Patriarchal gender norms: A life-cycle model of education, marriage, and labor supply choice

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Abstract

We examine the role of patriarchal gender norms in women's lifetime decisions of education, marriage, and labor supply in an equilibrium setting. In our model, patriarchal gender norms work through the institution of marriage. Specifically, it manifests itself in the belief, internalized by both men and women, that a woman's labor and efforts are more central than that of a man in sustaining domestic married life, with deviations from this norm being psychologically costly for both. This norm determines household decisions like allocating time to market and domestic labor. At the same time, it feeds through equilibrium interactions into the choice of education level that individuals make earlier in life and the subsequent structure of matches in the marriage market. In line with the empirical evidence, our model finds that a wife puts in fewer labor hours in the market and more at home than her husband.

JEL codes: D13, J12, J16, J22

Keywords: life-cycle model; social norms; intra-household decision-making; home production and women's labor supply

1 Introduction

The social sciences have extensively studied how most gender and social norms have historically privileged males over females (Heise et al. (2019), Weber et al. (2019)). Gender roles, specifying what is considered appropriate or acceptable behavior for a particular gender, are embedded in and reinforced through institutions like marriage. Over time, this socially constructed and conceptualized notion of gender is internalized by men and women alike and becomes a norm. There is growing evidence from across the globe emphasizing the

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role of cultural beliefs and their deep historical roots in women's decisions (for instance, Perry-Jenkins & Gerstel (2020); Alesina et al. (2013); Fernández (2007, 2013); Bertrand et al. (2015); Fernández and Fogli (2009); Nunn (2009)). It is then no surprise that these gendered norms have consequences on standard economic variables – for instance, level of education, marriage and fertility decisions, child-caring responsibilities, and labor force participation.

A key patriarchal gender norm that is the focus of this paper is the belief that a woman's labor and efforts, more than that of a man's, are central to sustaining domestic married life and the output resulting from marriage. Therefore, it is not surprising that this norm impacts a whole range of important outcomes. For instance, despite the rise in women's participation in the labor market, household work continues to be the primary responsibility of women (Marta Dominguez-Folgueras (2021), Perry-Jenkins & Gerstel (2020), Bianchi and Milkie (2010); Lachance-Grzela and Bouchard (2010)). Women do a larger share of the household chores, twice as much as their husbands, especially those considered "feminine" chores. Though family scholars have used several approaches to explain the division of domestic work like economic exchange (Braun et al. (2008)) and time availability (Braun et al. (2008); Fox (2009)), studies suggest that patriarchal gender norms remain an important determinant accounting for women's more significant load of domestic work (e.g., Marta Dominguez-Folgueras (2021), Gupta (1999); South and Spitze (1994); Hochschild (1990); Deutsch et al. (1993); Kroska (2004)). Furthermore, all the other factors are not gender-neutral. The notion that economic and time-related factors are independent of gender fails due to two primary considerations (Marta Dominguez-Folgueras (2021)). Firstly, the allocation of time and financial resources across society is inherently influenced by gender. Secondly, men and women experience the impact of these resources differently, indicating that gender cannot be disintegrated from the other factors. The labor market positioning of women is shaped by a myriad of factors including educational trajectories, career decisions, and discrimination (Blau & Kahn, 2017). In terms of education, for example, young women often select their fields of study with future family commitments in mind, opting for careers that would allow for a balance between work and family life (Duru-Bellat, 2004). Additionally, the necessity to juggle care duties influences women's career paths, with research on the motherhood wage gap suggesting that women may prioritize job features that accommodate family needs over higher pay (Blau & Kahn, 2017). Further, the prevalence of women in part-time employment across numerous nations reiterates the efforts to manage both professional and familial responsibilities (Beham et al., 2019). Studies on unemployment and time use reveal distinct patterns in how men and women allocate their additional leisure time, women's time is notably more elastic than men's, with women disproportionately dedicating their additional leisure time to household labor (Aguiar et al., 2013; Pailhé et al., 2019; Ström, 2002).

These sets of observations are well-documented empirically and broadly agreed upon by scholars studying gender across a range of disciplines, including in economics. However,

far less work exists that theoretically models the role that patriarchal gender norms in marriage play in outcomes not just within marriage but over a woman's life cycle, including education, consumption, and labor supply decisions. In doing so we speak to the connection between women's lifetime decisions. In this paper, we model the impact of the gender norm prescribing the primacy of women's labor to sustaining married life on their key lifetime decisions. In particular, we develop an equilibrium life-cycle model of education, marriage, consumption, and time allocation. We divide the lifetime of an individual into three stages. The individuals are forward-looking and make decisions at any stage, anticipating outcomes in the future. In the first stage, individuals choose their level of education, which can be high or low. Acquiring a high level of education involves a cost. In the second stage, if they choose to get married, they enter the marriage market, which produces a matching of married couples. In the third stage, they solve the consumption and time allocation problem between leisure and labor, where labor is allocated to both the market and the domestic sphere. A married couple behaves as a single decision-making unit maximizing the sum of their utilities. This utility depends on the level of consumption of a private good, leisure, and value from marriage. Purchase of the private good is made possible by the husband and wife participating in the labor market, where higher educated workers earn a higher wage than lower educated ones. The value from marriage, which is assumed to be the same for a matched couple, is generated from the husband and the wife putting in labor and effort to sustain domestic married life. In particular, it is a function of the time allocated by men and women towards domestic labor. In addition, we assume that disutility accrues from men's domestic labor. This captures the perceived patriarchal gender norm that women's labor and efforts are more central to sustaining domestic married life than that of men.

The equilibrium of our model spells out the optimal decisions in each stage. In particular, it specifies the proportion of men and women who choose different education levels, their decisions in the marriage market, and lastly, the consumption and time allocated to home and market labor. Conditional on the education decision and the match in the marriage market, we derive the optimal levels of consumption and time allocation for individuals. For households with the same level of education for both husband and wife, the wife enjoys fewer leisure hours than her husband. It is then no surprise that these hours are reallocated to domestic chores. Further, leisure hours for the wife fall, and the hours spent on domestic chores increase as the bias increases. For men, the time spent in the labor market increases with an increase in bias. In equilibrium, we find that a more significant proportion of men have a higher level of education than women. This has an immediate implication on the marriage market. Specifically, the marriage market matches include both assortative and non-assortative matches by "type" or education levels. Further, the only type of non-assortative match that would exist in equilibrium is where the husband has a higher level of education than the wife since there is a higher proportion of higher educated men than women. What is interesting is how these equilibrium interactions change as the bias and wage change. The proportion of individuals with different education levels changes with

bias. Consequently, the proportion of non-assortative matches also changes. In particular, with an increase in bias, the proportion of men who choose higher education rises, and that of women falls. This leads to a higher proportion of non-assortative matches where men are more educated than their wives.

There is extensive empirical evidence on how social and gender norms affect individual and collective decisions. A relatively small but growing literature attempts to model these complex norms theoretically. In her seminal work, Goldin (1994) indicates how cultural and social factors play a crucial role in the labor supply decisions of married women. Most work attempting to theorize gender or social norms focuses on women's labor force participation. For instance, Bertrand et al. (2021) and Fernández et al. (2004) model men who derive disutility from their wives working in the labor market. Fernández (2013) models the link between cultural change and women's labor force participation in the United States. Afridi et al. (2022) model individuals who derive disutility if they fall below a social benchmark level of a home (produced) good; for instance, the home good can be household expenditure on child education. They show that even with a gender neutral home production function, home good constraints wives' decision to supply labor. To the best of our knowledge, our paper is the first to model an aspect of the bias in gender norms in a life-cycle decision model theoretically. We develop a model explicitly capturing the gender norm towards household work and explore the effects of this bias on the key lifetime decisions of women, in particular, her education choice, marriage decisions, consumption, and time allocated in the labor market.

Our paper broadly draws on the vast literature that employs the collective framework of Chiappori (1988, 1992) to model labor supply decisions. In his model, the household utility is considered a weighted average of the spouses' utilities, where the exogenous weights are proxies for their bargaining power. Since then, many models have endogenized the bargaining power either as a function of the income earned by an individual (Basu (2006)) or by endogenizing the matching process in the marriage market (Moeeni (2021), Gayle and Shephard (2019) and Gousse et al. (2017)). In this line of work, our model is more closely related to the life-cycle models of Chiappori et al. (2009, 2018) and Moeeni (2021), that theoretically model education choices, marriage market, labor supply, and consumption. Both Chiappori et al. (2018) and Moeeni (2021) endogenize the bargaining power; however, we assume the household utility to be the sum of spouses' utilities without delving into their bargaining powers (as in Chiappori et al. (2009)). Chiappori et al. (2018) use a dynamic approach to model the lifetime decisions of the agents. We, on the other hand, adopt a three-stage static model as in Moeeni (2021). One major point of departure from the literature is how we accommodate patriarchal gender norms through the value of marriage and its impact on the lifetime decisions.

