What Determines Women's Labor Supply? The Role of Home Productivity and Social Norms

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Abstract

We highlight the role of home productivity in explaining the gender gap in labor force participation (LFP), and the non-monotonic relationship of women's LFP with their education in developing countries (India) in contrast to the developed economies (United Kingdom, U.K.). We construct a model of couples' time allocation decisions allowing for both market and home productivity to improve with own education. Our theoretical predictions match the data for India at low levels of women's education but over-predict labor supply at higher levels, unlike the U.K.. Incorporating constraints imposed by social norms regarding the gendered division of labor shows that norms can act as a binding constraint, producing much smaller increases in women's labor supply to market work at higher education levels in transition economies. Our analysis suggests that home productivity, along with social norms regarding couples' time allocation, can be critical determinants of women's labor supply in developing countries.

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Keywords: education, home production, social norms, women's labor supply, India

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1 Introduction

There has been a dramatic increase in women's labor supply in the U.S. and several developed countries since the beginning of the 20th century (Goldin (2006)). During this period, women's labor force participation rate (LFPR) increased by almost 70 percentage points, narrowing the gender gap in LFP, as women benefited from rising education accompanied by more favorable gender wage ratio, technological innovations which allowed them control over the timing of child-birth and reduced time in home production activities (Goldin and Katz (2000), Greenwood et al. (2005b)). In contrast to the western experience, similar socio-economic transitions have not necessarily resulted in lowering the gap between female and male LFPR significantly in developing countries.[1] Furthermore, the low levels of women's LFP are often accompanied by a non-monotonic relationship between their workforce participation and education, unlike in the OECD (OECD (2012)).[2] In contrast, men's labor supply is typically high and unchanged across all education levels in both developed as well as in transition economies.

We highlight these features of women's labor force participation observed in several transition economies - the wide gender gap and the non-monotonic relationship between women's workforce participation and education - by theoretically modelling a married couple's time allocation decisions. We incorporate not just home production, as in standard models of household decision-making, but also allow for home productivity to improve with education in a collective decision making framework following Chiappori (1988). Thus, agents derive utility from consumption, leisure, and a home good which is enjoyed jointly by the two-member household. Individuals may differ in terms of their education level, which we assume is exogenously determined before agents form the household.

A crucial feature of our model, therefore, is that the education level of the agents not only determines market productivity or the wages that they earn, but also their productivity at home. Hence, there are two possible channels through which couples' labor supply decisions could be affected in our model - market productivity and home productivity as education changes.[3] With an increase in the education level of women, the gender wage ratio may

[1] In India, for instance, women's LFPR is not only shockingly low (approximately 25%) but has also been stagnant for decades despite rising education, falling fertility and a prolonged period of high economic growth. Consequently, the gender gap in workforce participation remains wide. Cross country plots in the Data Appendix show other middle income or transition economies, besides India, as outliers with lower levels of female employment than expected at their levels of female education, fertility and per capita income.

[2] Cameron et al. (2001) show that the relationship between women's labor force participation and their education varies across developing countries - monotonically increasing (Thailand, Indonesia), flat (Korea) or non-monotonic (Sri Lanka and the Philippines).

[3] In our paper individuals' bargaining power within the household also varies with the (relative) level of education. A relative change in the bargaining power, of course, changes couple's time allocations; an

also move in their favor. But while a favorable relative wage encourages women's LFP, the accompanying rise in home productivity due to women's higher education also demands greater participation in the production of the home good. The net effect on the labor supply of women to market work is then determined by the relative strength of these two opposing forces.

We calibrate this model with time use data from urban India (a transition economy) and the United Kingdom (a developed economy) and simulate it to match the observed data on married women's and men's time on market work, home production and leisure. We show that in our base model with home production, and improvements in both market and home productivity with education, we are able to replicate both the observed non-monotonicity or U-shaped LFPR of women - fall in women's labor supply to market work at low and moderate levels of education and rise at higher levels of education - in urban India, and the monotonic increase in women's labor supply with their education in the U.K. Our theoretical predictions, therefore, match the observed data on market work and home production in both economies better than a standard model with constant home productivity, significantly so for India. However, for the more educated married women the model somewhat over predicts their time in the labor market relative to the observed data in the case of India. For men, on the other hand, the base model predicts behavior well for both economies.

To explain the mis-match at women's higher education level in India, we modify our base model to incorporate the social norm that married women spend a significant amount of time on home production while their husbands spend negligible time on household chores - a well-accepted and data validated norm in India and other developing countries.[4] With the social norm constraint, our model approximates more closely the subdued response of women's labor supply at higher level of education to more favorable gender wage ratio, while also approximating the low labor supply at lower education levels in India. Our results, therefore, underline the relevance of home productivity and the norms around the gendered division of labor in explaining women's market work in transition economies relative to developed countries.

Our analysis suggests that home production and the gendered division of labor may act as a binding constraint at higher levels of women's education, producing much smaller increases in wives' market work in transition economies relative to the high income countries.

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increase in women's bargaining power may reduce their labor supply to the market since agents value leisure more. Our analysis, while allowing for relative bargaining power to impact agents' LFP, underscores the role of home productivity in couple's time allocation decisions.

[4]Globally, women spend triple the time on unpaid care work than men, ranging from 1.5-2.2 in North America and Europe to 6-6.8 times longer in Middle East-North Africa and South Asia (http://www.oecd.org/dev/development-gender/MEASURING-WOMENS-ECONOMIC-EMPOWERMENT-Gender-Policy-Paper-No-16.pdf)

While the gender wage ratio plays an important role in determining both married men and women's labor supply across the distribution of education, it alone is unable to match women's labor supply at high levels of education in developing countries.[5] Besides several sensitivity checks through varying parameter values, we also test for alternative mechanisms such as non-availability of modern technology or of markets goods for home production and wealth effects to explain the observed patterns in women's LFP in transition economies. These mechanisms fail to explain the observed regularities in the data.

Existing theoretical models that incorporate home production focus on the experience of developed countries and suggest that a rise in women's wages (Attanasio et al. (2008), Siegel (2017)) and education or human capital (Olivetti (2006), (Gobbi (2018)), relative to men's, should be accompanied by higher time in the labor market, with ambiguous effects on their home production and leisure time.[6] In contrast to this literature, which includes home production either broadly or as child care, we develop a model that allows for education to affect productivity at home of both husbands and wives. Our model, where households jointly derive utility from home good, is backed by micro evidence from developing countries that education makes women (and possibly men) more productive in the home. For instance, Behrman et al. (1999) find that because households with an educated male member earned larger farm profits during the green revolution period in India (1968-1982), the returns to investing in male education increased. This, in turn, increased the demand for educated women in the marriage market and women with primary education spent more time at home, relative to less educated mothers. Lam and Duryea (1999) show that as Brazilian women

[5]Historically, women have disproportionately allocated greater time to home production than market production. Albanesi and Olivetti (2009) show that gender differences in wages can arise in equilibrium because employers believe that women have more home hours than men and therefore reduce women's wages. Gronau (1977) develops a model where decision making on allocation of time by individuals is split into work at home, work in the market and leisure to explain how the increase in wife's education in the U.S. led to an increase in market wages which correlates with rise in time spent in the market and a reduction in time spent both at home and on leisure. The role played by time spent on child rearing is supported by Kleven et al. (2018) who have used Danish administrative data to show that arrival of children can create about 20% difference in the long-run labor market outcomes between the genders. Guryan et al. (2008) using US data find that parent's time spent on children increases with both education and income. The effect of wages and education are the opposite on other home production activities.

[6]Attanasio et al. (2008) find that participation in the labor market during child-bearing years was lower compared to other years of women's lives in cohorts born in 1930s and 1940s, relative to the women born in the 1950s due to reduction in the cost of child care, along with narrowing of the gender-wage gap. More recently, Siegel (2017) builds a model linking fertility choices, home production and labor supply to show that rising relative wages of women compared to men lead to higher women's LFPR and a lower fertility rate due to a higher opportunity cost of having children in the U.S.Olivetti (2006) also argues that while earlier cohorts tended to specialize in child rearing and home production at the expense of engaging in market work at child bearing age, now women in the U.S. do not reduce the hours they work in the market during this period of their lives due to higher relative returns to experience. Recent time use data for developed economies indicates that an increase in married men and women's education is accompanied by an increase in their time on home production but at the cost of leisure, not work hours (Gobbi (2018)).

get more schooling, total fertility falls and wages rise, but the share of women working does not increase. They conjecture that home productivity effects may be large enough to offset increases in market wages up to the first eight years of education.

A relatively small but increasingly relevant literature suggests there can be social factors and norms that affect decision-making of agents in an economy and thereby impact economic development (Bernhardt et al. (2018), Chakraborty et al. (2015)). Goldin (1994), in her seminal work indicates that social and cultural factors can play a large role in married women's labor supply decisions. A model linking culture and women's labor force participation by Fernández (2013) looks at the link between cultural change and the evolution of women's labor force participation in the United States. Her theoretical model shows that increases in women's wages affect not only the returns from working but also the intergenerational beliefs about married women's returns from work thereby inducing a change in cultural attitudes towards women's work.

Contextually, social constraints are likely to be even more relevant in a developing country context. Repeated cross-sections of nationally representative survey data for India (1999-2011) show that across all education categories more than 90 percent of married, urban women report that they are 'required' to spend time on domestic work. Wives spend over 50 hours per week, on average, on household work while husbands spend no more than 5 hours per week. We, therefore, extend our analysis by incorporating both home production and social norms into couples' time allocations. We claim that the presence of social norms related to the division of labor within the household results in the muted response of women's workforce participation to higher education and wages. Thus, even when the gender wage ratio moves in favor of women at higher education levels, the norm of women contributing a certain number of hours to home production can weaken wives' labor supply to market work.

To the best of our knowledge, we are the first to develop a framework for understanding the determinants of women's labor supply in a transition economy at the aggregate level and contrast it with a high income country. Second, our findings highlight the crucial role of home productivity and norms in agents' decision-making, which may be even more relevant for developing countries. Finally, our analysis is able to show that there are varying factors that explain the level and variation in married women's labor supply with their education, while highlighting the role of home productivity and social norms. The findings lend support to recent experimental evidence from India (Dhar et al. (2018)) which suggest that educating young children on gender equality to address gender stereotypes can significantly increase boys' contribution to household chores. Thus, although social norms tend to be sticky, policy measures that address gender biases at a young age and target men, can be effective in reducing women's time on home production. This, in turn, could increase women's labor supply to the market.

The remainder of the paper is organized as follows. In Section 2 we present some of the key facts regarding women's labor supply in India and the U.K. and describe the data. The theoretical model, based on collective decision making, is formulated in Section 3. In Section 4 we calibrate and simulate our theoretical models. Section 5 discusses the contribution of three channels - gender wage ratio, home productivity and social norms - in explaining married men and women's labor supply across the entire education distribution. Sensitivity checks on the simulations and a discussion of other possible mechanisms that can explain changes in women's LFP with education are included in Section 6. We conclude in Section 7.

2 Background and Data

In this section we first present the stylized facts on married women's and men's labor supply in urban India, a country that typifies concerns related to women's labor market participation in economies transitioning from low to high economic growth. We use multiple rounds of the National Sample Survey (NSS) of India, which are conducted to capture employment every few years.[7] We restrict our attention to urban, married women and men in the economically productive age group of 20-45 years throughout. Note, however, that the facts we highlight here are equally applicable to a wider demographic group of men and women in India.[8]

Educational attainment has been increasing in India. In 1999, more than 30% women were illiterate, while the majority of men had at least secondary or higher secondary education. Between 1999 and 2011, while educational attainment has improved for both men and women, the improvement has been more dramatic for women. The proportion of illiterate men and women (married and in age group 20-45) in urban India have fallen by 6% and 12%, respectively, during 1999-2011. On the other hand, during the same time period, those completing secondary schooling or more have increased by 8 percentage points for men compared to 13 percentage points for women. Hence, the gender gap in higher educational

[7] The NSS surveys between 1983-2011 are the only consistent source of nationally representative data on employment at the individual and household level in India. We restrict our sample to urban context for two reasons: (1) greater comparability with developed countries and (2) unavailability of wage data for almost 70% of the rural workforce, i.e. the self-employed primarily engaged in agriculture (Klasen and Pieters (2015)). However, women's LFPR in rural areas also exhibits a U-shaped relationship with own education (Afridi et al. (2018)).

[8] Marriage is almost universal in India. According to the National Sample Survey (NSS) on Employment and unemployment for the year 1999, 98% urban women above the age 30 are ever married. A more recent National Family Health Survey (2015-16) also confirms that 98% of urban women above the age 30 are ever married and the median age at first marriage is low at 19.8 years in urban India.

attainment has narrowed significantly from 12% to 7%.

But while the gender gap in educational attainment has declined, there is almost no change in the labor force participation rates of women in urban India (Klasen and Pieters (2015)). Married women in the 20-45 age group have shown very low levels of LFPR, at around 22%, unchanging across the last three decades. The LFPR declines marginally as education increases from illiterate to higher secondary and then increases slightly at graduate and above (Figure 1). Overall, the LFPR of women is a U-shape, with a mild curvature, across education groups - a relationship that remains unchanged since the earliest data available in 1983.[9] Almost all married men on the other hand, are engaged in the labor market during the same period, irrespective of their education level (Figure 1).

The above stylized fact may partly be explained by gender gaps in market returns to education or market productivity (wages). However, as Figure 2 shows, the average real wages increase dramatically at higher levels of education for both married men and women. Moreover, the gender wage gap declines significantly at the higher secondary and graduate level of education. Thus, the non-responsiveness of more educated married women to the increase in their wages is puzzling. This non-responsiveness of married women becomes especially stark when we compare them to single women in the same age group (Figure 3 and Figure 4). Single women are a select group - younger (average age 24.5 years) and without children, but living with parents in households of size (5.2) comparable to married women, who in all likelihood will marry eventually when they are older. However, since they face the same labor demand conditions as married women, the contrast between the two groups highlights the potential role of household level factors in determining women's labor supply. Data show that single women not only have a higher level of LFPR than married women, but a larger proportion of these women work as their education levels and corresponding wages rise. On the other hand, married and single men do not behave very differently in terms of their LFPR across education groups.

These observations hold across each cross-section, resulting in more or less stable, low levels of labor supply by women and almost no responsiveness to the improvement in the gender wage ratio in the cross-section and between 1999-2011. This is in sharp contrast to the western experience, elucidated by Goldin (2006). To summarise, the following facts appear to be salient over the last few decades in urban India:

[9] Comparable surveys beyond 2011 have not been conducted in India. The NSS Organization has recently released the first Periodic Labor Force Survey (PLFS) 2017 (after the 2011 survey), while discontinuing the previous NSS. The PLFS, however, is not strictly comparable to the NSS or TUS due to a different sampling methodology. In the PLFS 2017 data too the LFPR of married urban women of age 20-45 is low at 22% and exhibits a similar U-shape pattern with education. It falls from 26% for illiterate or women having less than primary education to 14.5% for those having higher secondary education and increases to 30.6% for women who have graduate and above education.

Fact 1: As women's education level increases in urban areas, the proportion of married women of age 20-45 working in the labor market decreases and then increases marginally. The overall labor force participation of women has been stagnant at 25%.

Fact 2: As men's education level increases in urban areas, the proportion of married men of the same age group who are working in the labor market stays very high (above 95%) and flat.

Fact 3: Real mean wages rise both for women and men with their education. But across the education categories, the largest increase is for graduate and above category of education, and more so for women.

Given the fact that men and women's labor force attachment, both overall and by education, are relatively unchanged across the decades between 1999 and 2011 and that detailed time use data are available only for 1998, we henceforth focus on the urban sample of the nationally representative Time Use Survey (TUS) in 1998 for the same demographic group mentioned above.[10] The TUS data allow us to investigate the relationship between education and allocation of time to market work, home production and leisure. A reference period of the previous week was used for collecting the data. A weighted average of time spent on normal, weekend and irregular days was taken to arrive at average time spent (in minutes) on each activity in the reference week. We combine activities into time spent on the labor market, domestic work and leisure following Aguiar and Hurst (2007). See the Data Appendix A for details.

Not surprisingly, Figure 5 shows that average weekly hours of work correlate with changes in education as they do at the extensive margin above. More pertinently, we see that the time spent on domestic work is almost the converse of time spent at work for both married men and women (Figure 5), highlighted previously in Afridi et al. (2018). Married women spend, on an average, 1.33 hours per day in the market and 7.44 hours per day on domestic work (amounting to approximately 10% time being spent on market work by married urban women out of total time spent on all the three activities). On the other hand, married men spend almost no time on domestic work (0.6 hours a day) as opposed to 8.36 hours in the labor market. Unconditional on work force participation status, women's time spent on market work decreases monotonically until higher secondary education and then rises marginally for the highest education level - graduate or above. Men spend almost four times

[10]The TUS survey was conducted by the same nodal agency as the NSS surveys.

more hours in a day on market work.[11] These pictures reverse when we look at the time spent on home production − increasing monotonically, albeit insignificantly, until highest education level for women and almost flat for men.[12]

In contrast to the Indian context, labor supply of women increases with their education in the developed countries, for instance the U.K., which we consider for our study. Corresponding U.K. data for 2000 show that as own education rises the proportion of married women of age 20-45 engaged in the labor market also increases from 49% to 72% (on the extensive margin) while the proportion of married men in this age group in the labor market is around 80% and flat. Real mean wages rise both for women and men with their education. But while the increase is constant for the women, it rises steeply for men with degree and higher level of education. Using the U.K. time use data we then calculate proportion of time spent on labor market activities (Appendix A discusses the activity classification which is kept the same for India and the U.K.).[13] Here, we find that women with less than secondary education spend 16% of their time in a day on market work while women with a degree education spend 27% of their time on market work. Men's labor supply is greater than women's and more or less constant across education categories leading to a monotonic decline in the gender gap in market work as women's education increases.

From the following section onwards, the paper focuses entirely on the intensive margin of individuals' time allocation for both India and the U.K..

2.1 Data

For the calibration exercise for India, we use two nationally representative datasets - (1) Time Use Survey (TUS) of 1998 discussed above and (2) the National Sample Survey (NSS) 1999. Since the TUS does not contain data on wages, the wage returns to education are estimated using the latter survey.

For the TUS data, and in keeping with our previous discussion, the sample is restricted to individuals who are currently married and living in urban areas. We focus on women in the age group of 20-45 years and their husbands in the corresponding age group of 20-60

[11] We do not find any variation in the labor supply of both men and women by income quintiles within each education group.

[12] It is worth noting that women's time spent on exclusive child care (viz. child bathing, feeding, teaching) is, on average, less than 10 hours out of the 50 hours per week that women typically spend on domestic work (Afridi et al. (2018)).

[13] The U.K. TUS is best suited for our purposes since it contains information on couples, unlike the American Time Use Surveys (ATUS), for instance, which collect data for only one member of the family. The U.K. time use data does not classify areas on the basis of urban or rural, but since around 80% of population in U.K. lives in urban areas, the sample is comparable to that of urban India. The U.K. TUS records data for two days - a weekday and a weekend - which is then aggregated for the week assuming 5 weekdays and 2 weekends and corresponding proportions for each activity in the week are calculated.

years.[14] We generate a dataset where each observation gives the time spent at work (n_f and n_m), on home production (h_f and h_m), on leisure (l_f and l_m) and education levels (i and j) for each married couple along with their weights in the population.[15] Since educational attainment is not reported in years, we use six different education levels - Illiterate, Less than Primary, Primary, Middle, Higher Secondary, Graduate and above. Corresponding to the sample used in the TUS dataset we restrict the NSS data as well and estimate the median wage for men (w_m) and women (w_f) corresponding to each education category separately. Our final dataset comprises of 3725 couples.

