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 and social norms in explaining the gender gap in labor force participation (LFP), and the non-monotonic relationship of women's LFP with their education in India. We construct a model of couples' time allocation decisions allowing for both market and home productivity to improve with own education. Incorporating individual preference to produce a minimum level of the home good due to social norms, we show that our theoretical model can closely replicate the U-shaped relationship between women's education and their labor supply. Our analysis suggests that home productivity, along with social benchmarks on couples' time allocation to home good, can be critical determinants of women's labor supply in developing countries.

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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 & Katz, 2000; Greenwood *et al.* , 2005a). 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 low income economies.

We highlight these features of women's labor force participation observed in several developing countries - 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 (gender wage gap) and home produc-

[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 Figure A.1, Appendix A show other middle income 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). Klasen *et al.* (2021), using more recent data from eight developing countries, show that this U-shaped relationship is found to exist in India, Indonesia and Jordan. Tanzania, Bolivia and Vietnam exhibit a slight increase in female LFP with education while South Africa shows a steep rise.

tivity, as education changes.[3] We show theoretically that, with an increase in the education level of women, the gender wage ratio may 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.

In addition, we borrow from the vast literature on status consumption (Duesenberry & Press, 1949) to incorporate a social norm on production of the home good as a third channel that affects couples' labor supply decisions. Specifically, we include individual preferences on the extent to which the household deviates from the social norm of a benchmark level of the home produced good - child quality characterized by household expenditure on education.[4] Thus, households build status through production of a good that society values - the higher the home good production relative to the social norm or benchmark, the higher the utility the individual derives. In this unrestrictive theoretical framework, we do not place any constraints on how much time either the husband or the wife devotes to home production. Thus the social norm on the home good is gender neutral.[5]

We calibrate this model with time use and consumption expenditure data from urban India and simulate it to match the observed data on married women's and men's time on market work, home production and leisure. In urban India, we observe a fall in married women's time spent in the labor market between illiterate and middle education levels and a slight increase thereafter for higher secondary and graduate and above education levels. We show that in our model with the social norm on 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 a rise at higher levels of education. The calibration exercise shows that fall in relative female wage along with an increase in relative female home productivity between illiterate to less than primary explains the fall

[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 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] Here we follow the vast literature on intra-household behavior that has focused extensively on child quality as the public or home good produced within marriage (viz. Becker (1981)). Expenditure on education as a proportion of total household expenditure is amongst the highest categories of private expense incurred - more than 40% in India (National Sample Survey, 1999), and in many developing countries (World Bank).

[5] Note that globally women spend triple the time on unpaid care work (primarily child care) 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 (OECD).

in wife's labor market time upto middle education. The muted increase in female labor time for higher education levels is explained by a large increase in relative female home productivity and bargaining power within the household between middle to higher education levels. Our theoretical predictions, therefore, match the observed data on market work and home production better than a standard model with constant home productivity and no social norm.

Our analysis suggests that home production and social norms on a benchmark level of the home good may act as a constraint on wives' decision to supply labor for market work. 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.[6] 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 India. 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. 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 with children of more educated women spending greater time at home studying, relative to the less educated mothers. Lam & Duryea (1999) show that

[6] Albanesi & 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.

as Brazilian women 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). Contextually, social constraints are likely to be even more relevant in a developing country, particularly as income levels rise and households seek social mobility. Social norm and status goods have been analyzed extensively in the literature in various contexts (e.g. Abel (2006)). Goldin (1994), in her seminal work indicates that social and cultural factors can play a large role in married women's labor supply decisions while Fernández (2013) models the link between cultural change and the evolution of women's labor force participation in the United States. While the microeconomic literature has theorized on gender specific norms where men derive disutility from their wives working (Bertrand *et al.* , 2020; Fernández *et al.* , 2004), to the best of our knowledge, this is the first paper that explicitly models a (gender neutral) norm on home good production in an aggregate macroeconomic framework. We are able to show that even in a framework with no constraints on gender preferences, with households deriving a disutility if the production of the home good falls below a social benchmark, we can closely approximate the observed labor supply of married men and women.[7]

Our findings build on previous work by Lam & Duryea (1999) and Afridi *et al.* (2018) who highlight the U-shaped relationship between women's LFP and own education, and provide suggestive evidence of the role of home productivity in explaining this observed pattern. In contrast, we provide a theoretical framework to explain the mechanism through which home productivity can influence women's LFPR and calibrate the model to see the extent to which it can explain the U-shaped pattern of female LFPR with education. Furthermore, our analysis is able to show that norms enforced by society on the production of the home good may be an additional factor that explain the variation in married women's labor supply with their education. Specifically, we focus on production of a benchmark minimum human capital of the child within marriage, and show that even in the absence of gendered division of time, women may spend more time on domestic work and less in the market.[8]

[7]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. Thus, while social norm on the production of the home good may place a disproportionate burden on women, our theoretical model does not impose any gender constraints on time allocated to home good production.

[8]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

The paper is organized as follows. In Section 2 we present some of the key facts regarding women's labor supply in India 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. We examine alternative mechanisms that can explain changes in women's LFP with education in Section 6, while sensitivity checks on the simulations are reported in Section 7. Section 8 concludes.

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. We use multiple rounds of the National Sample Survey (NSS) of India, which are conducted to capture employment every few years.[9] 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.[10]

Educational attainment has been increasing in India. In 1999, more than 30% of women were illiterate, while the majority of men had at least secondary or higher secondary education. Between 1999 and 2011, educational attainment improved for both men and women, but the improvement was more dramatic for women. The proportion of illiterate men and women (married and in age group 20-45) in urban India fell by 6% and 12%, respectively, during 1999-2011. On the other hand, during the same time period, the proportion com-

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)).

[9]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 due to the unavailability of wage data for almost 70% of the rural workforce, i.e. the self-employed primarily engaged in agriculture (Klasen & Pieters, 2015) in the NSS. However, women's LFPR in rural areas also exhibits a U-shaped relationship with own education (Afridi *et al.* , 2018).

[10]In India 98% urban women above the age 30 are ever married and 95% of them have had at least one child upon marriage (NSS 1999). The average years of difference between age at first marriage and having the first child is ≈ 1.7 years in urban India. Thus, most urban married women in India have a child within the first two years of marriage. Marriage and child birth are intricately linked in the Indian context. These patterns have not changed much during 1998-2015 (National Family Health Survey (NFHS), various rounds).

pleting secondary schooling or more increased by 8% for men compared to 13% for women. Hence, the gender gap in higher educational attainment 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 & Pieters, 2015). Married women in the 20-45 age group have shown very low levels of LFPR, at around 22% - unchanged across the last three decades. Typically, their LFPR declines marginally as education increases from illiterate to middle-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.[11] Almost all married men on the other hand, were 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 gap in market returns to education or market productivity (wages). However, as Figure 2(a) and 2(b) show, the average real wages increase dramatically at higher levels of education for both married men and women. Moreover, the ratio of female to male wages rises (gender wage ratio) significantly at higher levels of education (Figure 2(c)). This rise can also be seen in the ratio of female wage to the wage of their spouses (Appendix Figure A.2).[12] 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 A.3 and Figure A.4, in Appendix A).[13] 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

[11]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 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.

[12]The patterns in the spousal wage ratio will be affected by both wages for each education level by gender as well as by patterns on assortative matching on education. Using data on couples we find that women are more likely to marry men who have education either equal or exceeding their education. Men are more likely to exceed their wife's education for lower levels of wife's education. Thus, the smaller female to male wage ratio at lower levels of education can be explained by assortative matching on education in the marriage market.

[13]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.

men do not behave very differently in terms of their LFPR across education groups.

These observations hold across each cross-section, indicating 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:

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, we henceforth focus on the urban sample of the nationally representative Time Use Survey (TUS) in 1998 for the same demographic group mentioned above.[14] The TUS data allow us to investigate the relationship between education and allocation of time to market work, home production and leisure.