The rest of the chapter is organized as follows. The next section lays out the formal model. Section 3 formally defines the notion of equilibrium, and Section 4 solves for the

equilibrium. Section 5 discusses the implications and empirical content of the model. Proofs of results appear in the Appendix.

2 The model

We now lay out the details of our life-cycle model of education, marriage, and intra-household allocation of time and consumption. Assume that there is a continuum of men and a continuum of women, with total mass equal to 1 for both. We denote the set of men by M and that of women by F, with a generic man in M denoted by m and a generic woman in F by f. The life cycle of an individual is split into three stages. In the first stage, individuals choose their level of education. In the second stage, they enter the marriage market and choose their match or decide to remain single. The final stage is the consumption and time allocation problem, where individuals are endowed with one unit of time that is allocated to leisure (l), domestic labor devoted to married life (n), if married, and market labor ($1 - l - n$). They derive utility from the consumption of a private good, leisure, and marriage.

Consider the first stage, where individuals choose their level of education. We assume this is a binary choice that could be either *high* (H) or *low* (L). The cost of choosing low education is normalized to zero. However, there is a gender-specific cost associated with high education. Let θ_i denote an individual specific barrier to education faced by individual i. The cost of education for men and women is an increasing function of this barrier and given by $c_m(\theta) = c_f(\theta) = \theta, m \in M, f \in F$. We assume that the distribution of θ is uniform on $[0, 1]$ for both the population of men and women. We identify individuals with their education level and often refer to them as H(igh)-type and L(ow)-type. The type of a typical man $m \in M$ is denoted by x and that of a woman $f \in F$ by y.

In the second stage, individuals enter the marriage market, where they choose to match or remain single. When an x-type man matches with a y-type woman, they form a *household* denoted by (x, y). An H-type man could either match with an H or an L-type woman. Similarly, an L-type man could match with either an H or an L-type woman. In case an x-type man chooses to remain single, we denote the household by $(x, 0)$. Similarly, $(0, y)$ denotes a household with a y-type woman who chooses to remain single. Thus, the set of all possible types of households that can emerge is:

$$\mathcal{H} = \big\{(H, H), (H, L), (L, H), (L, L), (H, 0), (L, 0), (0, H), (0, L)\big\}.$$

The final stage features the consumption and time allocation decision within each household. For married households, the man and the woman who form the household behave as a single decision making unit maximizing the sum of their individual utilities. Henceforth, we refer to them as husband and wife. Individuals derive utility from the consumption of

a private good (c), leisure (l), and the value generated from married life (v). Specifically, the utility of an individual is given by:

$$u(c, l, v) = ln(c) + ln(l) + ln(v)$$

The key detail of our model is in terms of how this value from marriage is theorized. Second, this value is generated from the domestic labor and effort that the husband and the wife put towards sustaining married life. We model patriarchal gender norms by hypothesizing that a wife's labor in the domestic sphere is believed to be more crucial to generating this value from marriage. In particular, the household experiences disutility if the husband spends hours on domestic labor. Specifically,

$$v = (\sqrt{n_m} + \sqrt{n_f})^2 - \gamma n_m, \ \gamma \geq 0,$$

where n_m and n_f denote the husband and wife's labor and effort towards the marriage, respectively, and γ captures the strength of the patriarchal gender norm. Note that the higher is γ, the higher is the disutility from the husband's domestic labor. It is also worth noting that consistent with the interpretation of a societal norm, this attitude is internalized by both men and women alike. In that sense, the value from marriage that we model incorporates not just the output of "physical goods" that may be produced from marriage but also "cultural goods." For instance, a given amount of domestic labor may be needed for household chores like cleaning and washing, and to accomplish this, the husband and wife's labor are perfect substitutes. However, if the man puts in these hours, it produces a certain disutility (for both the husband and the wife), given the patriarchal cultural norm that prevails in society. Finally, note that in a married household, both the husband and the wife experience the same value from marriage, re-emphasizing the interpretation of marriage and the value derived from it as a cultural phenomenon enmeshed within societal norms. Note that, for single households, $v_i = n_i, i \in \{M, F\}$.

We assume that any household operates as a single decision making unit. For single households, this is obvious. On the other hand, married households operate with the objective of maximizing the sum of the man's and woman's utility, subject to relevant constraints. Specifically, the private good is purchased from income earned from the man and woman's participation in the labor market, where the wage rates for H and L-types are given by w_H and w_L, respectively. Subsequently, we normalize w_L to 1 and denote w_H by w. The maximization problem for a household $(x, y) \in \mathcal{H}$ is given by:

$$U^*(x, y) = \max \left\{ (ln(c_x) + ln(l_x) + ln(v)) + (ln(c_y) + ln(l_y) + ln(v)) \right\} \quad (2.1)$$

subject to:

$$\text{budget constraint: } c_x + c_y \leq (1 - l_x - n_x)w_x + (1 - l_y - n_y)w_y \quad (2.2)$$

$$\text{feasibility constraints: } l_x + n_x \leq 1, l_y + n_y \leq 1 \quad (2.3)$$

$$\text{non-negativity constraints: } c_x, c_y, l_x, l_y, n_x, n_y \geq 0 \quad (2.4)$$

The household's budget constraint ensures that the total consumption is not greater than the total labor income of the household, where w_x and w_y are the wage rates of the x-type husband and the y-type wife, respectively. The feasibility constraints for husband and wife require the total time allocation towards domestic labor, market labor, and leisure to add up to one. The final constraint is the usual non-negativity constraint that holds for all the choice variables for both husband and wife. Finally, denote by $U_m^*(x, y)$ and $U_f^*(x, y)$ the utilities of the man and woman, respectively, at the optimal solution to the household problem. For future reference, note that given our parameterization, $U_m^*(x, y) > 0$ and $U_f^*(x, y) > 0$, for all $(x, y) \in \mathcal{H}$.

3   Equilibrium

To define the equilibrium of the model, we first introduce a couple of well-known concepts. First, is that of matching in the marriage market. A *matching* is a mapping $\mu : M \cup F \to M \cup F$, such that (i) for any $m \in M$, either $\mu(m) = m$ or $\mu(m) \in F$, (ii) for any $f \in F$, $\mu(f) = f$ or $\mu(f) \in M$, and (iii) $f = \mu(m)$ iff $m = \mu(f)$. We interpret $\mu(i)$ as i's match. When $\mu(i) = i$, it means that i is single and does not marry. For any matching μ, let $\hat{\mu}$ denote the distribution over the households in $\mathcal{H}$ induced by it. That is, for any $(x, y) \in \mathcal{H}$, $\hat{\mu}(x, y)$ is interpreted as the proportion of (x, y) households under the match μ. We next define the notion of a matching being blocked by an individual or a pair. A matching μ is blocked by an x-type man m, with a y-type partner $\mu(m)$, if $U_m^*(x, 0) > U_m^*(x, y)$. Similarly, the matching is blocked by a y-type woman f, with an x-type partner $\mu(f)$, if $U_f^*(0, y) > U_f^*(x, y)$. A matching μ is blocked by a pair consisting of an x-type man m and y-type woman f if $\mu(m)$ is y'-type, $\mu(f)$ is x'-type, and $U_m^*(x, y) > U_m^*(x, y')$, $U_f^*(x, y) > U_f^*(x', y)$. A matching μ is *stable* if it is not blocked by any individual or a pair.

Given (beliefs about) the matching μ that prevails in society, in the first stage, individuals can determine their payoffs from high and low education. Consider the choice of high education by a woman. Suppose the proportion of married households with an H-type woman is greater than zero under the match μ, i.e., either $\hat{\mu}(H, H) > 0$ or $\hat{\mu}(L, H) > 0$, then, if she marries, with probability $\hat{\mu}(H, H)/(\hat{\mu}(H, H) + \hat{\mu}(L, H))$, she forms an (H, H) household and derives utility $U_f^*(H, H)$, and with complementary probability an (L, H) household and derives utility $U_f^*(L, H)$. On the other hand, if she remains single, her utility will be $U_f^*(0, H)$. Then, her payoff from choosing high education is given by:

$$V_f(H; \mu) = \max\left\{ \left(\frac{\hat{\mu}(H, H)}{\hat{\mu}(H, H) + \hat{\mu}(L, H)} \right) U_f^*(H, H) + \left(\frac{\hat{\mu}(L, H)}{\hat{\mu}(H, H) + \hat{\mu}(L, H)} \right) U_f^*(L, H), \right.$$
$$\left. U_f^*(0, H) \right\},$$

where we adopt the convention that the first term is 0 if $\hat{\mu}(H, H) + \hat{\mu}(L, H) = 0$, i.e., the proportion of married households with an H-type woman under the matching μ is zero.