Corresponding to the 1998 TUS data for India, we use the 2000 U.K. time use survey data for the same demographic group - currently married/cohabiting women in the age group 20-45 whose husbands are 20-60 years old - to calibrate the parameter values.[16] Using information on the number of hours worked in a week and last month's wage in the U.K. TUS, we obtain daily wages assuming an eight hour work day from the same data set.[17] The education categories are defined according to the categorization provided in the U.K. TUS data - less than secondary, O-levels (secondary), A-levels (senior secondary) and Degree (graduate and above).[18] The final dataset used for calibration consists of time use data for 1129 couples in the U.K.. See Appendix B for details of the U.K. data set used in the analysis.

3 Theory: Base model

We construct a variant of the collective decision-making model introduced by Chiappori (1988) where time allocation decisions are made at the household level. The model assumes that agents in the economy marry and form a household. Thus, a household consists of two agents, a wife (f) and a husband (m). Henceforth, the terms women/female and men/male will refer to the couple forming the household, i.e. the wife and the husband, respectively.

Individual agents derive utility from private consumption (c), leisure (l), and from a joint home good (H) which is produced and enjoyed by both the members in the household. The

[14] In the couples time use data, the age of husbands for women aged 20-45 is between 21 and 60 for India. The stylized facts discussed earlier for married men in the age group 20-45, continue to hold for married men aged 21-60 as well.

[15] We drop all the outliers in the data, for whom time spent in discretionary activities (sleeping and personal hygiene) is either too small or too large. Keeping only the time spent in market work, home production and leisure, we normalize the time spent across these three activities.

[16] Proportion of couples who cohabit is 21% in the U.K. data.

[17] Wages are reported for the previous month in intervals and we take the mid point of the intervals and the lowest bound of wage for the topmost interval. For those individuals, not working or reporting a wage, their daily wage is imputed using the corresponding average wage of a person in their gender-education cell.

[18] In the final couples data the proportion of men in the four education categories are - 27%, 27%, 26% and 20%. For women the corresponding proportions are - 25%, 31%, 26% and 18%.

total time available to both the agents is normalized to one, out of which they allocate time on market work (n), time on producing the home good (h), and leisure, ($l = 1 - n - h$). Agents in the household may also differ in terms of their education level e which is assumed to be finite. While solving the model the education level is assumed to be a continuous variable.[19] Education level of the woman in the household is denoted by i and that of the man by j. In our notation, subscript $g \in \{m, f\}$ is used to represent gender and superscript i or j for education level. The utility function of an individual is assumed to be additively separable in its arguments. In particular,

$$U_g^e = \log(c_g^e) + \phi_L \log(1 - n_g^e - h_g^e) + \phi_H \log(H_g),$$

with $g \in \{m, f\}$. Parameters ϕ_L and ϕ_H, both positive, represent the affinity towards leisure and home good, respectively.[20]

Once the agents are matched (married, in our setup) and form a household, they derive joint utility where the Pareto weights of the man and woman are given by $\theta^{i,j}$ and $1 - \theta^{i,j}$, respectively. Pareto weights have a natural interpretation in terms of the relative power of decision making within the household. These weights are assumed to change with the relative education of spouses. The Pareto weights are, therefore, determined by one's own education (e.g. Thomas (1994)) and the education of the spouse with whom the agent is matched. Further, we assume that after the matching and formation of household, agents derive utility from a common home good H, that is, $H_g = H, \forall g = f, m$. The model of collective decision making allows agents to optimally allocate their time to market work and home production along with leisure, given their relative advantages in market and home production.

An important assumption of this model is that agents' education e is exogenous to household decision-making because it is pre-determined before household formation.[21] We make the standard assumption that the prevailing market wage rate w is determined by the education level e where $w'(e) \geq 0$. Further, crucially, we assume that the level of education also

[19] We use e to denote education level in case of a general functional form applicable to both men and women. When writing the functions specifically for men and women, we use i and j to denote the education levels of women and men, respectively. In the calibrations and the simulation we use six discrete education levels (0 = Illiterate, 1 = Less than Primary, 2 = Primary, 3 = Middle, 4 = Higher Secondary, 5 = Graduate and above).

[20] Choice of log additively separable utility function is fairly standard and the by-product is that it provides us with clean analytical solutions.

[21] For instance, if parental investments determine agents' education then the assumption of home good production in our model partly reinforces exogenous investment in education that parents make for their kids. Home production can well incorporate investment made or time spent on children for human capital accumulation.

determines the productivity (a) of the agents in generating the home good H. Formally, the home good H is produced using a CES production function given by,

$$H = q^{\delta}[z_f(a_f^i h_f^{i,j})^{1-\rho} + z_m(a_m^j h_m^{i,j})^{1-\rho}]^{(1-\delta)/(1-\rho)},$$

where h_f and h_m are the time spent by the woman and the man of the household, respectively, on home production. The terms z_g , $g \in \{m, f\}$ represent the share factors in the production function with $\sum_g z_g = 1$. Further, $a_f^i h_f^{i,j}$ and $a_m^j h_m^{i,j}$, measures effective time of women and men in production of the home good H. The parameter $\rho > 0$ is the inverse of the elasticity of substitution between time spent by the man and woman in the production of the home good. The cost of the market input used in home production is denoted by q. With $\delta > 0$, the model allows for substitution between the agent's time and use of market good available for the production of H.[22]

Household optimization

As mentioned above, households solve a joint utility maximization problem by choosing $\{c_f^{i,j}$, $c_m^{i,j}$, $n_f^{i,j}$, $n_m^{i,j}$, $h_f^{i,j}$, $h_m^{i,j}$, $l_f^{i,j}$, $l_m^{i,j}$, $q\}$. Precisely, household's utility maximization problem is given as follows:

$$\max_{c_f^{i,j}, c_m^{i,j}, n_f^{i,j}, n_m^{i,j}, h_f^{i,j}, h_m^{i,j}, l_f^{i,j}, l_m^{i,j}, q} \quad \theta^{i,j} U_m^j + (1-\theta^{i,j}) U_f^i, \tag{1}$$

subject to,

$$c_f^{i,j} + c_m^{i,j} + q = w_f^i n_f^{i,j} + w_m^j n_m^{i,j} \quad \text{[income constraint]},$$

$$n_f^{i,j} + h_f^{i,j} + l_f^{i,j} = 1,\ n_m^{i,j} + h_m^{i,j} + l_m^{i,j} = 1 \quad \text{[time constraints]},$$

$$H = q^{\delta}[z_f(a_f^i h_f^{i,j})^{1-\rho} + z_m(a_m^j h_m^{i,j})^{1-\rho}]^{(1-\delta)/(1-\rho)} \quad \text{[technology constraint], and}$$

$$c_f^{i,j}, n_f^{i,j}, h_f^{i,j}, l_f^{i,j}, c_m^{i,j}, n_m^{i,j}, h_m^{i,j}, l_m^{i,j} \geq 0 \quad \text{[non-negativity constraints]}.$$

The first constraint is the income constraint of the household which ensures that the consumption of female and male agents and the expenditure towards market good for home production is equal to the total income of the household. Next, time availability constraint, which holds for both females and males, guarantees that the total time on the three different activities adds up to one. The third constraint is the technology constraint for the household good production. The last constraint is the usual non-negativity constraint that will hold for both the agents.

[22] Though the home produced good (H) and the market input (q) vary with the education of the couple $\{i,j\}$, for notational simplicity we represent them as H and q throughout the paper.

The optimization problem defined above guarantees unique interior solutions for the choice variables (see details in Appendix C). The solution to the above problem using the first order conditions is given below:

$$c_f^{i,j} = \frac{(1-\theta^{i,j})(w_m^j + w_f^i)}{1+\phi_L+\phi_H}; c_m^{i,j} = \frac{\theta^{i,j}(w_m^j + w_f^i)}{1+\phi_L+\phi_H},$$

$$n_f^{i,j} = 1 - \frac{(1-\theta^{i,j})(1+\frac{w_m^j}{w_f^i})}{(1+\frac{(1+\phi_H)}{\phi_L})} - \frac{(1-\delta)(1+\frac{w_m^j}{w_f^i})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_f^{i,j}+1)}, \text{where } \Psi_f^{i,j} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^i a_m^j}{w_m^j a_f^i})^{\frac{1-\rho}{\rho}}, \quad (2)$$

$$n_m^{i,j} = 1 - \frac{\theta^{i,j}(1+\frac{w_f^i}{w_m^j})}{(1+\frac{(1+\phi_H)}{\phi_L})} - \frac{(1-\delta)(1+\frac{w_f^i}{w_m^j})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_m^{i,j}+1)}, \text{where } \Psi_m^{i,j} = 1/\Psi_f^{i,j}, \quad (3)$$

$$h_f^{i,j} = \frac{(1-\delta)(1+\frac{w_m^j}{w_f^i})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_f^{i,j}+1)}, \quad (4)$$

$$h_m^{i,j} = \frac{(1-\delta)(1+\frac{w_f^i}{w_m^j})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_m^{i,j}+1)}, \quad (5)$$

$$l_f^{i,j} = \frac{(1-\theta^{i,j})(1+\frac{w_m^j}{w_f^i})}{(1+\frac{(1+\phi_H)}{\phi_L})}; l_m^{i,j} = \frac{\theta^{i,j}(1+\frac{w_f^i}{w_m^j})}{(1+\frac{(1+\phi_H)}{\phi_L})}, \text{and}$$

$$q = \frac{\delta\phi_H(w_m^j + w_f^i)}{1+\phi_L+\phi_H}.$$

The following two relationships are then obvious from above:

$$\frac{h_f^{i,j}}{h_m^{i,j}} = (\frac{w_m^j z_f (a_f^i)^{1-\rho}}{z_m w_f^i (a_m^j)^{1-\rho}})^{1/\rho}, \text{and} \quad (6)$$

$$\frac{l_m^{i,j}}{l_f^{i,j}} = \frac{\theta^{i,j} w_f^i}{(1-\theta^{i,j})w_m^j}. \quad (7)$$

3.1 Theoretical decomposition of effects

The following expression for the allocation of time to market work by a wife with education level i and husband's education level, j, is obtained in this model,

$$n_f^{i,j} = 1 - \frac{(1-\theta^{i,j})(1+\frac{w_m^j}{w_f^i})}{(1+\frac{(1+\phi_H)}{\phi_L})} - \frac{(1-\delta)(1+\frac{w_m^j}{w_f^i})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_f^{i,j}+1)},$$

where $\Psi_f^{i,j} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^i a_m^j}{w_m^j a_f^i})^{\frac{1-\rho}{\rho}}$.

Note that Ψ_f falls with the relative home productivity ratio a_f/a_m but increases with the wage ratio w_f/w_m. Given that, the following three observations are clear from the above expression of $n_f^{i,j}$. First, $n_f^{i,j}$ increases with the level of w_f/w_m, that is, a favorable relative wage towards women encourages FLFP. Second, $n_f^{i,j}$ decreases with the Pareto weight $(1-\theta^{i,j})$ which implies that the higher the bargaining power of women in household decision making, the lower is the supply of market work by them (at the same time, they enjoy more consumption and leisure). Third, $n_f^{i,j}$ decreases with the level of home productivity ratio a_f/a_m, that is, as the home productivity of women relative to men increases, the supply of market work by women falls.

To understand how the labor supply of a wife at an education level $i+1$, matched with a husband of education level k, is different from that chosen by a wife with a lower education level i, matched with a husband of education level j (where $j \neq k$), we can take the difference between $n_f^{i+1,k} - n_f^{i,j}$ which can be written as,

$$n_f^{i+1,k} - n_f^{i,j} = \Lambda\big[\underbrace{(1-\theta^{i,j}) - (1-\theta^{i+1,k})}_{a} + \underbrace{(1-\theta^{i,j})\frac{w_m^j}{w_f^i} - (1-\theta^{i+1,k})\frac{w_m^k}{w_f^{i+1}}}_{b}\big]$$
$$+ (1-\delta)\Lambda\big[\underbrace{\frac{1+\frac{w_m^j}{w_f^i}}{1+\Psi_f^{i,j}} - \frac{1+\frac{w_m^k}{w_f^{i+1}}}{1+\Psi_f^{i+1,k}}}_{c}\big] \quad (8)$$

where $\Psi_f^{i,j} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^i a_m^j}{w_m^j a_f^i})^{\frac{1-\rho}{\rho}}$, $\Psi_f^{i+1,k} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^{i+1} a_m^k}{w_m^k a_f^{i+1}})^{\frac{1-\rho}{\rho}}$ and $\Lambda = (1+\frac{1+\phi_H}{\phi_L})^{-1} > 0$.

It can be seen from Equation 8, that the difference in the allocation of time to market work by a wife as her education level increases can be explained using the three components shown in the under-brackets. The first component (a) is clearly the effect of a change in Pareto weights when the wife's education increases (now matched to a husband having a different education level). The second component (b) reflects a combined effect of the Pareto weights and relative female wage. The third component (c) reflects the combined effect of relative female wage and relative female home productivity. All the three factors, namely

Pareto weights, relative female wage and relative female home productivity vary with the education level. The next paragraph sheds some light on the magnitude as well as the sign of the expression $n_f^{i+1,k} - n_f^{i,j}$.

The effect of a change in Pareto weights through (a) on the marginal labor supply is straight forward: higher Pareto weights for women imply less time allocated by them in market work. To understand term (b) better, let us first assume that Pareto weights are invariant to education and equal $1-\theta$. Then (b) can be written as $(1-\theta)(\frac{w_m^j}{w_f^i} - \frac{w_m^k}{w_f^{i+1}})$ which says that an overall increase in Pareto weights towards the woman may help raise her labor supply if the relative wage in the higher education category is higher than the relative wage in the previous education group, that is if $w_m^k/w_f^{i+1} < w_m^j/w_f^i$. Thus, women's labor supply to market work will depend positively on a favorable movement of the gender wage ratio towards them. This inequality may not hold if $(1-\theta)$ varies with education since $w_m^k/w_f^{i+1} < w_m^j/w_f^i$ does not necessarily imply $(1-\theta^{i+1,k})w_m^k/w_f^{i+1} < (1-\theta^{i,j})w_m^j/w_f^i$. To understand the term (c), we first assume that the home productivity ratios are constant, that is, $a_m/a_f = a_m^j/a_f^i = a_m^k/a_f^{i+1}$. Given that, a favorable wage movement, which means an improvement in the relative female wage in a higher education category, guarantees an increase in her labor supply. However, in our model home productivity varies with education. Hence as the gender ratio of home productivity improves in favor of the wife with her education level, the wife's labor supply may fall due to (c).

Briefly, when all three factors - the Pareto weights, the gender wage ratio, and the gender home productivity ratio - are allowed to vary then the final effect of a change in education on labor supply depends on the direction and relative magnitudes of the movements in (a), (b) and (c). While the previous literature has focused on the role of gender wage ratio and Pareto weights, our model shows that varying home productivity with the level of one's education is important for this analysis. In fact, later we compare the results from our general model with one where home productivity is constant throughout, the somewhat standard model for theorizing labor supply decision making by married couples. The above discussion clearly shows that the base model is capable of generating both a rise and a fall in market labor supply (U-shape) of married women as their education increases. For instance, for women with higher levels of education who may have a favorable gender wage ratio, this model can generate little increase (or in fact a fall) in market work if the rise in the home productivity ratio is much larger than the rise in wage ratio at those education levels.

We now turn to calibrating and simulating our model on agents' time allocation to market work, home production and leisure using the data sets mentioned above.

4 Calibration and Simulation Results

4.1 Base Model

The Pareto weights for each of the 36 combinations of spousal education are calibrated using the ratio of the first order conditions.[23] The parameters of the home production function - home productivity (a_f^i, a_m^j) and share of female and male labor input into home production (z_f, z_m) - and the preference parameters (ϕ_L and ϕ_H) are estimated using the closed form solutions obtained in the model. The observed values of each couple's time spent in the market and in home production are fitted to the theoretically derived expressions in Equations 2, 3, 4 and 5. Non-linear least squares method is used to minimize the distance between the actual values and the predicted values for time spent in labor market and home production.[24] This method gives the estimates for the 12 home productivity parameters (six each for men and women corresponding to each of the six education categories) and the three parameters - z_m, ϕ_L and ϕ_H - which do not change across education categories. We are able to get a set of unique solutions for all the calibrated parameters using non-linear least squares.

The calibrated parameters for India are shown in Table 1. For simplicity, the 36 calibrated Pareto weights (for each possible i, j education combination of wife and husband) are averaged for each education group of women in the table. The average household Pareto weight on wife's utility does not change significantly across lower education categories (on average it is 0.27 for Illiterate - Middle education women). It increases drastically when

[23] We have no a priori reason to assume that men and women have the same bargaining power within the household ($\theta = 0.5$), and across education categories, we estimate this parameter using the available data. Utilizing equation (7) from the model which relates the leisure ratio of men and women to $\theta^{i,j}$ and their wages, we have:

$$\frac{l_m^{i,j}}{l_f^{i,j}} = \frac{\theta^{i,j} w_f^i}{(1-\theta^{i,j}) w_m^j}.$$

From the TUS couples data, we substitute for average values of time spent on leisure by a woman and a man, and for median wages received by a woman and a man, for each combination of education categories of spouses. This gives us 36 values of θ's for each possible combination of spouses with different education levels. The average value of $\theta \approx 0.66$ across education categories. Thus, a man, on average, has greater bargaining power within a household.

[24] There are two ways to implement this. One, by taking each couple and fitting the relationship using non-linear least squares. In this case our data has several zero values for market time since many women do not participate in the labor market in India. Second, by using the average time spent spent in the labor market and on domestic work for each i, j combination of education of wife and husband and then fitting the relationship using non-linear least squares for these 36 education combinations. This method overcomes the lack of interior solutions in the first method, since on an average there is non-zero time allocated by women in each education combination. Both methods give similar predicted paths for time allocations by an average woman across education groups in our data. We use the first method to calibrate parameters and simulate our model.

women have more than higher secondary education (approximately 0.45). The change in bargaining power with wife's education is, therefore, unlikely to explain the initial decline in female LFPR and may reduce women's LFPR only at higher secondary education or above. The estimated home productivity parameters show that home productivity increases with increase in education for both men and women, with the rate of increase being largest for women in the highest education categories. Moreover, the share parameters in the home production function show that men's time spent in home production is about 28% and that by women is 72%. This is in line with existing data that show women spend much more time on home production than men in India. We also find that the ratio of ϕ_H and ϕ_L is 1.1, indicating that households place a greater weight on home production than leisure. Two behavioral parameter values are borrowed from the literature for the U.S. - (1) the inverse of the elasticity of substitution, ρ is set at 0.4037 and (2) δ, which measures the relative share of market inputs to labor in home production is set at 0.29.[25] Later we conduct sensitivity analyses to show that using different values of ρ or δ don't change the results significantly.

Table 2 shows the calibrated values for the parameters using the U.K. TUS data. The Pareto weights attached to women's preferences are high and increase less dramatically with their education than in India, where the average level of education of women is quite low. The home productivity parameters increase with education for both men and women, but the rate of increase is lower than that for India. The share of men's and women's time in home production is almost equal in U.K. data (z_m close to 0.50), in sharp contrast to India. Also, the ratio of ϕ_H and ϕ_L is 0.94, which means that households in U.K. value home production less than leisure. As in Table 1, ρ is set at 0.4037 and δ to 0.29.

Overall, our calibration results approximate the two economies well and capture the contrasting household preferences in time allocation.

4.1.1 Base model: Simulation

Table 3, Panel A, shows the theoretical predictions in the movement of relative wages, relative home productivity and relative Pareto weights in the base model, on changes in women's labor supply. The calibrated parameters are then used to calculate these movements across education levels to see the extent of changes in these ratios across education levels (Panel B). Clearly, the estimated changes across education levels match those predicted by the theoretical model perfectly. Using the above calibrated parameters we now predict time spent in the labor market, home production and leisure for individuals in each education

[25] For example, Greenwood et al. (2005a) obtain a very low value of δ at 0.14 while Benhabib et al. (1991) obtain a very high value at 0.92, with the low value obtained when housing is included in home production and a high value obtained when housing is excluded.

group in India. In our simulation exercise below, throughout we focus on the role of home productivity relative to market productivity, while allowing for Pareto weights to vary with education.