Not surprisingly, Figure 3 shows that average daily 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 3), highlighted previously in Afridi *et al.* (2018). Married women spend, on average, 1.33 hours per day in market work 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 three activities). On the other hand, married men spend

[14]The TUS survey was conducted by the same nodal agency as the NSS surveys. 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. This was then divided by seven to arrive at average hours spent on each activity per day. We combine activities into time spent on the labor market, domestic work and leisure following Aguiar & Hurst (2007). See Appendix B for details on the data set.

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 more hours in a day on market work.[15] 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.[16]

From the following section onwards, we focus entirely on the intensive margin of individuals' time allocation.

2.1 Data

For our analyses we use the two nationally representative data sets discussed above - (1) Time Use Survey (TUS) of 1998 and (2) the National Sample Survey (NSS), Employment and Unemployment Schedule 1999. 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 years.[17] 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.[18] 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. As the TUS does not contain data on wages, the wage returns to education are estimated using the NSS (1999). Corresponding to the sample used in the TUS dataset we restrict the NSS data as well and

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

[16] In contrast to the Indian context, labor supply of women increases with their education in the developed countries. For instance, 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 calculate proportion of time spent on labor market activities to 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.

[17] 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.

[18] 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.

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 (see Appendix B).

Our couples data set indicates that the average time spent on home production (domestic work) in the household (sum of husband and wife's time) is high, at nearly 8.5 hours per day, equivalent to a full day of market work. There is remarkably little variation in the total home production time by households' monthly per capita expenditure (MPCE) - 8.3 hours for the bottom relative to 8 for the top 10% of MPCE. Of the time spent on domestic work, nearly 1/8th (1.4 hours daily) of this time is spent on exclusive child care, again with barely any variation in child care time across households' MPCE (Figure A.5 in Appendix A).[19] This suggests a social benchmark on the time spent on producing the home good of 'child quality' - minimum level of human capital of the child.

Additionally, data on households' education expenditures from the National Sample Survey, Consumption Schedule (1999) show that education is one of the largest components of child quality expenditures by households.[20] Further, we find that child quality, measured by children's learning outcomes, increases with the level of education of their mothers. In the absence of data linking individuals to home produced goods within the household in the TUS, we utilize the Indian Human Development Survey (IHDS) in 2004-05 to examine the relationship between mother's education and her child's learning. Conditional on a number of confounding factors (viz. household's economic status, father's education and district of residence), a rise in mother's education is accompanied by higher reading, writing and math attainment of her children (Table A.1 in Appendix A). This suggests that the productivity of more educated (married) women in home production activities may be higher than that of the less educated.

Based on the above observations, we build a theoretical model that focuses on three determinants of women's labor supply - returns to market, returns to home production and a social norm represented by benchmarked minimum level of home good.

[19]Exclusive child care includes physical care (e.g. feeding and bathing), teaching, schooling supervision and travel with child. Women's contribution dominates household time spent on domestic work and child care, across households' MPCE.

[20]Despite universal free public education more than 68% of urban households reported private expenditure on children's education in 1999 (NSS, Consumption Schedule) in India. Growth in per capita expenditure on education between 1993 - 2011 was not only higher than that of total household expenditure across all income quintiles, it was higher in the bottom 10% of households by monthly per capita expenditure (MPCE) compared to the top 10%. Thus the ratio of per capita expenditure on education of top 10% to the bottom 10% of households declined during this period (Motkuri & Revathi, 2020), indicating higher aspirations for child quality as household incomes rise. Note that household food expenditure is likely to be the largest expenditure category, but food consumption data are not available for individual household members.

3 Theory: Basics

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 total time available to both 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. 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. Further, we assume that when agents are matched and form a household, both of them derive utility from a common home good H. The utility function of an individual is assumed to be additively separable in its arguments.

Crucially, following the vast theoretical literature on status building thorough utility adjustment (see Duesenberry & Press (1949); Clark & Oswald (1998); Ljungqvist & Uhlig (2000); Dupor & Liu (2003); Abel (2006); Buraschi & Jiltsov (2007); Barnett *et al.* (2013); Bishnu (2013), among others), we model individual preferences as subject to a benchmark level of home good production. This social norm results in a utility cost that both household members incur if the home good produced is lower than the benchmark specified by society. Thus, while the home good provides utility to both members, the benchmark affects the household adversely. Precisely, unless the family members produce a level of home good H that is more than the social norm $\bar{H}$, they do not derive any (net) utility from home good production.[21] We do not put any restriction on the hours worked on women or men on any of their activities directly, hence the social norm is gender neutral. In particular, the form

[21] Alternatively, a direct utility penalty because men dislike having their wives work outside the home has been theoretically presented in a model by Bertrand *et al.* (2020) where the home production is solely represented by time allocation to domestic work. Fernández *et al.* (2004) have a somewhat similar theoretical setup with home productivity and both the papers model the decision of marriage. In contrast, ours is a collective decision-making model where agents are already matched and home good production depends on individual productivity, time spent and market inputs. Further, we do not model shocks to individuals' options outside of marriage in the presence of a social norm as in Field *et al.* (2021).

of the utility function is given by,

$$U_g^e = \log(c_g^e) + \phi_L \log(1 - n_g^e - h_g^e) + \phi_H \log(H - \bar{H}),$$

with $g \in \{m, f\}$. Parameters ϕ_L and ϕ_H, both positive, represent the affinity towards leisure and home good, respectively.[22] Note that the home good (H) varies by education level of the matched couple too but for notational simplicity is represented by H throughout the paper.

We assume that agents' education is exogenous to household decision-making because it is pre-determined before household formation.[23] 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, we assume that the level of education also determines the productivity (a) of the agents in generating the home good H. In line with the above discussions, the home good H which is produced using a CES technology, is given by,

$$H = q^\delta \sum_g [z_g(a_g^i h_g^{i,j})^{1-\rho}]^{(1-\delta)/(1-\rho)}$$

where $h_g = h_f$, h_m are the time spent by the woman and the man of the household, respectively, on home production. The terms $a_f^i h_f^{i,j}$ and $a_m^j h_m^{i,j}$, measure effective time of women and men in production of the home good H, respectively. Further, z_g , $g \in \{m, f\}$ represent the share factors in the production function with effective time, where $\sum_g z_g = 1$. 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. Thus, H measures the effective expenditure in home good production.[24]

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

[22]Choice of log additively separable utility function is fairly standard and in our setup it provides us with clean analytical solutions. While we have assumed a subtractive form, $(H - \bar{H})$, a multiplicative form $(H/\bar{H})$ can as well represent the (net) utility from the home good.

[23]For simplicity, if we assume that parental investments determine agents' education then the assumption of home good production in our model partly reinforces investment in education that parents make for their kids and in the process they derive utility as is standard in many macroeconomic studies. Home production, thus, may incorporate investment made or time spent on children for human capital accumulation.

[24]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.

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. 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.[25]

3.1 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:

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

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, the 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. For notational simplicity, we do not put a superscript or subscript on H but it is denoted for the pair i, j. We introduce the parameter $\alpha^{i,j} \in (0,1)$ which represents the inverse of the responsiveness of home good production to a given social norm.[26] In our specification, if all households face the same social benchmark $\bar{H}$, households

[25] Note that we model household decision-making in a framework that assumes Pareto efficient outcomes. We do not make any assumptions about the specific bargaining process between husband and wife by modelling exogenous shocks to options outside marriage (as in cooperative or non-cooperative bargaining models). However, parents (for instance) can strategically choose agent's education before marriage which could affect their bargaining power post-matching.

[26] We follow the standard procedure of computing the competitive equilibrium in this setup. In the first step, the household considers the benchmark $\bar{H}$ as given when optimizing its utility. That is, given the exogenous level of $\bar{H}$ determined by society, household choices maximize the objective (utility) function.

that produce high H have low $\alpha^{i,j}$.[27]

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:

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

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

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

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

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

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

The optimal responses are then derived based on the given $\bar{H}$. In the second step, we plug in the expression for $\bar{H}$ which is formed in the society based on the actual H. Following the literature, this expression of $\bar{H}$ is assumed to be $\bar{H} = \alpha^{i,j} f(H)$, and for simplicity $f(H) = H$ with $\alpha^{i,j} \in [0, 1)$.

