Assortative Matching vs. Complementarity: Which Drives the Correlation of Hours Worked by Young Couples?

Lihan Liu*

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Abstract

This paper starts by documenting the positive correlation between annual hours worked by young husbands and wives without children. Two possible explanations for this phenomenon are assortative matching and complementarity of leisure. This paper evaluates these two possibilities jointly to determine their relative importance. I set up an individual labor supply problem for singles and a household labor supply model with complementarity of leisure for young couples. I select a subset of married couples from the NLSY79 for whom data both before and after marriage are available. Pre-marriage data are used to recover preferences which may vary across individuals. The data show strong positive assortative matching on individual preferences. Incorporating this heterogeneity of individual preferences, the post-marriage data are used to estimate the household labor supply model. A counterfactual analysis shows that complementarity of leisure is the main factor driving the positive correlation between hours worked by young husbands and wives.

Keywords: Assortative matching, Complementarity, Household labor supply

JEL Codes: D13, J22

*Department of Economics, University of Wisconsin, 1180 Observatory Drive, Madison, WI 53706; lliu24@wisc.edu.

1 Introduction

It is well known that there is positive correlation between the labor supply of married people. However, what drives this correlation is less clear. On the one hand, it may come from the complementarity of leisure within a family. On the other hand, it may come from certain assortative matching pattern in the marriage market. Examining the effects of these two possibilities is important as they have different implications. For example, consider a policy which could induce more working hours by married women. If the complementarity of leisure dominates, then the husband's hours worked may increase significantly. If, on the contrary, assortative matching dominates, then the labor supply of the husband may not change much associated with the increase in the wife's hours worked.

I document a positive correlation between hours worked by young husbands and wives, controlling for observable characteristics such as education, age and wage. One possible explanation for this positive correlation is that there are some unobservable personal characteristics which affect both marriage formation and family labor supply.[1] For example, if single young men and women with close values of leisure get married, they would have similar labor supply behavior after marriage. Put differently, assortative matching on individual preferences may drive the positive correlation between hours worked by husbands and wives. Another possible explanation is that married people enjoy spending time together, deriving higher value from leisure when spousal leisure increases. If this is the case, when the husband works less, the wife also wants to work less. I refer to this second explanation as complementarity of leisure. My paper aims to measure the extent to which each of these two factors drives the positive correlation of hours worked between husbands and wives.

Typically, papers incorporate heterogeneous individual preferences, but derive a reduced form labor supply equation from the structural model and apply a fixed effects

[1] "Estimation of family labor supply models is complicated by the fact that personal characteristics which affect marriage formation and marriage stability are likely to be related to characteristics determining labor supply, if the sorting of individuals into households is nonrandom." – Lundberg (1988). As Lundberg points out,without considering those characteristics, estimates from a household labor supply model might be biased.

model for estimation. However, reduced form models cannot be used for counterfactual analysis. Therefore, it is difficult to measure whether assortative matching on individual preferences or complementarity drives the positive correlation between hours worked by husbands and wives more. In this paper, I present a structural model which allows me to analyze the relative importance of these two factors.

I select a subset of married couples from the 1979 cohort of the National Longitudinal Survey of Youth (NLSY79). The advantage of this sample is that for each married pair both pre-marriage and post-marriage data are available. The pre-marriage data give information on observable characteristics such as education level, hourly earnings and hours worked. My results show that after controlling for the observable characteristics across couples, there is still positive and significant correlation between hours worked by husbands and wives even before they marry. This indicates assortative matching on some other unobservable characteristics. I assume this unobservable heterogeneity lies in individual preferences.[2] Specifically, I assume singles put different weights on consumption and leisure and set up the individual utility maximization problem. Using the pre-marriage data, I recover the preferences of each single.

In my household labor supply model, husbands and wives pool their income and transfer their utilities. These two points make specialization possible. The member with a higher wage works more and the one with a lower wage works less. In addition, a family has some leisure production technology. Leisure time taken by husbands and wives are used as two inputs to produce the real leisure consumed by married people. The more married people enjoy spending time together, the more complementary these two leisure inputs are.

Given the heterogeneous preferences for each couple recovered from pre-marriage data, I structurally estimate the household labor supply model. Three counterfactual experiments are conducted further to quantitatively measure how much of the positive correlation of hours worked is caused by complementarity and how much by assortative matching on individual preferences. In the first counterfactual experiment, I mimic a scenario where men and women randomly match on their individual preferences. I randomly draw a pair of

[2] I assume there is no complementarity while dating as it is hard to get data.

wages from the joint empirical distribution for each couple and draw individual preferences from the recovered empirical distribution for husband and wife separately. In the second counterfactual experiment, I keep men and women matched as in the data and change the household labor supply model so that there is no complementarity of leisure. The third counterfactual experiment excludes both assortative matching on individual preferences and complementarity.

The main findings are as follows. First, there is strong and positive assortative matching on individual preferences. Men who value leisure more tend to marry women who value leisure more. Second, specialization reduces the correlation of hours worked by 0.89. Third, complementarity increases the correlation of hours worked by 0.80. However, assortative matching on individual preferences only increases the correlation of hours worked by 0.03. Thus, I conclude that complementarity is the main factor which drives the positive correlation of hours worked for married couples.

The remainder of this paper is organized in the following manner. In Section 2, I discuss the related papers. In Section 3, I describe the sample, present evidence that there is positive correlation between hours worked by husbands and wives and show evidence for heterogeneity of individual preferences. In Section 4, I set up both an individual labor supply model and a household labor supply model. In Section 5, I explain how the model is estimated. In Section 6, I show the estimation results. In Section 7, I describe the counterfactual experiments. In Section 8, I summarize the findings. Sample selection rules and construction of key variables are illustrated in the appendix.

2 Literature Review

This paper is related to the literature on the collective representation of household behavior. Manser and Brown (1980) and McElroy and Horney (1981) are the first papers to characterize the household as a group of agents making joint decisions. In those papers the household decision process is modeled as a Nash bargaining problem. Chiappori (1988, 1992) extends their analysis to allow for any type of efficient decision process. The theo-

retical model used in the present paper is a simplification of Chiappori's collective model with equal decision making power.