Figure 6 plots the base model's predictions against the actual time allocations by women and men by education groups. The model is successful in generating a U-shaped female labor supply with respect to the education level - women's time allocation to market work falls from 11% for the illiterate to 7% for those with less than primary or primary levels of schooling and further to 4% at middle education level. It then rises to 17% and 21% for the two highest education levels, respectively. For men, the simulations mimic the relatively stable allocation of time to market work at over 60% across the education groups, though it somewhat under predicts market work at lower education levels. Overall the model does well for the other time allocation variables that we are focusing on in this analysis, including the large gender gap in time devoted to home good production.

However, we observe that the extent to which the model performs well for the lower and moderate education levels, it does not do so for women with higher education level. More specifically, it over predicts the female labor supply at higher secondary and graduate or above levels of education by 11 and 8 percentage points, respectively. Consequently it under predicts the time allocated to home production by women in these two high education groups. Thus, the simulations indicate that relative market and home productivity associated with highly educated women in India is unable to completely account for their low LFPR, even when we allow for higher bargaining power of these women. The calibrated parameters for U.K., in contrast, predict the market work and home production time very closely across the education distribution for both men and women as shown in Figure B.1 in Appendix B.[26]

Results from National Sample Surveys (NSS) of India suggest that women who primarily spend time doing domestic work do so because they are required to engage in it (Table 4).[27] More than 91% of women, across education categories, who report as not being engaged in market work and are involved mostly in domestic work, say that they are "required to spend

[26]Table 3 and Table B.1 show the changes in the three components of Equation 8 for India and U.K., respectively, with education. There are two notable differences between the two countries. First, the relative wage for women always increases with their education in the U.K. (column (1) of Table B.1), unlike in India (column (1) of Table 3). Second, the ratio of relative market productivity to relative home productivity for women at successive education levels is close to or more than 1 in U.K. (column (2) of Table B.1), but for India this is not the case. For example, in column (2) of Table 3, between illiterate and less than primary educated women this ratio is 0.87 while it is 0.14 between middle and secondary educated women. This suggests that in India women's market productivity may rise less in comparison to home productivity as their education increases.

[27]According to the World Values Survey (WVS) 1999 and 2012, the proportion of married women who agree that "Being a housewife is just as fulfilling as working for pay" is unchanged over time (at around 64%) and slightly increases with own education in India. Women's time spent on home production does not vary by fertility in the cross-section in India, either.

time on domestic duties" i.e. engage in it involuntarily − largely because they have no help with domestic work (only 7% say they cannot afford help while about 13% cite social and religious reasons for not working in the labor market). Among the women who voluntarily engaged in domestic work, only about 2% report lack of jobs as the main reason while a slightly higher proportion prefer domestic work (Table 4). Does this suggest that social norms regarding the division of labor within the household play a more significant role in transition economies, such as India, vis-a-vis a developed country like the U.K.?[28]

In the next section we attempt to verify whether social norms around gender-based division of household labor could potentially explain the low level of women's labor supply at the highest education levels in India.

4.2 Social norms constraint

We modify the base model to account for the social norm that home production activities are primarily women's responsibility in developing countries. To simplify, we assume that women and men spend fixed amounts of time in the production of the home good - zero by men. The modified home production function is now given as follows:

$$H = q^{\delta}(z_f(a_f^i h_0)^{1-\rho})^{(1-\delta)/(1-\rho)}.$$

Since men don't participate in home production, essentially we have $z_f = 1$ and $z_m = 0$, which means we can further simplify the home production function and write it as $H = q^{\delta}(a_f^i h_0)^{(1-\delta)}$ where h_0 is the fixed time that women spend on home production. Therefore, the only choice being made by the households is how much of the market input, q, is to be used to augment home production.[29]

This model requires calibration of the parameters - h_0, $\theta^{i,j}$, ϕ_L, and ϕ_H - since these are the only parameters that appear in the final expressions of the household choice variables.[30] For h_0 we use the average time spent in home production by women across education groups normalized by one. This is motivated by the observation that there is no significant difference

[28] Overall, gender norms in employment and house work are more pervasive in India than the U.K. For example, among all statements capturing gender beliefs, a comparable statement in the U.K. WVS 1995 and India WVS 1999 is "When jobs are scarce, men should have more right to a job than women". 46% and 19% married women (age 20-45) agree with this in India and U.K., respectively. For the most recent WVS in the two countries, this proportion is 47% in India (2012) while it is only 9% in the U.K. (2005). On the statement - "Being a housewife is just as fulfilling as working for pay" - among married women who are not working, 34% strongly agree (and 33% mildly agree) with this statement in India (2012) while none strongly agree (and 46% mildly agree) with it in the U.K. (2005).

[29] Our theoretical model is capable of generating, positive assortative mating on education, as observed in the data. It suggests that marriage market returns play a role in parental investments in girls' education. See Appendix D for details.

[30] The value of δ is taken exogenously to be 0.29 as in the base model.

in the hours spent on domestic work across women of different education groups up till higher secondary education (see Figure 5 where the confidence intervals have a large overlap). The average proportion of time spent by women in domestic work is 0.59 in the couples data. To calibrate $\theta^{i,j}$ we used the ratio of the first order conditions for leisure, as in the base model

$$\frac{l_f^i}{l_m^j} = \frac{(1-\theta^{i,j})(1-h_0+\frac{w_m^j}{w_f^i})}{\theta^{i,j}(1+(1-h_0)\frac{w_f^i}{w_m^j})}.$$

As before, we substitute for the median wages and average leisure for women and men in the above equation. This is done for all possible education level combinations of couples $\{i,j\}$ to get estimates for $\theta^{i,j}$. For the other parameters, we follow the same process as discussed for the base model.[31] We fit two equations, one each for the endogenous variables $n_f^{i,j}$ and $n_m^{i,j}$:

$$n_f^{i,j} = 1-h_0-\frac{(1-\theta^{i,j})(1-h_0+\frac{w_m^j}{w_f^i})}{1+(\frac{1+\phi_H\delta}{\phi_L})},$$

$$n_m^{i,j} = 1-\frac{\theta^{i,j}(1+(1-h_0)\frac{w_f^i}{w_m^j})}{1+(\frac{1+\phi_H\delta}{\phi_L})}.$$

4.2.1 Social norms constraint: Simulation

Figure 7 plots the predictions against the actual values for time spent in market work and leisure for women and men by education groups when social norm constraint is imposed for India. The simulated time allocated to market work by women at higher levels of education is now much closer to the actual levels than in the base model. While imposing the social norm constraint over predicts women's labor supply at higher secondary and graduate or above education levels by 5 and 4 percentage points, respectively, the gap between the simulated and actual levels is halved relative to the base model. The proportion of time allocated by men to market work is higher and thereby closer to the actual levels than in the base model. The model continues to predict well the time spent on market work by women at lower education levels. Overall, the simulation results suggest that social norms around the gendered division of labor are preventing women from increasing their labor supply in response to higher female wages observed at higher levels of education. This points to

[31] In this case ordinary least squares is used for estimation of parameters instead of non-linear least squares. We are not able to identify, ϕ_L, and ϕ_H using the above expression. However, we do not need the actual values of those parameters and we can use the value of the expression $\frac{1}{(1+\frac{(1+\phi_H\delta)}{\phi_L})}$ for the simulations.

rigidities in labor supply due to social constraints which prevent the optimal level of time allocation to market work by women.[32]

5 Discussion: Comparing across models

In previous sections we discussed two variants of our theoretical model - (1) the base model with both market and home productivity effects, and (2) base model with constraint imposed by the gendered division of labor. Using the TUS datasets for India and the U.K. we now calibrate and simulate a third model - the standard model in which only market productivity varies across education groups (i.e. home productivity is constant). Across all these three models we allow bargaining power to vary with education.[33]

Table 5 shows the allocation of time to work, home production and leisure, respectively, in the standard model, base model and the base model with the social norm constraint predicted at each education level, for India. In the top panel of Table 5, Panel A - column 1, varying market productivity and keeping home productivity constant predicts a U-shaped relationship between women's education and market work but it does not reproduce the fall in labor supply from illiterate to less than primary education levels. This model also predicts 19 to 23 percentage points higher time allocation to market work for the two most educated groups of women - those having higher secondary education and those who are graduate and above. Moreover, it under predicts time spent in home production by women at all education levels but by much more at the highest education levels - 24 to 32 percentage points - as

[32]A point to note here is that our theoretical model with the norm constraint is also capable of replicating the U-shape of the female labor supply with respect to education seen in the actual data. Using the same notations $n_f^{i,j}$ and $n_f^{i+1,k}$ used in the base model, the difference between labor supplied by women at two consecutive education levels i and $i+1$ can be written as:

$$n_f^{i+1,k} - n_f^{i,j} = \left[\frac{1}{1+\frac{1+\phi_H\delta}{\phi_L}}\right]\left[(1-h_0)\underbrace{[(1-\theta^{i,j})-(1-\theta^{i+1,k})]}_{d} + \underbrace{(1-\theta^{i,j})\frac{w_m^j}{w_f^i} - (1-\theta^{i+1,k})\frac{w_m^k}{w_f^{i+1}}}_{e}\right].$$

Here, the change in female labor supply with education, depends on the relative bargaining power as well as the wage ratio between men and women. The term d captures the fact that if the Pareto weight on the woman's utility increases as her education increases, she will supply less market labor and vice versa. The term e is similar to the term d but adjusted by the relative wage. An increase in Pareto weights with own education ensures that d is always negative. However, if w_m^k/w_f^{i+1} is very low compared to w_m^j/w_f^i due to a substantial (relative) increase in the wage level of women when their education level increases, e can be positive. Consequently, women may prefer supplying more market labor as their education increases if e is larger than d. Thus, the relative movements of the Pareto weights and the wage ratio across education levels can generate a U-shaped female labor supply with respect to education. Further, it is straightforward from the above expression that a higher h_0 reduces FLFP.

[33]In the model with constant home productivity a_f and a_m are held constant and the model is calibrated to simulate the paths for market work, time in home production and leisure.

shown in column 1 of the middle panel. The time allocated to leisure by women in the bottom panel of Table 5, in column 1, is consequently over predicted across the education distribution, again more so for the two highest education levels. For men, the constant home productivity model somewhat under predicts their labor supply and overpredicts leisure (Table 5, Panel B).

The base model, in contrast, performs much better than the model with constant home productivity as shown in column 2 of Table 5. First, it reproduces the fall in women's labor supply from illiterate to less than primary education levels and second, the gap between the predicted and actual labor supply for women with higher secondary and graduate or above education falls to 11 and 8 percentage points, respectively. The predicted time spent in home production by women increases and now matches closely with the actual time spent in domestic work. The match is almost perfect for lower education groups although we still under predict time spent in home production by women for the highest education group. Consequently, predicted time allocated to leisure is lower and closer to the data for women as shown in column 2, Panel A of Table 5.

Once the social norm constraint is incorporated in the base model, the gap in the labor supply to market work between the actual and simulated data is halved, relative to the base model, for women at highest education levels, as shown in column 3 of Table 5, Panel A. It also brings men's labor supply, across the education distribution, closer to the actual data (except for graduate and above where the model overshoots the actual level) in Panel B.

For U.K. we consider two models - (1) the standard, constant home productivity model and (2) our base model with both market and home productivity effects. The simulation results are presented for women and men in Panels A and B of Table 6, respectively. The model with constant home productivity (column 1) approximates well the labor supply paths for both men and women across education categories. However, the base model (column 2) improves on this, for both time spent in market work and time spent in home production with a larger improvement for the latter at lower education levels. The simulation results for U.K., therefore, suggest that changes in home productivity with education may matter for a developed country as well, though the extent of gap between these two models may be smaller than in a developing country.

Overall, a comparison of the theoretical simulations across models and between the two contexts indicates that besides market productivity, changes in home productivity of women and men as their education increases is a significant determinant of their time allocation decisions in both transition and high income economies. Home productivity effects are able to explain the low and stagnant level of women's labor supply for the lower education groups and to a large extent, though not fully, for women having more than secondary education in India. However, for highly educated women in transition economies, social norms play a role in explaining their low levels of time allocation to market work. Our conclusions hold up when we conduct our analysis with more recent data.

6 Robustness checks

6.1 Sensitivity analyses

We conduct sensitivity analyses of the predicted paths of labor supply, home production and leisure for the parameters which could not be calibrated and were taken from the existing literature on the U.S. - the inverse of the degree of substitutability between men and women (ρ) and the share of market inputs in home production (δ).[34] We conduct these sensitivity checks only for the Indian case since the U.K. economy quite likely resembles the U.S. closely.

Under the assumption that men and women are imperfect substitutes in home production (i.e. $0 < \rho \leq 1$), we calibrate the base model taking different values of $\rho \in [0.2, 0.6]$ around the benchmark value of 0.4037 in the literature.[35] The predicted paths do not change much for the base model because the share of men in home production is low. Similarly, we calibrate the base model with $\delta \in (0, 0.29)$. The benchmark value of δ taken from the U.S. data is 0.29 (an average across various studies). The calibrated value of δ for the U.S. depends on whether housing is included as a market good or not. In the Indian context since the share of market goods is likely to be smaller than that for a developed country, for sensitivity checks we take values less than 0.29. The predicted paths again do not change much. The results for these sensitivity checks are available on request.

6.2 Recent employment data

Since TUS data for India are not available beyond 1998 we conducted our analysis by approximating individuals' time allocations using the most recent, comparable employment data from the NSS 2011. The details of our assumptions for the approximation of time-allocation and the simulation results using the NSS 2011 are discussed in Appendix A. Specifically, Figure A.3.2 in Appendix A shows that the labor supply simulation results for the base model with the social norms constraint predicts well the labor supply of women across education categories in 2011, although it slightly under predicts it for women with higher secondary

[34] In the base model with the social norm constraint ρ does not play any role since it is eliminated from the home production technology. Also, separate identification of δ is not required for predicting the paths of labor supply and leisure in the social norm case as discussed earlier. We, therefore, need to check the sensitivity of the predictions to the above parameters only in the base model.

[35] Even if we do not assume men and women to be imperfect substitutes and instead allow $\rho > 1$, the simulation results are quite similar.

education. Similarly, our results for U.K. hold when we use the more recent 2015 U.K. TUS data as shown in Figure B.2 in Appendix B.

6.3 Heterogeneity

In this analysis we focus on urban couples, but existing literature finds a similar pattern of women's time in the labor market and domestic work with own education in rural India. Afridi et al. (2018) highlight this relationship and hypothesize that home productivity effects may be at play in generating the observed pattern in rural areas. Our paper not only illustrates the relationship between home productivity and time allocation decisions rigorously, it also shows that social norms can be binding for women.

Our social norm constraint assumes that husbands allocate almost no time to domestic chores. However, there may be heterogeneity in time allocation by men to home production along socio-demographic groups and across regions in India. Surprisingly, and in support of our theoretical assumption, we find insignificant differences in men's time allocation to domestic work in urban India by either caste or religion.[36] With the exception of the states of Meghalaya (comprising of primarily matrilineal groups) and Odisha, which comprise less than 11% of our sample, we do not find significant variation in the time spent by husbands on domestic work.

6.4 Other mechanisms

In this section we test for and reject alternative mechanisms that can explain the time allocation decisions of households, particularly women at higher education levels, in transition economies.

6.4.1 Market goods for home production

In low or middle income countries, limited supply of market goods can constrain women's time allocated to market work. This may be especially true for the more educated women, who are also more likely to belong to higher income households, and can afford to purchase market goods for home production. Hence the lack of or limited supply of market goods and services could be an alternative explanation of both low levels of women's time allocated to labor market and the muted response of women with higher levels of education to market wages.

[36] Among the Scheduled Tribes, Scheduled Castes and Other groups, men spend 4.9%, 4.7% and 4.1% of their total time on domestic work, respectively. Among Hindus, Muslims, Christians and Other religions men spend 4.3%, 3.3%, 4.9% and 3.8% of their time on domestic chores, respectively.

To test for this possible mechanism we constrain usage of market goods in the base model in two ways - no usage of market goods for home production ($\delta = 0$) or limited marketization for home production (fixing $q = \bar{q}$). This modification reduces wife's labor supply at higher education levels, in comparison to the base model, but by a very negligible proportion. Since in our model q is chosen optimally, households respond to lower amounts of q (relative to optimal) by reducing the total H produced at higher education levels. Thus, even though the total H produced by the household rises with education, the level of H is lower due to the constraint on the market good. Hence instead of increasing time spent on home production by the wife and consequently reducing labor supply by the wife, limited supply of q primarily results in lower production of the home produced good. Thus, the absence or low supply of market goods cannot explain the observed levels of women's time spent on market work in India.

6.4.2 Wealth

Another possible channel that could impact women's labor supply is household wealth. At higher education levels households are more likely to be wealthier, inducing a wealth effect which could lower women's LFP. We, therefore, incorporate exogenous increases in household wealth over the distribution of education using the 2003 National Sample Survey on Household Assets (NSS-HA) which collected information on assets owned by households. The estimated household wealth from land or residential property is too small to predict the muted allocation of time to market work by highly educated women.[37]

7 Conclusion

In comparison with the developed countries, several transition economies exhibit low and stagnant time allocated to labor market by women despite economic growth. While the decline in the gender gap in education is often accompanied by a more favourable gender wage ratio at higher levels of education, women exhibit little responsiveness in terms of increasing their labor market attachment. In this paper we develop a model that is capable of generating these observed regularities in women's labor supply. We then use detailed individual time use data for urban India and the U.K. to show that a rise in home productivity with education can explain married women's time allocation in both India and the U.K., significantly so in the former. However, the norm of wives alone being responsible for home production and

[37] We do not explicitly consider fertility since production of H partly captures fertility as a possible channel that impacts couples' time allocation decisions in our theoretical exposition. In addition, fertility declines monotonically with increasing education in India. Hence, fertility cannot explain the muted response of labor supply to increases in female market wage.

an almost complete absence of husband's time at home in India also explains a significant proportion of the low levels of women's labor force attachment at higher levels of education.

Our paper contributes to the existing literature on women's labor supply, broadly, and to the ongoing debate on women's LFP in transition economies such as India. We show that varying factors, and their interplay, can explain the persistent gender gap in LFPR and the non-monotonic relationship between women's market labor supply and their education. A rise in the relative female wage along with increase in female education is insufficient for improving FLFP if it is also accompanied by higher female home productivity. Our analysis also highlights the role of gender norms on the division of labor at home, emphasizing the relevance of policy measures that educate men against gender stereotypes to raise the level of women's LFP in developing countries. While there are several approaches to modelling gender norms, gendered division of labor within the home could also be reinforced through socio-economic changes induced by exogenous shocks such as the current pandemic - a worthwhile topic for future research.

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Table 1 Calibrated parameters (Base Model - India)

Paramater	Value	Description	Source
		Pareto weights (Female)	
$1-\theta^{1,j}$	0.279	Illiterate	calibrated
$1-\theta^{2,j}$	0.272	Less than primary	calibrated
$1-\theta^{3,j}$	0.263	Primary	calibrated
$1-\theta^{4,j}$	0.265	Middle	calibrated
$1-\theta^{5,j}$	0.481	Higher Secondary	calibrated
$1-\theta^{6,j}$	0.457	Graduate and above	calibrated
		Home productivity parameters: Male	
a_m^1	0.098	Illiterate	calibrated
a_m^2	0.121	Less than primary	calibrated
a_m^3	0.171	Primary	calibrated
a_m^4	0.279	Middle	calibrated
a_m^5	0.698	Higher Secondary	calibrated
a_m^6	1.967	Graduate and above	calibrated
		Home productivity parameters: Female	
a_f^1	0.023	Illiterate	calibrated
a_f^2	0.038	Less than primary	calibrated
a_f^3	0.035	Primary	calibrated
a_f^4	0.040	Middle	calibrated
a_f^5	1.453	Higher Secondary	calibrated
a_f^6	2.019	Graduate and above	calibrated
		Other parameters	
ϕ_L	0.871	Weight attached to leisure	calibrated
ϕ_H	0.954	Weight attached to home good	calibrated
z_m	0.283	Share in the home production of male time	calibrated
z_f	0.717	Share in the home production of female time	calibrated
ρ	0.4037	Inverse of degree of substitutability between men and women	literature
δ	0.290	Share of market input in the home production	literature

Note: To ease presentation the 36 calibrated Pareto weights (for each possible i, j education combination of wife and husband) are averaged for each education group of women in this table.