Similarly, the payoff of a woman from choosing low education, and that of a man from choosing high and low education are given, respectively, by:

$$V_f(L; \mu) = \max \left\{ \left(\frac{\hat{\mu}(L, L)}{\hat{\mu}(L, L) + \hat{\mu}(H, L)} \right) U_f^*(L, L) + \left(\frac{\hat{\mu}(H, L)}{\hat{\mu}(L, L) + \hat{\mu}(H, L)} \right) U_f^*(H, L), \right.$$
$$\left. U_f^*(0, L) \right\}$$

$$V_m(H; \mu) = \max \left\{ \left(\frac{\hat{\mu}(H, H)}{\hat{\mu}(H, H) + \hat{\mu}(H, L)} \right) U_m^*(H, H) + \left(\frac{\hat{\mu}(H, L)}{\hat{\mu}(H, H) + \hat{\mu}(H, L)} \right) U_m^*(H, L), \right.$$
$$\left. U_m^*(H, 0) \right\}$$

$$V_m(L; \mu) = \max \left\{ \left(\frac{\hat{\mu}(L, L)}{\hat{\mu}(L, L) + \hat{\mu}(L, H)} \right) U_m^*(L, L) + \left(\frac{\hat{\mu}(L, H)}{\hat{\mu}(L, L) + \hat{\mu}(L, H)} \right) U_m^*(L, H), \right.$$
$$\left. U_m^*(L, 0) \right\}$$

Further, note that the education choices can be characterized in terms of cut-off strategies. Specifically, there exists a cut-off cost of high education for men and women such that, below the cut-off, they choose high education, and low education otherwise. Denote this cut-off by θ_f^* for women and θ_m^* for men. That is,

$$\theta_f^* = \begin{cases} c_f^{-1}(V_f(H; \mu) - V_f(L; \mu)), & \text{if } V_f(H) > V_f(L) \\ 0, & \text{otherwise} \end{cases} \tag{3.1}$$

Similarly, the value of θ_m^* is obtained by solving

$$\theta_m^* = \begin{cases} c_m^{-1}(V_m(H; \mu) - V_m(L; \mu)), & \text{if } V_m(H) > V_m(L) \\ 0, & \text{otherwise} \end{cases} \tag{3.2}$$

We can now define our notion of equilibrium.

Definition 3.1. *An equilibrium is a collection* $\langle (\theta_f^*, \theta_m^*), \mu^*, (c_x^*, l_x^*, n_x^*, c_y^*, l_y^*, n_y^*)_{(x,y) \in \mathcal{H}} \rangle$ *such that*

(i) *Any woman* $f \in F$ *chooses high education, i.e.,* $V_f(H; \mu^*) - \theta_f \geq V_f(L; \mu^*)$ *iff* $\theta_f \leq \theta_f^*$*; and any man* $m \in M$ *chooses high education, i.e.,* $V_m(H; \mu^*) - \theta_m \geq V_m(L; \mu^*)$ *iff* $\theta_m \leq \theta_m^*$.

(ii) The matching μ^* is stable and

$$\frac{\hat{\mu}^*(\{(x,H) \in \mathcal{H} : x \in \{0,H,L\}\})}{\hat{\mu}^*(\{(x,y) \in \mathcal{H} : x \in \{0,H,L\}, y \in \{H,L\}\})} = \theta_f^*$$

$$\frac{\hat{\mu}^*(\{(H,y) \in \mathcal{H} : y \in \{0,H,L\}\})}{\hat{\mu}^*(\{(x,y) \in \mathcal{H} : x \in \{H,L\}, y \in \{0,H,L\}\})} = \theta_m^*$$

(iii) $(c_x^*, l_x^*, n_x^*, c_y^*, l_y^*, n_y^*)$ solves the household problem for each household $(x,y) \in \mathcal{H}$.

4 Solving the model

Now that we have specified the components of each stage, we discuss the steps involved in solving the model. We solve the model using backward induction. Specifically, the utility function in the first stage is the indirect utility of the second stage, and the utility function in the second stage could be interpreted as the indirect utility of the third stage, conditional on education choice. Therefore starting with the last stage, a household behaves as a single decision maker maximizing the sum of the spouses' utilities. The maximization exercise gives us the optimal level of consumption of private good, leisure, and value from marriage for all possible (x,y) household types that might enter the final stage. The individuals who choose to remain single maximize their individual utility. Next, in the second stage, individuals choose who they want to match with, conditional on their education level. Finally, in the first stage, individuals choose the level of education considering its future returns in labor and marriage markets.

4.1 Household optimization

As discussed above, a household $(x,y) \in \mathcal{H}$, where the husband's type is x and the wife's type is y, solves the utility maximization problem given by equation (2.1). We set up the Lagrange and provide a detailed solution to the optimization problem in the Appendix (Section A.1). The optimization problem guarantees unique interior solutions for the choice variables. Let $r = \sqrt{\frac{n_y}{n_x}}$. Then we can rewrite $v = n_x\big((1+r)^2 - \gamma\big)$. As we derive in the appendix, r is a function of γ and the wage ratio of husband and wife. Thus r is a constant for a given value of parameters. The solution, using the first order conditions, is given

below:

$$c_x = c_y = \frac{vrw_y}{2(1+r)} \tag{4.1}$$

$$l_x = \frac{vrw_y}{2w_x(1+r)} \tag{4.2}$$

$$l_y = \frac{vr}{2(1+r)} \tag{4.3}$$

$$n_x = \frac{(w_x + w_y)(1+r)}{2rw_y\big((1+r)^2 - \gamma\big) + (1+r)(w_x + w_y r^2)} \tag{4.4}$$

$$n_y = \frac{r^2(w_x + w_y)(1+r)}{2rw_y\big((1+r)^2 - \gamma\big) + (1+r)(w_x + w_y r^2)} \tag{4.5}$$

Given this, we now explicitly write down the optimal level of utilities of men and women from all possible matches in the marriage market. Firstly, the ratio r for different households is given by the following:

$$r_{HH} = \frac{\gamma + \sqrt{\gamma^2 + 4}}{2}$$

$$r_{HL} = \frac{\gamma + w - 1 + \sqrt{(\gamma + w - 1)^2 + 4w}}{2}$$

$$r_{LH} = \frac{\gamma w - w + 1 + \sqrt{(\gamma w - w + 1)^2 + 4w}}{2w}$$

$$r_{LL} = r_{HH}$$

Using these we define the respective domestic hours for men:

$$n_x(HH) = \frac{2(1 + r_{HH})}{2r_{HH}\big((1 + r_{HH})^2 - \gamma\big)(1 + r_{HH})(1 + r_{HH}^2)}$$

$$n_x(HL) = \frac{(1 + w)(1 + r_{HL})}{2r_{HL}\big((1 + r_{HL})^2 - \gamma\big)(1 + r_{HL})(w + r_{HL}^2)}$$

$$n_x(LH) = \frac{(1 + w)(1 + r_{LH})}{2wr_{LH}\big((1 + r_{LH})^2 - \gamma\big)(1 + r_{LH})(1 + wr_{LH}^2)}$$

$$n_x(LL) = n_x(HH)$$

We know $v = n_x\big((1+r)^2 - \gamma\big)$. Given r and n_x defined above, we get v for each household type. Substituting in the utility function gives us:

$$U_m^*(HH) = \frac{w}{4}v^3(HH)\Big(\frac{r_{HH}}{1+r_{HH}}\Big)^2, \quad U_m^*(HL) = \frac{1}{4w}v^3(HL)\Big(\frac{r_{HL}}{1+r_{HL}}\Big)^2$$

$$U_m^*(LH) = \frac{w^2}{4}v^3(LH)\Big(\frac{r_{LH}}{1+r_{LH}}\Big)^2, \quad U_m^*(LL) = \frac{1}{4}v^3(LL)\Big(\frac{r_{LL}}{1+r_{LL}}\Big)^2$$

$$U_f^*(HH) = \frac{w}{4}v^3(HH)\Big(\frac{r_{HH}}{1+r_{HH}}\Big)^2, \quad U_f^*(HL) = \frac{1}{4}v^3(HL)\Big(\frac{r_{HL}}{1+r_{HL}}\Big)^2$$

$$U_f^*(LH) = \frac{w}{4}v^3(LH)\Big(\frac{r_{LH}}{1+r_{LH}}\Big)^2, \quad U_f^*(LL) = \frac{1}{4}v^3(LL)\Big(\frac{r_{LL}}{1+r_{LL}}\Big)^2$$

The utility for all households is increasing in wages and decreasing in the patriarchal gender norms or bias. An H-type individual's domestic labor decreases in wages when they are matched with an L-type spouse. However, the opposite is true for an L-type individual. Men's domestic labor is decreasing, whereas women's domestic labor is increasing in bias.

4.2 Marriage market

In the second stage, individuals enter the marriage market. Each individual has three possible options – (i) marrying an H-type individual, (ii) marrying an L-type individual, and (iii) staying single. They choose among these options by comparing the utilities they would derive from the resulting households given by $U_i^*(x, y), i \in \{M, F\}$. For instance, an H-type woman f compares her utility $U_f^*(x, H)$ and $U_f^*(0, H)$; and an L-type woman compares $U_f^*(x, L)$ and $U_f^*(0, L)$, where $x \in \{H, L\}$ is the type of the man. These comparisons enable us to derive the preferences for each type of woman. Analogously we derive preferences for each type of man.