[27] In this formulation of the utility function, unless $\alpha^{i,j} = 0$, all households pay a utility cost due to the existence of the social norm, $(-\bar{H})$. As the quantity of own home good decreases, households find it more difficult to beat the social norm and, hence, bear a relatively higher utility cost. Alternatively, suppose $\bar{H}$ is the benchmark level of home good that the society believes every household must produce. Then, an individual household under the competitive equilibrium gets utility from a convex combination of 'own' home good and the 'degree to which it beats the societal benchmark' $\bar{H}$. This can formally be represented as $log([1-\alpha]H + \alpha[H - \bar{H}])$, where $\alpha \in (0, 1)$ is the relative importance given to overcoming the societal norm. Note that this representation is equivalent to $log(H - \alpha\bar{H})$. Assuming $\bar{H} = f(H) = H$ gives us exactly the same form of the utility function as elucidated in Section 3.1. Notice that the utility penalty for the societal norm (because of the existence of benchmark $\bar{H}$) exists irrespective of the amount of home good produced by the household.

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

Using the above expressions, it is straightforward to verify that in this proposed theoretical setup, all the endogenous variables are affected by the social norm. More precisely, for a given level of education i, j, if $\alpha^{i,j}$ is low, both members of the household provide lower labor time in home production and the level of leisure increases for both. However, the accompanying change in labor hours provided in the market remains ambiguous. Further, higher norm also results in higher expenditure on market input q required for home good production. The following two relationships are also, then, obvious from above:

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

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

Note that while θ affects the ratio of relative market labor supply $(n_f^{i,j}/n_m^{i,j})$ as well as leisure $(l_f^{i,j}/l_m^{i,j})$, it does not affect the ratio of time provided for home good production $(h_f^{i,j}/h_m^{i,j})$ because of the public nature of the home good. Also, in this setup relative market labor supply is affected by the benchmark $\bar{H}$. This statement follows directly from equations 2 and 3 above. This is a crucial feature of the model, since not only do we want to capture the effect of norm on individual market labor supply (that is, in absolute terms) but also the variation in the relative labor supply with the benchmark level of $\bar{H}$. This implies that the norm affects the market labor supply of both agents, however the effects are not symmetric and therefore the relative market labor supply is not independent of the parameter $\alpha^{i,j}$.

3.1.1 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,

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

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, keeping other factors constant, $n_f^{i,j}$ increases with the level of w_f/w_m, that is, a relative wage that favors women encourages FLFP. Second, $n_f^{i,j}$ decreases with the Pareto weight on men $(1-\theta^{i,j})$, ceteris paribus. This 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).[28]

Third, $n_f^{i,j}$ decreases with the level of home productivity ratio a_f/a_m. As the home productivity of women relative to men increases, the supply of market work by women falls, holding other factors constant. Each of these three effects are for a given level of $\alpha^{i,j}$. As we have mentioned above, the effect of $\alpha^{i,j}$ on $n_f^{i,j}$ is ambiguous.

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, we can take the difference between $n_f^{i+1,k} - n_f^{i,j}$ which can be written as,

[28] Theoretically, one can also construct models where an increase in women's bargaining power has an ambiguous effect on their time spent in market work in a non-cooperative framework (Heath & Tan (2020)). Alternatively, women who were previously not working may join the labor market when they reduce their weightage of husband's utility cost of a working wife (gender norm) as their bargaining power rises (Field *et al.* (2021)), although market work on the intensive margin would nevertheless fall, in a collective model. Note that incorporating a social norm in a non-cooperative framework is unlikely to predict unambiguous effects of bargaining power on women's labor supply – women's market work may increase only when wages are sufficiently high in the presence of a disutility from greater working hours due to the norm (either social or gender specific ((Field *et al.* (2021)). Our focus in this paper is on predicting the U-shaped relationship between women's education and their labor supply accounting for 3 factors - relative wages, relative bargaining power and relative home productivity in the presence of a gender-neutral norm (instead of gender-specific) on minimum home production in a collective setting.

$$
\begin{aligned}
n_f^{i+1,k} - n_f^{i,j} = & \underbrace{\left[\frac{(1-\theta^{i,j})}{\left(\frac{(1+\phi_L)}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i,j})} \right)} - \frac{(1-\theta^{i+1,k})}{\left(\frac{(1+\phi_L)}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i+1,k})} \right)} \right]}_{a} \\
& + \underbrace{\left[\frac{\frac{w_m^j}{w_f^i}(1-\theta^{i,j})}{\left(\frac{1+\phi_L}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i,j})} \right)} - \frac{\frac{w_m^k}{w_f^{i+1}}(1-\theta^{i+1,k})}{\left(\frac{1+\phi_L}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i+1,k})} \right)} \right]}_{b} \\
& + (1-\delta) \underbrace{\left[\frac{\left(1 + \frac{w_m^j}{w_f^i}\right)}{(1+\Psi_f^{i,j})\left(\frac{(1+\phi_L)(1-\alpha_{i,j})}{\phi_H} + 1 \right)} - \frac{\left(1 + \frac{w_m^k}{w_f^{i+1}}\right)}{(1+\Psi_f^{i+1,k})\left(\frac{(1+\phi_L)(1-\alpha_{i+1,k})}{\phi_H} + 1 \right)} \right]}_{c} . \qquad (8)
\end{aligned}
$$

Equation 8 shows 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. We first discuss the role of the three components, keeping $\alpha^{i,j}$ constant across education levels. 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 three factors in these components - Pareto weights, relative female wage and relative female home productivity - vary with the education level for a fixed α. The next paragraph sheds some light on 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 if the relative wage in the higher education category is greater than the relative wage in the previous education group, that is if $w_m^k/w_f^{i+1} < w_m^j/w_f^i$ (or equivalently if $w_f^{i+1}/w_f^i > w_m^k/w_m^j$, i.e. the relative gain in wage by a more educated woman is higher than the relative gain (or loss) in male wage), then this will increase the wife's labor supply. 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 the three factors are allowed to vary, 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. The above discussion clearly shows that the 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 that education level.

The discussion above is for a fixed level of $\alpha^{i,j}$ and $\alpha^{i+1,k}$. However, note that H is a normal good with respect to household (total) income and therefore with an increase in the level of education (hence wages), the level of home good production increases. Since in our theoretical model we assume a universal social norm $\bar{H}$ that is constant across all education groups, given the multiplicative relationship between H and $\bar{H}$ (Section 3.1 above), α is lower for the education group that produces a higher level of home good H. Thus a fall in α with increase in education reduces the market labor supply of the wife through the components (a) and (b). However, a fall in α through the component (c) results in an increase in her market labor supply. This means that keeping all else constant, when relative home productivity and its interaction with the relative market wage is taken into consideration, a decrease in α augments the market labor supply of the wife. Thus, the overall effect of a change in α due to a higher level of education of the wife suitably matched with a husband can be of either sign depending on the characteristics of the economy.[29]

[29] Note that the theoretical decomposition allows husband's education to change with wife's education to maintain consistency with our calibration exercise, which is empirically supported by evidence of assortative matching on education in India. We show the predicted effects on wife's labor supply for the special case, $k = j$, i.e. the education level of the wife increases from i to $i + 1$ while her husband's education is fixed, in

Table 1 summarizes the theoretical predictions in the movement of the four factors in Equation 8 - relative wages (column 2), relative home productivity (column 3), relative Pareto weights on men (column 4) and relative change in responsiveness to social norms on home production (column 5) - on changes in wife's labor supply. Row 1, columns (2)-(4) show the effect on wife's labor supply for each factor when these factors increase across education levels, i.e. the direction of change in them is > 1. For instance, following the above discussion, a relative increase in female to male wage ratio as wife's education level increases, leads to an increase in wife's labor supply across education levels (denoted by > 0 in column 2, row 1). Row 2 shows the predicted effect when these factors decrease across education levels, i.e. the direction of change in them is < 1. For instance, in row 2, a relative decrease in female to male wage ratio as wife's education level increases, decreases wife's labor supply across education levels (denoted by < 0 in column 2, row 2). The effects of change in home productivity, Pareto weights and norm responsiveness on wife's labor supply can be read in similar manner following the discussion above.[30] The last row shows that in the trivial case when none of the four factors change with wife's education ($= 1$), there is no change in her labor supply.