One of the principal difficulties of the identification of the collective model comes from the fact that individual preferences are unknown, and have to be estimated from household-level demands. One possible solution is to appeal to other sources of information to estimate preferences. In practice, this most often consists of the use of data on single people to estimate individual preferences, and then to use the results of these estimations in the analysis of couple behavior. This procedure is applied in Laisney (eds, 2006). They use extra sources to identify individual preferences which differ between men and women. My paper uses the pre-marriage and post-marriage data for the same group of people to recover the individual preferences for each single man and woman as well as family-specific parameters. These information are then used to analyze how assortative matching pattern on individual preferences affect household labor supply.

3 Data

I use data from the 1979 cohort of the National Longitudinal Survey of Youth (NLSY79), a nationally representative sample of 12,686 young men and women who were 14-22 years old when they were first surveyed in 1979. These individuals were interviewed annually from 1979 through 1994 and have been interviewed on a biennial basis since 1994, with the most recent available wave in 2008, when members of the sample were aged 43-51. Since their first interview, many of the respondents have made transitions from school to work, and from their parents' homes to being parents and homeowners. By 2008, 81.7% of the sample were identified as having been married at some point. A primary focus of the NLSY79 survey is labor force behavior such as hours worked, earnings and specific job characteristics. The survey also includes additional detailed questions on marital and fertility histories, educational attainment and income.

In this paper, I focus on the first marriages of 315 couples. These couples work and do not have kids within one year before and after their marriage. During these two years,

information regarding their age, education level, schooling status, hours worked and wage is available. I exclude couples who get married after the interview in the same year,[3] those whose first marriages last less than two interview periods,[4] those who have children during the first two interview periods of their marriages,[5] those who go to school[6] and those with information about hours worked and wages missed. The sample selection process is summarized in Table 11 in appendix. The construction of key variables is described in detail in the appendix.

For each couple, the one who answered the questionnaire is called the respondent of the NLSY79. 15.6% of the respondents identify themselves as Hispanic, 14.8% as black and 69.5% as non-black and non-Hispanic. The summary statistics are presented in Table 1. After marriage the average hours worked increases slightly (by 3.1% for males and by 3.2% for females). Associated with this increase, the hourly earnings increases a lot (by 17.47% for males and 19.19% for females).

Table 1: Characteristics of Married Couples

	Men		Women	
	Before Marriage	After Marriage	Before Marriage	After Marriage
Age	27.27	29.33	25.79	27.78
Years of schooling	14.54	14.82	14.57	14.83
Annual hours worked	2176.40	2243.12	1917.61	1978.73
Hourly earnings	12.02	14.12	10.58	12.61
Annual earnings	25844.18	31200.21	21132.23	25818.09

Note: Summary Statistics for 315 couples from the 1979 cohort of the National Longitudinal Survey of Youth (NLSY79) both before and after their first marriage.

3.1 Correlation in Post-marriage data

In my sample, the correlation between annual hours worked by husbands and wives is 0.15. This positive correlation implies that young couples change their labor supply behavior in the same direction.

[3] In this case, pre-marriage information is unavailable. Please refer to Figure (3) in appendix
[4] In this case, post-marriage information is unavailable. Please refer to Figure (5) in appendix.
[5] Since my current model does not have children, I drop 846 married couples with children.
[6] The current version does not include schooling but focuses on labor supply choices only.

It is natural to think that the above positive correlation could be explained by some observable characteristics such as education, age and wage. It is possible that singles with higher wages (or education levels) marry those who also have higher wages (or education levels). Because of the higher wages (or education levels), both of them would like to work more. To examine the explaining power of these observable characteristics, I run a regression of the husband's (or wife's) annual hours worked on his (or her) own age, education level and wage as well as spousal age, education level, wage and annual hours worked. The OLS estimates are listed in Table 2, within which education is measured by years of schooling and earnings is measured by income from wage and salary during the last year.

Table 2 shows that controlling for age, education level and wage of household members, there is still positive and significant correlation of hours worked for married couples. A typical husband, given other characteristics, increases his annual working hours by 0.13 on average when his wife works one more hour during the year. This effect is larger for the wife: one-hour increase in a husband's working time is associated with a 0.15 hours increase in his wife's annual working time on average.

Table 2: OLS Estimation of Household Labor Supply After Marriage

	Husband's annual hours worked	Wife's annual hours worked
Husband's annual hours worked		0.15**
		(0.06)
Wife's annual hours worked	0.13**	
	(0.05)	
Husband's hourly earnings	-21.47***	1.69
	(4.39)	(4.94)
Wife's hourly earnings	7.16***	1.64
	(2.30)	(2.53)
Husband's edu	73.63***	0.13
	(13.49)	(15.32)
Wife's edu	-8.79	22.40
	(14.46)	(15.61)
Husband's age	24.48***	-0.06
	(7.96)	(8.75)
Wife's age	-13.26*	12.74
	(7.95)	(8.61)
Constant	896.28***	922.20**
	(335.13)	(363.26)
Observations	304	304
R-squared	0.18	0.05

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

After controlling for these observables, why is there still positive correlation between hours worked by husbands and wives? One possible reason is that, within the household, one's leisure consumption may have positive externality on the other's utility because married men and women care about spousal leisure. Thus, complementarity of leisure generates similar labor supply behavior of married couples. Another possible reason could be that young people have different preferences for leisure and those with similar preferences get married. The section below aims to check the matching pattern in the pre-marriage data and provide evidence for assortative matching on individual preferences.

3.2 Assortative Matching Pattern in Pre-marriage Data

It is worthy to document some interesting matching pattern of observables for singles. First, a positive matching pattern on wages is found. The correlation of hourly earnings between single women and their future husbands is 0.36.[7] This shows that men with higher wages tend to marry women with higher wages.

