Married Women's Labor Force Participation and Intra-Household Bargaining Power*

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Abstract

I examine the effects of education on the labor force participation (LFP) of married women in an intra-household collective decision framework with imperfectly transferable utility and endogenous bargaining powers. In this case, individuals' pre-marriage choices including educational choices and matching on the marriage market, determine their bargaining power. Education has thus monetary (in the marriage and labor markets) and non-monetary (as a normal good) types of return. The estimated model exhibits the features that are consistent with the data. First, the female's bargaining power increases when a woman is more educated relative to her spouse. Second, women's LFP is an inverse U-shaped function of bargaining power. As a woman's bargaining power increases, she participates more in the labor market. However, over a certain level of bargaining power, women are less likely to work outside the home. Thus, this paper identifies a new channel through which education can affect LFP.

Keywords: Intra-Household Decision-Making, Collective Approach, Labor Force Participation, Women.
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1 Introduction

In this paper, I examine the effects of education on the labor force participation (LFP) of married women in the context of a static life-cycle model of education, marriage, and the household. Education is considered both as an investment and a consumption good. Individuals choose an education level because of its consumption value and future returns in the marriage and labor markets. In this model, Intra-household bargaining power is endogenous because educational choices and matching in the marriage market affect bargaining power. I use the model to simulate the effects of pre-marriage choices on married women's LFP. As we will see, the endogenizing of intra-household bargaining powers leads to results that differ from models that treat the bargaining power as exogenous.

The first paper to use the collective settings to model labor supply was the classic work by Chiappori (1988) and Chiappori (1992). In his model, household welfare is a weighted combination of the individuals' utilities, and weights are proxies for the power of each member of the household. He showed that unlike the unitary approach, who earns the income matters to household consumption patterns.[1]

The general collective model has two limitations. First, the bargaining powers are not observable, and the collective model does not offer any guidance for which variables determine bargaining power. In the general collective model, the power of each member in the household is fixed and exogenous.[2] One commonly accepted determinant of intra-household bargaining power is the male/female earning power, which is measured by the male/female wage ratio (Browning et al. (1994)). Thus, while a household's balance of power influences its choices, the choices cannot affect the household's balance of power (Basu (2006)). Basu (2006) is the first attempt at endogenizing the bargaining power in a model of intra-household behavior. He argued that the actual earning of an individual determines her/his bargaining power, not the potential wage. Since the real income is determined by the working hours, which is a choice, the individual's choices can affect the household's balance of power. Empirical evidence support Basu's model for Nepal, Australia, and India (Ray and Koolwal (2002); Maitra and Ray (2005); Lancaster et al. (2008)).[3] However, there is not an agreement on using earnings as a proxy for bargaining power. As Pollak (2005) argues,

[1] In the unitary model, couples maximize a unique utility function subject to a family budget constraint (Becker (1973)). The unitary model assumed that family expenditure pattern depends on total income rather than individual incomes, that means husbands and wives pool their income. Empirical evidence rejects this implication (Pollak (2005)).

[2] The sharing rule governs the distribution of household income between household members. Since the sharing rule is not observed, empirical analyses use distribution factors that affect Pareto weights (bargaining powers). Changes in distribution factors cause changes in the sharing rule. Existing studies use exogenous factors such as wage ratio, sex ratio, and rules of divorce as distribution factors.

[3] Still, in these studies wage rate is exogenous.

higher earnings because of higher working hours, and so less leisure and household production, does not bring more bargaining power. However, the higher earnings because of a high wage rate lead to more power within the household.

The second limitation of the general collective model is that estimates are obtained on the subpopulation of couples where both wife and husband are employed (Donni (2003)). Using wage ratio and earnings ratio as proxies, we cannot measure the bargaining of nonparticipants in the labor market. Restricting to a subpopulation may lead to selection bias. Moreover, labor supply decisions are limited to the choice of weekly or annual hours of work. Thus, we cannot use the general collective model to study labor force participation. There are a few studies that adopt the collective model to male and female nonparticipation (Donni (2003), Blundell et al. (2007), Bloemen (2010)). However, in those studies, the decision for participation in the labor markets only depends on the reservation wage, not bargaining power.[4] Donni (2003), Blundell et al. (2007), and Donni and Matteazzi (2018) consider the possibility of corner solutions for labor market participation. However, in their models, the braining powers are fixed and exogenous.

Gayle and Shephard (2019) and Goussé et al. (2017) remedy these drawbacks by providing a different foundation for bargaining power. They endogenize bargaining power by endogenizing marriage formation (bargaining powers will adjust to clear the marriage market) and measures it for both participants and nonparticipants. While they use different frameworks of modeling the marriage market,[5] in both settings, individual's choices affect their outside option which affects their bargaining power.[6] I complement these two studies by endogenizing the education decision. While Gayle and Shephard (2019) and Goussé et al. (2017) model education not as a choice but as an exogenous state variable that affects returns in the marriage and labor markets, my paper allows women to choose education considering the consumption value of education and anticipating its returns in the marriage and labor markets. In doing so, my model takes into account two channels regarding how education affects women's lifetime decisions. On the one hand, education increases the human capital level, which has returns in the marriage and labor markets. On the other hand, education is a consumption good, not a pure investment (Becker (2009), Lazear (1977)). Individuals choose higher education because they enjoy life as a student e.g., learning new things and meeting new people. Moreover, higher education will increase their status in society especially if they

[4] Each member chooses not to work if his (her) own market wage is below a reservation value.

[5] Gayle and Shephard (2019) consider a frictionless marriage market model with imperfectly transferable utility. Goussé et al. (2017) use a search-matching model with transferable utility.

[6] There is a broad agreement in the literature about the fact that in real negotiations when a player has an outside option her bargaining power increases. Gayle and Shephard (2019) use this model to find the optimal tax system. They do not address women's LFP questions.

choose to study in particular fields (Alstadsæter (2003)). Chiappori et al. (2009) and Chiappori et al. (2018) also considered a model of education and marriage with life-cycle labor supply and consumption. In their model, the consumption value of education is ignored and education is only an investment for marriage and labor markets. I estimate the model and analyze different channels of education effect on women's life-cycle decisions.

Considering the interaction between educational choices and matching patterns, this model can identify two separate effects of education on LFP. On the one hand, higher education increases the potential wage and thus increases the probability of participation in the labor market. On the other hand, the female's bargaining power is affected by the woman's education level. While the first effect of education is well acknowledged, the second effect is often ignored in economic literature. The general collective model and its extensions that take education and family composition as given predict a positive relationship between education and labor supply because the sole effect of education is an increase in the potential wage. This prediction is consistent with the observed data for developed countries. Aggregated time series data for developed countries reveal a positive relationship between LFP of women and their level of education.[7] In contrast, data for Iran (Figure 1) shows the low and decreasing rate of LFP of women despite an increase in the education level.[8] Most of the decrease in the aggregate female participation rate in recent years in Iran is attributable to a decrease in the participation rate of married women. Moreover, LFP of married women have decreased in successive cohorts (Figure 10 in Appendix C.1).[9] One would expect the Iranian women to weigh the consumption value of education heavily if higher education does not influence matching patterns in the marriage market and there are not many labor market opportunities for educated women. While similar trends are observed in some other developing countries, such as India and Middle Eastern and North African (MENA) countries (Syria, Morocco, etc.), little is known about the mechanism.[10] Female participation in these countries may be low because women do not wish to enter into labor markets, or because there are relatively few jobs available to them. While this paper does not explain the reduction in labor market outcomes such as LFP and employment rate, it can explain an increasing trend of education

[7] For example, in OECD countries female LFP increased from 60 percent to 62 percent, while women's average years of schooling has increased between 2006 and 2013 (Source: The World Bank). Theoretically, education is positively related to women's labor force participation because education raises income as well as the opportunity cost of non-market activities.

[8] According to data published by the Statistical Center of Iran (SCI), the number of women who attended university increased 131 percent in the last ten years. At the same time, female LFP fell by five percentage points, from 17 percent to 12 percent.

[9] During this time other factors which affect women's LFP (e.g., access to and cost of daycare and education cost) did not change and the fertility rate has declined.

[10] For example, Indian female LFP fell by seven percentage points, from 37 percent to 28 percent and Syrian female LFP fell from 16 percent to 14 percent, despite rapidly increasing educational attainment for girls between 2006 and 2013.

level when the return to education is not increasing in labor markets. I argue that collective models cannot explain these seemingly incongruent trends observed in some developing countries due to ignoring the consumption value of education and the effect of education on intra-household bargaining powers.

The model of this study is a three-part static model. Forward-looking women make decisions for all parts at time zero anticipating future returns.[11] First, individuals start by choosing their investments in education considering the non-monetary return of education (as a normal good) and anticipating returns in the marriage market and the labor market. Education level determines the individual type in the marriage market and the wage rate in the labor market. Second, they find their mate on the marriage market based on their human capital (type) and their characteristics. Intra-household bargaining powers adjust to clear the marriage market. Finally, in the last part, couples consume private goods and supply labor, subject to the household budget and time constraints. The household decision in the last part depends on the bargaining powers which are determined by the equilibrium of the marriage market.

This study uses data from 2006 to 2013 Iranian Household Income and Expenditure Survey (HIES) for estimation and testing fitness of the model. The advantage of this survey is that it contains rich information on individuals' demographic characteristics (such as age, gender, years of schooling, and relation with the head of the family) and detailed information on individuals' socioeconomic characteristics (such as employment, income, and expenditures). I use Iran as an example because this rich data is not available for other MENA countries. However, the results of this study also have implications for other economies with similar labor market conditions, particularly countries in the MENA region.

The estimated model exhibits the features that are consistent with the data. The female's bargaining power increases when a woman is more educated relative to her spouse. Greater bargaining power allows women to steer allocations in their preferred direction. How does a high bargaining power affect participation in labor markets? Having more bargaining power allow women to decide on their time allocation.[12] They may decide to work and have more income and consumption rather than being financially dependent on their husbands. However, poor labor market conditions (e.g, gender discrimination and wage gap) could discourage women from participating in the labor market. Since the theory cannot determine the direction of the effects, I need to answer the question empirically. The estimated model shows women's LFP is an inverse U-shaped function of bargaining power. Women's LFP initially increases as bargaining power goes up, but starts decreasing after bargaining power reaches a certain level. Therefore, as a woman's bargaining power increases, she participates more in the labor market. However, over a certain level of bargaining

[11] Since the model is static, there is no time dimension.

[12] Women with low barraging power are mostly low educated who face limited job opportunities.

power, women are less likely to work outside the home. This model cannot explain whether this reduction in LFP is related to preferences or labor markets barriers.[13]

The remainder of this paper is organized as follows. The theoretical framework of the model is covered in Section 2. Section 3 describes the sample used. In Section 4, I describe the empirical specification of the model and present the estimation results. Section 5 presents the simulations of the model. Section 6 discusses the properties of the model and implications. Finally, section 7 concludes with a summary of findings, discussion of limitations, and suggestions for future research.

2 The Model

I present an empirical model of education, marriage, and intrahousehold allocations (time and consumption) by considering a static equilibrium model. As in the general framework presented in Galichon et al. (2014), I allow for utilities to be imperfectly transferable across spouses. This study is a direct extension of the integrated collective and marriage-matching models approach developed by Gayle and Shephard (2019). Similar to their model, in this paper bargaining power is endogenous and is determined by the equilibrium of the marriage market. My model extends their model by allowing education to be endogenous. The model of this study is a three-part static model. I assume Pareto efficiency.[14] Since the model is time-invariant, women make decisions for all parts at time zero. First, the women independently invest in human capital; their decision is driven by their ability, preferences, and cost. I assume that human capital is equal to years of schooling. In this model, education has monetary (in the marriage and labor markets) and non-monetary (as a normal good) types of return. When investing in human capital, women must anticipate the outcome of their investment. This outcome has two distinct components: (i) education augments and sorts natural abilities that are sold in the labor market; (ii) a higher educational level has an impact on marital prospects, it affects the expected income of the future spouse, the total utility generated within the household and the intra-household allocation of this utility. Thus, education is signaling and/or screening device for unobservable ability in the labor and marriage market. Education has also a positive consumption value. In the second stage, women and men match on the marriage market. I consider one marriage market where individuals match based on their type. I assume that the education level, which is chosen in the first stage, determines the type in the second stage. At the end of the second stage, individuals choose

[13] Analyzing the impact of labor market opportunities and women's preferences (by taking the interactive effects into account) on women's LFP is left for future work.

[14] Haddad (2014) shows the validity of this assumption for Iranian households.

their mate or decide to remain single. Then, the third stage is the time and resource allocation problem. The last two stages are linked through the Pareto weights which clear the marriage market. Moreover, The first and last stages are linked through the education levels: the education levels chosen in the first stage, determine the potential wage in the household problem of the last stage.