Table 2 Calibrated parameters (Base model - U.K.)

Paramater	Value	Description	Source
		Pareto weights (Female)	
$1-\theta^{1,j}$	0.412	Less than secondary	calibrated
$1-\theta^{2,j}$	0.446	O-Level	calibrated
$1-\theta^{3,j}$	0.474	A-Level	calibrated
$1-\theta^{4,j}$	0.497	Degree	calibrated
		Home productivity parameters: Male	
a_m^1	0.444	Less than secondary	calibrated
a_m^2	0.496	O-Level	calibrated
a_m^3	0.604	A-Level	calibrated
a_m^4	1.000	Degree	calibrated
		Home productivity parameters: Female	
a_f^1	0.632	Less than secondary	calibrated
a_f^2	0.861	O-Level	calibrated
a_f^3	1.082	A-Level	calibrated
a_f^4	1.291	Degree	calibrated
		Other parameters	
ϕ_L	2.128	Weight attached to leisure	calibrated
ϕ_H	2.004	Weight attached to home good	calibrated
z_m	0.545	Share in the home production of male time	calibrated
z_f	0.455	Share in the home production of female time	calibrated
ρ	0.4037	Inverse of degree of substitutability between men and women	literature
δ	0.290	Share of market input in the home production	literature

Note: To ease presentation the 36 Pareto weights (for each possible i, j education combination of wife and husband) are averaged for each education group of women in this table.

Table 3 Decomposing the effects on wife's labor supply

	Δ Relative wage	Δ Relative wage to relative home productivity	Δ Pareto weight	Predicted Δ labor supply
	$(\frac{w_f^{i+1}}{w_m^k})/(\frac{w_f^i}{w_m^j})$	$\frac{((\frac{w_f^{i+1}}{w_m^k})/(\frac{w_f^i}{w_m^j}))}{((\frac{a_f^{i+1}}{a_m^k})/(\frac{a_f^i}{a_m^j}))}$	$\frac{\theta^{i+1,k}}{\theta^{i,j}}$	$n_f^{i+1,k} - n_f^{i,j}$
	(1)	(2)	(3)	(4)
Panel A: Theoretical prediction based on signs for Base Model				
	> 1	> 1	> 1	> 0
	< 1	< 1	< 1	< 0
	All other cases			Ambiguous
Panel B: Actual changes across education levels for Base Model (India)				
Education change				Actual Δ labor supply
$0-1$	.99	.87	1.01	< 0
$1-2$	.87	1.24	1.01	< 0
$2-3$	.92	1.05	.99	< 0
$3-4$	2.85	0.14	.71	> 0
$4-5$	1.06	1.31	1.05	> 0

Source: Time Use Data and NSS.

Note: Numeric education codes denote the following education levels. $0-$*Illiterate*, $1-$*Less than primary*, $2-$ *Primary*, $3-$ *Middle*, $4-$ *Higher Secondary*, $5-$ *Graduate and above*. The above signs and interpretation refers to the theoretical decomposition of changes in wife's labor supply derived in Equation 8. The different components of the decomposition are estimated using the parameter values calibrated for the base model using time use data on 3725 couples in India. The actual change in labor supply is the change in labor supply obtained through the calibrated model.

Table 4 Reasons for participation in domestic work (urban, married, age 20-45)

Panel A: Year 1999				
	Required to	No work	Preference	Other
Illiterate	93.79	2.02	2.65	1.53
Less than primary	93.49	2.07	2.84	1.6
Primary	93.83	2.31	2.46	1.4
Middle	93.4	2.03	3.05	1.52
Higher Secondary	92.78	2.57	2.95	1.71
Graduate and above	91.82	2.25	3.68	2.25
Panel B: Year 2011				
	Required to	No work	Preference	Other
Illiterate	96.08	1.16	1.64	1.12
Less than primary	95.09	0.79	2.54	1.58
Primary	96.83	0.9	1.45	0.81
Middle	94	1.86	2.51	1.64
Higher Secondary	94.6	1.12	2.71	1.57
Graduate and above	92.71	2.1	3.89	1.29

Source: National Sample Survey, Employment and Unemployment Schedules 1999 and 2011 (Authors' own calculations).

Note: The question asked whether a woman who primarily spent her time doing domestic work was required to do so or did so voluntarily. Those who reported engaging in domestic work voluntarily are further asked the reasons for doing so - unavailability of work, preference or others. This question is only asked to women who report spending majority of their time in domestic work. The number of women who answer this question are 30552 and 24831 in years 1999 and 2011 respectively.

Table 5 Comparison across models (India)

Education Level	Actual	Simulations		
		(1)	(2)	(3)
		Constant home productivity	Base model	Norms constraint
Panel A: Women				
		Time spent: Market work		
Illiterate	0.15	0.12	0.11	0.12
Less than primary	0.10	0.13	0.07	0.08
Primary	0.08	0.07	0.07	0.06
Middle	0.05	0.04	0.04	0.03
Higher Secondary	0.06	0.29	0.17	0.11
Graduate and above	0.13	0.32	0.21	0.17
		Time spent: Home production		
Illiterate	0.56	0.52	0.58	0.59
Less than primary	0.61	0.52	0.62	0.59
Primary	0.60	0.58	0.61	0.59
Middle	0.62	0.61	0.62	0.59
Higher Secondary	0.62	0.30	0.52	0.59
Graduate and above	0.53	0.29	0.49	0.59
		Time spent: Leisure		
Illiterate	0.28	0.38	0.30	0.29
Less than primary	0.30	0.39	0.30	0.32
Primary	0.35	0.40	0.31	0.34
Middle	1.00	1.00	1.00	0.38
Higher Secondary	1.00	1.00	1.00	0.30
Graduate and above	1.00	1.00	1.00	0.24

Table 5 (Contd) Comparison across models: India

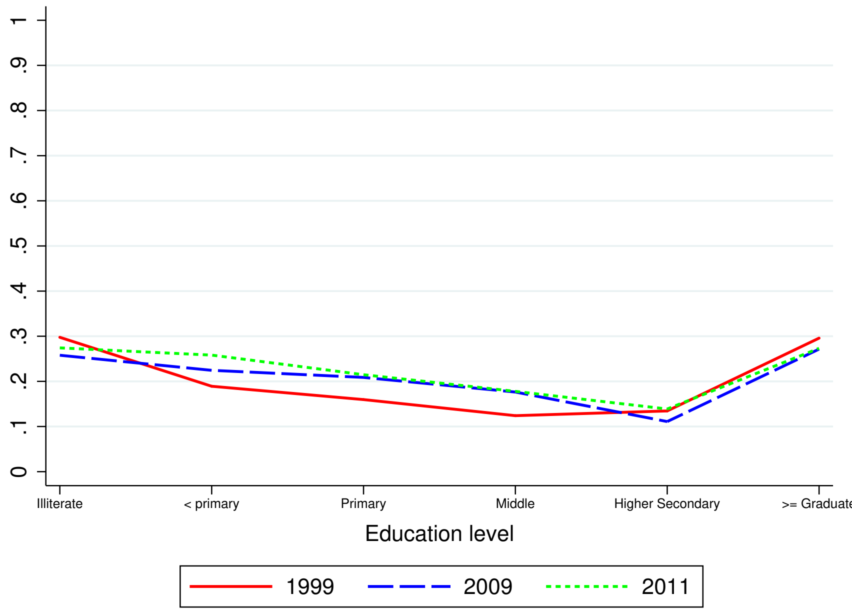
Education Level	Actual	Simulations		
		(1)	(2)	(3)
		Constant home productivity	Base model	Norms constraint
Panel B: Men				
		Time spent: Market work		
Illiterate	0.67	0.60	0.61	0.63
Less than primary	0.70	0.61	0.63	0.67
Primary	0.69	0.61	0.62	0.67
Middle	0.68	0.62	0.61	0.67
Higher Secondary	0.65	0.61	0.61	0.67
Graduate and above	0.60	0.60	0.64	0.65
		Time spent: Home production		
Illiterate	0.04	0.00	0.08	0.00
Less than primary	0.04	0.00	0.07	0.00
Primary	0.03	0.00	0.08	0.00
Middle	0.04	0.00	0.09	0.00
Higher Secondary	0.04	0.00	0.09	0.00
Graduate and above	0.06	0.00	0.05	0.00
		Time spent: Leisure		
Illiterate	0.29	0.40	0.31	0.37
Less than primary	0.27	0.39	0.30	0.33
Primary	0.28	0.39	0.30	0.33
Middle	0.28	0.38	0.30	0.33
Higher Secondary	0.30	0.39	0.30	0.33
Graduate and above	0.35	0.40	0.31	0.35

Table 6 Comparison across models (U.K.)

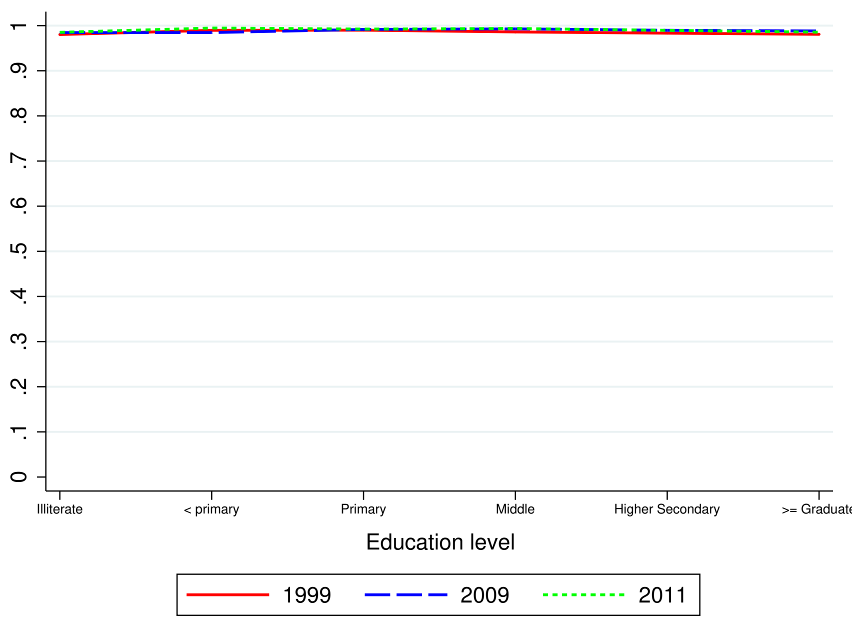
Education Level	Actual	Simulations	
		(1)	(2)
		Constant home productivity	Base model
Panel A: Women			
		Time spent: Market work	
Less than secondary	0.16	0.13	0.17
O-level	0.19	0.20	0.20
A-level	0.24	0.24	0.22
Degree	0.27	0.26	0.25
		Time spent: Home production	
Less than secondary	0.41	0.43	0.41
O-level	0.40	0.36	0.39
A-level	0.36	0.32	0.37
Degree	0.30	0.30	0.33
Panel B: Men			
		Time spent: Market work	
Less than secondary	0.38	0.38	0.39
O-level	0.40	0.38	0.40
A-level	0.40	0.40	0.40
Degree	0.39	0.43	0.37
		Time spent: Home production	
Less than secondary	0.21	0.18	0.19
O-level	0.19	0.18	0.19
A-level	0.19	0.16	0.19
Degree	0.18	0.13	0.22

Figure 1 LFPR by education (urban, married, age 20-45)

(a) Women



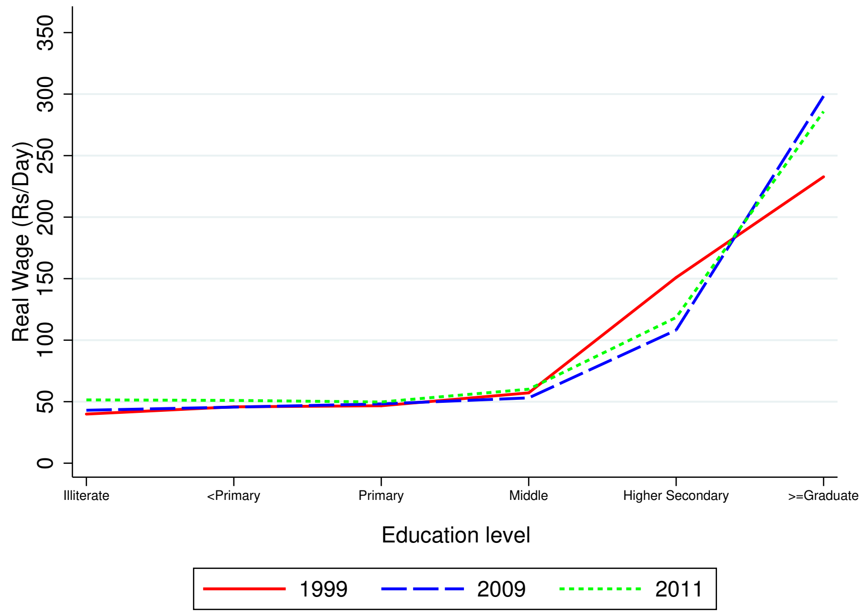
(b) Men



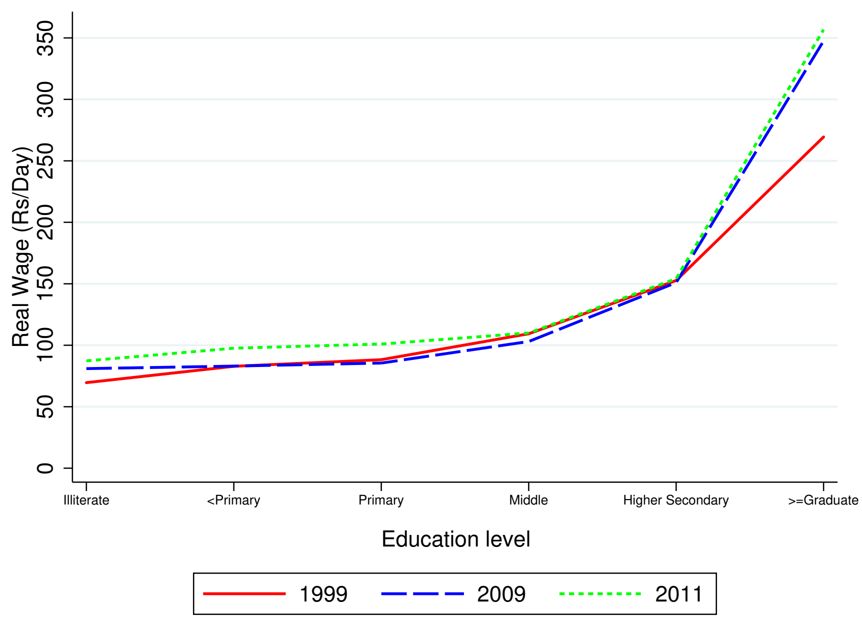
Source: National Sample Survey, Employment and Unemployment Schedules 1999, 2009 and 2011 (Authors' own calculations).
Note: LFPR is calculated using the usual status definition of employment in the NSS data. The sample size is 33,387 (in 1999), 26,103 (in 2009) and 25,864 (in 2011) for men and 37,732 (in 1999), 30,851 (in 2009) and 30,512 (in 2011) for women. See data appendix for details.

Figure 2 Returns to education (urban, married, age 20-45)

(a) Women



(b) Men

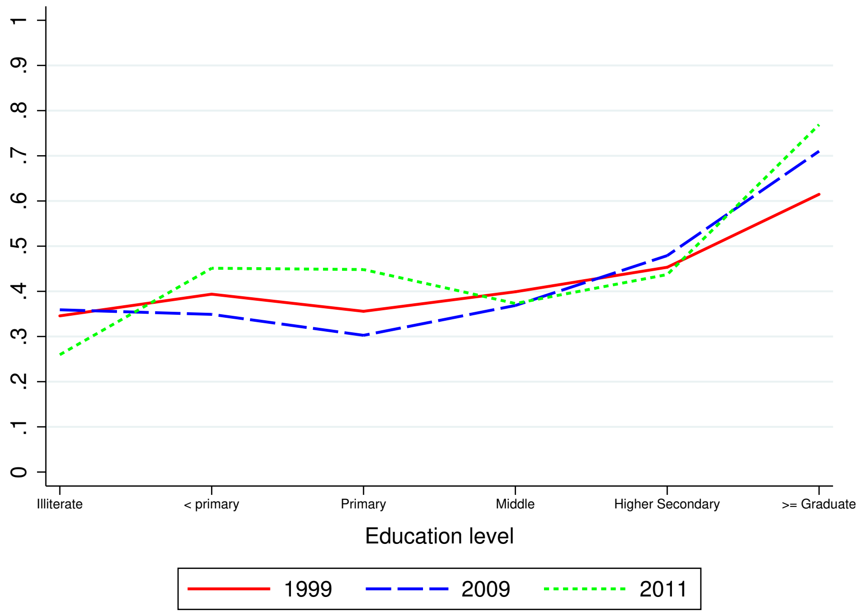


Source: National Sample Survey, Employment and Unemployment Schedules 1999, 2009 and 2011 (Authors' own calculations).

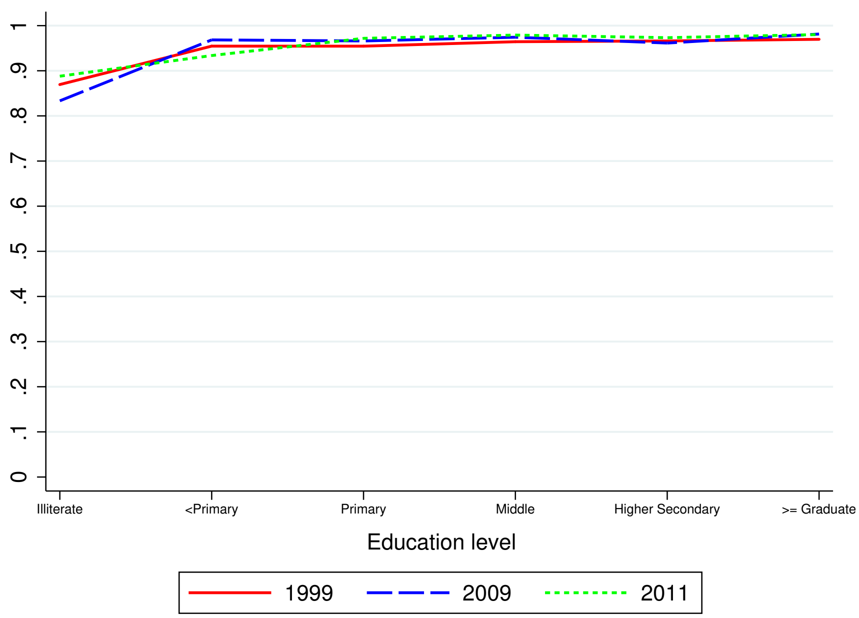
Note: Mean daily wages are calculated from the NSS data for each education-gender cell and deflated at 1999 price levels using the All India Consumer Price Index for Industrial Workers. The sample size is 17,466 (in 1999), 13,876 (in 2009) and 13,686 (in 2011) for men. and 3569 (in 1999), 3064 (in 2009) and 3032 (in 2011) for women.