Proposition 4.1. *(i) L-type women always prefer to marry an H-type man over an L-type man. L-type men always prefer to marry an H-type woman over an L-type woman.*

(ii) H-type women do not always prefer to marry an H-type man over an L-type man. H-type men do not always prefer to marry an H-type woman over an L-type woman.

(iii) Both men and women prefer to marry than to remain single.

Proof. Please refer to Section A.2. ◻

For H-type women we make the following observation. We know from the previous section, $U_f^*(HH) = \frac{w}{4} v^3(HH) \left(\frac{r_{HH}}{1 + r_{HH}} \right)^2$. Simplifying this and substituting from r_{HH}, we get, $U_f^*(HH) = \frac{2w(1 - \gamma + r_{HH})}{27}$. Similarly, $U_f^*(LH) = \frac{(1 + w)^3(1 - \gamma + r_{LH})}{108w}$. An H-type woman prefers to marry L-type man over H-type man if

$$\Delta U_f(H) = U_f^*(HH) - U_f^*(LH) < 0$$

$$\frac{2w}{27} \left(1 - \gamma + r_{HH} - \frac{(1 + w)^3(1 - \gamma + r_{LH})}{8w^2} \right) < 0$$

$$1 - \gamma + r_{HH} - \frac{(1 + w)^3(1 - \gamma + r_{LH})}{8w^2} < 0$$

$$1 - \gamma + r_{HH} < \frac{(1 + w)^3}{8w^2} \cdot (1 - \gamma + r_{LH})$$

We derive $\gamma_F(w)$ that gives us a locus of (γ, w) where an H-type woman is indifferent between marrying an L-type man and an H-type man (for precise expression, refer to the Appendix). As the figure below illustrates, when there is no bias, that is, for $\gamma = 0$, the level of wage at which an H-type woman is indifferent between an L and H-type man is approximately 11.445. This implies for a sufficiently high wage, and no disutility from men's domestic labor, an H-type woman would prefer an L-type man over an H-type man. This is because she can put in more hours in the market labor, and an L-type man can allocate more time towards domestic labor. As the bias increases, the wage at which the H-type woman would be indifferent between an L and H-type man increases. In other words, as the level of bias increases, women prefer an L-type over an H-type man at a higher wage. This is because as the bias increases, the disutility from men's domestic labor increases, and thus the woman needs a higher compensation, i.e., a higher wage, in order to be indifferent between an L and H-type man. The shaded area in the graph represents the (γ, w) values such that an H-type woman prefers an L-type man over an H-type man, and in the non-shaded area, her preferences are reversed. The intuition for this is simple. Suppose we are at a point (γ_0, w_0) on the curve, such that the H-type woman is indifferent. Now, holding the value of γ fixed at γ_0, she would still prefer the L-type man for all wages higher than w_0 because the cost or disutility from men's domestic labor is the same, but the compensation she receives is higher. Similarly, if we hold the wage rate fixed at w_0, and decrease γ, then an analogous argument suggests that she would prefer an L-type man. Further, note that the function asymptotically approaches a value of γ, say $\bar{\gamma}$, such that for all values $\gamma > \bar{\gamma}$, there exists a wage such that an H-type woman always prefers H-type man over an L-type man. This suggests that as patriarchy strengthens and disutility from men's domestic labor increases, there is no wage high enough to compensate for the disutility, and thus she would prefer an H-type man over an L-type man beyond $\bar{\gamma}$.

Similarly, H-type men, prefer an L-type woman over an H-type woman if

$$\Delta U_m(H) = U_m^*(HH) - U_m^*(HL) < 0$$

$$\frac{2w}{27}\left(1 - \gamma + r_{HH}\right) - \frac{\gamma(1+w)^3}{54w\left(\gamma - w - 1 + \sqrt{(\gamma + w - 1)^2 + 4w}\right)} < 0$$

$$\frac{2w}{27}\left(1 - \gamma + r_{HH} - \frac{\gamma(1+w)^3}{8w^2\left(r_{HL} - w\right)}\right) < 0$$

$$1 - \gamma + r_{HH} - \frac{\gamma(1+w)^3}{8w^2\left(r_{HL} - w\right)} < 0$$

$$1 - \gamma + r_{HH} < \frac{(1+w)^3}{8w^2} \cdot \frac{\gamma}{(r_{HL} - w)}$$

Analogously, we derive $\gamma_M(w)$ that gives us a locus of (γ, w) where an H-type man is indifferent between marrying an L-type woman and H-type woman (precise expression in the Appendix). As the figure below illustrates, when there is no bias, that is, $\gamma = 0$, the level of wage at which an H-type man is indifferent between an L and H-type woman is

Figure 1: Preferences of H-type women
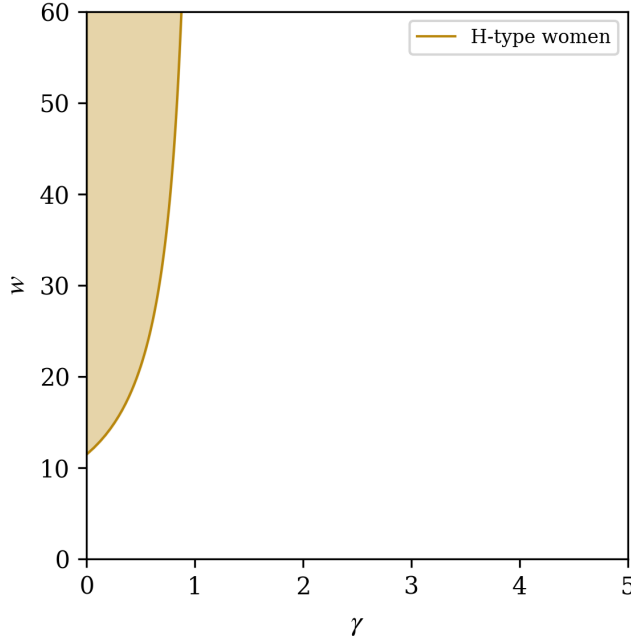
approximately 11.445. Since at $\gamma = 0$, the optimization problem is symmetric for men and women, and the value of wage is the same as for an H-type woman. For wages high enough, for all values of γ, he prefers an L-type woman to an H-type woman. This is because, for high wages, he would prefer to allocate more time to market labor while his wife allocates more time towards domestic labor. However, for wages lower than this cut-off, there exists a level of bias, such that the H-type man prefers H-type woman below this level. As the wage decreases, the level of bias at which the H-type man is indifferent between an H-type and L-type woman increases. That is, the level of bias at which an H-type man would be indifferent between an L and H-type woman is higher for a lower wage. This is because as wages fall, he would prefer an H-type woman as she would earn more in the market. But this also means he would have to allocate more time to domestic labor in the resulting (H, H) match. For a small fall in wages below 11.445, he prefers an H-type woman only when the disutility from his domestic labor is also small. As the wage falls further, even for a higher bias (higher disutility), he prefers an H-type woman as he values her contribution towards the market labor enough to be willing to contribute more towards the domestic labor and bear the disutility. This explains why the curve where an H-type man is indifferent between an H-type and an L-type woman is convex and downward sloping.

The shaded area in the graph represents the (γ, w) values such that an H-type man prefers an H-type woman over an L-type woman, and in the non-shaded area, his preferences are reversed. The intuition for this is as follows. Suppose we are at a point (γ_0, w_0) on the

curve, such that the H-type man is indifferent. Now, holding the value of γ fixed at γ_0, he would still prefer the L-type woman for all wages higher than w_0 because the cost or disutility from men's domestic labor is the same, but the compensation he receives is higher. Since he preferred an L-type woman at a lower wage, he would continue to do so at a higher wage. Similarly, if we hold the wage rate fixed at w_0 and increase γ, then an analogous argument suggests that he would prefer an L-type woman. Further, note that the function asymptotically approaches a value of w, say $\bar{w}$, such that for all values $w < \bar{w}$, an H-type man always prefers H-type woman over an L-type woman. This suggests that even as patriarchy strengthens and disutility from men's domestic labor increases, there is a wage low enough such that below it, an H-type man always prefers an H-type woman over an L-type woman.