Second, no strong assortative matching pattern on education is found. Among my sample, education information are available for both members for 305 pairs. I pick 4 education categories ("some high school or below", "high school graduate", "some college" and "college graduate or above"). The proportion for each category combination is listed in Table 3. The one without parenthesis is the proportion in the real data. The one with parenthesis is the proportion if single men and women match randomly given the marginal distribution of education levels. Table 3 shows that the assortative matching pattern on education is weak as the percentages in real data are quite close to those under random matching.

Before marriage, one striking fact is the correlation of annual hours worked between single men and their future wives is as high as 0.21.[8] Why single men and women make similar labor supply decision even before they get married? One may attribute this positive correlation to the above positive assortative matching on wage. To check the explaining power of it, I separately regress hours worked by single men and women on their own wage, education level and age as well as the wage, education level and age of their future spouses. The results are presented in Table 4. After controlling for those observables, there is still positive and significant correlation between hours worked by singles and their future spouses. One possible explanation is heterogeneity in individual preferences. If singles value consumption versus leisure differently, then the above positive and significant correlation suggests positive assortative matching pattern on individual preferences.

[7] The correlation of hourly earnings is 0.37 after marriage.

[8] Note that the correlation of hours worked decreases from 0.21 to 0.15 after marriage. One possible explanation is specialization. When husbands and wives are able to pool their income and transfer their utilities, the member with a higher wage work more and the one with a lower wage work less. The effect of specialization is quantified in section (7.1).

Table 3: Matching on Education Levels of Married Couples

	Wife's education levels				
Husband's education levels	Some high school or below	High school graduate	Some college	College graduate or above	Total
Some high school or below	0.00	0.66	0.66	0.66	1.97
	(0.07)	(0.48)	(0.56)	(0.85)	
High school graduate	0.33	7.54	6.89	8.85	23.61
	(0.85)	(5.80)	(6.73)	(10.22)	
Some college	1.31	8.20	8.20	15.74	33.44
	(1.21)	(8.22)	(9.54)	(14.47)	
College graduate or above	1.97	8.20	12.79	18.03	40.98
	(1.48)	(10.08)	(11.69)	(17.74)	
Total	3.61	24.59	28.52	43.28	100.00

Note: Numbers represent percentage. The percentage without parenthesis is the proportion for each education grid among the 305 couples of my sample. The one with parenthesis is the proportion for each grid if men and women randomly match on education given the marginal distribution of education levels.

Table 4: OLS Estimation of Individual Labor Supply Before Marriage

	Single man's annual hours worked	Single woman's annual hours worked
Future husband's annual hours worked		0.21***
		(0.06)
Future wife's annual hours worked	0.19***	
	(0.06)	
Future husband's hourly earnings	-16.89***	8.42*
	(4.28)	(4.56)
Future wife's hourly earnings	10.74***	-2.79
	(3.06)	(3.26)
Future husband's edu	18.98	11.85
	(15.09)	(15.79)
Future wife's edu	-12.95	44.26***
	(16.43)	(16.98)
Future husband's age	27.66***	2.11
	(9.20)	(9.75)
Future wife's age	-8.34	35.65***
	(9.12)	(9.31)
Constant	1,275.43***	-405.39
	(365.94)	(389.20)
Observations	304	304
R-squared	0.13	0.17

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: All variables are from pre-marriage data. I regress hours worked by singles on their own characteristics and the characteristics of their future spouses.

4 Model

4.1 Labor Supply Problem for Singles

Given the wage w_i, each single person i optimally chooses labor supply l_i and consumption c_i to maximize his individual utility as follows:

$$\underset{l_i,c_i}{max} U_i(l_i, c_i) = (\delta_i l_i^{\lambda} + (1-\delta_i)c_i^{\lambda})^{1/\lambda} \tag{1}$$

$$s.t. c_i = w_i(T - l_i) + N_i \tag{2}$$

$$T \geq l \geq 0$$

where T is the total allocatable time and N_i is the non-labor income.

$0 \leq \delta_i \leq 1$ is the weight which measures how singles value leisure relative to consumption and is assumed to vary across individuals. λ is the elasticity of substitution between leisure and consumption and is assumed to be the same across individuals. Before marriage, single young people choose different working hours because they have different wages and δ's.[9]

4.2 Household Labor Supply

Assume that individual preferences δ_i's do not change after marriage. Assume there are only public goods in a household. The married couple jointly chooses hours worked to maximize the sum of their utilities subject to the household budget constraint as follows:

$$\max_{l_M, l_F, c} (\delta_M L^\lambda + (1 - \delta_M)c^\lambda)^{1/\lambda} + (\delta_F L^\lambda + (1 - \delta_F)c^\lambda)^{1/\lambda} \tag{3}$$

$$s.t.\ c = w_M(T - l_M) + w_F(T - l_F) + N \tag{4}$$

$$T \geq l_M, l_F \geq 0$$

where $L = A(\frac{1}{2}l_M^\rho + \frac{1}{2}l_F^\rho)^{1/\rho}$ with $A > 0$ and $\rho \leq 1$ is the aggregate leisure consumed by married people, l_M represents leisure of the husband, l_F represents leisure of the wife, c represents consumption of public goods, $w's$ are the wages, T is the total allocatable time and N is the household non-labor income.

[9] I plan to extend my structural model into a dynamic one. However, as a starting point, the static model keeps the problem simple and straightforward.