Figure 3 LFPR by education (urban, never married, age 20-45)

(a) Women



(b) Men

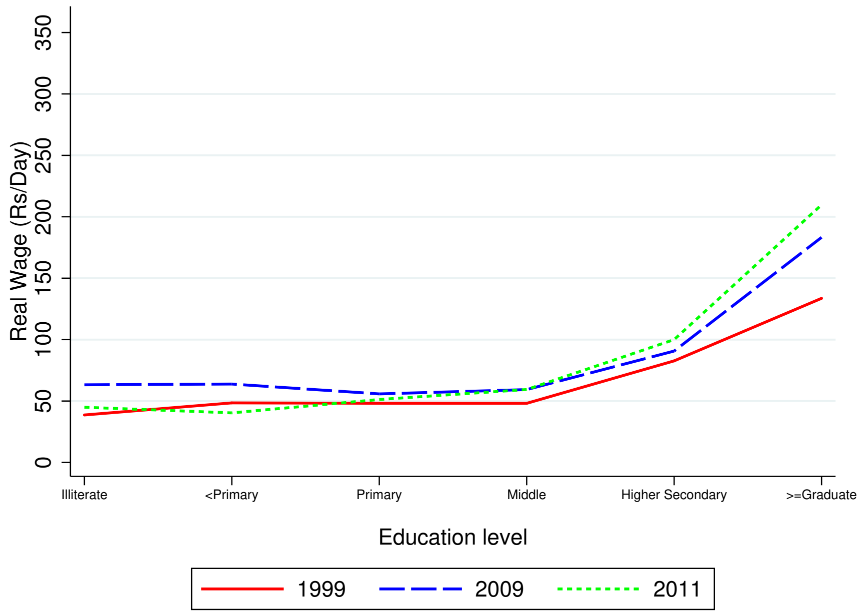


Source: National Sample Survey, Employment and Unemployment Schedules 1999, 2009 and 2011 (Authors' own calculations).

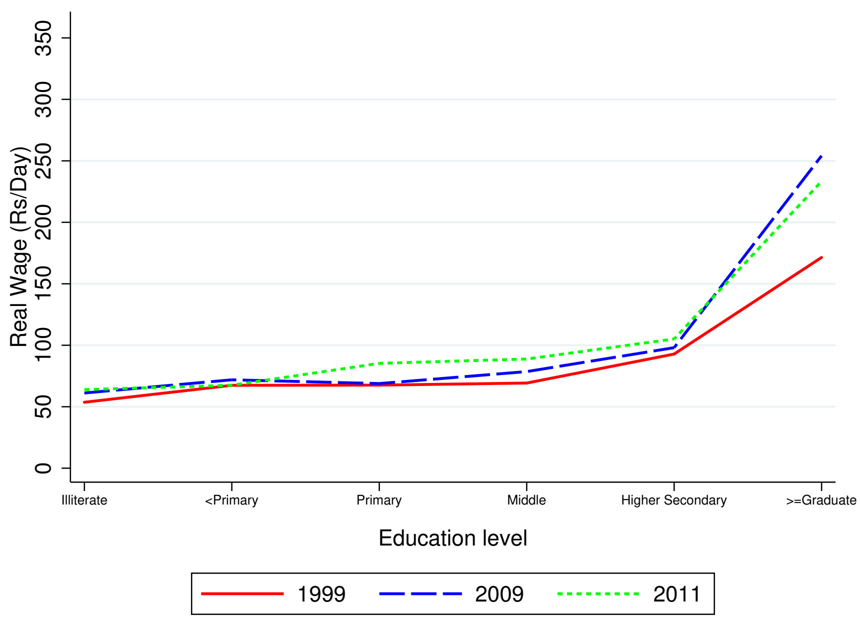
Note: LFPR is calculated using the usual status definition of employment in the NSS data for those not currently enrolled in education. The sample size is 12,253 (in 1999), 9424 (in 2009) and 8995 (in 2011) for men and 4211 (in 1999), 3621 (in 2009) and 3744 (in 2011) for women. See data appendix for details.

Figure 4 Returns to education (urban, never married, age 20-45)

(a) Women



(b) Men

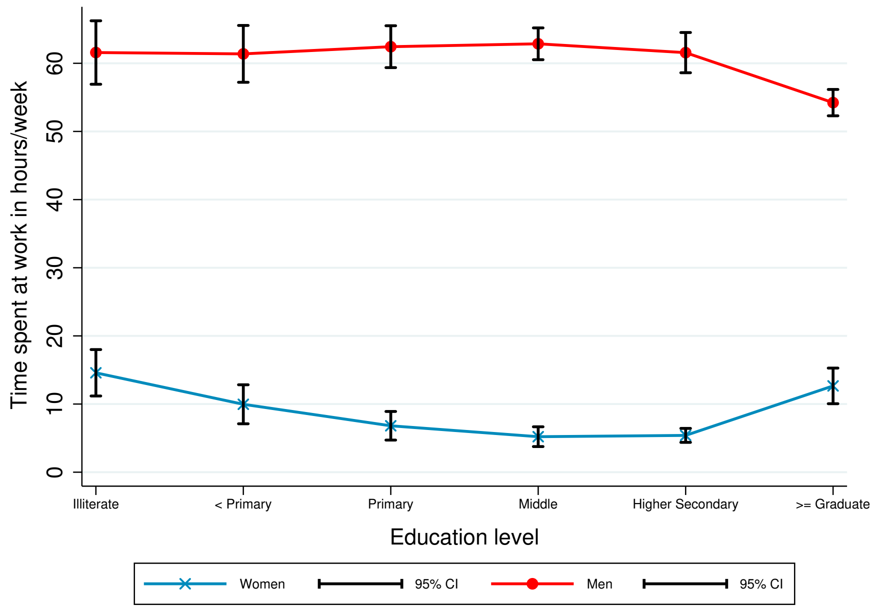


Source: National Sample Survey, Employment and Unemployment Schedules 1999, 2009 and 2011 (Authors' own calculations).

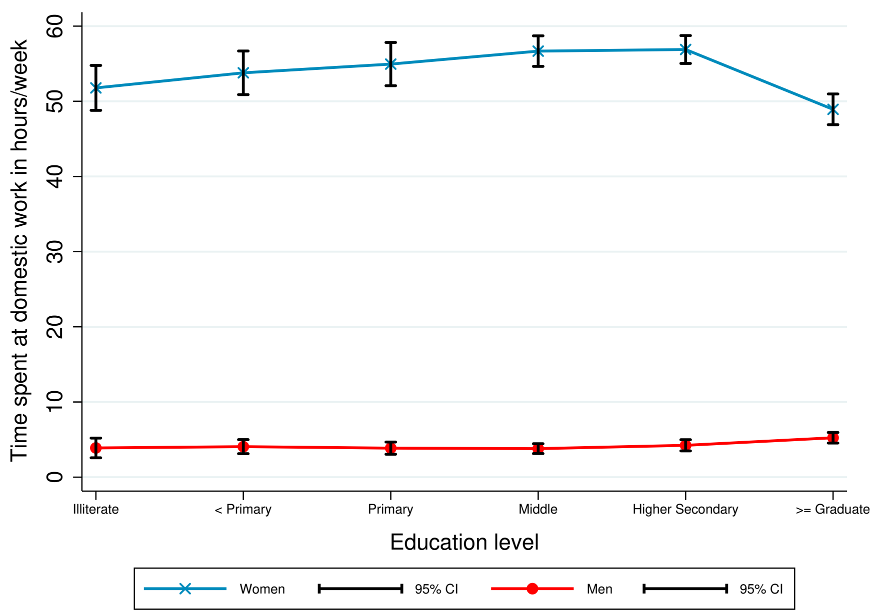
Note: Mean daily wages are calculated from the NSS data for each education-gender cell and deflated at 1999 price levels using the All India Consumer Price Index for Industrial Workers. The sample size is 5271 (in 1999), 4850 (in 2009) and 4607 (in 2011) for men and 985 (in 1999), 914 (in 2009) and 1076 (in 2011) for women.

Figure 5 Time allocation by education: weekly hours (urban, married, age 20-45)

(a) Labor Supply



(b) Domestic Work

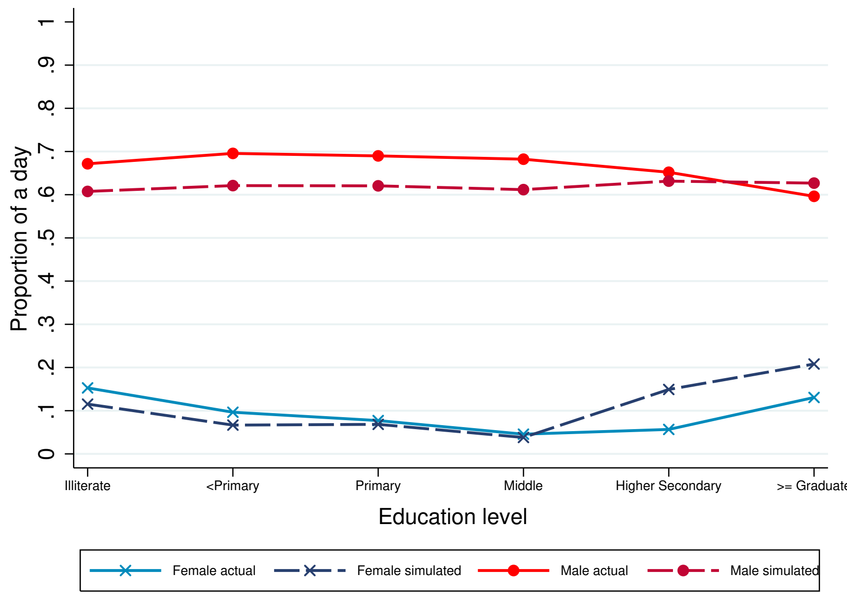


Source: Time Use Survey 1998 (Authors' own calculations).

Note: LFPR is calculated by summing up time spent in the reference week in labor market activities. Domestic work is calculated by summing up time spent in the reference week in home production activities. The sample size is 3859 and 4389 for men and women, respectively. See data appendix for details.

Figure 6 **Base model: simulations for time spent in labor market, home production, leisure**

(a) Labor Supply



(b) Domestic Work

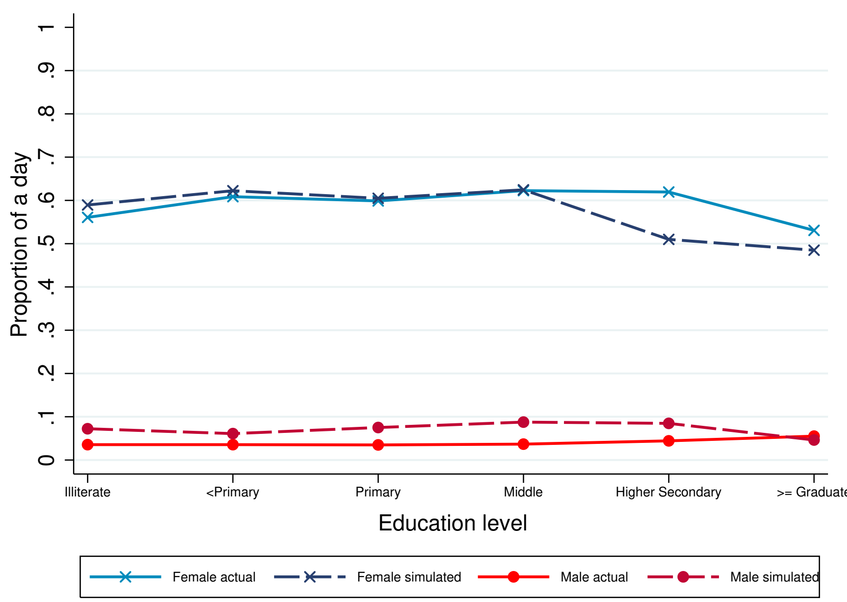
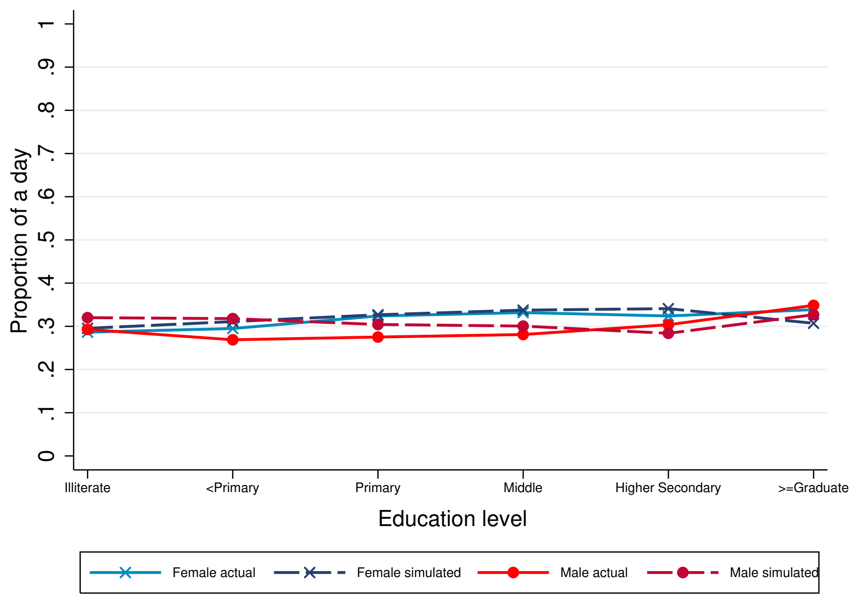


Figure 6 (contd.) Base model: simulations for time spent in labor market, home production, leisure

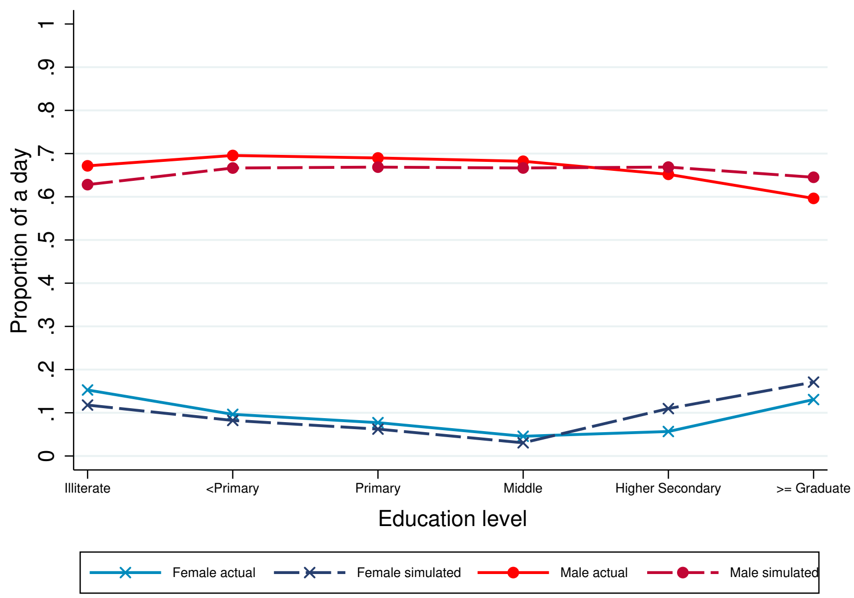
(c) Leisure



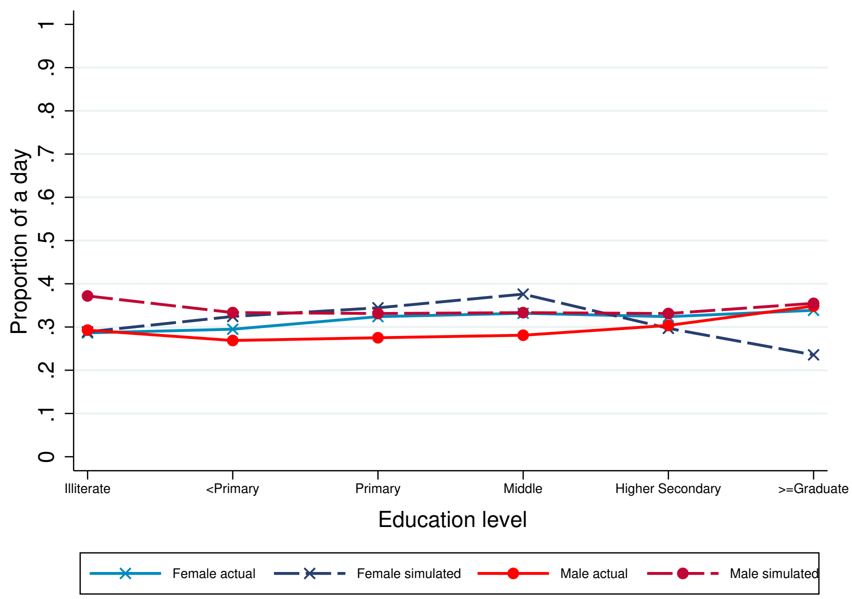
Note: Time spent in labor market, home production and leisure is shown as a fraction of the total time endowment of one. See data appendix for details on Time Use data for India.

Figure 7 Base model with norms constraint: simulations for time spent in labor market and leisure

(a) Labor Supply



(b) Leisure



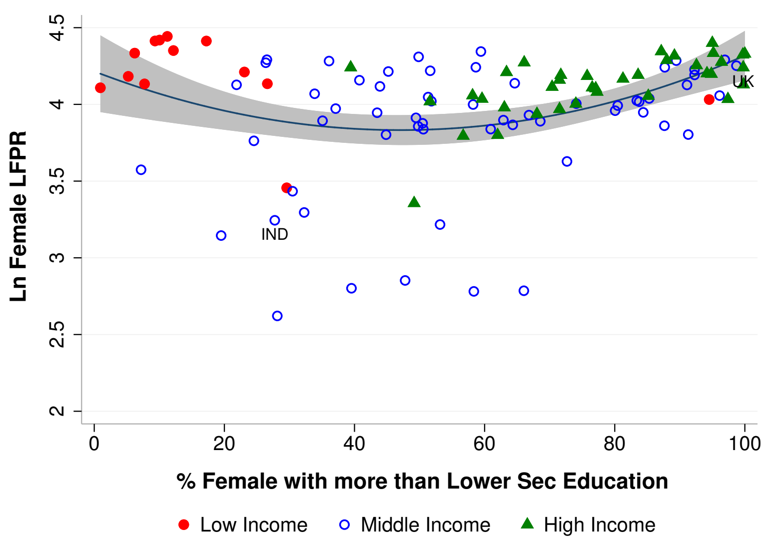
Note: Time spent in labor market and leisure is shown as a fraction of the total time endowment of one. See data appendix for details on Time Use data for India.