2.1 First Stage: Education Choice

Women choose the level of education to maximize their utility, but it is costly. Women have different motives to invest in education. Education affects future returns in labor and marriage markets. Education also offers a non-monetary return and has a positive consumption value.

$$\max_{Edu} \quad Utility(Edu) - Cost(Edu) = U(C, l) + Value(Edu) - Cost(Edu) \tag{1}$$

where Edu is education which is both a consumption good ($Value$ is consumption value of education) and an investment alternative. Women also get utility (U) from ordinary consumption (C) and leisure (l). A woman's consumption depends on the future income which depends on her own and her husband's education. I define four education categories: less than high school (less than 8 years), high school (9-12 years of education), Bachelor's and some college (13-16 years of education) and graduate education (17 years of education and higher). I assume the consumption value of less than high school and high school education is zero. I also assume the consumption value of post-secondary education depends on the field of study. Based on Iran Ministry of Science, Research and Technology (MSRT) reports, the popularity of different fields of study is different. Also, future job possibilities and wage rates are different among fields. I assume that the individuals choosing field depends on how much they care about future job possibilities and how much they care about how demanding and enjoyable the field is. Following Alstadsæter (2003), I consider the extreme case where the wage return is either low or high and the consumption value of the education is either low or high. I assume low consumption value equals zero and high consumption value equals the price women pay for education (tuition fees). Thus, based on MSRT reports on popularity and wage return of different fields of study, I define three types of education: Type-A education: high consumption value and low wage return (e.g., Architecture, Environmental Science), Type-B education: low consumption value and high wage return (e.g., Accounting, Kinesiology), Type-R education: high consumption value and high wage return (e.g, Medical School, Law School). A woman chooses Type-A post-secondary education if she puts more weight on the present than on the future. Not everybody chooses Type-R post-secondary education because of the cost. $Cost$ is the average tuition fee at different education levels and different fields

of study. For example, the most costly average tuition fees for Iranian students are in dentistry, followed by medicine and pharmacy. The least costly tuition fee is in humanities.[15] Education choice determines their type in the marriage market and their potential wage for solving the household problem in the last stage.

2.2 Second Stage: Marriage Market

In the second stage, women and men match on the marriage market. As mentioned before, the education level determines the type.[16] Thus, the utility function in this stage is conditional on education (which is chosen in the first stage). There are I types of men and J types of women. The population vector of men and women are M and F, respectively. Element m_i indicates the population of type i males, and similarly element f_j indicates the population of type j females. Marriage matching function is an $I \times J$ matrix τ whose i, j element τ_{ij} denotes the population of type i males married to type j females. Individuals may also choose not to get married. I use τ_{i0} and τ_{0j} to show the population of single males and females. The marriage matching function must satisfy the feasibility constraints:

$$\tau_{0j} + \sum_i \tau_{ij} = f_j \quad \forall j \tag{2}$$

$$\tau_{i0} + \sum_j \tau_{ij} = m_i \quad \forall i \tag{3}$$

$$\tau_{i0}, \tau_{0j}, \tau_{ij} \geq 0 \quad \forall i, j \tag{4}$$

An important timing assumption is that the decision on marriage is made after the decision about education level and before the intra-household negotiation about time and resource allocation. Thus, people make decisions for marriage based on the expected value of being single or being in any of the particular marriages. The utility from remaining single for a type i single male and type j single female depend only on their own wage and non-labor income:

$$U^j_{0j} = U^j_{0j}(W^j, Y^j) \tag{5}$$

$$U^i_{i0} = U^i_{i0}(W^i, Y^i) \tag{6}$$

where W^j and Y^j are type j single female's wage rate and non-labor income, respectively. Similarly, W^i

[15] Studying in public universities is free for talented students. However, since the average tuition is approximately equal to minimum wage, I use tuition fee for talented students as the opportunity cost of education.

[16] I assume the field of study has no effect on the type. Thus, while both the education level and field of study affect the consumption value of education and future return in the labor markets, only the level of education determines the type in the marriage market.

and Y^i are type i single male's wage rate and non-labor income.

For married individuals, the utility is a function of a candidate bargaining power μ_{ij} associated with a type i, j match, wife and husband's wage and wife and husband's non-labor incomes:

$$U_{ij}^j = U_{ij}^j(W^j, W^i, Y^j, Y^i, \mu_{ij}) \tag{7}$$

$$U_{ij}^i = U_{ij}^i(W^j, W^i, Y^j, Y^i, \mu_{ij}) \tag{8}$$

where W^j and W^i are type j wife and type i husband's wage rates. Y^j and Y^i are type j wife and type i husband's non-labor incomes. μ_{ij} is the wife's bargaining power that denotes the relative ability of the wife to negotiate with her husband on her own terms in order to persuade an agreement on consumption and labor supply. The utility of a type j woman, when married to a type i man, is strictly increasing in her bargaining power ($\partial U_{ij}^j(\mu_{ij})/\partial \mu_{ij} > 0$), while the utility of her husband is strictly decreasing in μ_{ij} ($\partial U_{ij}^i(\mu_{ij})/\partial \mu_{ij} < 0$).

Following Choo and Siow (2006), the marriage decision is made by comparing utilities of different matches and remaining single. The utility includes a systematic component (which depends on the type of a female and type of a potential husband) and an idiosyncratic payoff ($\theta_{ij}^{j,h}$ for a female h of type j that is specific to her and the type of her husband i). Thus, a woman marriage decision problem is:

$$\max_j [U_{0j}^j + \theta_{0j}^{j,h}, U_{1j}^j(\mu_{1j}) + \theta_{1j}^{j,h}, ..., U_{Ij}^j(\mu_{Ij}) + \theta_{Ij}^{j,h}] \tag{9}$$

I use an empirical extension of Choo and Siow (2006) matching framework by Gayle and Shephard (2019). By assuming that θ has a Type-I extreme value with an unknown scale parameter σ_θ and solving the above optimization problem, the demand and supply of each type are given by the conditional choice probabilities. The proportion of type j females who would like to marry a type i male (P_{ij}^j) and the proportion of type i males who would like to marry a type j female (P_{ij}^i) are as follows:

$$\begin{aligned} P_{ij}^j(\vec{\mu}^j) &= Pr[U_{ij}^j(\mu_{ij}) + \theta_{ij}^j > \max_{\forall g \neq i}[U_{gj}^j + \theta_{gj}^j, U_{0j}^j + \theta_{0j}^j]] \\ &= \frac{\tau_{ij}^d(\vec{\mu}^j)}{f_j} = \frac{exp(U_{ij}^j(\mu_{ij})/\sigma_\theta)}{exp(U_{0j}^j/\sigma_\theta) + \sum_{g=1}^I exp(U_{gj}^j(\mu_{gj})/\sigma_\theta)} \end{aligned} \tag{10}$$

$$P_{ij}^{i}(\vec{\mu}^{i}) = \frac{\tau_{ij}^{s}(\vec{\mu}^{i})}{m_i} = \frac{exp(U_{ij}^{i}(\mu_{ij})/\sigma_\theta)}{exp(U_{i0}^{i}/\sigma_\theta) + \sum_{h=1}^{J} exp(U_{ih}^{i}(\mu_{ih})/\sigma_\theta)} \tag{11}$$

where $\tau_{ij}^{d}(\vec{\mu}^{j})$ measures type j females who demand type i males and $\tau_{ij}^{s}(\vec{\mu}^{i})$ measures the supply of type i males. In equilibrium, Pareto weights adjust to clear the market such that the population of type i males demanded by type j females equals the population of type i males supplied to type j females. An equilibrium of the marriage market is characterized by $I \times J$ matrix Pareto weights $\vec{\mu} = [\vec{\mu}^{1}, \vec{\mu}^{2}, ..., \vec{\mu}^{J}]$:

$$\tau_{ij}(\vec{\mu}) = \tau_{ij}^{d}(\vec{\mu}^{j}) = \tau_{ij}^{s}(\vec{\mu}^{i}) \qquad \forall j = 1, ..., J \quad , \quad i = 1, ..., I \tag{12}$$

Thus, equilibrium weights ($\vec{\mu}$) depend on the relative scarcity of spouses of different types. My analysis diverts from Gayle and Shephard (2019) in that the type of individuals in the marriage market is a choice. Education level determines the individual type. Unlike Gayle and Shephard (2019), I consider education as an endogenous variable; women choose education (type) anticipating its returns in the marriage market. Thus, changes in the marriage markets can affect the education decision. By imposing appropriate parametric restrictions on the utility function, Proposition 1 proves the existence and uniqueness of the equilibrium for the marriage market.

While I allow for informational frictions because of unobserved heterogeneities, I assume that search frictions are negligible in the marriage market that means the individuals have easy access to each other. No search frictions implies marriage market equilibrium exists and is stable and Pareto efficient (Nick and Walsh (2007), Chiappori et al. (2008), Lauermann and Nöldeke (2015)). Moreover, premarital choices including educational decisions are efficient only in a large frictionless matching market (Peters and Siow (2002), Iyigun and Walsh (2004), Baker and Jacobsen (2007)). Based on the empirical literature, it is not clear which framework gives more precise predictions of marriage market outcomes. Existing studies that consider equilibrium models of marriage with frictions treat education as exogenous.

2.3 Third Stage: Time and Resource Allocation Problem

At the end of the second stage, individuals choose their mate or decide to remain single. In the last stage, individuals decide about time allocation and consumption. The utility function in this stage is conditional on husband characteristics (which is chosen in the second stage) and education (which is chosen in the first

stage). Time allocation problem for single females and similarly for single men is as follow:

$$\max_{C_0^j, l_0^j, L_0^j} \quad U^j(C_0^j, l_0^j) \tag{13}$$

$$st: \quad p\, C_0^j + W^j l_0^j < Y + W^j L_0^j \tag{14}$$

$$T_0^j = L_0^j + l_0^j \tag{15}$$

A single woman type j's utility (U^j) depends on consumption (C_0^j) and leisure (l_0^j). T_0^j is her total time which is allocated between work (L_0^j) and leisure. Her wage (W^j) is a function of her characteristics such as education (which is chosen in the first stage), experience, and economic conditions. Y is her non-labor incomes and p is the price of consumption.

For married individuals the problem is different. Couples consume goods and supply labor subject to the family budget and time constraints. Following Chiappori (1992), wife and husband behave as a single decision-maker maximizing the weighted sum of the spouses' utilities:

$$\max_{C^j, C^i, l^j, l^i, L^j, L^i} \quad \mu_{ij}\, U^j(C^j, l^j) + (1 - \mu_{ij})\, U^i(C^i, l^i) \tag{16}$$

$$st: \quad p(C^j + C^i) + W^j l^j + W^i l^i < Y + W^j L^j + W^i L^i \tag{17}$$

$$T^j = L^j + l^j \ , \ T^i = L^i + l^i \tag{18}$$

where μ_{ij} denote the wife's bargaining power of and $(1 - \mu_{ij})$ is her husband's. Household decision weights or bargaining powers will adjust to clear the marriage market. U^j and U^i are wife and husband's utility functions that depend on both consumption C (wife's consumption C^j and husband's consumption C^i) and leisure l (wife's leisure l^j and husband's leisure l^i). T^j and T^i are wife and husband's total time which are allocated between work (L^j is wife's working hours and L^i is husband's working hours) and leisure. W^j and W^i are wife and husband's wages that are functions of their characteristics such as education, experience, and economic conditions. I assume wife and husband pool their labor and non-labor ($Y = Y^j + Y^i$) earnings between themselves.[17] Since wife's and husband's utility functions are different, their decision depends on bargaining power. Figure 2 shows the relationship between all variables of the model.

Since the focus of this paper is the effects of education on LFP, not employment rate, I do not consider labor demand frictions. For example, a reduction in the probability of receiving job offers due to gender

[17] The non-labor income includes financial transferred aids, real estate incomes, subsidies, interest on bank deposits, bonds yield and share dividends, scholarships and cash gifts from others.

discrimination in labor markets tightens the labor market for female job seekers and can discourage them from participating. For simplicity, I assume changes in the demand side are reflected in wage rates.

Assuming the preferences are rational, monotonic, convex and continuous, the utility functions are increasing and quasi-concave. It is assumed that spouses know each other's preferences. Furthermore, I assume that each household member is endowed with direct preferences on her/his leisure and consumption. Therefore, household members have egoistic preferences. However, as Chiappori (1992) showed, "caring" form of individual preferences would lead to identical results. As in Galichon et al. (2014), utilities are imperfectly transferable across spouses. Moreover, I assume full commitment assumption in marriage to avoid issues related to divorce.