Figure 2: Preferences of H-type men
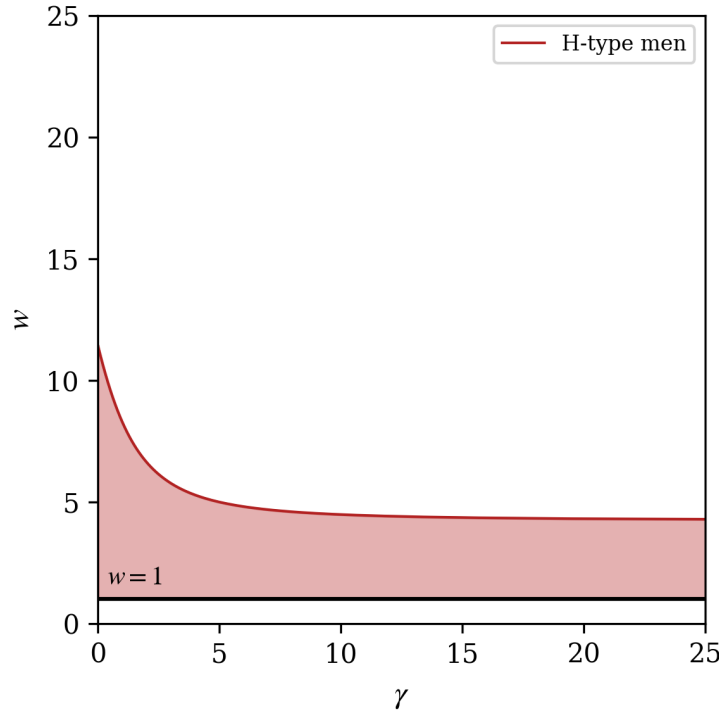
The Gale-Shapley result enables us to establish the following.

Remark 4.1. *Given an education profile of men and women, a stable match always exists.*

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4.3 Education choice

Folding back one step, we now move to the first stage, where individuals have to choose their education level – high or low. Recall that the cost of obtaining low education is zero, whereas that of high education for men and women is $c_m(\theta) = c_f(\theta) = \theta$, with the distribution of θ being uniform on $[0,1]$ for both the population of men and women. Let θ_m^* and θ_f^* denote the cost of education for men and women, respectively, where they are indifferent between choosing high education and low education. This means for values of $\theta_i < \theta_i^*$, individual i chooses high education and low education otherwise. Women are indifferent between choosing a high and low education level if

$$V_f(H) - c_f(\theta_f^*) = V_f(L)$$

Analogously, men are indifferent between choosing a high and low education level if

$$V_m(H) - c_m(\theta_m^*) = V_m(L)$$

Now that we have defined how individuals solve for each stage, we describe the equilibrium of the model. The equilibrium specifies the proportion of men and women who choose different education levels, their decisions in the marriage market, and lastly, the consumption and time allocated to home and market labor. To illustrate the type of equilibria that exist, we partition the $\gamma - w$ space into three regions.

Figure 3: Equilibrium
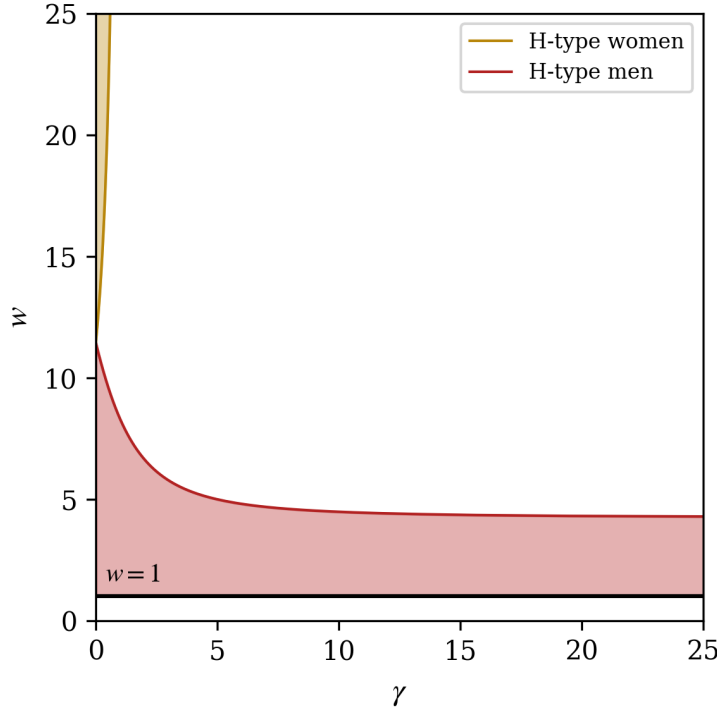
Region I is shaded in pink below the H-type men curve, Region II is the non-shaded area to the right of the two curves, and Region III is shaded in yellow to the left of the H-type women curve. We first establish that in Region I, there is one type of equilibrium where there is an equal proportion of H-type men and women, i.e., $\theta_m^* = \theta_f^*$. The marriage market has two assortative matches $\{(HH, LL)\}$. We refer to this as Type I equilibrium. Recall that in Region I, the marriage market preferences of the individuals are as follows: H-type men prefer to marry an H-type woman over an L-type woman. The H-type women and L-type individuals also have the same preferences. Given this, we derive a stable match in the marriage market that comprises $\{(HH), (LL)\}$. To see that it is stable, consider the H-type man. He prefers an H-type woman and thus has no incentive to deviate. An analogous argument is true for H-type woman. An L-type man prefers an H-type woman. However, she doesn't want to deviate from the (H, H) pair as she prefers an H-type man over an L-type man. Further, since the L-type man prefers to marry than remain single, he chooses to pair with L-type woman. A similar argument establishes that an L-type woman doesn't want to deviate. Next, we show that this match is feasible, that is, there exists an equal proportion of H-type individuals and L-type individuals. In other words, there exists a value $\theta_m^* = \theta_f^* \in (0, 1)$. Lastly, the consumption and time allocation for all individuals are given by the solution to the optimization problem. An interesting observation is that even though the wages earned by men and women are the same in both households, women allocate more time than their husbands to domestic labor.

We characterize two equilibria in Regions II and III. One equilibrium consists of household types $\{(HH), (HL)\}$ and the other consists of only $\{(HL)\}$. We refer to these as Type II and Type III equilibrium, respectively. It is straightforward to verify that no individual has the incentive to deviate from any of these equilibrium matches. Note that, in both these equilibria, the proportion of H-type men is greater than the proportion of H-type women. This means for higher values of wages and bias, a higher proportion of men choose high education than women. Consequently, in non-assortative matches, men allocate more time towards market labor than their wives. Women, on the other hand, allocate significantly more time towards domestic labor than their husbands. Further, this difference between the domestic labor allocation becomes starker with an increase in wages and/or bias.

Theorem 4.1. *(i) Type I equilibrium profile $\langle (\theta_f^*, \theta_m^*), \mu^*, (c_x^*, l_x^*, n_x^*, c_y^*, l_y^*, n_y^*)_{(x,y) \in \mathcal{H}} \rangle$ exists in Region I.*

(ii) Type II and Type III equilibrium profiles $\langle (\theta_f^*, \theta_m^*), \mu^*, (c_x^*, l_x^*, n_x^*, c_y^*, l_y^*, n_y^*)_{(x,y) \in \mathcal{H}} \rangle$ exist in Regions II and III.

Proof. Please refer to Section A.3. □

# 5   Implications of the model and empirical content

We now discuss some properties of the equilibrium. In terms of time allocation, an interesting prediction is that domestic labor varies significantly between men and women. This is in line with the empirical evidence. Women allocate more hours to domestic labor than their husbands, even when they have the same education level. Further, for any given level of wages, an increase in bias leads to a sharp decline in men's domestic labor in any household. Thus widening the gap between husband and wife's contribution towards domestic labor. The model predicts that for any wage level, and patriarchal gender norms not high enough, men contribute more time to domestic labor in assortative than in non-assortative households where they are matched with a lower educated woman. This, however, is not true when they are matched with a higher educated woman. The model predicts that leisure hours for the higher educated spouse are lower than, the lower educated spouse in any non-assortative household. Since women participate in the labor market and also allocate more time towards domestic labor, it leaves them with fewer hours of leisure. Empirically, this has been found to be an important reason why women do not participate in the labor market. Furthermore, for the same level of education, a woman spends fewer hours in the market than her husband.

We want to highlight how the equilibrium interactions change as the bias and wages change. The proportion of individuals with different education levels changes with bias. Consequently, the proportion of non-assortative matches also changes. In particular, with an increase in bias, beyond a certain value of wages, the proportion of men who choose higher education rises, and that of women falls. This leads to a higher proportion of non-assortative matches. This implication becomes evident as we move from Type I equilibrium to Type III equilibrium.

We now discuss the empirical content of the model. As discussed in the Introduction, the predictions of our model are consistent with what is observed worldwide in terms of time allocated by women in households compared to their male counterparts. We try to see how the various outcome variables in our model vary with patriarchy by using data from India. Patriarchy manifests in multiple socioeconomic spheres; thus, it becomes challenging to measure it empirically. It is especially critical in the Indian context, where gender norms are deeply rooted and reinforced through traditions and societal norms. We use the patriarchy index constructed by Singh et al. (2022), which modifies the original Patriarchy Index developed in Europe by Gruber and Szołtysek (2016). The index is constructed using NFHS, a demographic health survey conducted in India in 2015–16. It comprises of five domains: (i) domination of men over women, (ii) domination of the older generation over the younger generation, (iii) patrilocality, (iv) son preference, and (v) socio-economic domination. These five domains broadly capture a wide range of variables relating to different aspects of patriarchy.