APPENDIX

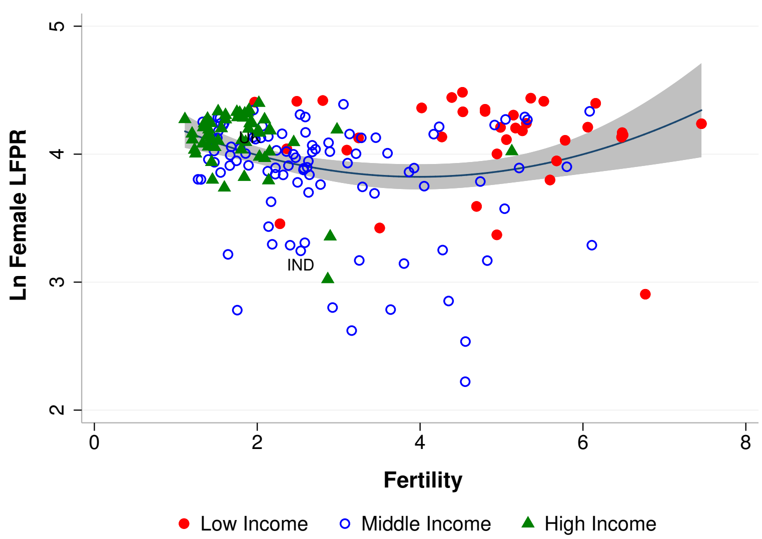
A Data Appendix

A.1 Cross-country plots of women's LFPR: Education, Fertility and GDP per capita

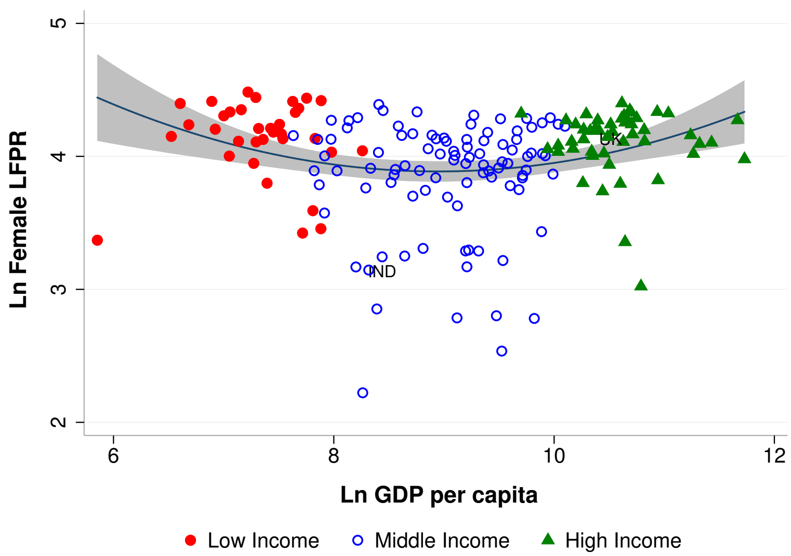
(a) Women's LFPR and women's education



(b) Women's LFPR and fertility



(c) Women's LFPR and per capita income



Source: World Development Indicators

Note: The graphs are plotted for all countries available in the World Bank dataset. Female LFPR refers to proportion of females aged 15-64 who participate in labor force. Education captures proportion of females aged 25 and above, having at least lower secondary (class 10 and above) level of education in 2011 (an average over last 5 years is taken because education details are not available for each country every year). Fertility measures total births per woman till the end of her childbearing age in year 2011. GDP per capita is measured in 2011 and is based on purchasing power parity in constant 2011 international dollars. The classification of countries into low, middle and high income is done according to the World Bank classification as in year 2011. The lower middle income and the upper middle income countries are clubbed together to form the middle income group. In graph (a), Kyrgyz Republic, a low income country but with a high level of secondary schooling completion, is at the right end of the schooling distribution.

A.2 Indian data for calibration

We draw on two datasets in the analysis:

A.2.1 National Sample Survey

The Employment and Unemployment rounds of India's National Sample Surveys (NSS) conducted in 1999-2000, 2009-10 and 2011-2012 (referred to as 1999, 2009 and 2011 in this paper) for urban India are used to calculate women's labor force participation rates over these years. These surveys are repeated cross sections of households (120,578, 100,957 and 101,724 households surveyed in 1999, 2009 and 2011, respectively), selected through stratified random sampling across all states, that are representative of the country's population.

Construction of education categories: NSS reports educations status of all members in the households by recording the highest level of education completed. These categories are collapsed to create six categories of education used in the paper - Illiterate, Less than Primary, Primary, Middle, Higher Secondary (includes secondary and higher secondary levels) and Graduate and above education.

Construction of labour force participation variable: NSS uses three reference periods to capture employment: (i) one year, (ii) one week, and (iii) each day of the previous week. This paper employs the Usual Principal and Subsidiary Status (UPSS) definition in the introductory graphs (Figure 1, Figure 3) since that is the most frequently used measure for comparing employment figures across years in India. This employment status is derived from two variables - Usual Principal Activity Status (PS) and Subsidiary Activity Status (SS).

The activity status on which a person spent relatively longer time (major time criterion) during the 365 days, preceding the date of survey, is considered the PS of the person. After determining the principal status, the economic activity on which a person spent 30 days or more during the reference period of 365 days, preceding the date of survey, is recorded as the SS of a person. In our analysis, if a person is defined to be in the labor force in either the principal activity status or the subsidiary activity status then she is defined to be in the labor force according to the UPSS definition.

Construction of real wages: The details about wages are collected in the weekly schedule of the NSS survey where each respondent is asked the number of days worked across various activity categories in each day of the previous week. Total weekly earnings are divided by total days worked in the week for an individual to arrive at the individual daily wage earned.

This is done for each year - 1999, 2009 and 2011 - and the wages for the years 2009 and 2011 are deflated using the Consumer Price Index for Industrial Workers (CPIIW) to make them comparable with 1999.

A.2.2 Time Use Survey

Time use data were collected from 18,591 households across six states of India in 1998-99 by the same nodal agency that conducts the National Sample Surveys to assess the detailed activity wise time spent by adults in India. The selection of states was purposive so that all regions (North west - Haryana, central - Madhya Pradesh, West - Gujarat, East - Orissa, South - Tamil Nadu and North-east - Meghalaya) of India were adequately represented. While the NSS surveys collect data on aggregate work, the time use survey allows us to break down various activities and classify them into activities that are directed towards labor market, household production and leisure.

The TUS adopted the interview method rather than diary or observation method for collection of data since not all respondents are literate enough to maintain time diaries. A reference period of one week was used for collecting the data. To capture the variation in the activity pattern, data were collected for three types of days - normal, weekly variant and abnormal - with a recall lapse of one day, i.e. a 24 hour recall with actual time spent in minutes recorded for each activity.

Classification of activities: We followed standard classification of time use activities for total market work (labor) and total non-market work (home production) (Aguiar and Hurst (2007)). Classification of activities into leisure is more subjective [38]:

(a) Time spent in labor market: farming, animal husbandry, fishing, food processing, collection of fruits/vegetables/fodder/forest produce, mining, construction, manufacturing, trade, business, services, travel to work and in search of job (paid and self employed labor which includes both formal and informal type of work).

(b) Time spent on home production: Fetching water (for drinking at home), collecting fuelwood (for cooking at home), household maintenance activities like cooking, cleaning,

[38] Different definitions are proposed by Aguiar and Hurst (2007) to construct a measure for leisure. The measure of leisure used in this paper coincides with the narrow definition since discretionary time is excluded from it. In addition, it also includes time spent on social and religious activities. Other minor deviations are - pet care is included both in home production and leisure by Aguiar and Hurst (2007) but we include it only in home production; gardening is not recorded as a separate activity in TUS survey of India and is clubbed under hobbies.

shopping for household supplies, supervising household work, repair of household goods, pet care, travel related to household maintenance, care for - children, the sick, the elderly and the disabled, non-formal education of children.

(c) Time spent on leisure: community services, social and cultural activities, hobbies, smoking and drinking, exercise, talking, resting and relaxing, participation in religious activities.

Activities like sleeping and maintaining basic physical well-being (hygiene and eating) constitute discretionary time and are removed from the 24 hours. The remainder of the time is then divided into the above three activities and normalized to one for the calibrations.

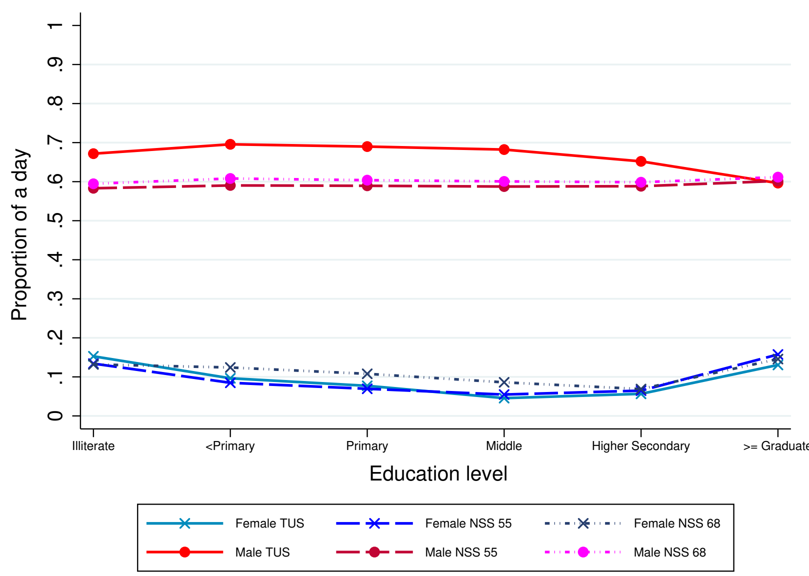
Imputation of wages for each education category: The six education categories are classified in the same manner as for the NSS since both NSS and TUS capture education using the same question. The TUS however do not contain data on wages. The daily wage data are imputed from NSS 1999 since these rounds were conducted closest to the TUS. Median daily wage is calculated for married individuals in each education category, for men and women separately, using the NSS survey. These are then used for imputation of wages for the corresponding education and gender category in the couple's data in the TUS while calibrating the model. We use wage data for all states in the NSS to impute wages in the TUS.

Creating a dataset on couples: The TUS (or the NSS) does not identify spouses formally. To identify couples we make use of the fact that the enumerators who conduct the survey are instructed to use a continuous serial number for recording household members and their corresponding details like relation to head, sex and marital status. The head of the household appears first, followed by head's spouse, the first son, first son's wife and their children, second son, second son's wife and their children and so on, for the sons who stay with the head. After the sons are enumerated, the daughters are listed followed by other relations, dependants, servants, etc. This data structure is used to identify couples in the data. Each couple then constitutes a household. Couples in which age of the women is between 20-45 are then used for analyses. Once women are filtered on their age in the couple's data, the corresponding age categories for their husbands are 21-60 in the data. Thus, while imputing the wages from the NSS, the age categories for women are 20-45 while for men are 21-60.

A.3 Checking robustness using recent employment data for India

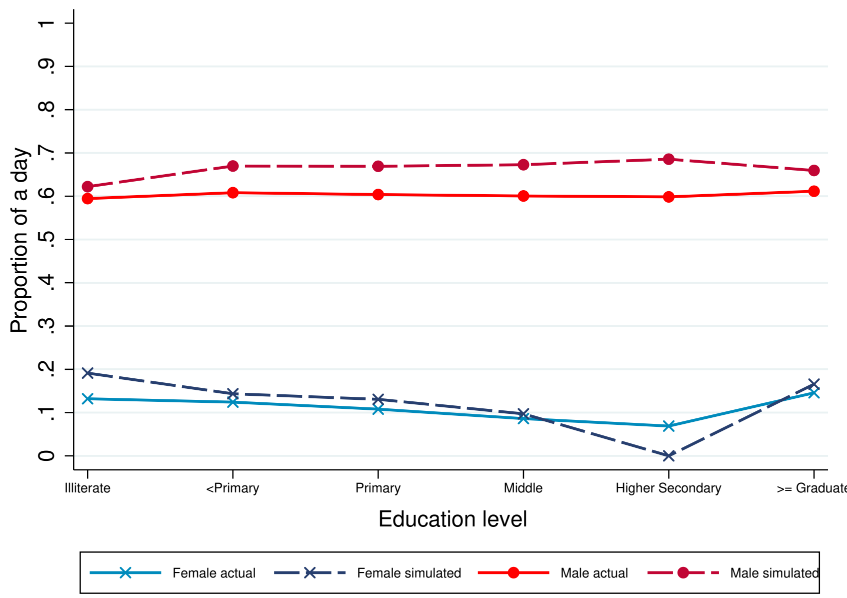
To calculate labor supply using NSS, consistent with the definition used in the TUS, we use the daily status definition of employment which captures the number of days a person was employed in the previous week. These are captured as half (0.5) or full (1) day. Assuming an eight hour work day, the total number of hours spent in employment in the past week are calculated for each individual. We then divide this figure by the average discretionary time per week obtained from the time use survey for each gender-education cell to obtain the proportion of time spent in the labor market in a reference week. Figure A.3.1 below shows that the TUS 1998 and NSS 1999 labor supply measures are close for women but not men. Thus, measurement error is likely for men in lower education groups when we use the NSS approximation and the simulated paths for men are likely to overpredict men's labor supply. We corroborate this using the TUS data where we find that on an average men who work, spend around 9.3 hours per day in market work. This is higher than our assumed 8 hour work day when approximating NSS for employment. For women, this is not a concern since on an average they report working for 3.5 hours, captured well in half day work in NSS.

Figure A.3.1 LFPR in urban India (married, age 20-45): comparison across TUS (1998) and NSS (1999, 2011)



Source: National Sample Survey, Employment and Unemployment Schedules 1999 (NSS 55) and 2011 (NSS 68), Time Use Survey 1998 (Authors' own calculations).

Figure A.3.2 Base model with norms constraint: Simulations for time spent in labor market using NSS (2011)



Source: National Sample Survey, Employment and Unemployment Schedules 1999 and 2011, Time Use Survey 1998 (Authors' own calculations).

Note: LFPR is calculated by summing up the days worked in the reference week in NSS data, multiplying it by eight (assuming 8 hour work day) and then dividing by discretionary time obtained for each education-gender cell. See data appendix for details.

B U.K. Data - Calibration and simulation of base model

The U.K. TUS data uses the standard diary method in the developed countries for collecting individual time allocation data. All individuals aged 8 or over in a household complete two one-day diaries (for a weekday and a weekend day). Children aged 8-13 years and adults aged 14 years or more were asked to complete different diaries based on slightly different activity classification. For each 10 minute time slot the adults reported the primary and the secondary activity. In our analyses the time was equally divided if a particular time slot had both primary and secondary activity. The activities were then clubbed together such that they matched the activity mapping to time spent in labour market, home production and leisure for India, the details of which are discussed in Appendix A.

Table B.1 Decomposing the effects on wife's labor supply (U.K. 2000)

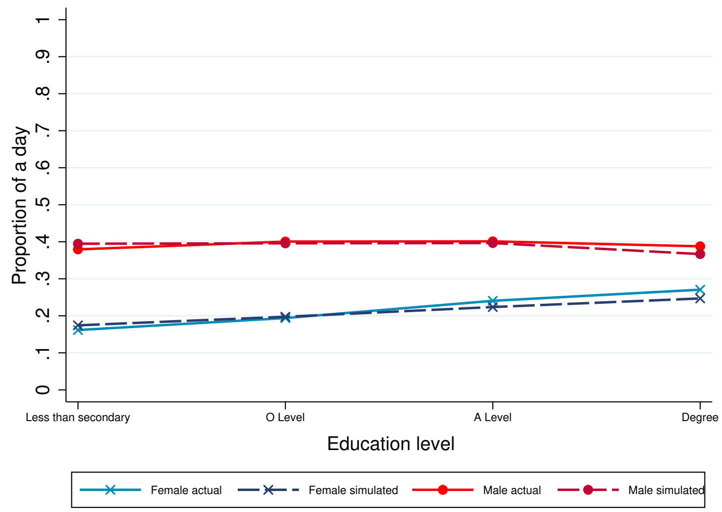
Education change	Δ Relative wage	Δ Relative wage to relative home productivity	Δ Pareto weight	Δ labor supply
	$(\frac{w_f^{i+1}}{w_m^k})/(\frac{w_f^i}{w_m^j})$	$\frac{((\frac{w_f^{i+1}}{w_m^k})/(\frac{w_f^i}{w_m^j}))}{((\frac{a_f^{i+1}}{a_m^k})/(\frac{a_f^i}{a_m^j}))}$	$\frac{\theta^{i+1,k}}{\theta^{i,j}}$	$n_f^{i+1,k} - n_f^{i,j}$
	(1)	(2)	(3)	(4)
$0-1$	1.18	.91	0.94	>0
$1-2$	1.12	1.01	0.95	>0
$2-3$	1.06	1.11	0.95	>0

Source: Time Use Data for U.K. 2000

Note: Numeric education codes denote the following education levels. $0-$*Less than secondary*, $1-$*OLevel*, $2-$*ALevel*, $3-$*Degree*. The above signs and interpretation refers to the theoretical decomposition of changes in wife's labor supply derived in Equation 8. The different components of the decomposition are estimated using the parameter values calibrated for the base model using time use data on 1129 couples in U.K.. The actual change in labor supply is the change in labor supply obtained through the calibrated model.

Figure B.1 Base model: simulations for time spent in labor market, home production, leisure (U.K. 2000)

(a) Labor Supply



(b) Domestic Work

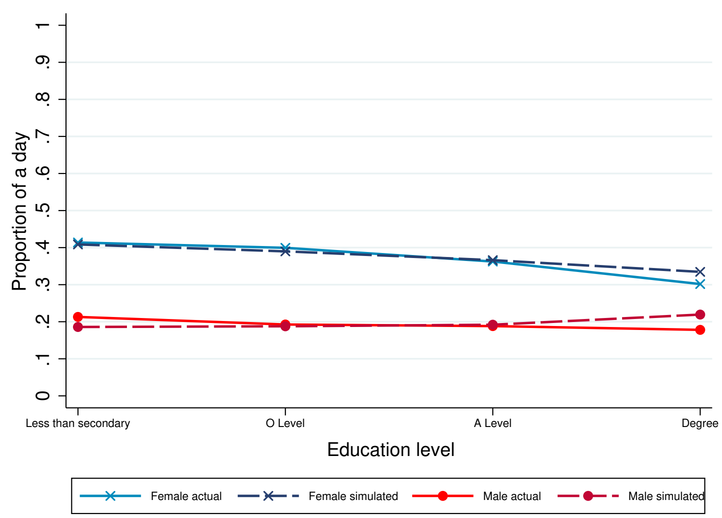
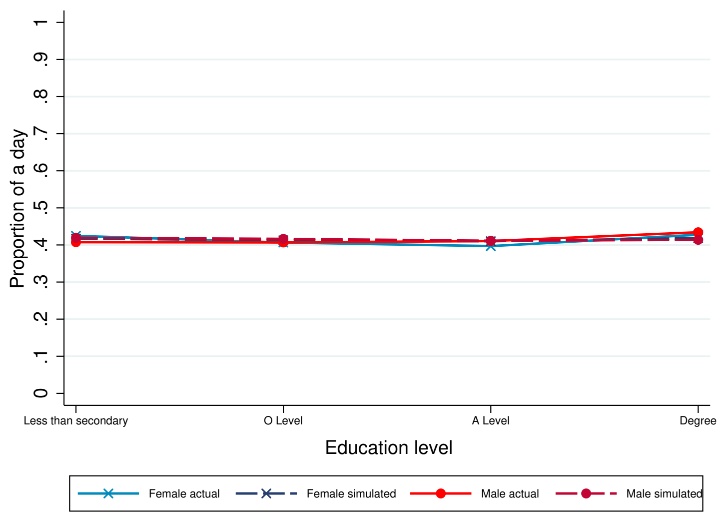


Figure B.1 Base model: simulations for time spent in labor market, home production, leisure (U.K. 2000)

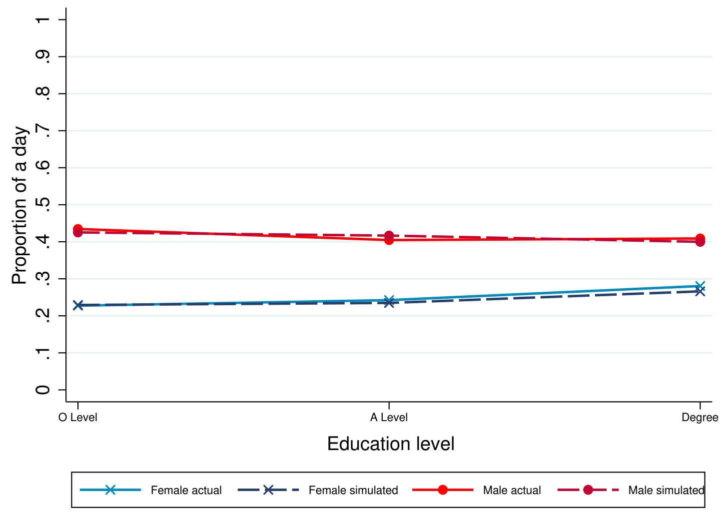
(c) Leisure



Note: Time spent in labor market, home production and leisure is shown as a fraction of the total time endowment of one.