We now turn to calibrating and simulating our model on agents' time allocation to market work, home production and leisure.

4 Calibration and Simulation

4.1 Calibration

The Pareto weights for each of the 36 combinations of spousal education are calibrated using the ratio of the first order conditions. 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. 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

Table C.1, Appendix C.

[30]The changes in relative wages, relative home productivity and Pareto weights have unambiguous effects on the wife's predicted labor supply. However, a change in the relative responsiveness to the norm on home production, denoted by a change in α across education groups in column (5), can result in either a decrease or an increase in women's labor supply.

combination of education categories of spouses. This gives us 36 values of θs for each possible combination of spouses with different education levels.[31]

Next, we discuss the calibration of the (inverse of) responsiveness to the social norm - the ratio of the benchmarked minimum home production to actual home production - for each spousal education group ($\alpha^{i,j} = \frac{\bar{H}}{H^{i,j}}$). As discussed earlier, the home production function in our setup measures the effective expenditure on the home good (expenditure adjusted for home productivity).[32] We use data on average household education expenditure per child in urban India (from NSS (1999)) as a proxy for effective expenditure on home good production.[33] We then compute the extent to which each education group exceeds the norm on home good production, i.e. the ratio of the minimum expenditure on education per child that must be incurred ($\bar{H}$) to the actual education expenditure per child incurred by an education group (H). The first percentile value of education expenditure per child of the lowest spousal education group ($e_f = Illiterate$ and $e_m = Illiterate$) denotes the benchmarked minimum level of home good production that must be incurred by all education groups, i.e. $\bar{H}$. We assume this minimum education expenditure, $\bar{H}$, to be fixed across all spousal education categories while the average household expenditure on education per child for each combination of spousal education (H) varies across spousal education groups. Using this procedure, we are able to calibrate the value of α for each of the 36 education groups.

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 theoretical expressions in Equations 2, 3, 4 and 5. 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

[31] The average value of $\theta \approx 0.66$ across education categories. Thus, a man, on average, has greater bargaining power within a household.

[32] In our model, q is total market expenditure in home good production and time is adjusted for home productivity. Therefore, two households may spend the same amount of money in purchasing market inputs and same time in home production but the the effective home production expenditure will be higher for households with greater home productivity.

[33] While education is one of the categories of home production, and child quality specifically, it is also likely to be amongst the largest components of household expenditures on children (which would include expenditure on child health, hired labor or equipment to aid in cooking, maintaining hygienic surroundings etc.). Recall our earlier discussion that expenditure on education as a proportion of total household expenditure is more than 40% in India (National Sample Survey, 1999) and that time spent on exclusive child care exhibits little variation across households (approx. 1.5 hours for the bottom 10% and 1.1 hours for the top 10% of household MPCE distribution). Further, education expenditures are not only substantive, but also rise with household income (from 23% for bottom to 53% for the top 10% of MPCE). Our results are unchanged if we use household expenditure for all children in the household or child learning outcomes (IHDS-II) as alternative proxies for home good production. These results are available on request.

change across education categories. We are able to obtain a set of unique solutions for all the calibrated parameters using non-linear least squares.[34]

The calibrated parameters are shown in Table 2. 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) but it increases drastically for women with 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.

As expected, α decreases as education increases since more educated women (men) produce a higher value of the home good (child quality) relative to the benchmarked minimum - in line with the theoretical analysis above. Thus α decreases from 0.018 (0.024) for illiterate women (men) to almost 0.008 (0.010) for primary-middle educated women (men) and further to 0.003 (0.002) for higher secondary and above educated women (men). Hence, on average women (men) in the highest education group produce almost 9 (12) times as much of the home good as illiterate women (men).

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 the highest education categories. The increase is smaller and uneven, though, for lower levels of education. Across the disaggregated education levels, from less than primary to middle schooling, home productivity is very similar. It would then be more intuitive to look at the comparison across broad four categories of education - illiterate, women with some education (less than primary - middle classes), completed schooling, and graduate. Here, we do find an unambiguous increase in home productivity between illiterate women (0.02) and women with some education (0.034) by almost 70%.

The share parameters in the home production function show that men's effective time spent in home production is about 35% and that by women is 65%. Though, on an average women's share of overall time in home production is almost 90%, adjusted for home produc-

[34]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 contain 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 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.

tivity this falls to 65%. This could be driven by a higher average home productivity of men relative to women up to middle education levels, as shown in the panel above of Table 2. 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.[35] Later we conduct sensitivity analyses to show that using different values of ρ or δ don't change the results significantly.

To summarize, our calibration results approximate the broad patterns observed in the Indian economy and also capture the household preferences in time allocation.

4.2 Simulation

In this section, we first verify the contribution of each channel towards the observed movements in wife's labor market time. To do this, we use data on wages and the calibrated parameters to calculate the movement of relative wages, home productivity, Pareto weights and the (inverse of) responsiveness to the social norm (i.e. the extent to which the benchmarked minimum home production is lower than actual home production) across education levels. These are reported in Table 3 for changes across each consecutive education level in column (1), denoted by the following numeric codes: $0 - Illiterate$, $1 - Less\ than\ primary$, $2 - Primary$, $3 - Middle$, $4 - Higher\ Secondary$, $5 - Graduate\ and\ above$.

It can be seen that the relative female wage ratio in column (2) of Table 3 declines (or increases by less than one) for each consecutive level between illiterate and middle schooling. This observed fall in relative female wages contributes towards reducing wife's labor supply with an increase in her education up to middle schooling. Thereafter, the relative female wage ratio increases (or change by more than one) for education levels from middle - graduate and above, which would raise wife's labor supply between these education levels. These findings are in line with the theoretical predictions in Table 1, column (2), which shows that wife's relative labor supply is positively related with relative female wages. Similarly, an increase in relative female home productivity from illiterate to less than primary and middle to higher secondary (denoted by a change of more than one in column (3) of Table 3 for these education levels) would contribute towards reducing female labor supply across these education levels (Table 1, column (3)). Column (4) shows that bargaining power of men does not change much when wife's education increases from illiterate to middle schooling

[35]For example, Greenwood *et al.* (2005b) 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 when housing is excluded.

while it falls when wife's education increases from middle to higher secondary schooling. As predicted in Table 1, column (4), this should contribute towards decreasing the wife's labor supply from middle to higher secondary schooling, holding other factors constant. Lastly, column (5) shows that α decreases across successive levels of wife's education, which has an ambiguous effect on wife's labor supply, as discussed theoretically earlier.

Using the estimated wages and the calibrated parameters we predict the time spent in the labor market, home production and leisure for individuals in each education group in urban India, accounting for all the four factors simultaneously. Figure 4 plots the model's predictions against the actual time allocations observed in the data for women and men by education groups. The model is successful in generating a U-shaped female labor supply with respect to their 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 time allocation variables that we are focusing on in this analysis, including the large gender gap in time devoted to home good production.

5 Discussion

In previous sections we constructed a theoretical model with changing market productivity, home productivity and a norm on home good production. Using the TUS datasets for India we now calibrate and simulate the standard model - which allows only market productivity to vary across education groups (i.e. home productivity is constant and there is no additional utility from generating more home good than a basic minimum benchmark) - for comparison with our analysis.[36] We allow bargaining power to vary with education in both models.

Table 4 shows the allocation of time to work, home production and leisure, predicted at each education level, in the data (column 1) standard model (column 2) and the model posited in this paper (column 3) for women (Panel A) and men (Panel B). In Panel A varying market productivity and keeping home productivity constant (column 2) 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. The standard 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

[36] 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 spent in home production and leisure.

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 shown in column (2) relative to column (3) in the middle panel. The time allocated to leisure by women reported in the bottom panel of Table 4, is consequently over predicted by the standard model across the education distribution, again more so for the two highest education levels when we compare columns (2) and (3). For men, the standard model somewhat under predicts their labor supply and overpredicts leisure (Table 4, Panel B).

In contrast, the model posited in this paper performs much better than the standard model as shown in column (3) of Table 4. 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, relative to the standard model. 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 by women in the bottom of Panel A, Table 4 is lower and closer to the actual data, for the model posited in this paper as shown in column (3).