To avoid two sources of bias, as explained before, I consider a static equilibrium model that means there is no time dimension. First, the accumulation of errors in these three stages will lead to biased estimates. Second, since this model combines discrete (e.g., education and labor force participation) and continuous choices (e.g., consumption and working hours), the value function of a dynamic solution is neither smooth nor concave. Thus, I consider a static equilibrium model in which forward-looking individuals make decisions for all parts at time zero anticipating future returns.[18] The utility in the three stages is the same: the utility function in the first stage is the indirect utility function of the second stage, and the utility function in the second stage could be interpreted as the indirect utility function of the third stage (conditional on education). I solve the model by working backward from the last stage. Thus, I start with the labor supply and consumption decisions that are functions of the wife's education, her intra-household bargaining power, and her spouse's education. Then, I move to the second stage, i.e. the marriage market. The solution of this stage allows me to construct the utility of woman, conditional on her education level. The utility function in the second stage is the indirect utility function of the third stage. Finally, in the first stage, women choose the level of education considering its consumption value and future returns in labor and marriage markets. The Utility function in the first stage is the indirect utility function of the second stage. Table 8 in Appendix C.2 shows a list of all variables of the model. As this table shows, price index (p), non-labor income (Y), individuals' total time (T^j and T^i) and age (age^j and age^i) are pre-determined variables. The price index (p) and individuals' total time (T^j and T^i) are normalized to 1. The source of other exogenous variables is Iranian Households' Income and Expenditures Surveys (HIES). Other variables of the model including wife and husband's consumption (C^j and C^i), leisure (l^j and l^i), labor supply (L^j and L^i), wage (W^j and W^i) and education level (Edu^j and Edu^i) are endogenous. Wife and husband's

[18] In fact, education is not a dynamic choice. Most individuals complete their education by age 24 in Iran. Less than 5% of Iranian students are aged above 25. While decisions on marriage, consumption and labor supply are dynamic, to avoid bias and complexity, I assume individuals make decisions for these variables at time zero.

consumption (C^j and C^i) are unobservable, but I can observe total consumption ($C^j + C^i$) from HIES. Also, I observe individuals' education levels (years of schooling and fields of study: Edu^j and Edu^i) and labor supply (L^j and L^i) from the data set. By having labor supply, I can calculate leisure ($l^j = 1 - L^j$ and $l^i = 1 - L^i$). I observe wage (W^j and W^i) only for workers and thus, I have to find the potential wage for non-workers. Moreover, the wife's intra-household bargaining power (μ) is endogenous and is determined by the equilibrium of the marriage market.

3 Data

The main data source is the Iranian Households' Income and Expenditures Surveys (HIES) from 2006 to 2013.[19] This sample covers near 40,000 households every year. It is conducted yearly by the Statistics Center of Iran (SCI). I restrict my main sample to the couples in which wives and husbands are aged between 15 and 65 and do not have children.[20] I also exclude from the sample all retired workers, men who are doing mandatory military services, those who are physically unable to work, and those who are prohibited by law from working. Since the behavior of rural and urban households is different, I only study households who live in urban regions of the country. I do not lose too much of the sample because 75% of the population live in urban areas.

The advantage of this survey is that it contains rich information on individuals' demographic characteristics (such as age, gender, marital status, years of education, and relation with the head of the family) and detailed information on individuals' socioeconomic characteristics (such as employment, income, and expenditures). However, this data set has some limitations. The "annual" working hours are not observable in HIES. Since individuals are asked about the "daily" hours of work and the number of days they worked during the last week, I calculate the annual hours of work as (daily hours of work $\times$ number of workdays during the last week $\times$ number of weeks in a year). Moreover, HIES does not provide the wage rate, which is the average hourly earnings. I calculate the wage rate by dividing total yearly labor income over annual working hours. Another limitation of HIES is that it does not provide the non-labor income, but it reports a detailed composition of individuals' income. Thus, I consider the non-labor income as the summation of financial transferred aids, real estate incomes, subsidies, interest on bank deposits, bonds yield and share dividends, scholarships, and cash gifts from others.

[19] This data set is available from 1984 but some essential variables for this study such as hours of work were not asked before 2006.

[20] Since the focus of this paper is LFP not fertility, my sample includes couples with no children. Allowing for children is left for future work.

Table 1 reports the descriptive statistics of key variables during the period 2006-2013. As this table shows, the proportion of highly educated people (people with post-secondary education) has increased among women (from 22% to 31%) and men (from 23% to 26%). The increase in the education level of Iranian women is mostly related to a large increase in the proportion of highly educated women and a reduction in the proportion of low educated women. Despite the increase in the education level, females' participation in the labor market has decreased from 17% in 2006 to 13% in 2013. Highly educated females have higher participation rates than the others, but it has seen a sharper downward trend from 43% in 2006 to 28% in 2013. Besides, the annual real wage decreased over time with a stronger reduction among educated workers.[21] Although the nominal wage rate had increased, it had not been synchronized with the rate of inflation. Overall, we observe a low and decreasing trend of LFP of married women especially among women with a high education level in Iran.

I consider preference heterogeneity across individuals. However, since this data is not a panel, I cannot track individuals over time. Instead of tracking individuals, as Deaton (1985) suggests, I use the mean-based pseudo-panel approach to track cohorts of individuals.[22] Thus, I assume preference parameters are the same for all individuals in the same cohort but are different across cohorts. Before using this repeated cross-sectional data, I address two data issues: (1) cohort stability over time and (2) differentiation between age, period, and cohort effects.

1. Establishing the stability of cohorts over time

   I defined cohorts based on gender and generation (birth year) to prevent the movement of individuals between cohorts over time. Moreover, since this paper only studies households who live in urban regions, I eliminate immigrants to the urban area from the data to maintain cohort stability. There is a trade-off between the number of cohorts and the number of observations in each cohort (Deaton (1985)).[23] In this paper, the gender characteristic consists of a male cohort and a female cohort. The generation characteristic consists of two cohorts: the old (born between 1941 and 1965) and young (born between 1966 and 1998) generation cohorts. The gender (2), and generation (2) cohort definitions describe 4 potential ($2 \times 2 = 4$) cohorts. Repeated over the eight census years, there is a potential of 32 cells of cohort mean data.

[21] This reduction in the real wage is mostly related to a sharp drop in 2008. It could be related to the United Nations economic sanctions against Iran that were imposed in December 2007.

[22] A cohort is a group of individuals with fixed membership over time. Thus, an individual is a member of exactly one cohort which is the same for all periods, for instance, age cohorts or cohorts based on sex.

[23] If the number of cohorts is small, estimations have small sample problems. However, if I define a large number of cohorts the size of each cohort will not be large enough for estimation the average characteristics of each cohort.

2. Differentiating between age, period, and cohort (APC) effects

   Observed variance in individuals' choices can be attributed to three related effects: (a) differences between cohorts (cohort effects); (b) differences associated with different points in the life cycle (age effects); and/or (c) differences associated with different periods (period effects). I cannot identify these three effects simultaneously because only one time dimension and one individual or cohort dimension exists. More specifically, the functional relationship between all three effects causes perfect collinearity when all three effects are fully specified (period=age+cohort) (Fienberg and Mason (1985) and Ryder (1965)). The question of how best to solving this identification problem has generated controversy, especially among sociologists (Rodgers (1982) and Smith et al. (1982)). Although there is a variety of approaches to solve the APC conundrum, each has limitations. One common approach is to impose a linear restriction on any pair of age, period, or cohort variables (e.g., if the membership in the cohort born 1971-1980 is no different from membership in the 1981-1990 cohort, then I can restrict the cohort effects to be equal for this pair). For estimating parameters of utility functions, I address the age, period, and cohort identification problem by using a linear restriction that all age effects are equal and are included in the constant term. Thus, individuals' preferences differ across cohorts, and an individual's preferences change over time. However, this change is related to time effect, not to an age effect.

4 Identification and Estimation the Model

I solve the model by working backward from the last stage. In this framework that the household consists of two individuals with distinct utility functions, the decision process leads to Pareto efficient outcomes. I start with the labor supply and consumption decisions for couples and consider Cobb-Douglas preferences:

$$\max_{C^j,C^i,l^j,l^i,L^j,L^i} \quad \mu_{ij}\ Ln[(C^j)^{\alpha_j}(l^j)^{1-\alpha_j}] + (1-\mu_{ij})\ Ln[(C^i)^{\alpha_i}(l^i)^{1-\alpha_i}] \tag{19}$$

$$st: \quad p(C^j + C^i) + W^j l^j + W^i l^i < Y + W^j L^j + W^i L^i \tag{20}$$

$$T^j = L^j + l^j \tag{21}$$

$$T^i = L^i + l^i \tag{22}$$

I assume that $l^j > 0$ and $l^i > 0$. Since wife and husband's preferences (α_j and α_i) are not the same, utilities are imperfectly transferable across spouses. Moreover, I consider preference heterogeneity i.e., I assume that α_j and α_i, and so the optimal level of consumption and leisure are different across cohorts

and during the time. After solving F.O.Cs of this maximization problem, I have four equations in four unknowns (C^j, C^i, l^j, l^i):

$$C^j = \alpha_j \mu_{ij}(Y + W^j + W^i) \tag{23}$$

$$C^i = \alpha_i(1 - \mu_{ij})(Y + W^j + W^i) \tag{24}$$

$$l^j = \frac{(1-\alpha_j)\mu_{ij}(Y + W^j + W^i)}{2W^j}, \quad if \quad 0 < l^j < 1 \tag{25}$$

$$l^i = \frac{(1-\alpha_i)(1-\mu_{ij})(Y + W^j + W^i)}{2W^i}, \quad if \quad 0 < l^j < 1 \tag{26}$$

C^j and C^i are unobservable. In fact, I can only observe total consumption ($C = C^j + C^i$). Thus, I combine Eq (23) and Eq (23):

$$C = C^j + C^i = \alpha_j \mu_{ij}(Y + W^j + W^i) + \alpha_i(1 - \mu_{ij})(Y + W^j + W^i) \tag{27}$$

Moreover, the wife's share of consumption which is given by:

$$S^j_{ij}(\mu_{ij}) = \frac{\alpha_j \mu_{ij}}{\alpha_i + (\alpha_j - \alpha_i)\mu_{ij}} \tag{28}$$

is increasing in the wife's bargaining power ($\partial S^j_{ij}(\mu_{ij})/\partial \mu_{ij} = \frac{\alpha_i \alpha_j}{(\alpha_i + (\alpha_j - \alpha_i)\mu_{ij})^2} > 0$).[24]

As Eq (25) implies the optimal amount of wife's labor supply ($1 - l^j$) is an inverse function of her bargaining power (μ) and her non-labor earning ($Y + W^i$).[25] Another variable that affects a woman's labor supply is her wage (W^j). If wage increases, on the one hand, the opportunity cost of leisure increases that makes women give up leisure and work more (the substitution effect). On the other hand, the higher wage increases her income for given working hours that makes her work less and spend this higher income on leisure (the income effect). Thus, education affects labor supply through two channels: bargaining power and wage.

The model allows the corner solution where it is optimal not to participate in the labor markets. I find

[24] As Figure 14 in Appendix C.6 shows wife's consumption share is increasing in the wife's bargaining power. Consumption expenditures of households are reported based on the Classification of Individual Consumption According to Purpose (COICOP). Thus, we observe the total household consumption of each category. Although we cannot observe the wife's share of consumption, some goods and services such as clothes and footwear can breakdown to men/women/children. I proxy wife's consumption share by the ratio of spending on women's items (including women's clothes, women's shoes, jewelry, makeup, etc.) to total spending. I consider those goods and services that cannot breakdown to a specific individual as "shared goods" such as food, housing, etc. I assume all family members have an equal share of shared goods.

[25] As I mentioned before, I assume the wife and husband pool their labor and non-labor earnings between themselves. Thus, the wife's labor income is W^j and her non-labor earning is the sum of family non-labor income (Y) and her husband's wage (W^i).

the corner solution using Kuhn-Tucker conditions in the maximization:

$$L^j = 0 \Rightarrow \frac{\partial \mathcal{L}}{\partial L^j} < 0 \Rightarrow \mu_{ij} > \frac{2}{1-\alpha_j} \frac{W^j}{Y + W^j + W^i} \tag{29}$$

As Eq (29) shows when a woman's potential wage is so low or her bargaining power is so high the optimal decision is not to work. To determine who participates and who does not I need the potential wages. I have access to actual wage observations (as a proxy for the potential wages) for only those who work. Thus, I need to estimate potential wages for nonparticipants. I do not model the demand side of labor markets in this paper. Instead, I estimate the reduced form of wage functions which explained in sub-section 4.1.1 (estimation parameters of the reduced form of wage functions).

I now move to the second stage (the marriage market). The utility function in this stage could be interpreted as the indirect utility function of the third stage: $\nu(edu^i, edu^j, Y, \mu_{ij})$. An equilibrium of the marriage market is described by the Pareto weights matrix $\vec{\mu} = [\vec{\mu^1}, \vec{\mu^2}, ..., \vec{\mu^J}]$ such that the demand of type i males by type j females is equal to the supply of type i males to type j females:

$$\tau_{ij}(\vec{\mu}) = \tau^d_{ij}(\vec{\mu}^j) = \tau^s_{ij}(\vec{\mu}^i) \qquad \forall j = 1, ..., J \quad , \quad i = 1, ..., I \tag{30}$$

Proposition 1. The marriage market has a unique equilibrium.