Figure B.2 Base model: simulations for time spent in labor market, home production, leisure (U.K. 2015)

(a) Labor Supply



(b) Domestic Work

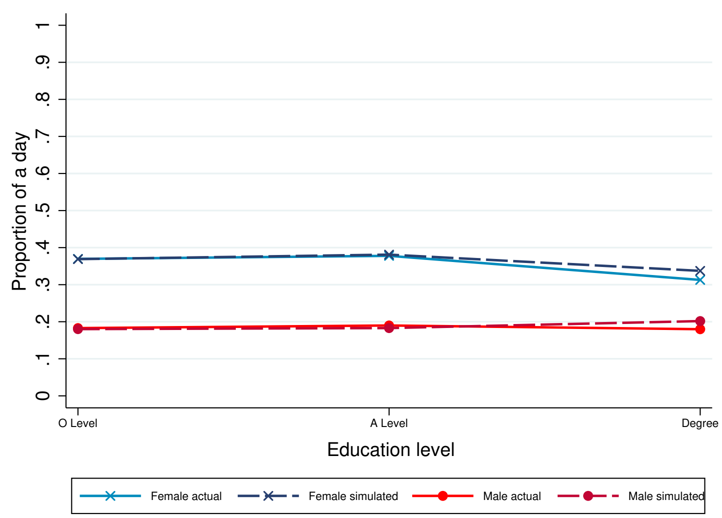
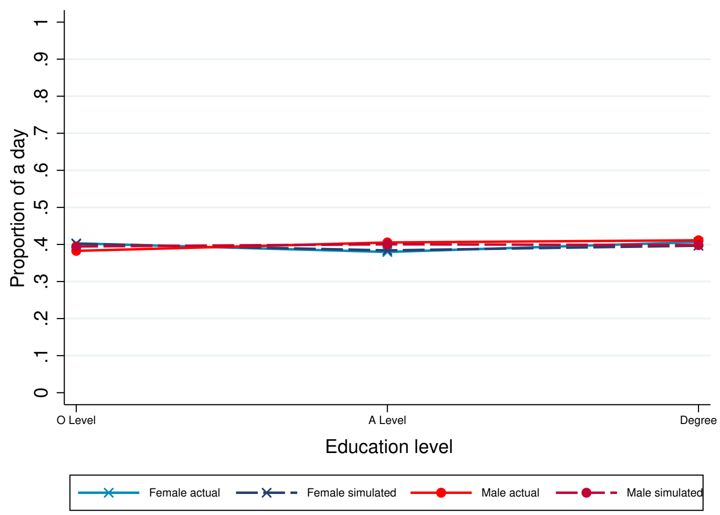


Figure B.2 (contd.) Base model: simulations for time spent in labor market, home production, leisure (U.K. 2015)

(c) Leisure



Note: Time spent in labor market, home production and leisure is shown as a fraction of the total time endowment of one.

C Base model and norms constraint

C.1 Base Model

Solution of Household optimization problem:
The Lagrangian of the household optimization problem is $L = U + \lambda_1(\sum_g w_g^e n_g^e - \sum_g c_g^e - q)$, where $U = \theta^{i,j} U_m^j + (1-\theta^{i,j}) U_f^i$ and $U_g = \log(c_g^e) + \phi_L \log(1 - n_g^e - h_g^e) + \phi_H \log(H_g^e)$, $g \in \{m, f\}$. Further, as mentioned above, we have assumed that $H_g^e = H$, $\forall g = f, m$ with the specification $H = q^\delta [z_m (a_m^j h_m^{i,j})^{1-\rho} + z_f (a_f^i h_f^{i,j})^{1-\rho}]^{(1-\delta)/(1-\rho)}$. First order conditions with respect to the choice variables are as follows:

$$c_m^{i,j} \ : \frac{\theta^{i,j}}{c_m^{i,j}} = \lambda_1, \tag{C.9}$$

$$c_f^{i,j} \ : \frac{1-\theta^{i,j}}{c_f^{i,j}} = \lambda_1, \tag{C.10}$$

$$q \ : \frac{\phi_H \delta}{q} = \lambda_1, \tag{C.11}$$

$$n_m^{i,j} \ : \frac{\theta^{i,j} \phi_L}{1 - n_m^{i,j} - h_m^{i,j}} = \lambda_1 w_m^j, \tag{C.12}$$

$$n_f^{i,j} \ : \frac{(1-\theta^{i,j}) \phi_L}{1 - n_f^{i,j} - h_f^{i,j}} = \lambda_1 w_f^i, \tag{C.13}$$

$$h_m^{i,j} \ : \frac{\theta^{i,j} \phi_L}{1 - n_m^{i,j} - h_m^{i,j}} = \frac{\phi_H (1-\delta) z_m (a_m^j h_m^{i,j})^{1-\rho}}{h_m^{i,j} (z_m (a_m^j h_m^{i,j})^{1-\rho} + z_f (a_f^i h_f^{i,j})^{1-\rho})}, \tag{C.14}$$

$$h_f^{i,j} \ : \frac{(1-\theta^{i,j}) \phi_L}{1 - n_f^{i,j} - h_f^{i,j}} = \frac{\phi_H (1-\delta) z_f (a_f^i h_f^{i,j})^{1-\rho}}{h_f^{i,j} (z_m (a_m^j h_m^{i,j})^{1-\rho} + z_f (a_f^i h_f^{i,j})^{1-\rho})}. \tag{C.15}$$

From (C.12) and (C.14), we can write $\lambda_1 w_m^j = \frac{(1-\delta) z_m (a_m^j h_m^{i,j})^{1-\rho}}{h_m^{i,j} (z_m (a_m^j h_m^{i,j})^{1-\rho} + z_f (a_f^i h_f^{i,j})^{1-\rho})}$. Similarly, from (C.13) and (C.15), we can have $\lambda_1 w_f^i = \frac{(1-\delta) z_f (a_f^i h_f^{i,j})^{1-\rho}}{h_f^{i,j} (z_m (a_m^j h_m^{i,j})^{1-\rho} + z_f (a_f^i h_f^{i,j})^{1-\rho})}$. Taking the ratio of the above two equations we get,

$$\frac{h_f^{i,j}}{h_m^{i,j}} = \left(\frac{w_m^j z_f (a_f^i)^{1-\rho}}{z_m w_f^i (a_m^j)^{1-\rho}}\right)^{1/\rho}. \tag{C.16}$$

We denote this ratio as $\gamma = (\frac{w_m^j z_f (a_f^i)^{1-\rho}}{z_m w_f^i (a_m^j)^{1-\rho}})^{1/\rho} = \frac{h_f^{i,j}}{h_m^{i,j}}$. Using, (C.9) and (C.10) and substituting

λ_1 in terms of q from (C.11) we can re-write the budget constraint as,

$$q(1+\frac{1}{\phi_H\delta}) = (w_m^j n_m^{i,j} + w_f^i n_f^{i,j}). \tag{C.17}$$

Similarly, adding (C.14) and (C.15) and eliminating λ_1 using (C.11) we get,

$$q(\frac{1}{\delta}-1) = (w_m^j h_m^{i,j} + w_f^i h_f^{i,j}). \tag{C.18}$$

Adding (C.17) and (C.18) we get,

$$q(\frac{1}{\delta}+\frac{1}{\delta\phi_H}) = w_m^j(h_m^{i,j}+n_m^{i,j}) + w_f^i(h_f^{i,j}+n_f^{i,j}). \tag{C.19}$$

We can re-write (C.12) and (C.13) after eliminating λ_1 using (C.11) as follows,

$$n_m^{i,j}+h_m^{i,j} = 1-\frac{\theta^{i,j}q\phi_L}{\delta w_m^j\phi_H},$$

and

$$n_f^{i,j}+h_f^{i,j} = 1-\frac{(1-\theta^{i,j})q\phi_L}{\delta w_f^i\phi_H}.$$

Therefore we can solve for q using the above two equations and equation (C.19), giving us,

$$q = \frac{\delta(w_m^j+w_f^i)}{(1+\frac{(1+\phi_L)}{\phi_H})}. \tag{C.20}$$

Using $h_f^{i,j}=\gamma h_m^{i,j}$ we can solve for $h_m^{i,j}$ from (C.14), where we replace the LHS using (C.12) and substitute for λ_1 from (C.11). Which gives us $h_m^{i,j}=\frac{(1-\delta)qz_m((a_m^j)^{1-\rho})}{\delta w_m^j(z_m(a_m^j)^{1-\rho}+z_f(\gamma(a_f^i)^{1-\rho})}$ or using the value of q from (C.20), rearranging

$$h_m^{i,j} = \frac{(1-\delta)(1+\frac{w_f^i}{w_m^j})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_m^{i,j}+1)} \tag{C.21}$$

where $\Psi_m^{i,j}=(\frac{z_f}{z_m})^{1/\rho}(\frac{w_m^j a_f^i}{w_f^i a_m^j})^{\frac{1-\rho}{\rho}}$ and using $h_f^{i,j}=\gamma h_m^{i,j}$ gives us

$$h_f^{i,j} = \frac{(1-\delta)(1+\frac{w_m^j}{w_f^i})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_f^{i,j}+1)} \tag{C.22}$$

where, $\Psi_f^{i,j} = 1/\Psi_m^{i,j}$. Now $n_m^{i,j} = 1 - \frac{\theta^{i,j} q \phi_L}{\delta w_m^j \phi_H} - h_m^{i,j}$ implies that

$$n_m^{i,j} = 1 - \frac{\theta^{i,j}(w_m^j + w_f^i)}{(1 + \frac{(1+\phi_H)}{\phi_L})w_m^j} - \frac{(1-\delta)(1+\frac{w_f^i}{w_m^j})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_m^{i,j}+1)}. \tag{C.23}$$

Also, $n_f^{i,j} = 1 - \frac{(1-\theta^{i,j}) q \phi_L}{\delta w_f^i \phi_H} - h_f^{i,j}$, and which implies that

$$n_f^{i,j} = 1 - \frac{(1-\theta^{i,j})(w_m^j + w_f^i)}{(1 + \frac{(1+\phi_H)}{\phi_L})w_f^i} - \frac{(1-\delta)(1+\frac{w_m^j}{w_f^i})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_f^{i,j}+1)}. \tag{C.24}$$

The expressions for $l_m^{i,j}$ and $l_f^{i,j}$ are obtained by using $l_m^{i,j} = 1 - n_m^{i,j} - h_m^{i,j}$ and $l_f^{i,j} = 1 - n_f^{i,j} - h_f^{i,j}$, which finally result in

$$l_m^{i,j} = \frac{\theta^{i,j}(1+\frac{w_f^i}{w_m^j})}{(1+\frac{(1+\phi_H)}{\phi_L})}, \tag{C.25}$$

and

$$l_f^{i,j} = \frac{(1-\theta^{i,j})(1+\frac{w_m^j}{w_f^i})}{(1+\frac{(1+\phi_H)}{\phi_L})}. \tag{C.26}$$

Comparisons: Comparisons of labor supply in the market and time spent on home production between two different education groups for both women and men are presented below.

Change in time spent in labor market by women: From the expression derived for female labor supply to the market, we can write the difference in the labor force choice made by women at two consecutive education levels ($i+1$ and i matched to husbands with education levels k and j respectively) as,

$$\begin{aligned} n_f^{i+1,k} - n_f^{i,j} = \Lambda\big[&\underbrace{(1-\theta^{i,j}) - (1-\theta^{i+1,k})}_{a} + \underbrace{(1-\theta^{i,j})\frac{w_m^j}{w_f^i} - (1-\theta^{i+1,k})\frac{w_m^k}{w_f^{i+1}}}_{b} \big] \\ &+ (1-\delta)\Lambda\big[\underbrace{\frac{1+\frac{w_m^j}{w_f^i}}{1+\Psi_f^{i,j}} - \frac{1+\frac{w_m^k}{w_f^{i+1}}}{1+\Psi_f^{i+1,k}}}_{c} \big] \end{aligned} \tag{C.27}$$

where $\Psi_f^{i,j} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^i a_m^j}{w_m^j a_f^i})^{\frac{1-\rho}{\rho}}$, $\Psi_f^{i+1,k} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^{i+1} a_m^k}{w_m^k a_f^{i+1}})^{\frac{1-\rho}{\rho}}$ and $\Lambda = (1 + \frac{1+\phi_H}{\phi_L})^{-1} > 0$.

As discussed earlier in Section 3.1, the above expression shows that the base model is capable of generating a non-monotonic relationship of women's labor supply with their education.

Change in time spent in home production by women: From the expression derived above for female time spent at home production, we can write the time at home production chosen by a wife at higher education level $i+1$ who is matched with a husband of education level k, and that chosen by a wife with a lower education level i matched with a husband of education level j as

$$h_f^{i,j} = \frac{(1-\delta)(1+\frac{w_m^j}{w_f^i})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_f^{i,j}+1)}, \Psi_f^{i,j} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^i a_m^j}{w_m^j a_f^i})^{\frac{1-\rho}{\rho}},$$

$$h_f^{i+1,k} = \frac{(1-\delta)(1+\frac{w_m^k}{w_f^{i+1}})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_f^{i+1,k}+1)}, \Psi_f^{i+1,k} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^{i+1} a_m^k}{w_m^k a_f^{i+1}})^{\frac{1-\rho}{\rho}}.$$

This implies

$$h_f^{i+1,k} - h_f^{i,j} = (1-\delta)\Lambda[(\frac{1+\frac{w_m^k}{w_f^{i+1}}}{1+\Psi_f^{i+1,k}}) - (\frac{1+\frac{w_m^j}{w_f^i}}{1+\Psi_f^{i,j}})] \tag{C.28}$$

where $\Psi_f^{i,j} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^i a_m^j}{w_m^j a_f^i})^{\frac{1-\rho}{\rho}}$, $\Psi_f^{i+1,k} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^{i+1} a_m^k}{w_m^k a_f^{i+1}})^{\frac{1-\rho}{\rho}}$ and $\Lambda = (1+\frac{1+\phi_H}{\phi_L})^{-1} > 0$.

The above expression shows that the change in time spent in home production by a wife as her education increases depends on relative wage and relative home productivity of the matched spouses. If wife's relative wage increases with her education ($\frac{w_m^k}{w_f^{i+1}} < \frac{w_m^j}{w_f^i}$) then her time spent in home production would fall. However, if there is a simultaneous increase in her relative home productivity ($\frac{a_m^k}{a_f^{i+1}} < \frac{a_m^j}{a_f^i}$), her time in home production would increase. The final direction of change in home production time depends on the magnitude of the movements in relative wage and relative home productivity, as wife's education increases.

In a similar manner, it is straightforward to write the comparative static conditions for the changes in time spent by men in labor market and home production as their education increases.

Change in time spent in labor market by men: From the expression derived for male labor supply to the market, we can write the labor force chosen by a husband at higher education level $j+1$ who is matched with a wife of education level k, and that chosen by a husband with a lower education level j matched with a wife of education level i as

$$n_m^{i,j} = 1 - \frac{(\theta^{i,j})(1+\frac{w_f^i}{w_m^j})}{(1+\frac{(1+\phi_H)}{\phi_L})} - \frac{(1-\delta)(1+\frac{w_f^i}{w_m^j})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_m^{i,j}+1)}, \Psi_m^{i,j} = (\frac{z_f}{z_m})^{1/\rho}(\frac{w_m^j a_f^i}{w_f^i a_m^j})^{\frac{1-\rho}{\rho}}$$

$$n_m^{k,j+1} = 1 - \frac{(\theta^{k,j+1})(1+\frac{w_f^k}{w_m^{j+1}})}{(1+\frac{(1+\phi_H)}{\phi_L})} - \frac{(1-\delta)(1+\frac{w_f^k}{w_m^{j+1}})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_m^{k,j+1}+1)}, \Psi_m^{k,j+1} = (\frac{z_f}{z_m})^{1/\rho}(\frac{w_m^{j+1} a_f^k}{w_f^k a_m^{j+1}})^{\frac{1-\rho}{\rho}}.$$

This implies

$$\begin{aligned} n_m^{k,j+1} - n_m^{i,j} &= \Lambda[\theta^{i,j}(1+\frac{w_f^i}{w_m^j}) - \theta^{k,j+1}(1+\frac{w_f^k}{w_m^{j+1}})] \\ &\quad + (1-\delta)\Lambda[(\frac{1+\frac{w_f^i}{w_m^j}}{1+\Psi_m^{i,j}}) - (\frac{1+\frac{w_f^k}{w_m^{j+1}}}{1+\Psi_m^{k,j+1}})] \end{aligned} \tag{C.29}$$

where $\Psi_f^{i,j} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^i a_m^j}{w_m^j a_f^i})^{\frac{1-\rho}{\rho}}$, $\Psi_f^{k,j+1} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^k a_m^{j+1}}{w_m^{j+1} a_f^k})^{\frac{1-\rho}{\rho}}$ and $\Lambda = (1+\frac{1+\phi_H}{\phi_L})^{-1} > 0$.

The expression shows that the model is also capable of generating a non-monotonic relationship of husband's labor supply with increase in his education. The three factors affecting the change in husband's labor force choice with his education are - change in Pareto weights, change in spousal wage ratio and change in spousal home productivity ratio - as his education increases. The final effect depends on the direction and the magnitude of each of the three components.

Change in Time spent in home production by men: From the expression derived for male time spent at home production, we can write the time in home production chosen by a husband at higher education level $j+1$ who is matched with a wife of education level k, and that chosen by a husband with a lower education level j matched with a wife of education level i as

$$h_m^{i,j} = \frac{(1-\delta)(1+\frac{w_f^i}{w_m^j})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_m^{i,j}+1)}, \Psi_m^{i,j} = (\frac{z_f}{z_m})^{1/\rho}(\frac{w_m^j a_f^i}{w_f^i a_m^j})^{\frac{1-\rho}{\rho}}$$

$$h_m^{k,j+1} = \frac{(1-\delta)(1+\frac{w_f^k}{w_m^{j+1}})}{(1+\frac{(1+\phi_L)}{\phi_H})(\Psi_m^{k,j+1}+1)}, \Psi_m^{k,j+1} = (\frac{z_f}{z_m})^{1/\rho}(\frac{w_m^{j+1} a_f^k}{w_f^k a_m^{j+1}})^{\frac{1-\rho}{\rho}}.$$

This implies

$$h_m^{k,j+1} - h_m^{i,j} = (1-\delta)\Lambda[(\frac{1+\frac{w_f^k}{w_m^{j+1}}}{1+\Psi_m^{k,j+1}}) - (\frac{1+\frac{w_f^i}{w_m^j}}{1+\Psi_m^{i,j}})] \tag{C.30}$$

where $\Psi_f^{i,j} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^i a_m^j}{w_m^j a_f^i})^{\frac{1-\rho}{\rho}}$, $\Psi_f^{k,j+1} = (\frac{z_m}{z_f})^{1/\rho}(\frac{w_f^k a_m^{j+1}}{w_m^{j+1} a_f^k})^{\frac{1-\rho}{\rho}}$ and $\Lambda = (1+\frac{1+\phi_H}{\phi_L})^{-1} > 0$.

Again, it is straightforward to see that the husband's time spent in home production reduces as his relative wage improves with education ($\frac{w_f^k}{w_m^{j+1}} < \frac{w_f^i}{w_m^j}$) and increases if his relative home productivity improves with education ($\frac{a_f^k}{a_m^{j+1}} < \frac{a_f^i}{a_m^j}$). The final direction of change depends on the direction and the magnitude of these two effects.