To summarize, the fall in relative female wage between illiterate to middle schooling combined with an increase in relative female home productivity between illiterate to less than primary explains the fall in wife's labor market time upto middle education levels. Thereafter, between middle to graduate and above education levels, the muted increase in female labor time is explained by a large increase in relative female home productivity and bargaining power within the household between these education levels. These findings are in line with the theoretical expositions discussed in Table 1, which show that relative female labor supply increases with a rise in relative female wage but decreases with increase in relative home productivity and relative female bargaining power. Further, social norms on a benchmark level of home good production play a role in explaining the low levels of women's time allocation to market work. Our model performs better than the standard model since it incorporates all the four channels - changes in relative wage, home productivity, bargaining power and social norms towards home good production.

The model is 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.Even after accounting for the supply side factors, an 8 percentage point gap remains between the predictions of our model and the actual labor supply of women who have graduate or higher education. This could possibly be explained by the low level of demand for women's labor or differences in the type of work demanded by women (for instance, flexible time schedule) and those available in the market at higher levels of education in India (Afridi *et al.* , 2018).

6 Alternative mechanisms

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

6.1 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 at higher levels of education to market wages.

Note that in our setup, households choose optimal amount of market good in home production. To test for the possible mechanism described above we constrain the usage of market goods in the model by imposing a restriction that q is same across education levels and that $q \leq \bar{q}$. Here $\bar{q}$ is defined to be strictly less than the minimum of the optimal q obtained across all education levels in the main model. This modification reduces wife's labor supply at higher education levels, in comparison to our model, but by a negligible amount. Since in our original setup q is chosen optimally, households respond to a constant amount of q (which is also lower relative to the optimal) by reducing the total H produced at higher education levels, while H still exceeds the minimum benchmark of $\bar{H}$ for high education groups. Thus, even though the total H produced by the household rises with education, the level of H is now lower due to the constraint on the market good. Hence, instead of increasing time spent on home production by the wife and consequently reducing her labor supply, restricting q primarily results in lower production of the home produced good. Thus, the absence or low supply of market goods may not explain the observed levels of women's time spent on market work in India.[37]

[37] It is, of course, possible that our measure of home produced good is imperfect - the benchmark level of home production may be higher than what the available data on education expenditure reveals. Given this caveat, the observed gap between women's predicted and the actual labor supply could be bridged by accounting for limited supply of market goods and higher social norm on home good production.

6.2 Household wealth

Another possible channel that could impact women's labor supply is household wealth. As female education levels increase, 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. Appendix Figure A.6 plots the simulations for labor supply, domestic work and leisure after incorporating the wealth effect. We do observe some reduction in labor supply but not substantially over and above our model's predictions. Overall, 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.[38]

7 Robustness checks

7.1 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). Under the assumption that men and women are imperfect substitutes in home production (i.e. $0 < \rho \leq 1$), we calibrate our model taking different values of $\rho \in [0.2, 0.6]$ around the benchmark value of 0.4037 in the literature.[39] The predicted paths do not change much because the share of men's time in home production is smaller than women's. Similarly, we calibrate the 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.

[38] 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.

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

7.2 Variation of social norm across education groups

Recall that our theoretical model assumes a single $\bar{H}$ for society, i.e. the minimum benchmark for the home good is the same for all education groups. However, it is possible that $\bar{H}$ varies by education - higher education groups may desire higher minimum level of child quality. Notably, we calibrate the value of α, which represents the ratio of $\bar{H}$, to actual H. When higher education groups have a higher benchmarked level of home good, the ratio of the two ($\frac{\bar{H}}{H}$) may not vary significantly across education groups, since they also produce higher levels of H.[40]

We check the robustness of our results to calibrating α using the first percentile value of education expenditure per child for each education group as the $\bar{H}$ for that group. Indeed, Appendix Table A.2 shows that α does not vary much across education of women and men, except for the highest education group, when we allow $\bar{H}$ to vary by education groups. Appendix Figure A.7 plots the simulations for labor supply, domestic work and leisure using this alternative model. We do not find much difference from our previous predictions when $\bar{H}$ is constant across education groups.[41]

7.3 Recent employment data

We conduct 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 and Figure A.8. Specifically, Appendix Figure A.9 shows that the labor supply simulation results for our model predicts well the U-shaped labor supply of women across education categories in 2011 as well.

8 Conclusion

Low and stagnant allocation of time to the labor market by women in India despite economic growth and higher educational attainment is a puzzle. 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

[40] In fact, given our methodology, even if we keep $\bar{H}$ constant, the higher desired responsiveness of home production at higher education levels is captured in our model through higher H and consequently low α. Therefore, whether we capture a higher responsiveness or a higher $\bar{H}$, it should not make much difference theoretically.

[41] We are able to reproduce the U-shaped relationship between women's education and their LFP when we alternatively fix $\bar{H}$ at the average or median education expenditure of the lowest education group.

regularities in women's labor supply by their education level. We use detailed individual time use data for urban India to show that a rise in home productivity with education along with a social norm on producing a minimum benchmarked level of the home good can explain the U-shaped relationship between married women's time allocation and their education. Importantly, the assumed social norm is not imposed on any particular gender, but rather on the entire household, therefore, our results are driven by differential home and market productivity of household members.

Our model predicts the observed patterns in the data more closely than a standard model with home production but without home productivity and social norms. The analysis, thus, contributes to the existing literature on women's labor supply, broadly, and to the ongoing debate on women's LFP in developing economies such as India. We show that multiple factors, and their interplay, can explain the persistent gender gap in LFP and the non-monotonic relationship between women's market labor supply and their education.

While we do not incorporate demand side factors affecting women's LFP explicitly, to the extent that labor demand is reflected in the equilibrium market wage, they are accounted for in the analysis. Nevertheless, it is possible that differences between the type of work demanded by women and those available in the market constrain their employment opportunities at higher education levels. Thus demand-side factors may account for the residual gap between women's predicted and observed time spent on market work in our analysis.

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Table 1 Theoretical predictions of effects on wife's labor supply

Direction of Δ in variable	Δ Relative wage $(\frac{w_f^{i+1}}{w_m^k})/(\frac{w_f^i}{w_m^j})$	Δ Relative home productivity $(\frac{a_f^{i+1}}{a_m^k})/(\frac{a_f^i}{a_m^j})$	Δ Pareto weight (men) $\frac{\theta^{i+1,k}}{\theta^{i,j}}$	Δ in Norm responsiveness $\frac{\alpha^{i+1,k}}{\alpha^{i,j}}$
(1)	(2)	(3)	(4)	(5)
	Effect on wife's labor supply			
> 1	> 0	< 0	> 0	*Ambiguous*
< 1	< 0	> 0	< 0	*Ambiguous*
$= 1$	No change			

Note: Column 1 shows the direction of change in each of these four variables - relative wages (column 2), home productivity (column 3), Pareto weight (column 4) and norm responsiveness (column 5). Each cell in columns 2-5 shows the predicted direction of change in wife's labor supply for a given change in the corresponding variable (column 1) when her education increases. The predictions follow the theoretical decomposition of changes in wife's labor supply derived from Equation 8. For example, an increase (> 1, depicted in row 1 in column 1) in the relative wage ratio when wife's education level increases, raises her labor supply (> 0, row 1 in column 2).