Since the household leisure has the feature of externality, a leisure production technology is defined to describe the set of options for the joint leisure consumption that are available to household members.[10] The household leisure production technology is assumed to have the CES form $L = A(\frac{1}{2}l_M^\rho + \frac{1}{2}l_F^\rho)^{1/\rho}$ with $A > 0$ and $\rho \leq 1$.[11] Parameter A measures the equivalence scale of leisure production. The leisure production function has the constant elasticity of substitution $\gamma = \frac{1}{1-\rho}$.[12] It measures how well the husband's leisure and the wife's substitute with each other. As γ approaches 0, the production function goes to the Leontief function $L = minA(l_M, l_F)$. In this case, leisure of the husband and the wife are perfect complements. The husband's leisure time is valuable only when his wife also consumes a certain amount of leisure. Thus, the husband and the wife will increase or decrease leisure time at the same time. As γ approaches ∞, the production function goes to the linear one $L = A(\frac{1}{2}l_M + \frac{1}{2}l_F)$. In this case, the leisure of the husband and the wife are perfect substitutes. To maximize the household utility, the one who earns a higher wage work and the one who earns a lower wage stays at home. As γ approaches 1, the utility function goes to the Cobb-Douglas case $L = Al_M^{\frac{1}{2}}l_F^{\frac{1}{2}}$.

If household leisure does not have externality, the leisure consumption by married people is the exact amount of leisure time they take. Then the household utility maximization problem shrinks to the case without complementarity as follows:

$$\max_{l_M, l_F, c} (\delta_M l_M^\lambda + (1-\delta_M)c^\lambda)^{1/\lambda} + (\delta_F l_F^\lambda + (1-\delta_F)c^\lambda)^{1/\lambda} \tag{5}$$

$$s.t.\ c = w_M(T - l_M) + w_F(T - l_F) + N \tag{6}$$

[10] For a married person, the time not spent on the labor market can be divided into private leisure (that agents use independently from each other), public leisure (that agents enjoy together) and home production. However, my paper does not aim to analyze the allocation of time among those three categories. Instead, a household leisure production technology with aggregate leisure as arguments is assumed.

[11] I put equal weight on l_M and l_F, assuming leisure taken by the husband and leisure taken by the wife have the same productivity. It will not be difficult to parametrize weight as $L_M = A(\eta l_M^\rho + (1-\eta)l_F^\rho)^{1/\rho}$ and $L_F = A(\eta l_F^\rho + (1-\eta)l_M^\rho)^{1/\rho}$. η measures the weight of one's own leisure.

[12] Since my paper assumes a household leisure production technology with aggregate leisure as arguments, the elasticity of complementarity $\gamma = \frac{1}{1-\rho}$ measures the complementarity between the total leisure of a husband and his wife. It includes both substitution of home production and complementarity of public leisure.

$$T \geq l_M, l_F \geq 0$$

5 Estimation

5.1 Recovering of Individual Preferences

Suppose econometricians can observe individual leisure l_i, wage w_i, consumption c_i. Each individual is assumed to maximize his utility $U_i(l_i, c_i) = (\delta_i l_i^{\lambda} + (1-\delta_i)c_i^{\lambda})^{1/\lambda}$ under the individual budget constraint $c_i = w_i(T - l_i) + N_i$. Assume individuals put different weight δ_i on leisure. The elasticity of substitution between leisure and consumption is $\frac{1}{1-\lambda}$, which is assumed to be the same across the individuals. To identify this model, I assume $cov[\ln w, \ln(\frac{1}{\delta} - 1)] = 0$.[13]

For each individual i, the first order conditions for the maximization problem (1) subject to the budget constraint (2) can be written as follows:

$$\frac{1}{\lambda}[\delta_i l_i^{\lambda} + (1-\delta_i)c_i^{\lambda}]^{\frac{1}{\lambda}-1}\delta_i \lambda l_i^{\lambda-1} = \eta w_i \tag{7}$$

$$\frac{1}{\lambda}[\delta_i l_i^{\lambda} + (1-\delta_i)c_i^{\lambda}]^{\frac{1}{\lambda}-1}(1-\delta_i)\lambda c_i^{\lambda-1} = \eta \tag{8}$$

where η is the Lagrangian Multiplier. Taking the log of the ratio of equation (7) and equation (8) and rearranging the terms, I obtain

$$log\frac{l_i}{c_i} = \frac{1}{(\lambda-1)}logw_i + \frac{1}{(\lambda-1)}log(\frac{1}{\delta_i} - 1) \tag{9}$$

Individual consumption is calculated from equation (2) taking the time endowment T as 5000 hours per year. If $cov[\ln w, \ln(\frac{1}{\delta} - 1)] = 0$ holds, I am able to estimate equation

[13] $cov[\ln w, \ln(\frac{1}{\delta} - 1)] = 0$ is used to recover individual preferences from the pre-marriage data. Suppose this assumption is violated, for example, people with higher δ (the weight on leisure) work less and attend less school, probably they will end up with less human capital and lower wages. Then the estimate of $\delta_i's$ are upward biased. To relax this strong assumption, instrumental variables are needed. One possibility is IQ which can be argued correlated with one's wage but not correlated with one's preferences.

(10) by OLS. The estimation results are listed in Table 5.[14]

$$log\frac{l_i}{c_i} = \alpha_0 + \alpha_1 log w_i + \epsilon_i \tag{10}$$

where ϵ_i is the error term.

Table 5: Estimation of Equation (10)

	Estimate	Std. error
α_1	-1.14	(.07)
α_0	.72	(.16)

The consistent estimate for λ can be calculated by $\frac{1}{(\hat{\lambda}-1)} = \hat{\alpha}_1$. I get $\hat{\lambda} = 0.12$.

Given $\hat{\lambda} = 0.12$, individual preferences can be calculated by $\frac{1}{(\hat{\lambda}-1)} log(\frac{1}{\hat{\delta}_i} - 1) = \hat{\alpha_0} + \hat{\epsilon_i}$, where $\hat{\epsilon_i}$ is the regression residual from equation (10). The summary statistics of individual preferences are listed in Table 6.