Proof. See Appendix C.3.

For the identification of the Pareto weights, I need to assume that the idiosyncratic marital payoffs have a Type-I extreme value distribution with an unknown scale parameter σ_θ. Thus, I can use a numerical algorithm that Gayle and Shephard (2019) applied for solving for the equilibrium and calculating the market clearing vector of Pareto weights (Appendix C.4). Women and men match on the marriage market and their decision constrained by preferences, non-labor incomes, and wages. I observe wages for workers and I estimate the potential wages for non-workers.

Finally, in the first part women choose the level of education:

$$\max_{Edu} \quad Ln[(C^j)^{\alpha_j} * (l^j)^{1-\alpha_j}] + Value(Edu) - Cost(Edu) \tag{31}$$

The first term of utility function in this stage ($Ln[(C^j)^{\alpha_j} * (l^j)^{1-\alpha_j}]$) is the indirect utility function of the second stage: $\nu(edu^i, edu^j, Y)$. As mentioned before, I define four education levels and assume the consumption value of education depends on field of study ($Edu \in \{Edu_1, Edu_2, Edu_3^A, Edu_3^B, Edu_3^R, Edu_4^A, Edu_4^B, Edu_4^R\}$). Thus, the education decision is a discrete choice problem. Besides the consumption value of education, ed-

ucation increases the potential wage. Having more future income increases the future own utility. It also increases the non-labor income of the mate and so the mate's utility. Thus, education increases attractiveness in the labor market and the marriage market. There is trade-off between a smaller share of a big pie (match to a relatively higher educated husband and thus have higher family income but lower bargaining power) or a bigger share of a small pie (match to a relatively lower educated husband and thus have lower family income but higher bargaining power).

$$Prob[Edu = edu_s] = Prob[U(C(edu_s), l(edu_s)) + Value(edu_s) - Cost(edu_s) > U(C(edu_r), l(edu_r)) + Value(edu_r) - Cost(edu_r)] \ \forall r \neq s \tag{32}$$

After solving this problem and finding Edu, I calculate W^j by using a reduced form of wage functions. Then, I can have μ in the second stage equilibrium (Eq (30)) by knowing the education level as the individuals' type. Finally, I can compute C^j, C^i, l^j and l^i.

4.1 Estimation

I estimate my model with Generalized Methods of Moments estimation (GMM) using data from 2006 to 2013 Iranian Household Income and Expenditure survey. The model has three groups of parameters and unknowns: $I \times J$ matrix Pareto weights ($\vec{\mu}$), utility function parameters (α_j, α_i), and wage functions parameters.

As mentioned before, I estimate a reduced form of wage functions to estimate the wage parameters. Then, taking estimated wage parameters, I estimate Pareto weights and parameters of utility functions. However, Pareto weights and utility function parameters cannot be identified together because I have fewer equations than unknowns (underdetermined system of equations) for the couples where wives do not participate in the labor market (who are the majority of the sample). Thus, I need to impose another assumption. following Gayle and Shephard (2019), I assume that preferences are unchanged by marriage. Now, I can estimate the parameters in three steps:

(1) estimation parameters of the reduced form of the wage functions

(2) estimation preference parameters (α_i, α_j) for each cohort (young and old) over time using observed time allocation decisions of single individuals and assuming that preferences are unchanged by the marriage

(3) using a numerical algorithm to find Pareto weights ($\vec{\mu}$) from the equilibrium of the marriage market

I use three sets of moments. The first set of moments relate to the marriage market. I use the number of single men and women by own education and married households by joint education. The second set of moments relate to the labor market. I use mean and standard deviation of conditional work hours, employment rates, and labor force participation rates by education, marital status, and cohort. I assume all men participate in the labor market. I also used moments related to accepted wages and conditional earnings: the mean and standard deviation of the accepted log wage and the mean and standard deviation of non-labor income (described by education, marital status, cohort, and gender). The last set of moments relate to education choice. I use the mean and standard deviation of completing education levels by marital status, cohort, and gender.

4.1.1 Estimation Parameters of the Reduced Form of the Wage Functions

I estimate parameters of wage equations by the Heckman two-stage method. I observe the wage only for those who work. Since working people are not randomly selected from the population, estimation results using this subpopulation may be biased. Thus, I use the Heckman correction to correct for this selection bias. The Heckman correction includes two stages. In the first step, women decide to participate in the labor market or not. The second step estimates the effects of the independent variables on the wage. Since 99% of husbands are participants in my sample, I assume all men participate in the labor market. I explain the detail of wage equations parameters estimation in Appendix C.5.1.

Table 2 shows the estimated coefficient of the wage equation. Concerning the education variable, I find that a higher education level increases the hourly wage and the effect is statistically significant. Moreover, age has a positive and significant effect on the hourly wage. However, the effect of the square of the age is negative, which means that over a certain age, the wage does not increase anymore.

Table 3 reports the estimated parameters of the men's wage equation. The results suggest that education has a positive effect on men's hourly wages. The concavity of the wage is captured by the quadratic age terms, age and age^2, whose coefficients, β_{2m} and β_{3m}, are respectively positive and negative. Thus, the age has a positive on the hourly wage, but over a certain age, the wage does not increase anymore.

4.1.2 Estimation Preference Parameters

Taking estimated wages parameters, I can estimate parameters of utility functions using observed consumption and time allocation decisions. Following Gayle and Shephard (2019), since consumption of each family member is not observable, I assume preferences are unchanged by marriage and use observed consumption

and time allocation decisions of single individuals to estimate parameters of utility functions. Unlike Gayle and Shephard (2019), I allow preference heterogeneity across cohorts and over time. Individuals' preferences differ across cohorts (gender and birth cohorts) and over time but do not vary by type (education) and labor market status.[26] To estimate preference parameters, as Deaton (1985) suggests, I use the mean-based pseudo-panel approach to track cohorts of individuals.[27] Mean-based pseudo panels follow cohort means and thus suffer less from individual level measurement error problems.

As mentioned before in the section 2, the time allocation problem for single females and single males are as follow:

$$\begin{aligned} \max_{C_0^k, l_0^k, L_0^k} \quad & \alpha_k Ln(C_0^k) + (1-\alpha_k) Ln(l_0^k) \\ st: \quad & C_0^k + W^k l_0^k < Y + W^k L_0^k \\ & T_0^k = L_0^k + l_0^k, \quad l_0^k > 0 \\ & for \quad k = i, j \end{aligned}$$

I use F.O.Cs of single individuals' time allocation decision (equations (33), (34) for workers, and (35) for nonparticipants) as moment conditions to estimate preference parameters with Generalized Methods of Moments estimation (GMM):

$$C_0^k = \alpha_k (Y + W^k) \tag{33}$$

$$l_0^k = \frac{(1-\alpha_k)(Y+W^k)}{2W^k} \quad if \quad 0 < l_0^K < 1 \tag{34}$$

$$(1-\alpha_k) + \frac{2W^k}{Y+W^k} < 0 \quad if \quad L_0^K = 0 \quad \text{(corner solution)} \tag{35}$$

Table 4 shows estimated parameters of utility functions for each cohort over time. As this table shows, preferences are statistically different across cohorts and over time. In all years, the young cohort (born between 1966 and 1998) have a greater value of marginal utility of consumption (α) than the old cohort (born between 1941 and 1965). Moreover, the trends are increasing for both genders and cohorts (Figure 3 and 4). Although there is heterogeneity across the various cohorts, on average, the marginal utility of leisure is greater for women than for men. Thus, women are less willing than men to participate in the labor market if they can choose. Reported values for $1-\alpha$ are small because there are big differences in

[26] This change is related to time effects, not age effects. As mentioned previously, I address the age, period, and cohort identification problem by assuming that all age effects are equal.

[27] This approach is equivalent to an instrumental variables approach where the grouping variables is the instrument.

the measurement of the scale of consumption ($2.4 \times 10^6 \leq C \leq 755 \times 10^6$) and leisure ($0 < l \leq 1$). Table 9 in Appendix C.5.2, which reports marginal utilities of consumption and leisure, also shows this big scale difference.

Since the number of moment conditions is greater than the dimension of the parameter vector (α_j, α_i), the model is over-identified. Over-identification allows me to check whether or not the model's moment conditions match the data well. The J-test shows that I can not reject the null hypothesis ($H_0 : m(\alpha_j, \alpha_i) = 0$), so the validity of the moment conditions cannot be rejected.

4.1.3 Pareto Weights

To solve the equilibrium and calculate the market-clearing vector of Pareto weights, I use the numerical algorithm that Gayle and Shephard (2019) applied based on that presented in Galichon et al. (2014) (Appendix C.4). As mentioned before, the type of individual is associated with gender and education. For each gender, I define four education categories. Thus, there are $4 \times 4 = 16$ potential types of marital matches. Table 5 and Figure 5 show Pareto weights (wife's bargaining power) for different matches in the marriage market. Equality test results for each pair of Pareto weights (e.g., $H0 : \mu_{11} = \mu_{1i}, i = 2, 3, 4$ for women type 1) shows the women's Pareto weight in different matches are significantly different.

Pareto weights show some important features. First, when a woman is more educated relative to her spouse, she has more power. For example, a college educated woman has on average a 50% share if she is married to a man with the same level of education. If this woman is married to a low educated man (type 1), her share is higher (52%). However, there are two exceptions: (1) a woman of type 1 (low educated) has more bargaining power if she is married to a man of type 3 rather than a man of type 2 ($\mu_{31} > \mu_{21}$); (2) a woman of type 4 (graduate education) has more bargaining power if she is married to a man of type 3 or 4 rather than a man of type 2 ($\mu_{34}, \mu_{44} > \mu_{24}$). Second, as Figure 6 shows, the female weight increases when a woman has more wealth (non-labor income) relative to her spouse. This figure can explain the two exceptions. As Figure 6 (a) shows, a woman of type 1, who is married to a man of type 3, owns (on average) the biggest share of household wealth than the other women of type 1. These women are the most wealthy people among women of type 1 (Figure 11 in Appendix C.5). Moreover, women of type 4, who are married to the men of type 2, own the smallest share of household wealth among women of type 4 (Figure 6 (d)) and among women who are married to the men of type 2 (Figure 12 in Appendix C.5). Third, spouse educational differences have asymmetric gender impact on intra-household bargaining powers: $\mu_{xy} + \mu_{yx} \neq 1$.

5 Simulation and Goodness of Fit

This section presents evidence of the within-sample fit of the model. To measure how well the model describes the data, I compare the individuals' actual choices with predicted measures of their decisions. I use estimated parameters and exogenous variables (age, birth cohort, year, and family non-labor income) to simulate the model and obtain predicted variables.

Table 6 presents the actual and simulated labor force participation rate for all married women (childless) and for different levels of wife's bargaining power. As this table shows, the participation of married women in the labor force first increases with their intra-household bargaining power, then decreases. The simulated data shows the same pattern. Figures 7 and 8 show the actual simulated labor force participation rate over time and by education, respectively. As these figures show, in the actual data, the average women's LFP has decreased over time. This reduction is mostly related to a reduction in precipitation rates of highly educated women. The simulated data from the model (dashed lines) replicate these patterns. Moreover, the actual mean of LFP among different groups (by birth cohort, year, education, and intra-household bargaining power) is not statistically different from the simulated mean at 5%.

Figure 9 shows how well the model can explain the decisions on the marriage market. Each point reflects an element of the matching function: the percentage of different matches (ij match denotes marriages in which husband is type i and wife is type j). Blue and red points show the proportion of different matches in actual and simulated data, respectively. For example, the percentage of marriages in which both wife and husband are type 1 (less than high school) is around 37% in actual and simulated data (the two points on the top right of the graph). As another example, around 13% of total matches in actual and 12% in simulated data are marriages in which both wife and husband are type 3 (Bachelor's and some college). The points are highly concentrated around the 45-degree line, indicating the percentage of different matches in actual and simulated data are similar. As for robustness check, in Appendix C.6, I use different proxies for bargaining powers and compare the results with endogenous bargaining powers obtained from the model. Measures that are frequently used to proxy for women's bargaining power include education ratio and consumption ratio. The results show these proxies have a positive correlation with the endogenous bargaining powers. I also find a similar inverse U-shaped relationship between the female LFP and the above proxies for women's bargaining power.

Table 7 presents the actual and simulated educational distribution among old and young cohorts of women. As this Table shows, young cohort are more educated than old cohort. Proportion of low educated women (less than high school) has decreased form 80% among old cohort to 34% among young cohort

women. The model predictions are close to the actual values. Also, actual and simulated data show changes in the college major choice over time. The proportion of female students in college majors Type-A increased (e.g., proportion of female students who enrolled in Arts increases from 18% in 2006 to 35% in 2013) and the proportion of female students in college majors Type-B decreased (e.g., proportion of female students who enrolled in Education decreases from 9% in 2006 to 3% in 2013).