Table 2 Calibrated parameters

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
		Ratio of $\bar{H}$ to H: Male	
$\alpha^{i,1}$	0.024	Illiterate	calibrated
$\alpha^{i,2}$	0.015	Less than primary	calibrated
$\alpha^{i,3}$	0.012	Primary	calibrated
$\alpha^{i,4}$	0.009	Middle	calibrated
$\alpha^{i,5}$	0.005	Higher Secondary	calibrated
$\alpha^{i,6}$	0.002	Graduate and above	calibrated
		Ratio of $\bar{H}$ to H: Female	
$\alpha^{1,j}$	0.018	Illiterate	calibrated
$\alpha^{2,j}$	0.011	Less than primary	calibrated
$\alpha^{3,j}$	0.009	Primary	calibrated
$\alpha^{4,j}$	0.007	Middle	calibrated
$\alpha^{5,j}$	0.004	Higher Secondary	calibrated
$\alpha^{6,j}$	0.002	Graduate and above	calibrated
		Home productivity parameters: Male	
a_m^1	0.051	Illiterate	calibrated
a_m^2	0.062	Less than primary	calibrated
a_m^3	0.088	Primary	calibrated
a_m^4	0.142	Middle	calibrated
a_m^5	0.355	Higher Secondary	calibrated
a_m^6	1.000	Graduate and above	calibrated
		Home productivity parameters: Female	
a_f^1	0.020	Illiterate	calibrated
a_f^2	0.032	Less than primary	calibrated
a_f^3	0.030	Primary	calibrated
a_f^4	0.034	Middle	calibrated
a_f^5	1.276	Higher Secondary	calibrated
a_f^6	1.761	Graduate and above	calibrated

Table 2 (contd.) Calibrated parameters

Paramater	Value	Description	Source
		Other parameters	
ϕ_L	0.871	Weight attached to leisure	calibrated
ϕ_H	0.945	Weight attached to home good	calibrated
z_m	0.349	Share in the home production of effective male time	calibrated
z_f	0.651	Share in the home production of effective 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 and α values (for each possible i, j education combination of wife and husband) are averaged for each education group of women and men in this table.

Table 3 Estimated changes in factors affecting wife's time allocation

Wife's education change	Δ Relative wage $(\frac{w_f^{i+1}}{w_m^k})/(\frac{w_f^i}{w_m^j})$	Δ Relative home productivity $(\frac{a_f^{i+1}}{a_m^k})/(\frac{a_f^i}{a_m^j})$	Δ Pareto weight (men) $\frac{\theta^{i+1,k}}{\theta^{i,j}}$	Δ in Norm responsiveness $\frac{\alpha^{i+1,k}}{\alpha^{i,j}}$
(1)	(2)	(3)	(4)	(5)
$0-1$	.99	1.15	1.01	0.61
$1-2$	.87	0.7	1.01	0.81
$2-3$	.92	0.88	.99	0.76
$3-4$	2.85	21.74	.71	0.58
$4-5$	1.06	0.81	1.05	0.63

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*. Average relative wage, relative home productivity, Pareto weight and norm responsiveness is estimated for each level of wife's education using the calibrated parameter values from time use data for 3725 couples. Changes in estimated ratios across successive education levels are reported in columns 2-5.

Table 4 Comparison across models

Education Level	Actual	Simulations	
	(1)	(2)	(3)
		Constant home productivity and no norm	Varying home productivity and including norm
Panel A: Women			
		Time spent: Market work	
Illiterate	0.15	0.12	0.11
Less than primary	0.10	0.13	0.07
Primary	0.08	0.07	0.07
Middle	0.05	0.04	0.04
Higher Secondary	0.06	0.29	0.17
Graduate and above	0.13	0.32	0.21
		Time spent: Home production	
Illiterate	0.56	0.52	0.59
Less than primary	0.61	0.52	0.62
Primary	0.60	0.58	0.61
Middle	0.62	0.61	0.62
Higher Secondary	0.62	0.30	0.51
Graduate and above	0.53	0.29	0.49
		Time spent: Leisure	
Illiterate	0.29	0.36	0.31
Less than primary	0.29	0.35	0.30
Primary	0.32	0.35	0.33
Middle	0.33	0.35	0.34
Higher Secondary	0.32	0.41	0.32
Graduate and above	0.34	0.39	0.30

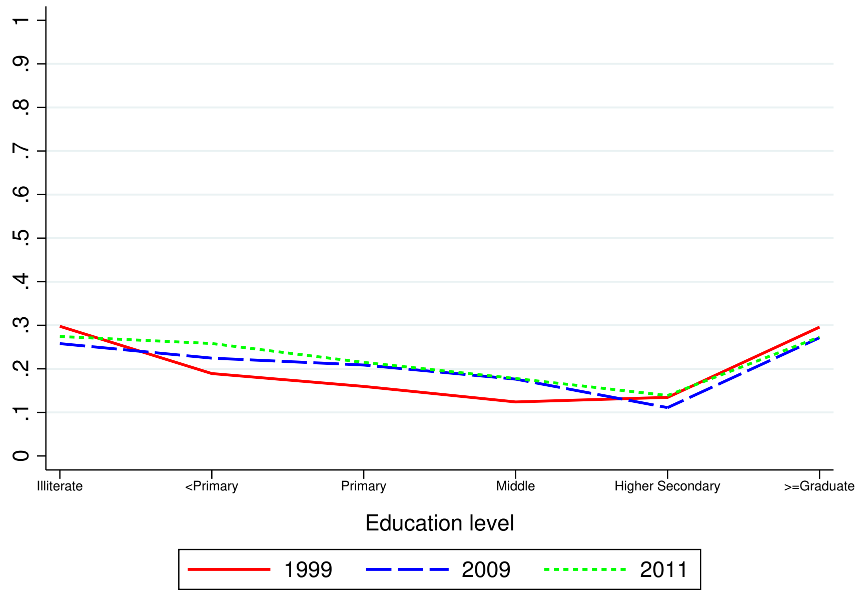
Table 4 (contd.) Comparison across models

Education Level	Actual	Simulations	
	(1)	(2)	(3)
		Constant home productivity and no norm	Varying home productivity and including norm
Panel B: Men			
		Time spent: Market work	
Illiterate	0.67	0.60	0.61
Less than primary	0.70	0.61	0.63
Primary	0.69	0.61	0.62
Middle	0.68	0.62	0.61
Higher Secondary	0.65	0.61	0.61
Graduate and above	0.60	0.60	0.64
		Time spent: Home production	
Illiterate	0.04	0.00	0.08
Less than primary	0.04	0.00	0.07
Primary	0.03	0.00	0.08
Middle	0.04	0.00	0.09
Higher Secondary	0.04	0.00	0.09
Graduate and above	0.06	0.00	0.05
		Time spent: Leisure	
Illiterate	0.29	0.40	0.31
Less than primary	0.27	0.39	0.30
Primary	0.28	0.39	0.30
Middle	0.28	0.38	0.30
Higher Secondary	0.30	0.39	0.30
Graduate and above	0.35	0.40	0.31

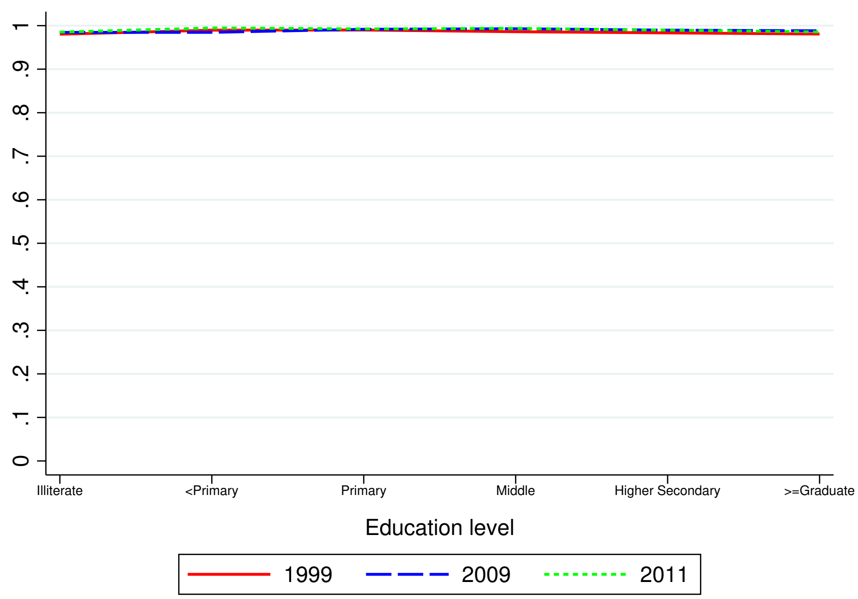
Note: Column (1) shows the actual value of time spent in a particular activity. Column (2) shows the predicted time spent in an activity obtained by calibrating a model where home productivity is constant across education levels and there is no social norm imposed on home produced good. Column (3) shows the predicted time spent in an activity obtained by calibrating a model where home productivity varies across education levels and there is a social norm imposed on the amount of home good produced. Panel A shows these for women while Panel B shows these for men.