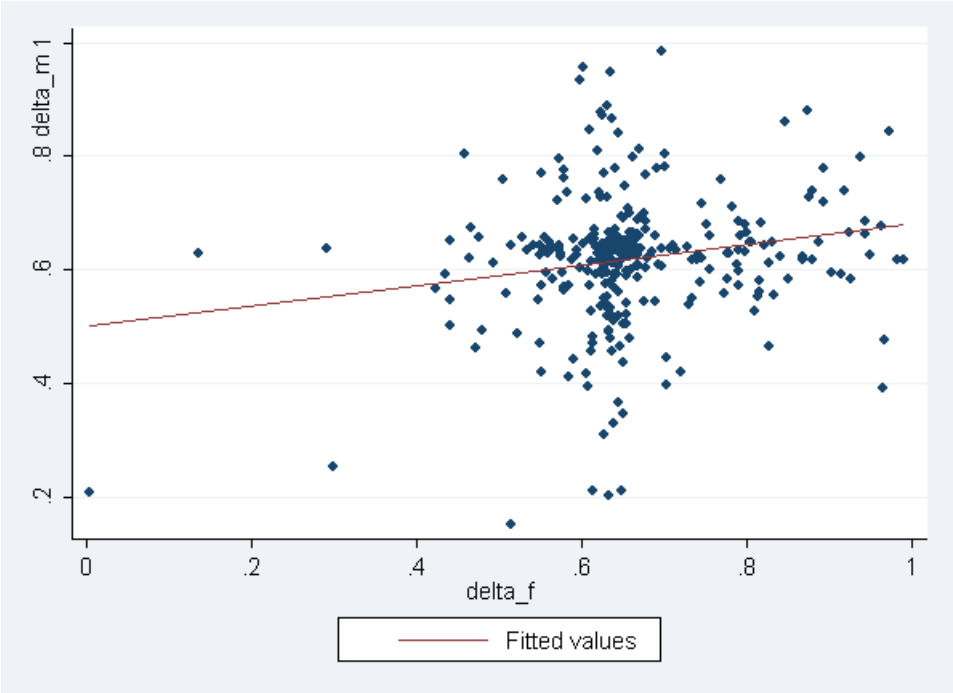
Table 6: Summary Statistics of Individual Preferences

Variable	Mean	Std. error	Min	Max
δ_M	.62	(.12)	.15	.98
δ_F	.66	(.12)	.00	.99

The correlation of δ_M and δ_F is 0.19 with bootstrap 95% confidence interval [0.049, 0.327]. This implies that there is significant and strong positive assortative matching pattern on individual preferences. Men tend to marry women with similar values of leisure. To visualize the assortative matching pattern, I plot δ_M versus δ_F in Figure 1.

[14] Heteroskedasticity-corrected standard errors are provided.

Figure 1: Pattern of Assortative Matching on Individual Preferences



5.2 Estimation of Household Labor Supply Model

5.2.1 Indirect Inference

Since the aim of this paper is to explain the positive correlation between hours worked by husbands and wives, I want to get estimates so that my model captures closely the correlation in the real data. Thus indirect inference is employed. Let $\hat{\beta_T}$ be the vector which contains a set of moments that captures the theoretically relevant aspects of the real data. Let $\hat{\theta_S}$ be the parameter values that generate data with auxiliary moments $\hat{\beta_S}$. Parameters of the model $\hat{\theta} = \begin{pmatrix} \hat{A} \\ \hat{\rho} \end{pmatrix}$ are chosen to minimize the distance between simulated moments and moments from the real data as follows:[15]

$$\hat{\theta}(\Omega) = \underset{\theta}{argmin}[\hat{\beta}_T - \hat{\beta}_S(\theta)]'[\hat{\beta}_T - \hat{\beta}_S(\theta)]$$

[15]The current version uses the identity matrix as the weight matrix. To obtain efficient estimates, the inverse of the variance-covariance matrix of $\hat{\beta_T}$ by bootstrap could be applied.

Here $\hat{\beta_T} = \begin{pmatrix} corr(l_M, l_F) \\ mean(l_M) \\ mean(l_F) \end{pmatrix}$. Given each pair of $\theta = \begin{pmatrix} A \\ \rho \end{pmatrix}$, household labor supply problem in equation (3) is solved subject to the household budget constraint equation (4). Then the vector of simulated moments $\hat{\beta}_S(\theta) = \begin{pmatrix} corr(l_M(\theta), l_F(\theta)) \\ mean(l_M(\theta)) \\ mean(l_F(\theta)) \end{pmatrix}$ is calculated.

5.2.2 Identification

Recall that the household leisure production function has the CES form $L = A(\frac{1}{2}l_M^\rho + \frac{1}{2}l_F^\rho)^{1/\rho}$, with $A > 0$ and $\rho \leq 1$. A measures the equivalence scale of household leisure production. The more productive the technology is, the more hours married people would like to put into leisure production. Thus the absolute level of leisure consumed, which is captured by the average amount of hours taken as leisure by husband and wife, helps to pin down the parameter A.[16] $\gamma = \frac{1}{1-\rho}$ measures the extent that leisure time of the husband and the wife substitute for each other. If leisure hours of married people are close to perfect complements, they should increase or decrease at the same time. Then the correlation of hours worked would be high. On the contrary, if leisure of the husband and the wife substitute each other perfectly, they should increase or decrease in the opposite direction. Then the correlation of hours worked would be low. Thus the correlation of hours worked shed light on parameter ρ.

6 Results

Parameter estimates are presented in Table 7. The elasticity of substitution γ is 0.60. It implies that husband's leisure and wife's leisure are close to perfect complements. The non-parametric bootstrap 95% confidence intervals are listed in the last column of the

[16] Note that the assumption that $\delta's$ are identical before and after marriage is crucial for the identification of A. Once the weights of leisure and consumption are recovered from pre-marriage data, the way married people allocate their time between leisure and market production help to pin down the equivalence scale A.

table.

Table 7: Parameter Estimates

Parameter	Estimates	Bootstrap 95% Confidence Interval
A	1.04	[0.62, 1.34]
$\gamma = \frac{1}{1-\rho}$	0.60	[0.46, 0.73]

For each couple, given their individual preferences, wages and parameter estimates in Table 7, the simulated hours worked are obtained from the household utility maximization problem in equation (3) subject to equation (4). In Table 8, I list the correlation of hours worked, the mean of hours worked by husbands and the mean of hours worked by wives from both the real data and the simulated data. Table 8 shows that the simulated moments match the real ones well.