6 Discussion

By considering different motives for education, this paper stresses that women with the same level of education could be heterogeneous groups in the labor market. This model of education choice can be used for analyzing the life cycle effects of different policies that change education costs, education returns in labor and marriage markets, and consumption values of education. For example, a discriminatory policy that leads to poor labor market conditions could make a shift from college majors with low consumption value and high wage return (Type-B) to college majors with high consumption value and low wage return (Type-A). Thus, even when higher education does not influence matching patterns in the marriage market and there are not many labor market opportunities for educated women, we would expect women to get a higher education if they weigh the consumption value of education heavily.

Besides the consumption value of education, one motive of investment in education is its return in the marriage market. As the results of estimating Pareto weights show, the wife's bargaining powers in different matches are significantly different. When a woman is more educated relative to her spouse, she has more power (with two exceptions: $\mu_{31} > \mu_{21}$ and $\mu_{34}, \mu_{44} > \mu_{24}$).

Another motive of investment in education is its return in the labor market. Based on this model, the theoretical effect of education on women's LFP is ambiguous. On the one hand, education raises the opportunity cost of non-market activities and thus increases the probability of participation in the labor market. On the other hand, education affects the female's bargaining power in the household. The effect of education on LFP through this channel, which could be positive or negative, is often ignored in the economic literature. Since the effect could go either way, I conduct empirical analysis using Iranian data. Simulated data suggests that in couples where either the husband is much more educated than the wife or the wife is much more educated than the husband, the wife is less likely to work. While women's LFP in matches in where couples have the same education level is 63.7%, it is only 8.2% when the difference in educational level of wife and husband is two levels or more (e.g., matches in where wife has a bachelor's degree (education level=3) and husband has not completed high school (education level=1) or vice versa).

It could be because the wife's education and so the potential wage is low or because her bargaining power is high such that the optimal decision is not to work. Thus, in these matches, most of the wife's utility comes from her leisure and husband's income. For example among women with a bachelor's degree, those who match with a husband with graduate education have the highest value of utility, while this match has the lowest value of the wife's bargaining power. This match leads to a small share of a big pie (total household welfare). Among this group of women, those who match with a low educated husband have the lowest value of utility, while this match has the highest value of the wife's bargaining power (a big share of a small pie). Female participation may be low because they do not wish to enter into labor markets, or because there are relatively few jobs available to them. This model cannot measure the importance of each factor contributed to changes in labor market outcomes. I leave analyzing the impact of labor market opportunities on women's LFP and their preference (by taking the interactive effects into account) to future work.

7 Conclusion

In this paper, I presented an equilibrium model of education choice, marriage and labor supply with imperfectly transferable utility and endogenous bargaining powers. In this model, education is considered both as an investment (which has future returns in the marriage and labor markets) and a consumption good. Educational choices and matching in the marriage market affect women's intra-household bargaining power. Education also affects labor supply decisions through two channels. On the one hand, higher education increases the potential wage and thus increases the probability of participation in the labor market. On the other hand, education affects women's intra-household bargaining power. Greater bargaining power allows women to steer allocations in their preferred direction. For instance, women with larger bargaining power may prefer staying at home to working outside if they find little opportunity in the labor market. Considering the consumption value of education and allowing bargaining power to be endogenous lead to results that differ from models that take education as a pure investment and treat the bargaining power as exogenous.

I used data from 2006 to 2013 Iranian Household Income and Expenditure Survey (HIES) for estimation and testing the fitness of this model. I found that women's labor force participation is an inverse U-shaped function of bargaining power. Women's LFP initially increases as bargaining power goes up, but starts decreasing after bargaining power reaches a certain level. Therefore, as a woman's bargaining power increases, she participates more in the labor market. However, over a certain level of bargaining power,

women are less likely to work outside the home.

There are several limitations to my model that should be addressed in future work. First, my focus in this paper was on LFP not employment rates. Thus, I ignored labor demand frictions and for simplicity, I assumed all changes in the demand side that can affect LFP are reflected in wage rates. In particular, this model cannot explain whether the decision about participating in the labor market is related to preferences or labor market conditions, and cannot measure the contribution of each factor. I also ignored the fertility decision and solved the model for couples with no children. One generalization is allowing for children and including the demand side of labor markets e.g., probability of receiving job offers. Second, although family decisions during time can affect the household's balance of power, in my model bargaining powers are fixed. Finally, I assumed that human capital is equal to years of schooling. It would be more precise to add the ability to human capital function, but I can not observe any variable in the HIES to calculate the ability. Thus, I need to find a proxy or assume a distribution for ability, that would be left for future work.

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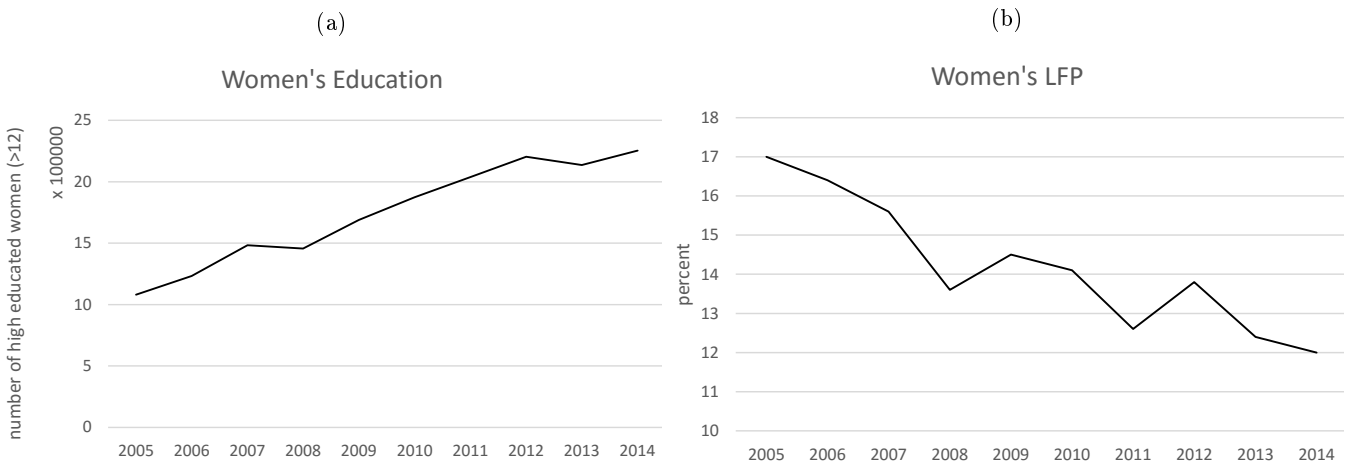
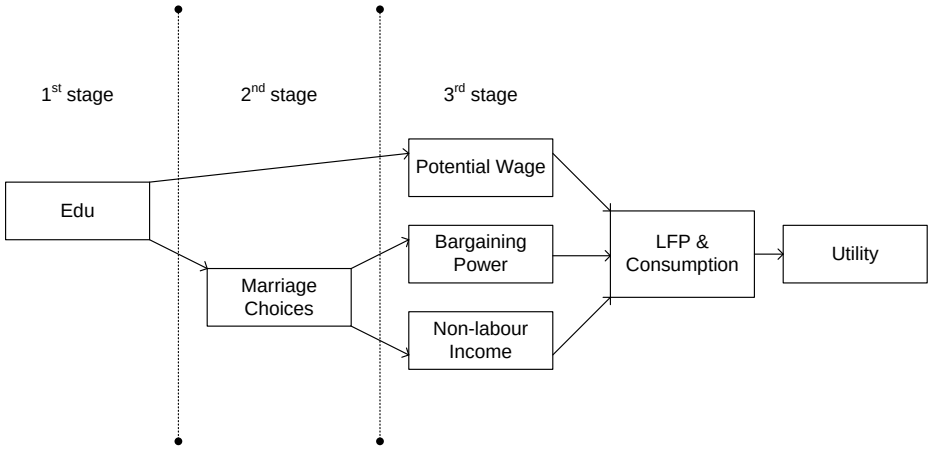
A Figures

Figure 1: Women's Education and LFP Trends



Note: Figure shows the low and decreasing rate of LFP of women despite an increase in the education level in Iran.
Source: Statistical Center of Iran (SCI)

Figure 2: Schematic Diagram of Whole Model



Note: Figure shows the relationship between all variables of the model.

Figure 3: Estimated Women's Utility parameter α_f

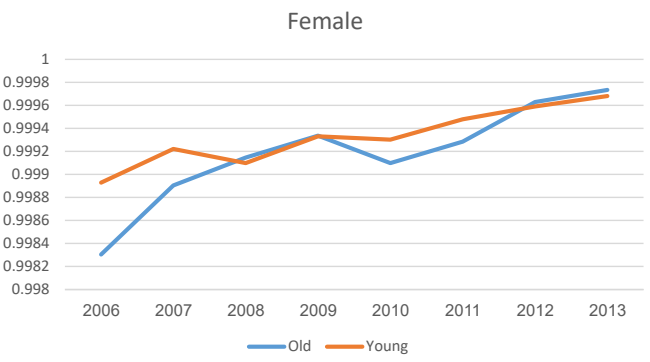


Figure 4: Estimated Men's Utility parameter α_m

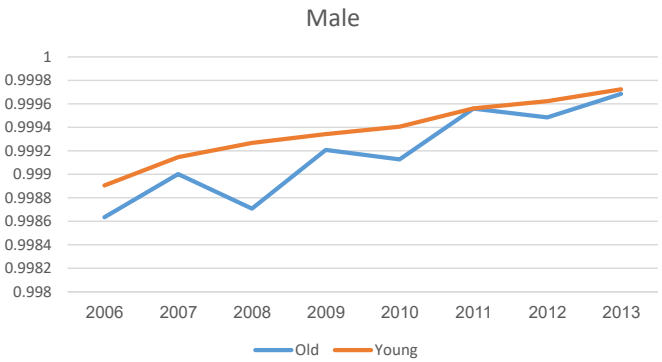
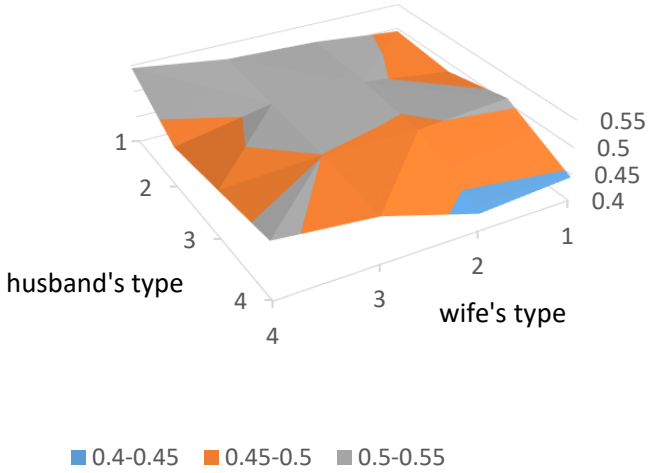
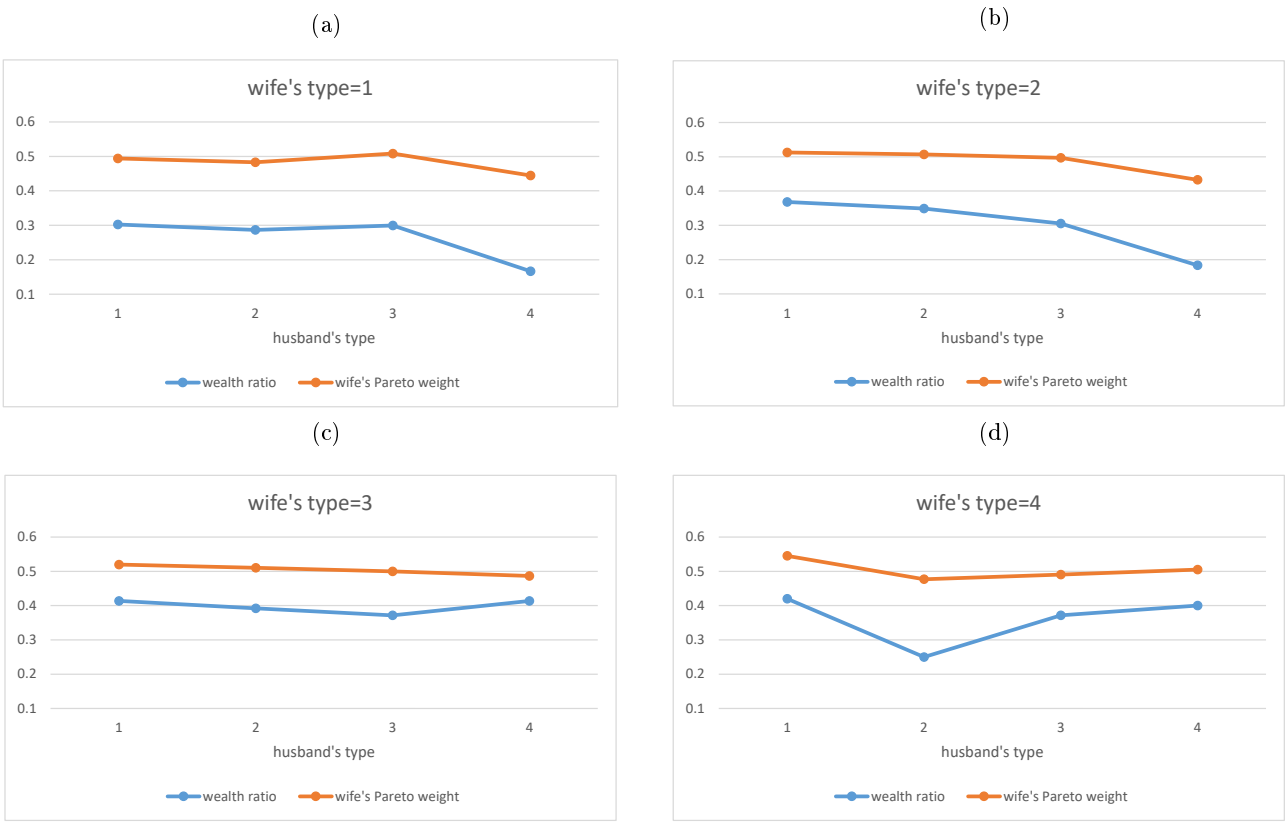