C.2 Norms constraint

Solution of Household optimization problem:
The Lagrangian of the household's maximization problem is now $L = U + \lambda_1(\sum_g w_g^e n_g^e - \sum_g c_g^e - q)$. where $U = \theta^{i,j} U_m^j + (1-\theta^{i,j}) U_f^i$, and $U_g = log(c_g^e) + \phi_L log(1-n_g^e-h_g^e) + \phi_H log(H_g^e)$, $g \in \{m, f\}$, with $H = q^\delta (a_f^i h_0)^{(1-\delta)}$. First order conditions with respect to various variables are as follows:

$$c_m^{i,j} \ : \frac{\theta^{i,j}}{c_m^{i,j}} = \lambda_1, \tag{C.31}$$

$$c_f^{i,j} \ : \frac{1-\theta^{i,j}}{c_f^{i,j}} = \lambda_1, \tag{C.32}$$

$$q \ : \frac{\phi_H \delta}{q} = \lambda_1, \tag{C.33}$$

$$n_m^{i,j} \ : \frac{\theta^{i,j}\phi_L}{1-n_m^{i,j}} = \lambda_1 w_m^j, \tag{C.34}$$

$$n_f^{i,j} \ : \frac{(1-\theta^{i,j})\phi_L}{1-n_f^{i,j}-h_0} = \lambda_1 w_f^i. \tag{C.35}$$

Equations (C.34) and (C.35) can be re-written as

$$n_m^{i,j} = 1 - \frac{\theta^{i,j}\phi_L}{\lambda_1 w_m^j}, \tag{C.36}$$

$$n_f^{i,j} = 1 - h_0 - \frac{(1-\theta^{i,j})\phi_L}{\lambda_1 w_f^i}. \tag{C.37}$$

Substituting for $n_m^{i,j}$, $n_f^{i,j}$, $c_m^{i,j}$, $c_f^{i,j}$ and q from the first order conditions in terms of λ_1 in the budget constraint we get $\lambda_1 = \frac{1+\phi_H\delta+\phi_L}{w_m^j + w_f^i(1-h_0)}$. We then substitute this expression for λ_1

in (C.36) and (C.37) to get $n_m^{i,j}$ and $n_f^{i,j}$ in terms of the exogenous variables. The final expressions of market labor and home production time for both men and women are as follows:

$$n_f^{i,j} = 1 - h_0 - \frac{(1-\theta^{i,j})(1-h_0+\frac{w_m^j}{w_f^i})}{1+(\frac{1+\phi_H\delta}{\phi_L})}, \tag{C.38}$$

$$n_m^{i,j} = 1 - \frac{\theta^{i,j}(1+(1-h_0)\frac{w_f^i}{w_m^j})}{1+(\frac{1+\phi_H\delta}{\phi_L})}, \tag{C.39}$$

$$l_f^{i,j} = 1 - n_f^{i,j} - h_0 = \frac{(1-\theta^{i,j})(1-h_0+\frac{w_m^j}{w_f^i})}{1+(\frac{1+\phi_H\delta}{\phi_L})}, \tag{C.40}$$

$$l_m^{i,j} = 1 - n_m^{i,j} = \frac{\theta^{i,j}(1+(1-h_0)\frac{w_f^i}{w_m^j})}{1+(\frac{1+\phi_H\delta}{\phi_L})}. \tag{C.41}$$

Also, from the F.O.C with respect to q we have $\frac{\phi_H\delta}{q} = \lambda_1$ which implies $q = \frac{\phi_H\delta}{\lambda_1}$ and using the expression for λ_1 derived earlier we can write

$$q = \frac{w_m^j + w_f^i(1-h_0)}{(1+(\frac{1+\phi_L}{\phi_H\delta}))}. \tag{C.42}$$

Comparisons: Comparisons of labor supply in the market for both women (n_f) and men (n_m) are presented below. From the expression derived for female labor force choice, we can write the difference in labor supply choice made by a wife of education $i+1$ matched to a husband of education level k and a wife of education i matched to a husband of education level j, with the social norms constraint as:

$$n_f^{i+1,k} - n_f^{i,j} = \left[\frac{1}{1+\frac{1+\phi_H\delta}{\phi_L}}\right]\left[(1-h_0)\underbrace{[(1-\theta^{i,j})-(1-\theta^{i+1,k})]}_{d} + \underbrace{[(1-\theta^{i,j})\frac{w_m^j}{w_f^i} - (1-\theta^{i+1,k})\frac{w_m^k}{w_f^{i+1}}]}_{e}\right].$$

Here two quantities determine the change in wife's labor supply choice as her education increases - change in Pareto weights and change in spousal wage ratio. As wife's education increases, Pareto weight on her preferences is likely to go up resulting in a fall in her labor supply. Whether there is eventually a fall or a rise in her labor supply depends on the direction of movement in the spousal wage ratio. In general, wife's labor supply increases if her wage relative to her husband's wage increases with her education and vice versa. Thus, the social norms case is also capable of generating a non-monotonic relationship between wife's education and her labor supply.

Similarly, the change in labor supply of husband with increase in his education can be written as:

$$n_m^{k,j+1} - n_m^{i,j} = \left[\frac{1}{1+\frac{1+\phi_H\delta}{\phi_L}}\right]\left[\theta^{i,j}(1+(1-h_0)\frac{w_f^i}{w_m^j}) - \theta^{k,j+1}(1+(1-h_0)\frac{w_f^k}{w_m^{j+1}})\right].$$

Clearly, again there are are two factors affecting the direction of change - change in Pareto weights and change in spousal wage ratio - as husband's education increases. Hence, husband's labor supply can increase or decrease depending on the direction and magnitude of the two factors.

D Marriage market: Assortative matching conditions

Parents often make decisions related to children in their adolescence, especially so in developing countries. In addition, the marriage market, in countries such as India, is characterized by positive assortative matching in terms of the levels of education of the man and woman (See Table below). The model that we have presented above can explain this fact well and we show this theoretical result particularly in the base model with the social norm constraint.

Table D.1 Education level of husband for each level of wife's education

	Education level of husband					
Education level of wife	Illiterate	Less than primary	Primary	Middle	Higher Secondary	Graduate and above
Illiterate	36.05	19.78	13.92	14.83	14.08	1.33
Less than primary	5.59	33.32	14.13	23.31	19.69	3.95
Primary	1.85	5.72	25.13	28.19	34.53	4.58
Middle	4.82	2.3	7.83	29.83	46.55	8.68
Higher Secondary	0.25	0.72	3.95	7.97	55.62	31.49
Graduate and above	0.66	0.31	0.2	1.14	12.19	85.5

Source: Time Use Survey 1998 (Authors' own calculations).
Note: These matching rates are calculated using data on 3725 couples in the Time Use Data.

We denote the additional utility obtained from marriage over remaining single when a woman of education level i marries a man of education level j and level k by $\Sigma_{i,j}$ and $\Sigma_{i,k}$ respectively. The condition under which a matching (i,k) is preferred to the matching (i,j) to a woman is given by $\Sigma_{i,k} - \Sigma_{i,j} > 0$. In this appendix, we show that this condition can be satisfied if $w_m^k > w_m^j$ by a sufficiently large amount, to overcome the negative effect generated from falling Pareto weights.[39] Since wages increase with the level of education, the matching (i,k) is preferred to the matching (i,j) if wage returns to education level k is sufficiently greater than that for education level j.

Similarly, the additional utility obtained from marriage over remaining single when a man of education level j marries a woman of education level i and k are denoted by $\Omega_{i,j}$ and $\Omega_{k,j}$ respectively. The condition under which matching (k,j) is preferred to the matching (i,j) to a man is then given by $\Omega_{k,j} - \Omega_{i,j} > 0$. We show later that the inequality holds when $w_f^k > w_f^i$ and/or $a_f^k > a_f^i$ are/is large enough to overcome the loss due to the fall in the Pareto weight. Combining the above two, we can then claim that both men and women prefer a spouse of higher education, if the wage returns are sufficiently higher for men and wage returns or home productivity returns are sufficiently higher for women, as their education increases.

[39] Instead of verifying it through additional utility gain, a direct comparison between the utility of matched men with education level j and k will lead to the same conclusion.

Since there are a finite number of individuals at each education level, the above result leads to positive assortative matching on education.

Our claim suggests, therefore, that parental investments in daughters' education may be to enhance their value in the marriage market rather than the labor market (e.g. Attanasio and Kaufmann (2017)) in developing economies. This ties in with the social norm of women bearing a disproportionately higher burden of household chores and the findings of the previous literature on the value attached to educated wives (e.g. Behrman et al. (1999)). Hence, the centrality of marriage market considerations necessitates incorporating the role of home productivity in households' labor supply decisions. Future research could analyse parental decision-making in understanding women's labor supply in a life-cycle framework if and when cohort level data become available.

D.1 Model for unmarried individuals

An unmarried agent maximizes $\max_{c_g^e, n_g^e, h_g^e, q} U_g^e$ where $U_g^e = \log(c_g^e) + \phi_L \log(1 - n_g^e - h_g^e) + \phi_H \log(H)$ is the utility derived from consumption c_g^e, leisure $l_g^e = 1 - n_g^e - h_g^e$ where n_g^e is the time spent on market work and h_g^e is the time spent on home production. Home production H here takes the form $H = q^\delta (a_g^e h_g^e)^{1-\delta}$ since the home good is produced by a single person. Variable q represents the amount spent on the market good, and a_g^e measures productivity in producing home good. The budget set on which the agent maximizes utility is given by $c_g^e + q = w_g^e n_g^e$.

The lagrangian of the above problem can be written as $L = U_g^e + \lambda(w_g^e n_g^e - c_g^e - q)$. The First Order Conditions are given as follows:

w.r.t. c_g^e :

$$\frac{1}{c_g^e} = \lambda, \tag{D.1}$$

w.r.t. q :

$$\frac{\phi_H \delta}{q} = \lambda, \tag{D.2}$$

w.r.t. n_g^e :

$$\frac{\phi_L}{1 - n_g^e - h_g^e} = \lambda w_g^e, \tag{D.3}$$

w.r.t. h_g^e :

$$\frac{\phi_L}{1 - n_g^e - h_g^e} = \frac{\phi_H (1-\delta)}{h_g^e}, \tag{D.4}$$

w.r.t. λ :

$$c_g^e + q = w_g^e n_g^e. \tag{D.5}$$

Substituting c_g^e and q from (D.1) and (D.2) into (D.5), we get

$$\lambda = \frac{1+\phi_H\delta}{w_g^e n_g^e}. \tag{D.6}$$

Substituting λ from (D.6) into (D.3) and (D.4), we get

$$h_g^e = \frac{n_g^e \phi_H(1-\delta)}{1+\phi_H\delta}. \tag{D.7}$$

Rearranging (D.4), we can write $(\phi_L + \phi_H(1-\delta))h_g^e = \phi_H(1-\delta)(1-n_g^e)$. Now substituting the expression for h_g^e from (D.7) in the above expression we get, $(\phi_L + \phi_H(1-\delta))\frac{n_g^e\phi_H(1-\delta)}{1+\phi_H\delta} = \phi_H(1-\delta)(1-n_g^e)$, which implies

$$n_g^e = \frac{1+\phi_H\delta}{1+\phi_L+\phi_H}. \tag{D.8}$$

Also substituting the above expression for n_g^e in (D.7), we get

$$h_g^e = \frac{\phi_H(1-\delta)}{1+\phi_L+\phi_H}, \tag{D.9}$$

and therefore

$$l_g^e = 1 - n_g^e - h_g^e = \frac{\phi_L}{1+\phi_L+\phi_H}. \tag{D.10}$$

We also have $\lambda = \frac{\phi_H(1-\delta)}{w_g^e h_g^e}$ from (D.6), which gives

$$c_g^e = \frac{w_g^e}{1+\phi_L+\phi_H} \tag{D.11}$$

and

$$q = \frac{w_g^e \phi_H \delta}{1+\phi_L+\phi_H}. \tag{D.12}$$

Using the above expressions, the indirect utility functions for women and men can be written as follows,

$S_f^i = \log(\frac{w_f^i}{1+\phi_L+\phi_H}) + \phi_L \log(\frac{\phi_L}{1+\phi_L+\phi_H}) + \phi_H(\delta \log(\frac{w_f^i\phi_H\delta}{1+\phi_L+\phi_H}) + (1-\delta)\log(\frac{a_f^i\phi_H(1-\delta)}{1+\phi_L+\phi_H}))$ and
$S_m^j = \log(\frac{w_m^j}{1+\phi_L+\phi_H}) + \phi_L \log(\frac{\phi_L}{1+\phi_L+\phi_H}) + \phi_H(\delta \log(\frac{w_m^j\phi_H\delta}{1+\phi_L+\phi_H}) + (1-\delta)\log(\frac{a_m^j\phi_H(1-\delta)}{1+\phi_L+\phi_H}))$.

D.2 Indirect utility for married individuals in the model with norms

We have the following expressions for the endogenous variables in the model with norms:

$$c_m^{i,j} = \frac{\theta^{i,j}(w_m^j + w_f^i(1-h_0))}{1+\phi_H\delta+\phi_L}, \tag{D.13}$$

$$c_f^{i,j} = \frac{(1-\theta^{i,j})(w_m^j + w_f^i(1-h_0))}{1+\phi_H\delta+\phi_L}, \tag{D.14}$$

$$n_f^{i,j} = 1-h_0 - \frac{(1-\theta^{i,j})(1-h_0+\frac{w_m^j}{w_f^i})}{1+(\frac{1+\phi_H\delta}{\phi_L})}, \tag{D.15}$$

$$n_m^{i,j} = 1 - \frac{\theta^{i,j}(1+(1-h_0)\frac{w_f^i}{w_m^j})}{1+(\frac{1+\phi_H\delta}{\phi_L})}, \tag{D.16}$$

$$l_f^{i,j} = \frac{(1-\theta^{i,j})(1-h_0+\frac{w_m^j}{w_f^i})}{1+(\frac{1+\phi_H\delta}{\phi_L})}, \tag{D.17}$$

$$l_m^{i,j} = \frac{\theta^{i,j}(1+(1-h_0)\frac{w_f^i}{w_m^j})}{1+(\frac{1+\phi_H\delta}{\phi_L})}, \tag{D.18}$$

$$h_f^{i,j} = h_0, h_m^{i,j} = 0, \tag{D.19}$$

and

$$q = \frac{w_m^j + w_f^i(1-h_0)}{(1+(\frac{1+\phi_L}{\phi_H\delta}))}. \tag{D.20}$$

Using the expressions for the choice variables derived above, we get the following expressions for indirect utility for married men and women respectively:
$U_m^j = \log(\theta^{i,j}\Pi_{i,j}) + \phi_L \log(\phi_L \frac{\theta^{i,j}\Pi_{i,j}}{w_m^j}) + \zeta_{i,J}$, and
$U_f^i = \log((1-\theta^{i,j})\Pi_{i,j}) + \phi_L \log(\phi_L \frac{(1-\theta^{i,j})\Pi_{i,j}}{w_f^i}) + \zeta_{i,J}$ where
$\Pi_{i,j} = \frac{w_m^j + w_f^i(1-h_0)}{1+\phi_H\delta+\phi_L}$ and $\zeta_{i,J} = \phi_H\delta \log(\phi_H\delta\Pi_{i,j}) + \phi_H(1-\delta)\log(a_f^i h_0)$.

Comparison of indirect utility between married and unmarried

It can be easily verified that
$U_f^i - S_f^i = (1+\phi_L)\log(\frac{(1-\theta^{i,j})\Xi_{i,j}}{w_f^i}) + \phi_H\delta\log(\frac{\Xi_{i,j}}{w_f^i}) + \phi_H(1-\delta)\log(\varphi)$, and
$U_m^j - S_m^j = (1+\phi_L)\log(\frac{\theta^{i,j}\Xi_{i,j}}{w_m^j}) + \phi_H\delta\log(\frac{\Xi_{i,j}}{w_m^j}) + \phi_H(1-\delta)\log(\varphi\frac{a_f^i}{a_m^j})$ where
$\Xi_{i,j} = \frac{(w_m^j + w_f^i(1-h_0))(1+\phi_L+\phi_H)}{(1+\phi_H\delta+\phi_L)}$ and $\varphi = \frac{h_0(1+\phi_L+\phi_H)}{\phi_H(1-\delta)}$.

For both the equations, the first expression in the right hand side denotes the gain in utility from consumption and leisure for married women compared to unmarried women. The remaining expressions in the right denote the gain in utility from additional home production for married compared to unmarried.

D.3 Comparison of matching types

For women

Using the above expressions we can derive the additional utility obtained from marriage over remaining single when a woman of education level i marries a man of education level j, denoted by $\Sigma_{i,j}$ above, and is given by $\Sigma_{i,j} = (1+\phi_L)\log(\Xi_{i,j}\frac{1-\theta^{i,j}}{w_f^i}) + \phi_H\delta\log(\Xi_{i,j}\frac{1}{w_f^i}) + \phi_H(1-\delta)\log\varphi$. Similarly we can derive $\Sigma_{i,k}$ and finally we get $\Sigma_{i,k} - \Sigma_{i,j} = (1+\phi_H\delta + \phi_L)\log(\frac{w_m^k + w_f^i(1-h_0)}{w_m^j + w_f^i(1-h_0)}) + (1+\phi_L)\log(\frac{1-\theta^{i,k}}{1-\theta^{i,j}})$. If higher level of education guarantees higher wage, we have $w_m^k > w_m^j$ and therefore the first term on the right hand side is positive. However, that might also mean (as seen in the data for Pareto weights varying with education level of men and women) that $\theta^{i,k} > \theta^{i,j}$ and therefore $1-\theta^{i,k} < 1-\theta^{i,j}$ which then implies that the second term in the right hand side is negative. The overall effect of the increase of the husband's education level is therefore ambiguous. Note that $\Sigma_{i,k} - \Sigma_{i,j} > 0$ if w_m^k is significantly higher than w_m^j so that it overcomes the negative effect generated from falling Pareto weights.

For men

Similarly, we can derive the additional utility obtained from marriage over remaining single when a man of education level j marries a woman of education level i, denoted by $\Omega_{i,j}$ above, and is given by $\Omega_{i,j} = (1+\phi_L)\log(\Xi_{i,j}\frac{\theta^{i,j}}{w_m^j}) + \phi_H\delta\log(\Xi_{i,j}\frac{1}{w_m^j}) + \phi_H(1-\delta)\log(\varphi\frac{a_f^i}{a_m^j})$. Similarly we can derive $\Omega_{k,j}$ and finally we can show that $\Omega_{k,j} - \Omega_{i,j} > 0$ implies $(1+\phi_H\delta + \phi_L)\log(\frac{w_m^j + w_f^k(1-h_0)}{w_m^j + w_f^i(1-h_0)}) + \phi_H(1-\delta)\log(\frac{a_f^k}{a_f^i}) + (1+\phi_L)\log(\frac{\theta^{k,j}}{\theta^{i,j}}) > 0$. Since both wages and home productivities are increasing functions of education, the first two terms on the left are either both positive or negative at the same time. In particular, as education level of the woman increases i.e. when $k > i$ we have $w_f^k > w_f^i$ and $a_f^k > a_f^i$ which means that the first two terms on the left hand side are positive. However, when $k > i$ we might also have $\theta^{k,j} < \theta^{i,j}$ since it is seen from the data that as the education level of the woman in the household increases it leads a lowering of the husband's bargaining power in the household. This then implies that $\log(\frac{\theta^{k,j}}{\theta^{i,j}}) < 0$. Therefore, the effect of an increase in the wife's education level is positive on the husband's utility through the wage and home productivity channels, but it leads a lowering of his utility due to a lowering of his bargaining power in the household. The sign of the overall effect remains ambiguous. Observe that $\Omega_{k,j} - \Omega_{i,j} > 0$ if $w_f^k > w_f^i$ and/or $a_f^k > a_f^i$ are/is large enough to overcome the loss due to fall in Pareto weight.