We use the Time Use Survey (TUS) 2019 to investigate the relationship between time allocation at home and market activities. As one would expect, we find that women undertake domestic work much more than men. More pertinently, Afridi et al. (2022) find that the time spent on domestic work is almost the converse of time spent at work for both married men and women. For the working age group (15-59), the time spent by women on unpaid activities at home is more than 6 hours per day. The corresponding time spent by men on domestic work is around an hour per day. In Figure 4a, we compare the time spent by women on domestic work across the states in India and see how it correlates with the patriarchy index. We find a positive correlation between the relative time women and men spend on domestic work and the patriarchy index. Our second variable of interest is the education level of women in the tertiary sector. We use the All India Survey on Higher Education (AISHE) 2017-18 and look at the relative gross enrolment ratio of females to males in tertiary education. As predicted by the equilibrium in our model, higher education is lower for women as compared to men in the states where the patriarchy index is higher (Figure 4b).

Figure 4: Correlation between patriarchy and female outcome variables

(a) Time spent on domestic work

(b) Enrolment in tertiary education
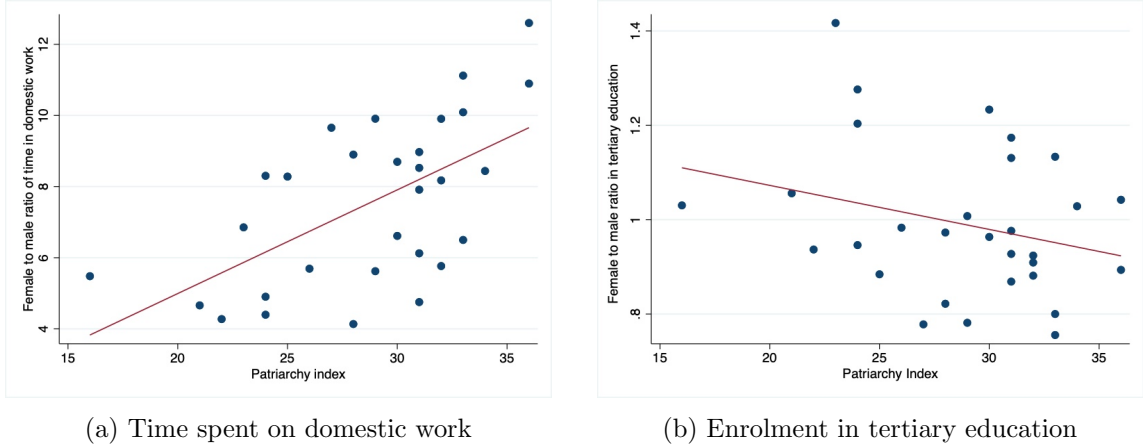
A Appendix

A.1 Optimization problem

Solving the third stage consumption and time allocation problem of the household.

$$\max_{c_x,c_y,l_x,l_y,n_x,n_y} U(x,y) = ln(c_x) + ln(l_x) + ln(c_y) + ln(l_y) + 2ln(v)$$

subject to,

$$\text{budget constraint: } c_x + c_y \le (1 - l_x - n_x)w_x + (1 - l_y - n_y)w_y$$
$$\text{value from marriage: } v = (\sqrt{n_m} + \sqrt{n_f})^2 - \gamma n_m, \ \gamma \ge 0,$$
$$\text{feasibility constraints: } l_x + n_x \le 1, l_y + n_y \le 1$$
$$\text{non-negativity constraints: } c_x, c_y, l_x, l_y, n_x, n_y \ge 0$$

We know budget constraint is always effective i.e, $c_x + c_y = (1 - l_x - n_x)w_x + (1 - l_y - n_y)w_y$. Therefore we consider cases where it is always effective. It is straightforward to see that $c_x, c_y, l_x, l_y, n_x, n_y > 0$. This implies the non-negativity constraints always slack. Note that both the feasibility constraints cannot be effective together with the budget constraint. If it were true, then the household income would be zero, and accordingly, consumption of the private good would be zero. Given this, we now set up the Lagrange for the problem:

$$L = ln(c_x) + ln(l_x) + ln(c_y) + ln(l_y) + 2ln((\sqrt{n_m} + \sqrt{n_f})^2 - \gamma n_m)$$
$$+ \lambda_1 \big(w_x + w_y - c_x - c_y - w_x l_x - w_x n_x - w_y l_y - w_y n_y\big)$$
$$+ \lambda_2 \big(1 - l_x - n_x\big)$$
$$+ \lambda_3 \big(1 - l_y - n_y\big)$$

The first order conditions with respect to the choice variables are as follows:

$$c_x : \frac{1}{c_x} - \lambda_1 = 0 \tag{A.1}$$

$$c_y : \frac{1}{c_y} - \lambda_1 = 0 \tag{A.2}$$

$$l_x : \frac{1}{l_x} - \lambda_1 w_x - \lambda_2 = 0 \tag{A.3}$$

$$l_y : \frac{1}{l_y} - \lambda_1 w_y - \lambda_3 = 0 \tag{A.4}$$

$$n_x : \frac{2}{v}\left(\frac{\sqrt{n_x} + \sqrt{n_y}}{\sqrt{n_x}} - \gamma\right) - \lambda_1 w_x - \lambda_2 = 0 \tag{A.5}$$

$$n_y : \frac{2}{v}\left(\frac{\sqrt{n_x} + \sqrt{n_y}}{\sqrt{n_y}}\right) - \lambda_1 w_y - \lambda_3 = 0 \tag{A.6}$$

We take the case where only the budget constraint is effective. That is, $\lambda_1 > 0$ and $\lambda_2 = \lambda_3 = 0$.

$$L = ln(c_x) + ln(l_x) + ln(c_y) + ln(l_y) + 2ln((\sqrt{n_m} + \sqrt{n_f})^2 - \gamma n_m)$$
$$+ \lambda_1 \big(w_x + w_y - c_x - c_y - w_x l_x - w_x n_x - w_y l_y - w_y n_y\big)$$

Equating Equations A.1 and A.2, we get $c_x = c_y$. From Equations A.3 and A.4, we get $l_y = l_x\left(\frac{w_x}{w_y}\right)$. Similarly Equations A.5 and A.6 imply $(1 + r)\left(\frac{rw_y - w_x}{rw_y}\right) = \gamma$. Substituting Equation A.1 in A.3 gives $l_x = \frac{c_x}{w_x}$. Similarly, from Equations A.2 and

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A.4, $l_y = \dfrac{c_y}{w_y}$, and from Equations A.1 and A.5, $\dfrac{1}{c_y} = \dfrac{2}{v \cdot w_y}\left(\dfrac{1}{r} + 1\right)$. Rearranging, $c_y = \dfrac{vrw_y}{2(1+r)}$. Substituting all the variables in terms of c_y in the budget constraint:

$$2c_y + 2c_y + w_x \cdot n_x + w_y \cdot n_y = w_x + w_y$$

$$4 \cdot \frac{vrw_y}{2(1+r)} + n_x(w_x + w_y \cdot r^2) = w_x + w_y$$

$$n_x = \frac{(w_x + w_y)(1+r)}{2rw_y\left((1+r)^2 - \gamma\right) + (1+r)(w_x + w_y r^2)}$$

This gives the optimal values of the choice variables as specified below:

$$c_x = c_y = \frac{vrw_y}{2(1+r)} \tag{A.7}$$

$$l_x = \frac{vrw_y}{2w_x(1+r)} \tag{A.8}$$

$$l_y = \frac{vr}{2(1+r)} \tag{A.9}$$

$$n_x = \frac{(w_x + w_y)(1+r)}{2rw_y\left((1+r)^2 - \gamma\right) + (1+r)(w_x + w_y r^2)} \tag{A.10}$$

$$n_y = \frac{r^2(w_x + w_y)(1+r)}{2rw_y\left((1+r)^2 - \gamma\right) + (1+r)(w_x + w_y r^2)} \tag{A.11}$$

For this critical point to exist, we need to ensure that:

$$1 - l_x - n_x \geq 0 \text{ and } 1 - l_y - n_y \geq 0$$

Simplifying this we get,

$$\frac{(w_x + w_y)(1+r)}{2rw_y\left((1+r)^2 - \gamma\right) + (1+r)(w_x + w_y r^2)} \leq \min\left\{\frac{1}{\alpha}, \frac{1}{\beta}\right\},$$

where $\alpha = \dfrac{rw_x w_y\left((1+r)^2 - \gamma\right) - 2(1+r)}{2(1+r)}$ and $\beta = \dfrac{rw_y^2\left((1+r)^2 - \gamma\right) - 2r^2(1+r)}{2(1+r)}$.