Table 8: Target and Simulated Moments

Moments	NLSY	Simulated
$corr(l_M, l_F)$	0.15	0.13
$mean(l_M)$	2756.9	2703.6
$mean(l_F)$	3021.3	3075.6

7 Counterfactual Analysis

7.1 Factors affecting correlation

There are four factors which affect the correlation between hours worked by husbands and wives. They are specialization, complementarity of leisure, assortative matching on individual preferences and assortative matching on wage. Before I conduct counterfactual experiments to disentangle them, I clarify the four factors one by one and give intuition about how they affect the correlation.

First of all, before marriage each individual maximizes his/her own utility subject to the individual budget constraint. Singles have to work to support themselves. After marriage, facing the household budget constraint, the married couple jointly allocates time between

leisure and working hours to maximize the sum of individual utilities. Income pooling and utility transferability allow the husband and the wife benefit from specialization. The one with a higher wage works more and the one with a lower wage works less.

Second, the correlation of hours worked for married couples is affected by complementarity of leisure. If married people enjoy time together, they derive a higher value from leisure when their spouses are taking more leisure. The more complementary spousal leisure is, the higher correlation of hours worked would be. In the extreme case of perfect complements, when the husband increases his working hours, his wife gives up the part of her leisure time which becomes valueless without the company of her husband.

The third factor which affects the correlation of hours worked is assortative matching on individual preferences. Recall that the utility level for husbands is $U^M(l_M, l_F, c) = (\delta_M L^\lambda + (1-\delta_M)c^\lambda)^{1/\lambda}$, where $L = A(\frac{1}{2}l_M^\rho + \frac{1}{2}l_F^\rho)^{1/\rho}$. The larger δ_M is, the more leisure time the husband would take. Section 5.1 shows that there is positive assortative matching pattern on δ. The stronger this positive assortative matching pattern is, the more similar labor supply behavior husbands and wives would have, the larger the correlation of hours worked would be.

The last factor is assortative matching on wages. The fact that people with higher wages tend to marry those with higher wages is documented in section 3.2. As mentioned in the beginning of this section, after marriage, income pooling and utility transferability allow married people to take advantage of the wage difference and benefit from specialization. The one with a higher wage works more and the one with a lower wage works less. Therefore, couples with similar wages benefit less from specialization. The correlation of their hours worked will be larger.

Table 9 summarizes how the correlation of hours worked for married couples changes according to each factor.

Table 9: Effects of Four Factors on Correlation

Factor	Effect on correlation
specialization	decrease
complementarity of leisure	increase
assortative matching on individual preferences	increase
assortative matching on wages	increase

7.2 The factor which drives the correlation down

The correlation between hours worked for married couples decreases from 0.21 to 0.15 after marriage. What drives the correlation down? The answer is specialization. Because of income pooling and transferable utilities, the member with a higher wage works more and the one with a lower wage works less.

To be accurate about how much specialization drive down the correlation after marriage, I apply the pre-marriage data and obtain the correlation between hours worked by single men and their *future* wives in a scenario where they are allowed to pool their income and transfer their utilities with them. Given the recovered preferences and pre-marriage wages, for the 315 pairs in my sample, I solve the household utility maximization problem without complementarity in equation (5) subject to the household budget constraint in equation (6).

Comparing with the pre-marriage correlation between hours worked by single men and women (which is 0.21), if singles are allowed to pool income and transfer utilities with their future spouses, the correlation between hours worked by men and women decreases greatly to -0.68. The dramatic decrease measures the effect of specialization and implies that while comparing the correlation of hours worked for singles and the one for married people, one has to seriously take into account the remarkable negative effect of specialization.

7.3 Assortative matching on individual preferences vs. complementarity

Even though specialization reduces the correlation between hours worked by men and women from 0.21 to -0.68, the post-marriage correlation is still as high as 0.15. What drives it back up? I start from the baseline model which includes specialization, complementarity

of leisure and assortative matching on individual preferences and wages. Then I conduct counterfactual experiments to quantify how much the assortative matching on individual preferences and complementarity increases the correlation, respectively. The strategy is to exclude one of these two factors at a time from the baseline model, simulate optimal labor supply behavior and obtain the correlation in this new scenario. The difference between the correlation in the counterfactual experiment and the one in the baseline model measures the effect of that factor.

In all counterfactual experiments, labor supply behaviors are simulated given the estimates gotten in section (5)($\hat{A} = 1.04,\ \hat{\rho} = -0.67,\ \hat{\lambda} = 0.12$). Individual preferences $\delta's$ are assumed to be the same both before and after marriage. The empirical distribution of wages is from the post-marriage data. Correlations for all experiments are listed in Table 10. In the first column, correlations from my sample are also listed.

In the second column, the results from the baseline model are listed. The baseline model includes specialization, complementarity of leisure and assortative matching on individual preferences and wages and is considered to be the benchmark for comparison. To obtain the correlation in the baseline model, I randomly draw a vector of characteristics (w_M,w_F, δ_M, δ_F) from the joint empirical distribution for each couple. Then I solve the household labor supply problem with complementarity as in equation (3) subject to equation (4).

The first counterfactual experiment is conducted to examine the effect of assortative matching on individual preferences. I randomly match men and women on their preferences to obtain the correlation of hours worked if they do not have similar values of leisure. Specifically, for each couple, I randomly draw a pair of wages (w_M,w_F) from the joint empirical distribution. At the same time, I randomly draw individual preferences from the empirical distribution of males for husbands and from the one of females for wives. Then I solve the household labor supply problem with complementarity in equation (3) subject to equation (4).

The second counterfactual experiment is conducted to examine the effect of complementarity of leisure. I keep men and women matched as in the real data. However, I change

the model so that there is no complementarity of leisure. In particular, for each couple, I randomly draw a vector of characteristics $(w_M, w_F, \delta_M, \delta_F)$ from the joint empirical distribution. Then I solve the household labor supply problem without complementarity as in equation (5) subject to equation (6).