Figure 5: Wife's Bargaining Power by her and her husband's type



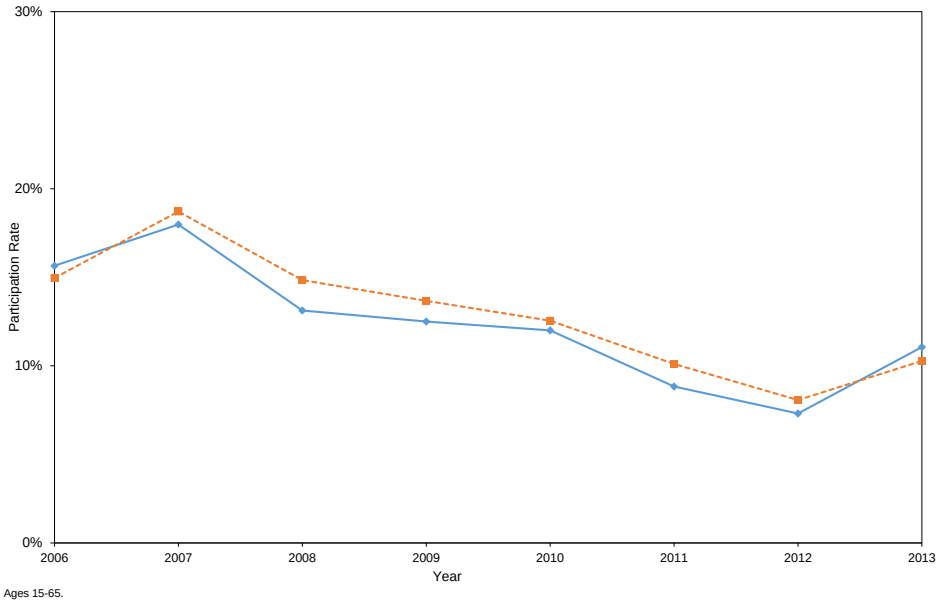
Note: Figure shows the wife's bargaining power by her and her husband's type according to table 5.

Figure 6: Wife's Bargaining Power and Wealth Ratio by type



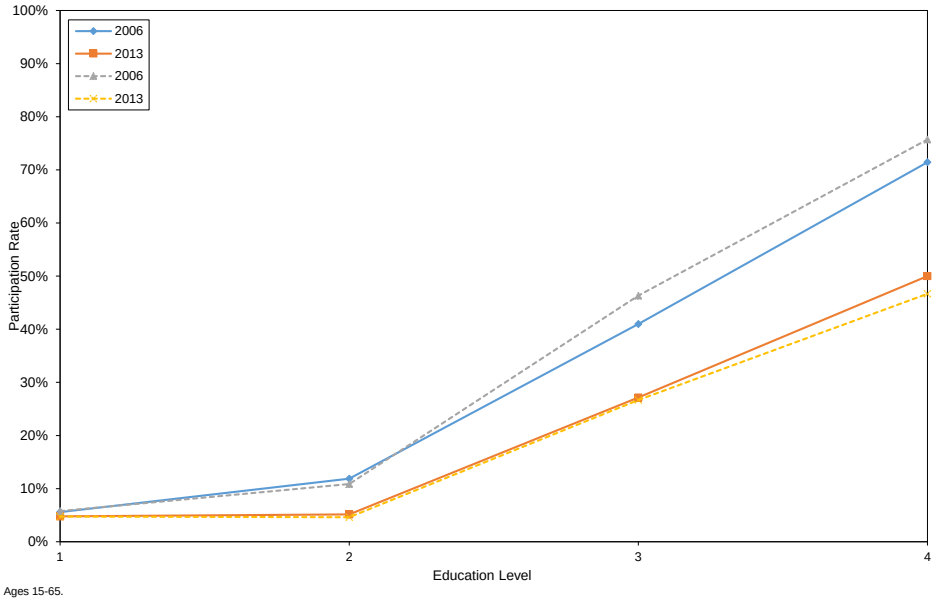
Note: Figure shows women's bargaining power and wealth ratio in different matches. Wealth denotes the non-labor income and wealth ratio defines as $\frac{\text{wife's wealth}}{\text{wife's wealth}+\text{husband's wealth}}$. As Figure shows, the female weight is increasing when a woman has more wealth relative to her spouse. However, there are two exceptions. A woman of type 1, who is married to a man of type 3, owns (on average) the biggest share of household wealth than the other women of type 1 (a). In fact, these women are the most wealthy people among women of type 1. Moreover, women of type 4, who are married to the men of type 2, own the smallest share of household wealth among women of type 4 (d).

Figure 7: Average Labor Force Participation by year:
Data vs Model



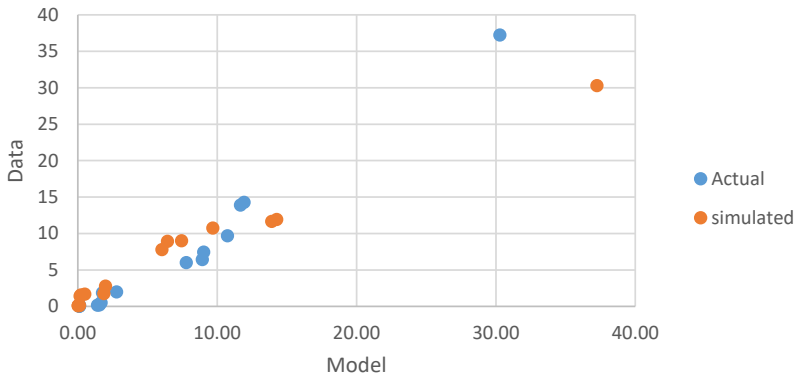
Note: Figure shows married women's LFP over time in actual (blue solid lines) and simulated (red dashed lines) data.

Figure 8: Average Labor Force Participation by year and education:
Data vs Model



Note: Figure shows married women's LFP by education for years 2006 and 2013 in actual (solid lines) and simulated (dashed lines) data.

Figure 9: Elements of the Empirical and Predicted Marriage Market Matching Function



Note: Figure shows elements of the matching function (percentage of different matches) in actual (blue) and simulated (red) data. For example, the two points on the top right of the graph are associated with marriages in which both wife and husband are type 1 (around 37% in actual and simulated data). The points are highly concentrated around the 45-degree line, indicating the percentage of different matches in actual and simulated data are similar.

B Tables

Table 1: Descriptive Statistics for Married Couples whiteout Children

		women		men	
		All	High educated	All	High educated
Population (%)	2006	-	22.2	-	22.5
	2013	-	31.4	-	25.6
Participation Rate (%)	2006	17.1	43.2	99.6	98.4
	2013	13.0	28.9	99.6	98.5
Annual Real Wage (million Rial)	2006	48.1	62.2	79.4	143.0
	2013	43.9	52.8	48.3	65.9
Annual Nominal Wage (million Rial)	2006	23.1	26.5	28.5	43.2
	2013	80.6	89.0	78.6	108.0

Note: Table reports summary statistics for the main sample (married individuals without children). As this table shows, the percentage of high educated people (people with post-secondary education) has increased among women (from 22% to 31%) and men (from 23% to 26%). Despite the increase in the education level, females' participation in the labor market has decreased from 17% in 2006 to 13% in 2013. High educated females have higher participation rates than the others, but it has seen a sharper downward trend from 43% in 2006 to 28% in 2013. In addition, the annual real wage decreased over time with a stronger reduction among educated workers. In fact, the nominal wage rate had increased, but it had not been synchronized with the rate of inflation. Overall, we observe a low and decreasing trend of LFP of married women specially among women with a high education level in Iran.

Table 2: Estimation results : Heckman (Women's Wage Equation)

Variable	Coefficient	(Std. Err.)
Equation 1 : real wage per hour (Unit: /1000)		
education	2.572**	(0.337)
age	2.395**	(0.681)
age^2	-0.015†	(0.009)
Intercept	-48.607**	(14.154)
Equation 2 : select		
education	0.113**	(0.008)
age	-0.021**	(0.007)
age^2	0.0003*	(0.0001)
spouse education	-0.222**	(0.017)
spouse education^2	0.012**	(0.001)
husband's employment dummy	-1.076**	(0.077)
Equation 3 : mills		
lambda	-6925.383*	(2941.196)
rho	-0.30536	
sigma	22679.36	
Number of obs	9156	
Wald chi2(10)	196.91	
Prob > chi2	0.0000	

Note: Table reports women's wage equation parameters using Heckman two-stage method. The first step is estimating selection equation ($z_{ct} * \gamma_j + v_{ct} > 0$). The second step is estimating regression equation ($W_{it}^j = \beta_{0f} + \beta_{1f} * Edu_{it}^j + \beta_{2f} * age_{it}^j + \beta_{3f} * (age_{it}^j)^2 + \lambda_t + u_{it}$)

Table 3: Estimation results : Men's Wage Equation (Unit: /1000)

Variable	Coefficient	(Std. Err.)
education	2.028**	(0.107)
age	0.976**	(0.321)
age^2	-0.004	(0.003)
Intercept	-12.833*	(6.124)
Number of obs	7515	
F(10, 7504)	50.59	
Prob > F	0.0000	
R-squared	0.0632	
Adj R-squared	0.0619	
Root MSE	38754	

Note: Table reports estimated coefficients of the men's wage equation ($W_{it}^i = \beta_{0m} + \beta_{1m} * Edu_{it}^i + \beta_{2m} * age_{it}^i + \beta_{3m} * (age_{it}^i)^2 + \lambda_t + e_{it}$)

Table 4: Estimation results : α_f and α_m
(Unit: *100)

	Cohort1 (Old) born between 1941 and 1965		Cohort2 (Young) born between 1966 and 1998	
	women	men	women	men
Year	$1-\alpha_f$	$1-\alpha_m$	$1-\alpha_f$	$1-\alpha_m$
2006	0.170	0.137	0.107	0.109
	(0.057)	(0.031)	(0.032)	(0.015)
2007	0.109	0.100	0.078	0.085
	(0.073)	(0.043)	(0.030)	(0.013)
2008	0.085	0.129	0.090	0.073
	(0.020)	(0.053)	(0.023)	(0.007)
2009	0.066	0.079	0.067	0.066
	(0.013)	(0.020)	(0.010)	(0.011)
2010	0.090	0.087	0.070	0.059
	(0.035)	(0.018)	(0.015)	(0.008)
2011	0.071	0.044	0.052	0.044
	(0.021)	(0.010)	(0.009)	(0.005)
2012	0.037	0.052	0.041	0.038
	(0.007)	(0.016)	(0.007)	(0.004)
2013	0.027	0.031	0.032	0.028
	(0.008)	(0.006)	(0.009)	(0.003)
average	0.075	0.087	0.061	0.063
	(0.010)	(0.013)	(0.006)	(0.003)

Notes: Preference parameters estimated using the moments based on single individuals' time allocation problem. I assume that preferences are different for different genders and birth cohorts and over time. Standard errors are reported in parentheses. Young cohort includes people who were born between 1966 and 1998. People in the old cohort were born between 1941 and 1965.
The values of $1-\alpha$ are small because there are big differences in the measurement of the scale of consumption ($2.4 \times 10^6 \leq C \leq 755 \times 10^6$) and leisure ($0 < l \leq 1$).