A.2 Proof of Proposition 4.1

(i) We first show that L-type men always prefer to marry an H-type woman over an L-type woman. This means $U_m^*(LH) > U_m^*(LL)$.

$$U_m^*(LH) = \frac{w^2}{4} \cdot v(LH)^3 \cdot \left(\frac{r_{LH}}{1 + r_{LH}}\right)^2$$

$$U_m^*(LL) = \frac{1}{4} \cdot v(LL)^3 \cdot \left(\frac{r_{LL}}{1 + r_{LL}}\right)^2$$

We first prove that $r_{LL} > r_{LH}$.

$$r_{LL} = \frac{\gamma}{2} + \frac{\sqrt{\gamma^2 + 4}}{2}$$

$$r_{LH} = \frac{\gamma w - w + 1}{2w} + \frac{\sqrt{(\gamma w - w + 1)^2 + 4w}}{2w}$$

Comparing the first terms of both expressions,

$$\frac{\gamma}{2} > \frac{\gamma w - w + 1}{2w}$$
$$\implies w > 1$$

Now, comparing the second terms,

$$\frac{\sqrt{\gamma^2 + 4}}{2} > \frac{\sqrt{(\gamma w - w + 1)^2 + 4w}}{2w}$$
$$\implies w^2(3 + 2\gamma) > w(2\gamma + 2) + 1$$

Let $F(w, \gamma) = w^2(3 + 2\gamma) - w(2\gamma + 2) + 1$. We need to show that it is increasing in both the arguments to establish our result. Note that $F(1, 0) = 0$. Now, we show that $F'(w) > 0$ and $F'(\gamma) > 0$. $F'(w) = 6w + 4w\gamma - 2\gamma - 1$. It is straightforward to see that $F'(w) > 0$. Next, $F'(\gamma) = 2w(w - 1) > 0$. This gives us $r_{LL} > r_{LH}$. We next show the following,

$$v(LH)w^2 > v(LL)$$

$$\implies \frac{(1 + w)(1 + r_{LH})((1 + r_{LH})^2 - \gamma)w^2}{2wr_{LH}((1 + r_{LH})^2 - \gamma) + (1 + r_{LH})(1 + wr_{LH}^2)} > \frac{2(1 + r_{LL})((1 + r_{LL})^2 - \gamma)}{2r_{LL}((1 + r_{LL})^2 - \gamma) + (1 + r_{LL})(1 + r_{LL}^2)}$$

It can be verified that the LHS is decreasing in r_{LH}. We replace r_{LH} by r_{LL} as we know $r_{LL} > r_{LH}$. This simplifies the inequality

$$\frac{(1 + w)w^2}{2wr_{LL}((1 + r_{LL})^2 - \gamma) + (1 + r_{LL})(1 + wr_{LL}^2)} > \frac{2}{2r_{LL}((1 + r_{LL})^2 - \gamma) + (1 + r_{LL})(1 + r_{LL}^2)}$$

$$\frac{(1 + w)w^2}{2} > \frac{2wr_{LL}((1 + r_{LL})^2 - \gamma) + (1 + r_{LL})(1 + wr_{LL}^2)}{2r_{LL}((1 + r_{LL})^2 - \gamma) + (1 + r_{LL})(1 + r_{LL}^2)}$$

Simplifying the expression gives for $w > 1$, the inequality always holds true. From the calculations above, we know $r_{LL} > r_{LH}$ and $v(LH)w^2 > v(LL)$. We verify that the difference between $v(LH)w^2 - v(LL)$ outweighs the difference between $r_{LL} - r_{LH}$. Thus, $U_m^*(LH) > U_m^*(LL)$.

To show that L-type women always prefer to marry an H-type man over an L-type man. This means $U_f^*(HL) > U_f^*(LL)$.

$$U_f^*(HL) = \frac{1}{4} \cdot v(HL)^3 \cdot \left(\frac{r_{HL}}{1 + r_{HL}}\right)^2$$

$$U_f^*(LL) = \frac{1}{4} \cdot v(LL)^3 \cdot \left(\frac{r_{LL}}{1 + r_{LL}}\right)^2$$

We first prove that

$$r_{HL} = \frac{\gamma + w - 1 + \sqrt{(\gamma + w - 1)^2 + 4w}}{2} > \frac{\gamma + \sqrt{\gamma^2 + 4}}{2} = r_{LL}.$$

Note that $r_{HL} = r_{LL}$ when $w = 1$. Further, r_{HL} is an increasing function of w. At $\gamma = 0, r_{HL} = w > 1 = r_{LL}$. Thus, it is straightforward to see that $r_{HL} > r_{LL}$. Now we show that

$$v(HL) = \frac{(1 + w)(1 + r_{HL})\left((1 + r_{HL})^2 - \gamma\right)}{2r_{HL}\left((1 + r_{HL})^2 - \gamma\right) + (1 + r_{HL})(w + r_{HL}^2)}$$

$$> \frac{2(1 + r_{LL})\left((1 + r_{LL})^2 - \gamma\right)}{2r_{LL}\left((1 + r_{LL})^2 - \gamma\right) + (1 + r_{LL})(1 + r_{LL}^2)} = v(LL)$$

Since we have established $r_{HL} > r_{LL}$, we replace r_{HL} by r_{LL} on the LHS.

$$v(HL) = \frac{(1 + w)}{2r_{LL}\left((1 + r_{LL})^2 - \gamma\right) + (1 + r_{LL})(w + r_{LL}^2)}$$

$$> \frac{2}{2r_{LL}\left((1 + r_{LL})^2 - \gamma\right) + (1 + r_{LL})(1 + r_{LL}^2)} = v(LL)$$

Rearranging the terms,

$$\frac{2r_{LL}\left((1 + r_{LL})^2 - \gamma\right)}{2} + \frac{(1 + r_{LL})(1 + r_{LL}^2)}{2} > \frac{2r_{LL}\left((1 + r_{LL})^2 - \gamma\right)}{1 + w} + \frac{(1 + r_{LL})(w + r_{LL}^2)}{1 + w}$$

Since the RHS is decreasing in w, $v(HL) > v(LL)$. Thus, $U_f^*(HL) > U_f^*(LL)$.

(ii) For H-type women:

$$\Delta U_f(H) = U_f^*(HH) - U_f^*(LH)$$

$$\frac{2w}{27}\left(1 - \gamma + r_{HH} - \frac{(1 + w)^3(1 - \gamma + r_{LH})}{8w^2}\right) = 0$$

$$1 - \gamma + r_{HH} - \frac{(1 + w)^3(1 - \gamma + r_{LH})}{8w^2} = 0$$

Simplifying this gives us γ as a function of w denoted by $\gamma_F(w)$.

$$\gamma_F(w) = \begin{cases} \dfrac{-1 - 6w - 15w^2 - 4w^3 + 33w^4 - 22w^5 + 15w^6}{16w^3(1 + w)^3} \\ \quad - \dfrac{(-1 - 7w - 22w^2 - 42w^3 - 57w^4 + w^5)}{16w^3(1 + w)^3}\sqrt{\dfrac{(1 + 3w)(-1 - 3w + 2w^2 + 38w^3 + 15w^4 + 13w^5)}{(-1 - 4w + w^2)(1 + 4w + 7w^2)}}, \\ \qquad\qquad\qquad\qquad\qquad \text{if } 11.445 \le w \le 57.7 \\[2mm] \dfrac{-1 - 6w - 15w^2 - 4w^3 + 33w^4 - 22w^5 + 15w^6}{16w^3(1 + w)^3} \\ \quad + \dfrac{(-1 - 7w - 22w^2 - 42w^3 - 57w^4 + w^5)}{16w^3(1 + w)^3}\sqrt{\dfrac{(1 + 3w)(-1 - 3w + 2w^2 + 38w^3 + 15w^4 + 13w^5)}{(-1 - 4w + w^2)(1 + 4w + 7w^2)}}, \\ \qquad\qquad\qquad\qquad\qquad \text{if } w > 57.7 \end{cases}$$

The function is continuous at $w = 57.7$ as $w = 57.7$ is one of the roots of $-1 - 7w - 22w^2 - 42w^3 - 57w^4 + w^5$. It can be verified by taking the first-order derivatives that this function is increasing. Further, $\lim_{w \to \infty} \gamma_F(w) = 1.08$. This means as wages increase, the function asymptotically approaches $\gamma = 1.08$.

Similarly, H-type men:

$$\Delta U_m(H) = U_m^*(HH) - U_m^*(HL) = 0$$

$$\frac{2w}{27}(1 - \gamma + r_{HH}) - \frac{\gamma(1+w)^3}{54w\left(\gamma - w - 1 + \sqrt{(\gamma + w - 1)^2 + 4w}\right)} = 0$$

$$\frac{2w}{27}\left(1 - \gamma + r_{HH} - \frac{\gamma(1+w)^3}{8w^2(r_{HL} - w)}\right) = 0$$

$$1 - \gamma + r_{HH} - \frac{\gamma(1+w)^3}{8w^2(r_{HL} - w)} = 0$$

$$\gamma_M(w) = \begin{cases} \dfrac{-1 - 6w + w^2 + 28w^3 + 33w^4 - 54w^5 - w^6}{16w^2(1+w)^3} \\[2em] + \dfrac{(1 + 7w + 22w^2 + 42w^3 + 57w^4 - w^5)}{16w^2(1+w)^3}\sqrt{\dfrac{(-1 - 6w + 25w^2 + 108w^3 + 129w^4 - 6w^5 + 7w^6)}{(-1 - 4w + w^2)(1 + 4w + 7w^2)}} \end{cases}$$

It can be verified by taking the first-order derivatives that this function is decreasing. Further, $\lim_{\gamma \to \infty} \gamma_M(w) = 5 + \sqrt{2}$. This means as γ increases, the function asymptotically approaches $w = 5 + \sqrt{2}$.