The third counterfactual experiment excludes both complementarity and assortative matching on individual preferences. Specifically, for each couple, I randomly draw a pair of wages (w_M, w_F) from the joint empirical distribution. At the same time, I randomly draw individual preferences from the empirical distribution of males for husbands and from the one of females for wives. Then I solve the household labor supply problem without complementarity as in equation (5) subject to equation (6).

There are several notable points regarding Table 10. First, comparing the baseline model with experiment 1, without assortative matching on individual preferences, the correlation decreases by 0.03 (from 0.12 to 0.09). Second, comparing the baseline model with experiment 2, without complementarity, the correlation drops greatly by 0.80 (from 0.12 to -0.69). The above two points imply that complementarity of leisure drives the correlation back more than assortative matching on individual preferences. Finally, comparing experiment 2 with experiment 3, without complementarity, assortative matching on individual preferences has no prominent effect on the correlation.

Table 10: Role of Assortative Matching on Individual Preferences and Complementarity

	sample	baseline model	experiment 1	experiment 2	experiment 3
$corr\,(l_M,l_F)$	0.145	0.119	0.087	-0.683	-0.696
$corr\,(w_M,w_F)$	0.372	0.342	0.342	0.342	0.342
$corr\,(\delta_M,\delta_F)$	0.188	0.174	0.002	0.174	0.002
complementarity		Yes	Yes	No	No
Number of random draws B=4000					

Note:

1. *$corr\,(w_M,w_F)$ and $corr\,(\delta_M,\delta_F)$ measure the degree of assortative matching on wages and individual preferences, respectively.*
2. *Individual preferences are assumed to be the same before and after marriage. All the variables except individual preferences are from post-marriage data.*
3. *The baseline model is used for comparison. It includes all four factors, specialization, complementarity of leisure, assortative matching on individual preferences and assortative matching on wages.*
4. *Experiment 1 excludes assortative matching on individual preferences. Men and women are matched randomly on δ.*
5. *Experiment 2 excludes complementarity of leisure. Both husbands and wives care about their own leisure only.*
6. *Experiment 3 excludes both complementarity of leisure and assortative matching on individual preferences. Men and women are matched randomly on δ. And both husbands and wives care about their own leisure only.*

8 Conclusion

This paper shows that the positive correlation between hours worked by husbands and wives comes from both the joint labor supply decision of married couples and the similarity of individual preferences. Moreover, the joint labor supply decision is the main factor that drives the correlation.

First, individual preferences are recovered from the single's utility maximization problem using pre-marriage data of 315 couples from NLSY79. A strong positive matching pattern on individual preferences are found, which provides evidence that men who value leisure more tend to marry women who value leisure more. Then I apply the post-marriage

data and estimate the household labor supply model, incorporating heterogeneity of individual preferences.

I find that if singles are allowed to pool their income and transfer utilities with their future spouses, the correlation of hours worked decreases from 0.21 in the data to -0.68. Thus, specialization could be a factor which drives the correlation of hours worked down after marriage.

To examine what drives the correlation of hours worked back up after marriage, I conduct three counterfactual experiments. The counterfactual analysis suggests that the complementarity of leisure drives the positive correlation between hours worked by husbands and wives more than assortative matching on individual preferences. Without complementarity, the correlation drops by 0.80. However, without assortative matching on individual preferences, the correlation only drops by 0.03.

The fact that the positive correlation of hours worked by married young couples mainly come from the complementarity of leisure instead of the similarity of their individual preferences implies that the interaction within household play an important role in determining the labor supply of married people. This suggests that regarding policies about labor supply of couples, policy makers should take the indirect effect on the spouse into account.

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Appendix

Sample Selection

A key feature of the NLSY79 is that a series of edited Supplemental Fertility File variables was constructed from 1982 through the present. These variables reflect the beginning and ending dates of marriages. These variables include the month and year a respondent began a first, second, or, beginning in 1988, a third marriage and the month and year a first or second marriage ended, for example, 'Month Began 1st Marriage.' From these variables, we are able to trace out the exact year and month when the first marriage began and ended for each individual.

Information collected as part of the household roster is available for spouses and partners at each survey point if they are listed as members of the household. I need to identify the appropriate relationship to the respondent (that is, code "1" for spouse) through variables that are specific for this purpose. Typically, information on age, relationship to respondent, highest grade of schooling completed, and employment in the past calendar year is collected during each survey.

Since during each survey, the respondents and their spouses are asked questions about their employment in the past calendar year, I use the survey answers from the year when the respondents get married at the first time to collect information about respondents and their spouses when they are single. However, to make sure the spousal information collected for the first time is pure information when they are single, I only keep the respondents who get married before the interview in the same year. Figure 2 and Figure 3 shows the situation when single information is available or unavailable, respectively. The interview date in NLSY79 varies year by year. From 1979 to 1986, NLSY79 interviews generally were conducted in the first half of the year. Beginning in 1987, the fielding period was shifted to the summer and fall months. This continued until 2002 when the survey began in January with a telephone effort. Therefore, there is no way to get information about spouses when they are single for those respondents who get married for the first time in or after 2002.