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

(a) Women



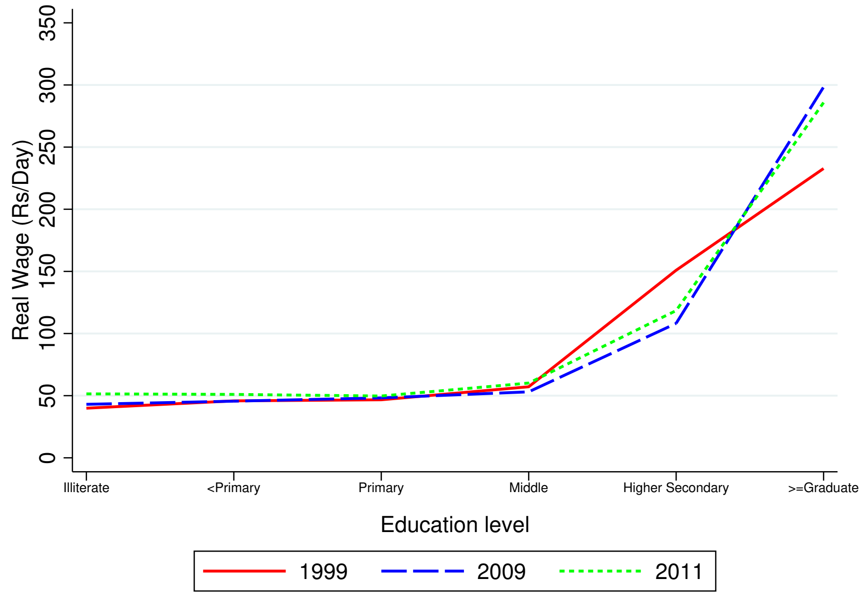
(b) Men



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

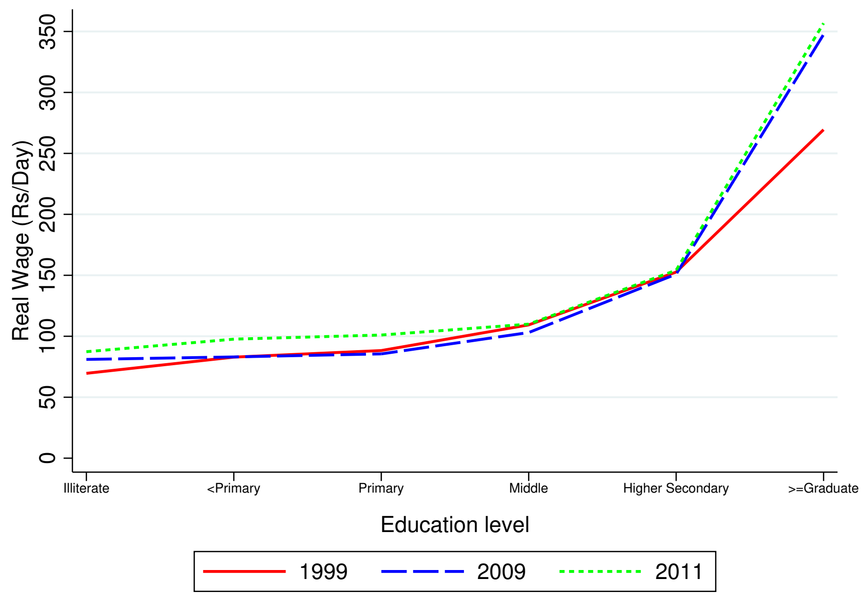
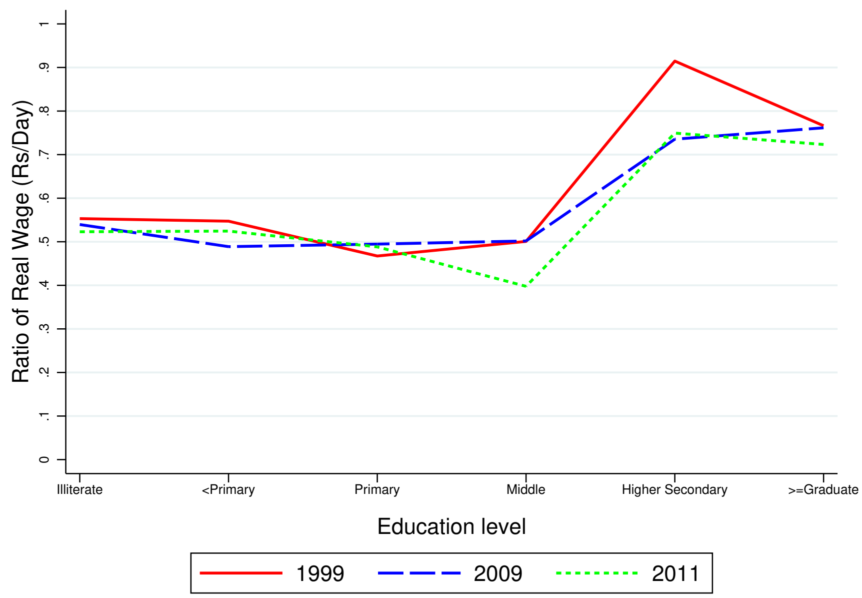


Figure 2 Returns to education (urban, married, age 20-45)

(c) Gender Wage Ratio

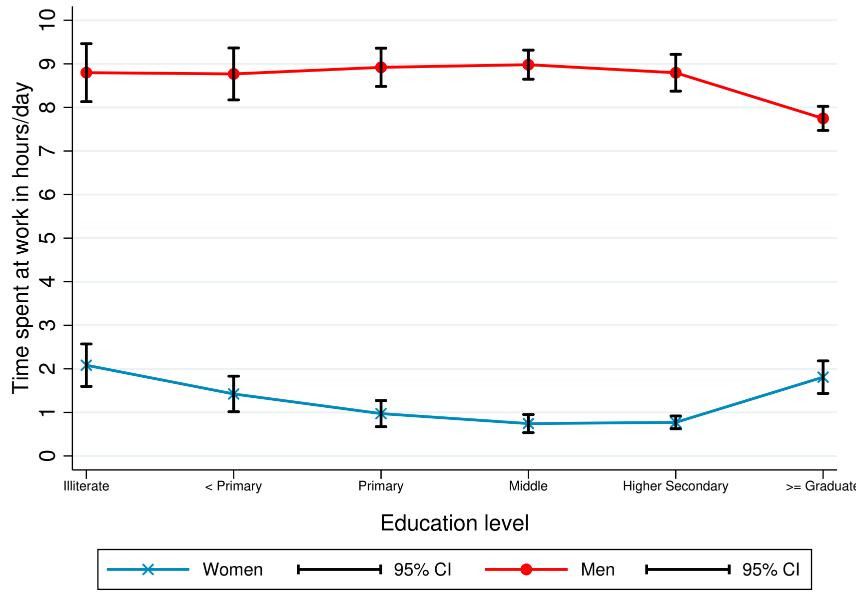


Source: National Sample Survey, Employment and Unemployment Schedules 1999, 2009 and 2011 (Authors' own calculations).