(iii) The utility from remaining single for a j-type individual is:

$$u(j) = ln(c_j) + ln(l_j) + ln(n_j)$$

subject to the following constraints, $c_j = (1 - l_j - n_j)w_j$ and $l_j + n_j \leq 1, c_j, l_j, n_j \geq 0$.

For an H-type individual, $U_m^*(H) = U_f^*(H) = \frac{w}{27}$. It is straightforward to verify that $U_m^*(H, L) > \frac{w}{27}$ and $U_f^*(L, H) > \frac{w}{27}$. Thus the utility that an H-type individual derives when matched with an L-type individual is more than when they choose not to marry. Furthermore, since utility is increasing in wages, an H-type individual would also prefer to marry an H-type individual than choose to not marry. Similarly, for an L-type individual, $U_m^*(L) = U_f^*(L) = \frac{1}{27}$. In this case, $U_m^*(L, L) > \frac{1}{27}$ and $U_f^*(L, L) > \frac{1}{27}$. Thus they are better-off if they choose to marry than remain single.

A.3 Proof of Theorem 4.1

To show that an equilibrium profile $\langle(\theta_f^*, \theta_m^*), \mu^*, (c_x^*, l_x^*, n_x^*, c_y^*, l_y^*, n_y^*)_{(x,y)\in\mathcal{H}}\rangle$ exists, we show that the equilibrium objects exist for each stage. The household optimization problem

in the final stage has a unique solution (Kuhn-Tucker Theorem). By Gale Shapley, we know that there exists a unique marriage market matching that is stable. What remains to show is that there exist cut-offs (θ_f^*, θ_m^*) for men and women, respectively, such that neither of them wants to deviate and (θ_f^*, θ_m^*) must simultaneously solve equations (3.1) and (3.2).

Type I equilibrium: In Region I, we claim the following to be an equilibrium under certain parametric restrictions. The cut-off education levels for men and women are given by:

$$\theta_f^* = \theta_m^* = \frac{1}{27} \cdot (2 - \gamma + \sqrt{4 + \gamma^2})(w - 1).$$

The marriage market has two equilibrium households, (H, H) and (L, L). We first verify this claim. Consider the H-type man. He doesn't have any incentive to deviate and match with an L-type woman as he prefers the H-type woman. He is not better off remaining single either as $U_m^*(H, H) > U_m^*(H, 0)$. Similar argument hold for all other individuals. Note if these are the households in the marriage market, then,

$$
\begin{aligned}
V_f(H; \mu) &= 1 \times U_f^*(H, H) + 0 \times U_f^*(L, H) \\
&= U_f^*(H, H) \\
V_f(L; \mu) &= 0 \times U_f^*(H, L) + 1 \times U_f^*(L, L) \\
&= U_f^*(L, L) \\
V_m(H; \mu) &= 1 \times U_m^*(H, H) + 0 \times U_m^*(H, L) \\
&= U_m^*(H, H) \\
V_m(L; \mu) &= 0 \times U_m^*(H, L) + 1 \times U_m^*(L, L) \\
&= U_m^*(L, L)
\end{aligned}
$$

This implies

$$
\begin{aligned}
\theta_f^* &= V_f(H; \mu) - V_f(L; \mu) \\
&= U_f^*(H, H) - U_f^*(L, L) \\
\theta_m^* &= V_m(H; \mu) - V_m(L; \mu) \\
&= U_m^*(H, H) - U_m^*(L, L)
\end{aligned}
$$

Since $U_f^*(H, H) = U_m^*(H, H)$ and $U_f^*(L, L) = U_m^*(L, L)$, $\theta_f^* = \theta_m^*$. Substituting the values of utilities, we get,

$$\theta_f^* = \theta_m^* = \frac{1}{27} \cdot (2 - \gamma + \sqrt{4 + \gamma^2})(w - 1).$$

This is well-defined, that is, $1 \le \theta_f^* = \theta_m^* \le 1$ if $w < \frac{29}{2}$ and $\gamma > \frac{27(-4w+31)}{2(w-1)(2w-29)}$. Lastly, the optimal levels of consumption and time allocations are given by the solution to the household optimization problem (Eq. 4.1 to Eq. 4.5).

In Regions II and III, we claim the following two equilibria:

(i) Type II equilibrium: In this case, the cut-offs for men and women are $\theta_m^* = 1$ and $\theta_f^* = U_f^*(H,H) - U_f^*(H,L)$, respectively. The marriage market has two equilibrium households, (H,H) and (H,L). To verify this, consider the H-type man. He doesn't have an incentive to deviate and be single as $U_m^*(H,L) > U_m^*(H,0)$. Similarly, the L-type woman has no incentive to deviate as she prefers an H-type man over remaining single. The H-type woman prefers an H-type man in Region II but prefers an L-type man in Region III. However, in either case, she is not better off deviating as she prefers to marry than remain single. If these are the households in the marriage market, then,

$$
\begin{aligned}
V_f(H;\mu) &= 1 \times U_f^*(H,H) + 0 \times U_f^*(L,H) \\
&= U_f^*(H,H) \\
V_f(L;\mu) &= 1 \times U_f^*(H,L) + 0 \times U_f^*(L,L) \\
&= U_f^*(H,L) \\
V_m(H;\mu) &= \theta_f^* \times U_m^*(H,H) + (1-\theta_f^*) \times U_m^*(H,L) \\
V_m(L;\mu) &= \max\{0 \times U_m^*(L,L) + 0 \times U_m^*(L,H), U_m^*(L,0)\} \\
&= U_m^*(L,0)
\end{aligned}
$$

This implies

$$
\begin{aligned}
\theta_f^* &= V_f(H;\mu) - V_f(L;\mu) \\
&= U_f^*(H,H) - U_f^*(H,L) \\
\theta_m^* &= V_m(H;\mu) - V_m(L;\mu) \\
&= \theta_f^* \times U_m^*(H,H) + (1-\theta_f^*) \times U_m^*(H,L) - \frac{1}{27}
\end{aligned}
$$

This is stable if the expected utility of a man with the highest cost, $\theta_m = 1$, is greater if he chooses H level of education than if he chooses L, i.e., $V_m(H;\mu) - 1 > V_m(L;\mu)$. Thus, the solution exists when the following inequality is satisfied in Regions II and III,

$$
\left(U_f^*(H,H) - U_f^*(H,L)\right) U_m^*(H,H) + \left(1 - U_f^*(H,H) + U_f^*(H,L)\right) U_m^*(H,L) - \frac{1}{27} \geq 1
$$

(ii) Type III equilibrium: In this case, the cut-offs for men and women are $\theta_m^* = 1$ and $\theta_f^* = 0$, respectively. The marriage market has only one equilibrium household, (H,L). To verify this, consider the H-type man. He doesn't have an incentive to deviate and be single as $U_m^*(H,L) > U_m^*(H,0)$. Similarly, the L-type woman has no incentive to deviate as she prefers an H-type man over remaining single. If this is the household in the marriage

market, then,

$$V_f(H;\mu) = \max\{0 \times U_f^*(H,H) + 0 \times U_f^*(H,L), U_f^*(0,H)\}$$
$$= U_f^*(0,H)$$
$$V_f(L;\mu) = 1 \times U_f^*(H,L) + 0 \times U_f^*(L,L)$$
$$= U_f^*(H,L)$$
$$V_m(H;\mu) = 0 \times U_m^*(H,H) + 1 \times U_m^*(H,L)$$
$$= U_m^*(H,L)$$
$$V_m(L;\mu) = \max\{0 \times U_m^*(L,L) + 0 \times U_m^*(L,H), U_m^*(L,0)\}$$
$$= U_m^*(L,0)$$

This implies

$$\theta_f^* = V_f(H;\mu) - V_f(L;\mu)$$
$$= \frac{w}{27} - U_f^*(H,L)$$
$$\theta_m^* = V_m(H;\mu) - V_m(L;\mu)$$
$$= U_m^*(H,L) - \frac{1}{27}$$

This is stable if the expected utility of a man with the highest cost, $\theta_m = 1$, is greater if he chooses H level of education than if he chooses L, i.e., $V_m(H;\mu) - 1 > V_m(L;\mu)$. Similarly, for women $V_f(H;\mu) - 0 < V_f(L;\mu)$. Thus, in Regions II and III, the solution exists when $\frac{w}{27} < U_f^*(H,L)$ and the following is satisfied,

$$(a)\ \gamma < \frac{-112w(1 + 4w - 106w^2 + 4w^3 + w^4)}{(1+w)^3(1 - 109w + 3w^2 + w^3)} \text{ and } w < 9.04 \text{ or, } (b)\ w \geq 9.04.$$

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