Table 5: Pareto weight distribution

	Women's Type (education degree)			
	Less than high school	High school	Bachelor's and some college	Graduate education
Men's Type (education degree):				
(1) Less than high school	0.494	0.513	0.520	0.545
	(0.001)	(0.001)	(0.004)	(0.058)
(2) High school	0.483	0.507	0.510	0.477
	(0.002)	(0.001)	(0.001)	(0.010)
(3) Bachelor's and some college	0.508	0.497	0.500	0.491
	(0.002)	(0.001)	(0.001)	(0.005)
(4) Graduate education	0.445	0.433	0.487	0.505
	(0.012)	(0.003)	(0.002)	(0.004)

Notes: Table shows the distribution of Pareto weights (standard errors in parentheses). Type is defined by education levels:
type1: Less than high school (year of schooling ≤ 8)
type2: High school (year of schooling: 9-12)
type3: Bachelor's and some college (year of schooling: 13-16)
type4: Graduate education (year of schooling > 16)

Table 6: Labor Force Participation Rate: Data vs Model

	Actual LFP rate (%)	Simulated LFP rate (%)
total sample	12.10	13.77
bargaining power:		
$\mu < 0.49$	7.31	7.42
$0.49 \leq \mu \leq 0.51$	14.33	13.55
$\mu > 0.51$	4.68	8.87

Notes: Table shows the actual and simulated married women's labor force participation rate for among different levels of wife's bargaining power. As this table shows, the participation of married women in the labor force first increases with their intra-household bargaining power, then decrease. The simulated data shows the same pattern.

Table 7: Educational Distribution: Data vs Model

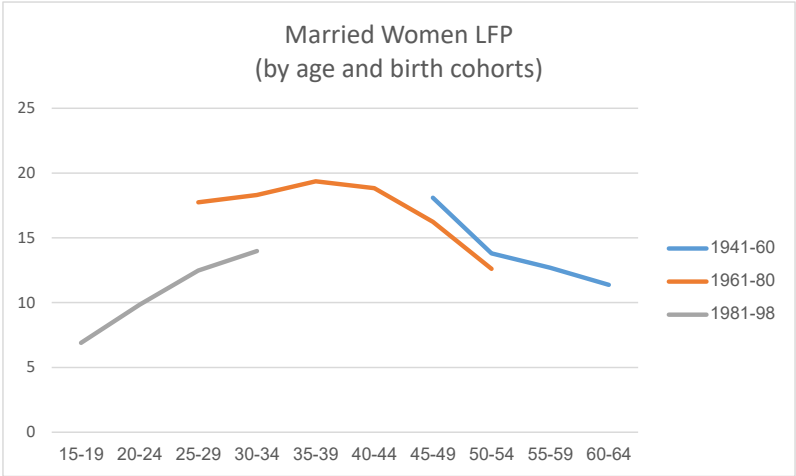
	Cohort1 (Old)		Cohort2 (Young)	
Education	data	simulated	data	simulated
(1) Less than high school	0.804	0.811	0.338	0.380
(2) High school	0.137	0.134	0.369	0.387
(3) Bachelor's and some college	0.057	0.052	0.287	0.238
(4) Graduate education	0.003	0.003	0.005	0.004

Notes: Table shows the actual and simulated educational distribution among old and young cohorts of women. As this Table shows, young cohort are more educated than old cohort. The model predictions are close to the actual values.

C Appendix

C.1 Data

Figure 10: Married Women LFP by age and birth cohorts



Note: Figure shows that LFP has decreased in successive cohorts.
Source: Author's calculation based on Iranian Labor Force Survey

C.2 Model

Table 8: List of Variables

variable	expression	source
Endogenous Variables		
C^j	wife's consumption	unobservable
C^i	husband's consumption	unobservable
l^j	wife's leisure	$T^j - L^j$
l^i	husband's leisure	$T^i - L^i$
L^j	wife's labor supply	HIES
L^i	husband's labor supply	HIES
W^j	wife's potential wage	model
W^i	husband's potential wage	model
μ	wife's intra-household bargaining power	model
Edu^j	wife's education level	HIES
Edu^i	husband's education level	HIES
Exogenous Variables		
p	price index	normalized to 1
Y	non-labor income (real estate incomes, subsidies, ...)	HIES
T^j	wife's total time	normalized to 1
T^i	husband's total time	normalized to 1
age^j	wife's age	HIES
age^i	husband's age	HIES

Note: Table reports the list of all variables of the model. The source of exogenous variables is Iranian Households' Income and Expenditures Surveys (HIES).

C.3 Proof of Proposition 1

Proposition 1. The existence and uniqueness of a marriage market equilibrium

Proof:

Define function F as $\tau^s_{ij}(\vec{\mu}^j) - \tau^d_{ij}(\vec{\mu}^i)$. F is a continuous function on the closed interval $[0,1]$.

$$\begin{aligned}
F &= \tau^s_{ij}(\vec{\mu}^j) - \tau^d_{ij}(\vec{\mu}^i) = U^i_{ij}(\mu_{ij}) - U^i_{i0} - [U^j_{ij}(\mu_{ij}) - U^j_{0j}] - \sigma_\theta[ln\tau^s_{0j} - ln\tau^d_{i0}] \\
&= ln(C_i^{\alpha_i} l_i^{1-\alpha_i}) - U^i_{i0} - [ln(C_j^{\alpha_j} l_j^{1-\alpha_j}) - U^j_{0j}] - \sigma_\theta[ln\tau^s_{0j} - ln\tau^d_{i0}] \\
&= \alpha_i lnC_i + (1-\alpha_i)lnl_i - \alpha_j lnC_j - (1-\alpha_j)lnl_j - U^i_{i0} + U^j_{0j} - \sigma_\theta[ln\tau^s_{0j} - ln\tau^d_{i0}] \\
&= \alpha_i ln[\alpha_i(1-\mu_{ij})(Y+W_j+W_i)] + (1-\alpha_i)ln[\frac{(1-\alpha_i)\mu_{ij}(Y+W_j+W_i)}{2W_i}] \\
&- \alpha_j ln[\alpha_j(1-\mu_{ij})(Y+W_j+W_i)] - (1-\alpha_j)ln[\frac{(1-\alpha_j)\mu_{ij}(Y+W_j+W_i)}{2W_j}] \\
&- U^i_{i0} + U^j_{0j} - \sigma_\theta[ln\tau^s_{0j} - ln\tau^d_{i0}]
\end{aligned}$$

F is differentiable on the open interval $(0,1)$:

$$\frac{\partial F}{\partial \mu_{ij}} = \frac{-\alpha_i}{1-\mu_{ij}} + \frac{1-\alpha_i}{\mu_{ij}} + \frac{\alpha_j}{1-\mu_{ij}} - \frac{1-\alpha_i}{\mu_{ij}} = \frac{\alpha_j - \alpha_i}{\mu_{ij}(1-\mu_{ij})}$$

since $0 < \mu_{ij} < 1$, if $\alpha_j > \alpha_i$ then $\frac{\partial F}{\partial \mu_{ij}} > 0$ and F is strictly increasing. If $\alpha_j < \alpha_i$ then $\frac{\partial F}{\partial \mu_{ij}} < 0$ and F is strictly decreasing. Thus F in strictly monotone.

Moreover, $\lim_{\mu \to 0} F = \infty$ and $\lim_{\mu \to 1} F = -\infty$

Therefore, F has exactly one real zero. Thus, the marriage market clearing condition has exactly one real root.

C.4 Marriage Market Numerical Algorithm

In this Appendix, I describe the iterative algorithm that Gayle and Shephard (2019) used to calculate the market-clearing vector of Pareto weights. The algorithm is based on that presented in Galichon et al. (2014). Using the conditional choice probabilities from equation (6), the demand equation of type j women

for type i spouses is:

$$P_{ij}^{j}(\vec{\mu}^{j}) = Pr[U_{ij}^{j}(\mu_{ij}) + \theta_{ij}^{j} > \max_{\forall g \neq i}[U_{gj}^{j} + \theta_{gj}^{j}, U_{0j}^{j} + \theta_{0j}^{j}]]$$
$$= \frac{\tau_{ij}^{d}(\vec{\mu}^{j})}{f_j} = \frac{exp(U_{ij}^{j}(\mu_{ij})/\sigma_\theta)}{exp(U_{0j}^{j}/\sigma_\theta) + \sum_{g=1}^{I} exp(U_{gj}^{j}(\mu_{gj})/\sigma_\theta)}$$
$$\Rightarrow \sigma_\theta[ln\tau_{ij}^{d}(\vec{\mu}^{j}) - ln\tau_{0j}^{d}] = U_{ij}^{j}(\mu_{ij}) - U_{0j}^{j} \tag{36}$$

where $\tau_{ij}^{d}(\vec{\mu}^{j})$ indicates the population of type j females who demand type i males. Similarly, the proportion of type i males who would like to marry a type j female is given by:

$$P_{ij}^{i}(\vec{\mu}^{i}) = \frac{\tau_{ij}^{s}(\vec{\mu}^{i})}{m_i} = \frac{exp(U_{ij}^{i}(\mu_{ij})/\sigma_\theta)}{exp(U_{i0}^{i}/\sigma_\theta) + \sum_{h=1}^{J} exp(U_{ih}^{i}(\mu_{ih})/\sigma_\theta)}$$
$$\Rightarrow \sigma_\theta[ln\tau_{ij}^{s}(\vec{\mu}^{i}) - ln\tau_{i0}^{s}] = U_{ij}^{i}(\mu_{ij}) - U_{i0}^{i} \tag{37}$$

where $\tau_{ij}^{s}(\vec{\mu}^{i})$ is the supply of type i males.
The algorithm proceeds as follows:

1. Provide an initial guess of the measure of both single females $0 < \tau_{0j}^{d} < f_j$ for $j = 1, ...J$, and single males $0 < \tau_{io}^{s} < m_i$ for $i = 1, ..., I$.

2. Taking the difference of the demand (equation (36)) and the supply (equation (37)) functions for each i, j marriage market, and imposing the market clearing condition $\tau_{ij}^{d} = \tau_{ij}^{s}$ I obtain:

$$\sigma_\theta[ln\tau_{i0}^{s} - ln\tau_{0j}^{d}] = U_{ij}^{j}(\mu_{ij}) - U_{0j}^{j} - [U_{ij}^{i}(\mu_{ij}) - U_{i0}^{i}] \tag{38}$$

   which given the single measures τ_{0j}^{d} and τ_{i0}^{s} is only a function of the Pareto weight for the marriage-market μ_{ij}. Given my assumptions on the utility functions there exists a unique solution to equation (38). This step therefore requires solving for the root of $I \times J$ univariate equations.

3. From Step 2, I have a matrix of Pareto weights μ given the single measures τ_{0j}^{d} and τ_{i0}^{s} from Step 1. These can be updated by calculating the conditional choice probabilities (equation (36) and equation (37)). The algorithm returns to Step 2 and repeats until the vector of single measures for both males and females has converged.

C.5 Estimation

C.5.1 Parameters of the Wage Functions

I estimate parameters of wage equations by the Heckman two-stage method. Wages are observable only for those who work. Since working people are not randomly selected from the population, estimation results using this subpopulation may be biased. Thus, I use the Heckman correction to correct for this selection bias. The Heckman correction includes two stages. The first step is a choice model in which the dependent variable is the probability of participation in the labor market. Women's decision to work depends on their reservation wage (which depend on education (years of schooling) and age), her husband education and employment, and economic conditions.[28]

The second step estimates the effects of the independent variables on the wage. Individual's wage varies by gender and education. Most papers also use the experience as an explanatory variable in the wage equation, but in the HIES data, I can not observe any variable to calculate the experience. Since there is a negative correlation between experience and education,[29] omitting this variable would produce a bias to the estimated effect of the education level on the wage. To solve this omitted variable bias problem, age is commonly used as a proxy for years of work experience.[30] For simplicity, I consider the wage equation as a linear function of education, age, the square of age, and time:

$$W_{it}^{j} = \beta_{0f} + \beta_{1f} * Edu_{it}^{j} + \beta_{2f} * age_{it}^{j} + \beta_{3f} * \left(age_{it}^{j}\right)^{2} + \lambda_t + u_{it} \qquad \text{regression equation} \tag{39}$$

$$z_{ct} * \gamma_j + v_{ct} > 0 \qquad \text{selection equation} \tag{40}$$

$$z = [\text{education}, \text{age}, \text{husband's education \& employment}, \text{economic conditions}]$$

where W_{it}^{j} is the female i's real hourly wage at time t, and similarly for the other variables in the model. λ_t is a time trend variable introduced to control for time-varying factors such as economic conditions.

Table 2 reports the estimated parameters of these two equations. The estimated coefficient of the selection equation shows that age has a positive but decreasing effect on women's LFP. Age can affect participation through two channels: work-leisure preferences and work experience (James et al. (2007)).

[28] I include some other variables such as non-labor income (i.e. rent, interest, financial aid, transfers and income of homemade products) and family's income from selling used durable goods. These variables have not any significant effect. Also, I include husband's income, but it has collinearity with husband education.

