	93	
Hispanic	Percentage	44.59	47.30	−2.71	50.17	41.56	8.61
	Standard error	(7.05)	(12.86)	(12.35)	(6.45)	(24.08)	(24.25)
	Observations	109	56		109	56	

Samples from NSFG 2002, born between April, 1957 and December, 1967 (comparable to NLSY79 cohort, 37 – 44 years old at the day of interview); weighted using provided weights and survey design variables; standard errors are in parentheses

[1] 'Any cohabitation' includes current cohabitation, pre-marital cohabitation (married with the cohabitation partner), and non-marital cohabitation

[2] 'Non-marital cohabitation' includes current cohabitation and cohabitations that end without marriage

[3] Those who have no college education

[4] Those who have some college or higher education

Table A5: Percentage of women gave birth (pregnancy ended as live birth) during cohabitation among those who have had child

		Any cohabitation[1]			Non-marital cohabitation[2]		
		Low edu.[3] (1)	High edu.[4] (2)	Difference (1) - (2)	Low edu. (3)	High edu. (4)	Difference (3) - (4)
All	Percentage	18.76	8.96	9.80	9.57	4.40	5.18
	Standard error	(2.33)	(1.48)	(2.55)	(1.45)	(1.00)	(1.75)
	Observations	602	708		602	708	
White	Percentage	13.38	5.96	7.42	4.83	3.30	1.53
	Standard error	(3.43)	(1.35)	(3.29)	(1.94)	(1.26)	(2.02)
	Observations	269	467		269	467	
Black	Percentage	35.81	17.70	18.11	22.18	11.99	10.19
	Standard error	(5.33)	(4.44)	(6.90)	(4.01)	(3.95)	(6.41)
	Observations	151	131		151	131	
Hispanic	Percentage	25.99	31.38	−5.39	16.58	7.80	8.78
	Standard error	(5.32)	(7.72)	(8.16)	(3.34)	(3.39)	(5.19)
	Observations	166	83		166	83	

Samples from NSFG 2002, born between April, 1957 and December, 1967 (comparable to NLSY79 cohort, 37 – 44 years old at the day of interview); weighted using provided weights and survey design variables

[1] 'Any cohabitation' includes current cohabitation, pre-marital cohabitation (married with the cohabitation partner), and non-marital cohabitation

[2] 'Non-marital cohabitation' includes current cohabitation and cohabitations that end without marriage

[3] Those who have no college education

[4] Those who have some college or higher education