Figure 2: Spousal Pre-marriage Information is Available

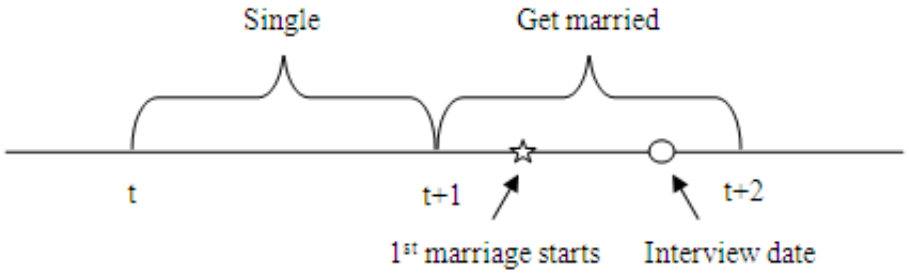
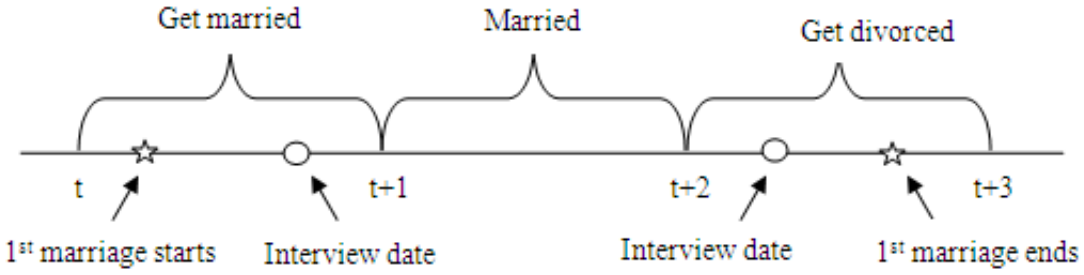


Figure 3: Spousal Pre-marriage Information is Unavailable



The information from the survey one year after the respondents get married includes mixed information about respondents and their spouses both when they are single and married. Therefore, I collect information for married couples using the survey two years after the respondents get married. Those whose first marriage did not last for at least two survey periods are dropped. Figure 4 and Figure 5 shows the situation when single information is available and unavailable, respectively.

Figure 4: Post-marriage Information is Available

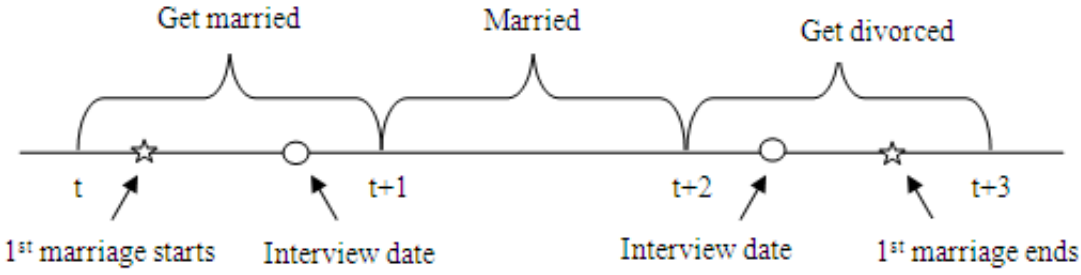
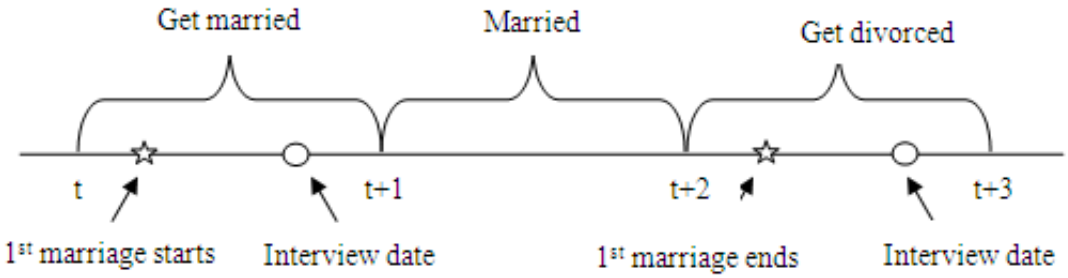


Figure 5: Post-marriage Information is Unavailable



To keep the problem simple, I also dropped the observations if the respondents or their spouses went to school during the sample period. If the respondents were not attending or enrolled in school since the date of last interview, I treat their schooling status as no schooling. For spouses, I assume they did not go to school if there was no increase in their highest grades. Moreover, in my sample, the families that have ever had any child are also dropped. Table (11) shows how I end up with 315 respondents.

Table 11: Sample Selection

Selection Criteria	# of Respondents dropped	# of Respondents remaining
		12,686
Single and married information are available	11,189	1497
No children	846	651
Neither of them went to school	208	443
No missing information about hours worked	54	389
No missing information about age or grade	18	371
Both members worked	56	315

Construction of Key Variables

Variables such as grade, hours worked, income and wage are constructed for one-year period both before and after marriage for 315 married young couples.

Education NLSY79 respondents regularly answer the highest grade they have attended. The spouse's education level can be collected if the respondents list their spouses on the household roster. The spouse's education level is measured by the highest grade completed.

Hours-worked In NLSY79, respondent's hours worked in the past calendar year is created from the work history using all recorded jobs for each respondent (up to 10 jobs). Spouse's information has been collected during each interview on weeks worked and hours worked per week in the past year. I multiply these two variables to calculate the total hours worked in the past year for the spouses.

Income I use total income from wages and salary in past calendar year as the measure of the respondent's and spouse's income.

Wage-rate All the respondents and their spouses can be classified into two groups. Those who worked in the past calendar year without missing value for their income and those who worked in the past calendar year with a missing value for their income. I use the ratio of income and hours worked to measure the wage for the first group. To infer the wage for the second group, I combine information for both respondents and spouses and regress wage on their age, age-squared, education, education-squared and the cross term of age and education separately for men and women. The estimates are listed in Table 8. The wages for the second group are predicted by the estimates given their age and education.

Table 12: OLS Estimation of Hourly Earnings for Workers

	Male Workers The Natural Logarithm of Hourly Earnings	Female Workers The Natural Logarithm of Hourly Earnings
Age	-0.003	0.229***
	(0.017)	(0.042)
Edu	-0.012	-0.026
	(0.026)	(0.035)
Age-squared	0.0009***	-0.003***
	(0.000)	(0.001)
Edu-squared	0.003***	0.005***
	(0.001)	(0.001)
Age*Edu	-0.0007	-0.001
	(0.001)	(0.001)
Constant	1.557***	-2.118***
	(0.320)	(0.699)
Observations	651	651
R-squared	0.146	0.235

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Data from the 1979 cohort of the National Longitudinal Survey of Youth (NLSY79)