[29] People who pursue higher education have lower levels of experience.

[30] Mincer and Polachek (1974) uses the transformation experience = age - years of schooling - 6, assuming workers start working immediately after completing their education and the age of completing the education is years of schooling + 6.

Young women are more likely to be full-time students and thus less likely to participate in the labor market. Middle-aged women are more likely to have work experience and family responsibilities and thus more likely to participate in the labor market. Older women are more likely to have resources for retirement and are less likely to participate as they approach the retirement age.

As we expect, an educated woman is more likely to participate in the labor market because she expects a higher wage. Regarding the impact of spousal education, the estimated results show that the husband's education has a negative but increasing effect on the wife's LFP. Since an educated husband has a higher income (higher total family income), such couples can consider the division of household labor such as the wife does more housework and works less outside the home (Becker and Becker (2009)). However, over a certain level of husband's education, women are more likely to work outside the home. Moreover, wives with employed husbands have significantly lower participation probabilities. This finding points to the presence of the "added worker effect" in the sense that unemployment of husbands encourages their wives to work. Furthermore, the time effect is negative, which means time-varying factors such as economic conditions make women less likely to participate in the labor market.

Since 99% of husbands are participants in my sample, I assume all men participate in the labor market. Thus, I do not need to estimate the selection equation for them. I estimate the wage equation for men as a linear function of education, age, square of age and time:

$$W_{it}^{i} = \beta_{0m} + \beta_{1m} * Edu_{it}^{i} + \beta_{2m} * age_{it}^{i} + \beta_{3m} * \left(age_{it}^{i}\right)^{2} + \lambda_t + e_{it} \tag{41}$$

where W_{it}^{i} is the male i's real hourly wage at time t, and similarly for the other variables. Again, I control time-varying factors by λ_t. Table 3 reports the estimated parameters of the men's wage equation.

C.5.2 Estimation Preference Parameters

Reported values for $(1-\alpha)$ in Table 4 are small because there are big differences in the measurement of the scale of consumption ($2.4 \times 10^6 \leq C \leq 755 \times 10^6$) and leisure ($0 < l \leq 1$). Table 9, which reports marginal utilities of consumption and leisure, also shows this big scale difference.

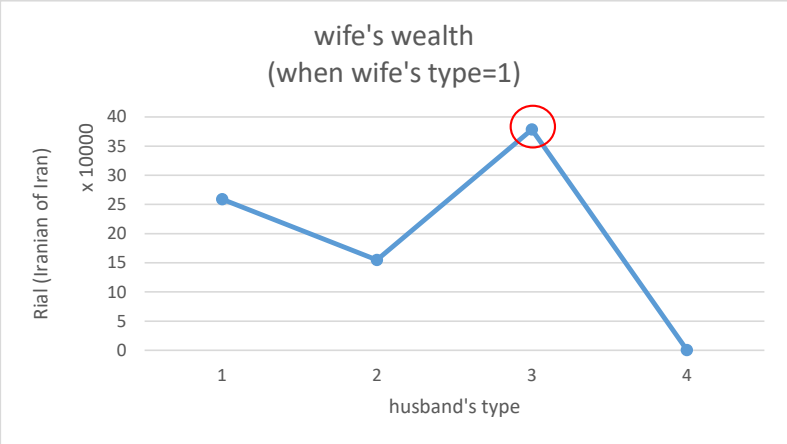
Table 9: Marginal Utilities of Consumption and Leisure

	Cohort1 (Old)				Cohort2 (Young)			
	women		men		women		men	
	MUC	MUl	MUC	MUl	MUC	MUl	MUC	MUl
2006	2.53E-08	0.174	2.24E-08	0.152	1.77E-08	0.120	1.86E-08	0.152
2007	2.48E-08	0.110	1.19E-08	0.114	2.87E-08	0.083	1.98E-08	0.117
2008	1.90E-08	0.086	1.87E-08	0.151	2.20E-08	0.097	2.10E-08	0.094
2009	2.25E-08	0.067	1.60E-08	0.087	2.01E-08	0.075	1.98E-08	0.084
2010	1.76E-08	0.091	1.70E-08	0.095	1.49E-08	0.079	1.81E-08	0.073
2011	1.34E-08	0.072	1.17E-08	0.046	1.49E-08	0.057	1.32E-08	0.056
2012	1.25E-08	0.037	1.03E-08	0.056	1.38E-08	0.045	8.93E-09	0.047
2013	1.04E-08	0.027	9.16E-09	0.034	7.62E-09	0.033	7.74E-09	0.035

Note: Table reports marginal utilities of consumption (MUC) and leisure (MUl) for single individuals.

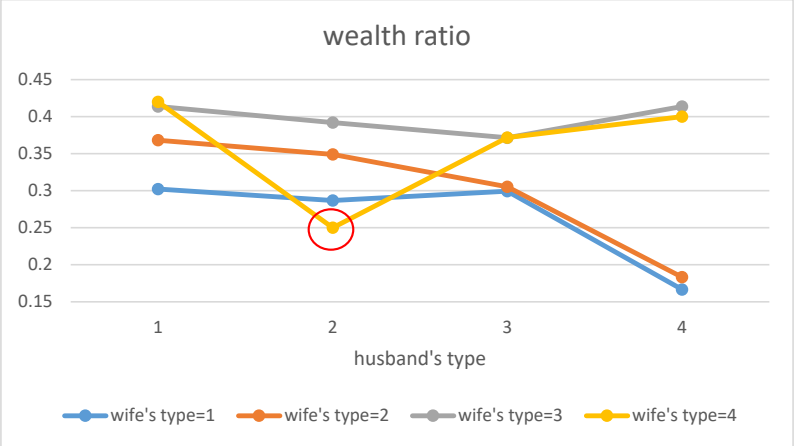
C.5.3 Pareto weights

Figure 11: Wealth (non-labor income)



Note: Women of type 1, who are married to a man of type 3, are the most wealthy people among women of type 1.

Figure 12: Wife's Wealth Ratio



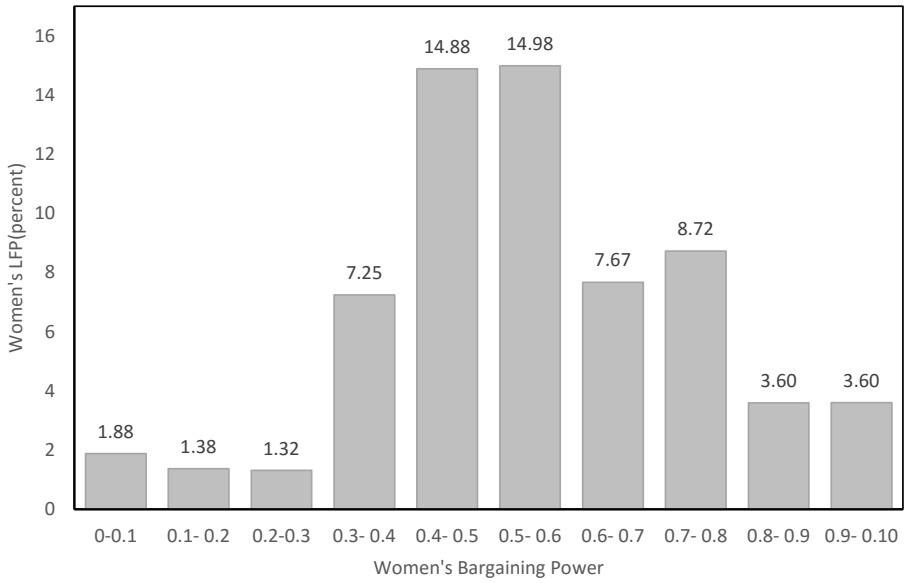
Note: Figure shows women's wealth ratio in different matching. Wealth denotes the non-labor income and wealth ratio defines as the share of wife's wealth in the household. Women of type 4, who are married to the men of type 2, own the smallest share of household wealth among women of type 4 and among women who are married to the men of type 2.

C.6 Robustness Check

I this section, I use different proxies for bargaining powers and compare the results with endogenous bargaining powers. Measures that are frequently used to proxy for women's bargaining power include education ratio and consumption ratio. First I use the couple's education ratio ($\frac{Schooling^j}{Schooling^j+Schooling^i}$ where $Schooling^j$ is wife's years of schooling and $Schooling^j$ is husband's years of schooling) as a measure of bargaining powers. This proxy considers the effect of women's choices (educational and marriage decisions) on their bargaining power. Figure 13 shows women's LFP by different values of education ratio as a proxy for intra-household bargaining powers. As this Figure shows, women with relatively low and relatively high bargaining power participate less in the labor market which is consistent with the inverse U-shaped relationship between the female LFP and bargaining power from the model.

Table 10 reports changes in the wife's share of education in the household (as a proxy for her bargaining power) over time in the sample and among educated women. Although the values of this indicator for educated women are greater than the whole sample, the bargaining power for educated women who work is lower compared to all educated women. For instance, in 2006 the average of bargaining power was 0.56 for educated women, and 0.54 for employed educated women.

Figure 13: Married Women's LFP



Note: Figure shows women's LFP by different values of education ratio ($\frac{Schooling^j}{Schooling^j+Schooling^i}$) as proxy for intra-household bargaining powers. As this Figure shows, women with relatively low and relatively high bargaining power participate less in the labor market which is consistent with the inverse U-shaped relationship between the female LFP and bargaining power from the model.

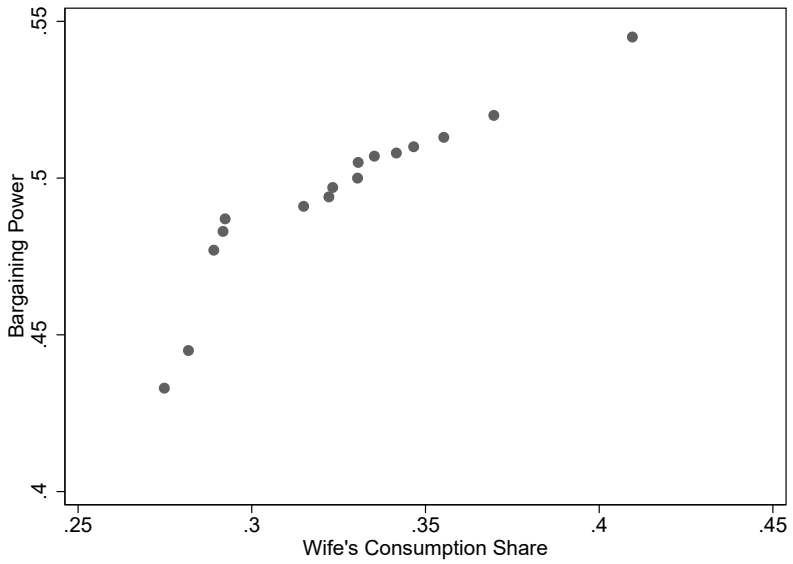
Table 10: Bargaining Power Proxies (education ratio)

	2006	2007	2008	2009	2010	2011	2012	2013
whole sample	0.432	0.437	0.434	0.432	0.436	0.436	0.434	0.446
	(0.201)	(0.197)	(0.198)	(0.203)	(0.200)	(0.199)	(0.202)	(0.199)
College educated	0.558	0.560	0.559	0.568	0.565	0.563	0.561	0.554
	(0.062)	(0.059)	(0.068)	(0.073)	(0.069)	(0.064)	(0.061)	(0.055)
College educated and employed	0.542	0.540	0.544	0.558	0.547	0.549	0.549	0.542
	(0.057)	(0.054)	(0.063)	(0.072)	(0.066)	(0.063)	(0.058)	(0.054)

Note: Table shows the bargaining power of married women using education ratio ($\frac{Schooling^j}{Schooling^j+Schooling^i}$) as a proxy. Although the values of this indicator for educated women are greater than the whole sample, the bargaining power for educated women who work is lower compared to all educated women.

The second proxy I use for women's bargaining power is the wife's consumption share. The idea (consistent with Eq (28) is that women with more bargaining powers can have more consumption. Figure 14 shows the relationship between endogenous values of bargaining powers (from the second stage of the model) and the wife's consumption share. As this Figure indicates, the wife's consumption share is increasing in the wife's bargaining power.

Figure 14: Women's Consumption Share for different Bargaining Power



Note: Figure shows the relationship between intra-household bargaining power and wife's consumption share. Although we cannot observe the wife's share of consumption, some goods and services such as clothes and footwear can breakdown to men/women/children. I proxy wife's consumption share by the ratio of spending on women's items (including women's clothes, women's shoes, jewelry, makeup, etc.) to total spending. I consider those goods and services that cannot breakdown to a specific individual as "shared goods" such as food, housing, etc. I assume all family members have an equal share of shared goods. Thus, I proxy wife's share of consumption by

$$\left(\text{household spending on women goods} + \frac{\text{household spending on shared goods}}{\text{household size}}\right)/\text{household total spending}$$