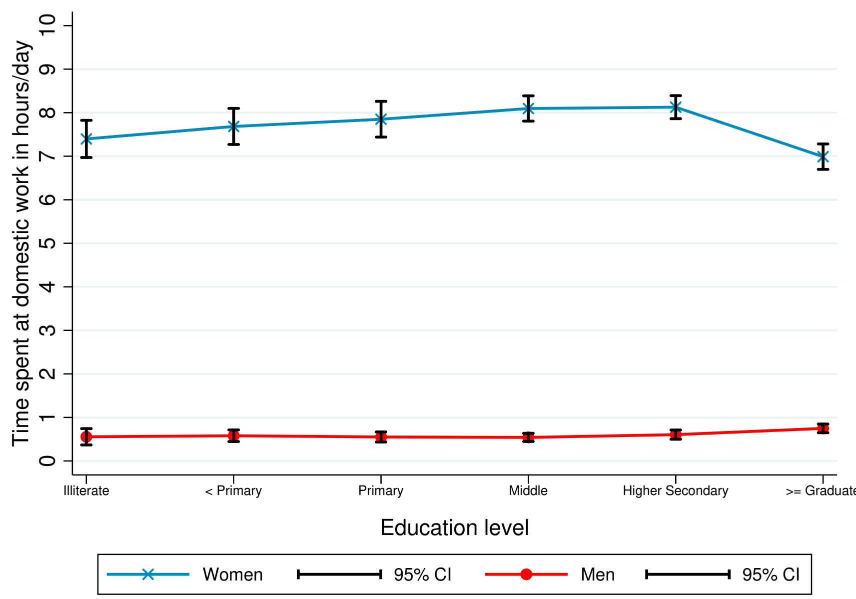
Note: Mean daily wage is calculated from the NSS data for each education-gender cell and deflated at 1999 price levels using the All India Consumer Price Index for Industrial Workers. The sample size is 17,466 (in 1999), 13,876 (in 2009) and 13,686 (in 2011) for men. and 3569 (in 1999), 3064 (in 2009)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

Figure 3 Time allocation by education: daily hours (urban, married, age 20-45)

(a) Labor Supply



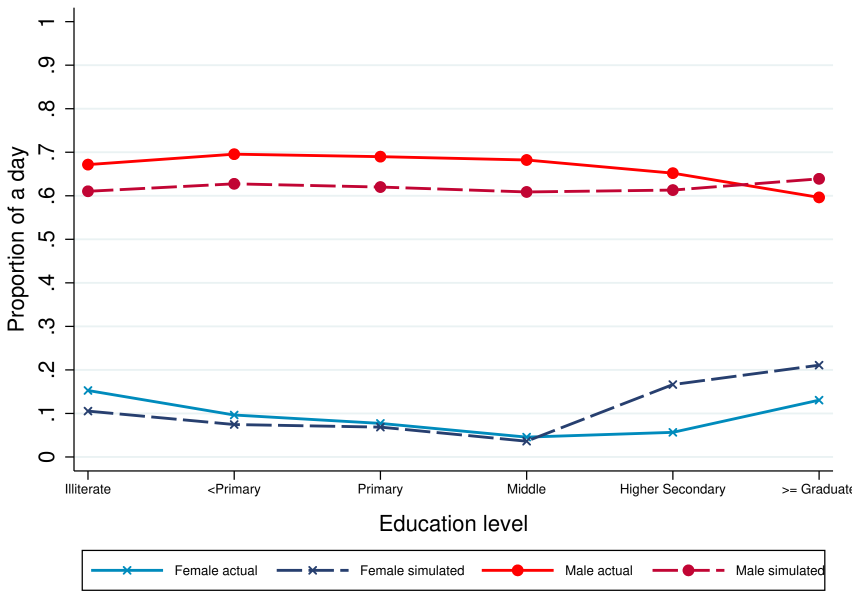
(b) Domestic Work



Source: Time Use Survey 1998 (Authors' own calculations).
Note: Labor supply is calculated by summing up the time spent on labor market activities on the reference day. Domestic work is calculated by summing up the time spent on home production activities on the reference day. The sample size is 3859 and 4389 for men and women, respectively. See data appendix for details of activity classification in the Time Use data.

Figure 4 Simulations for time spent in labor market, home production, leisure

(a) Labor Supply



(b) Domestic Work

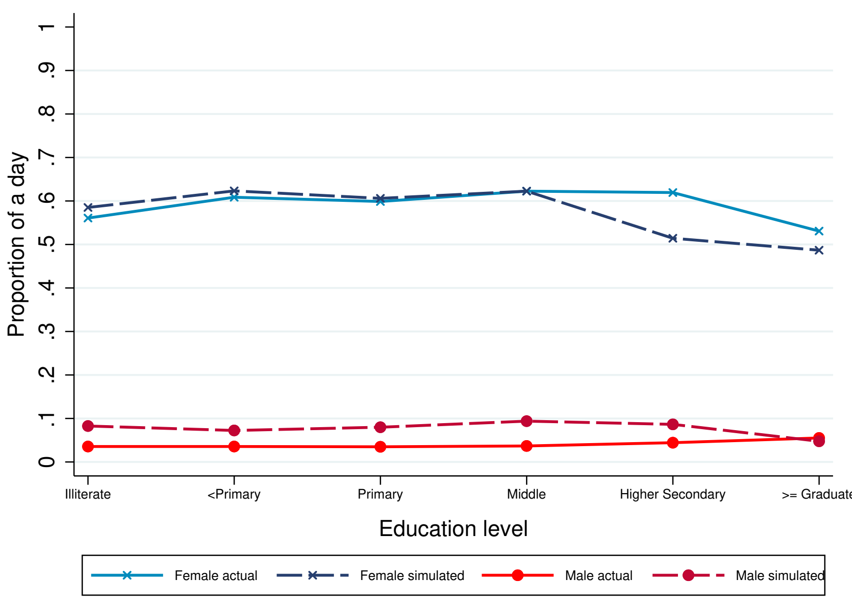
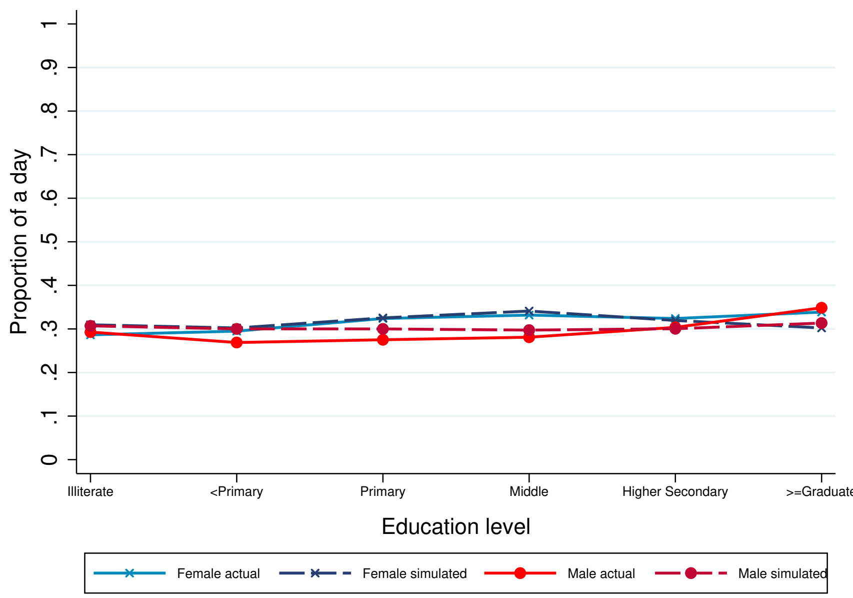


Figure 4 (contd.) Simulations for time spent in labor market, home production, leisure

(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.

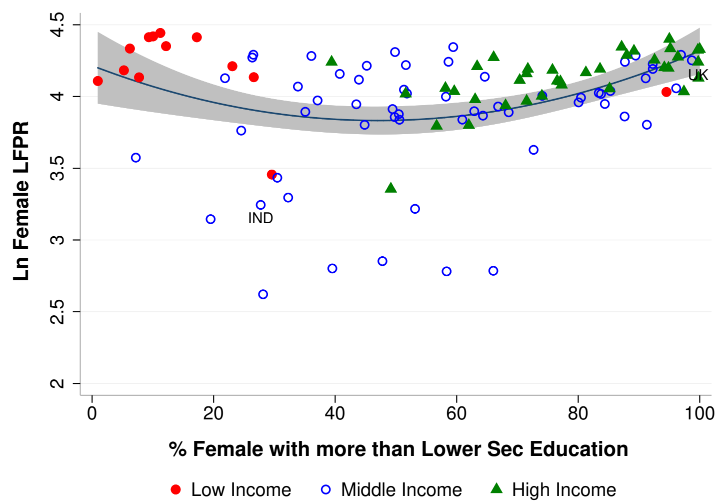
ONLINE APPENDIX

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

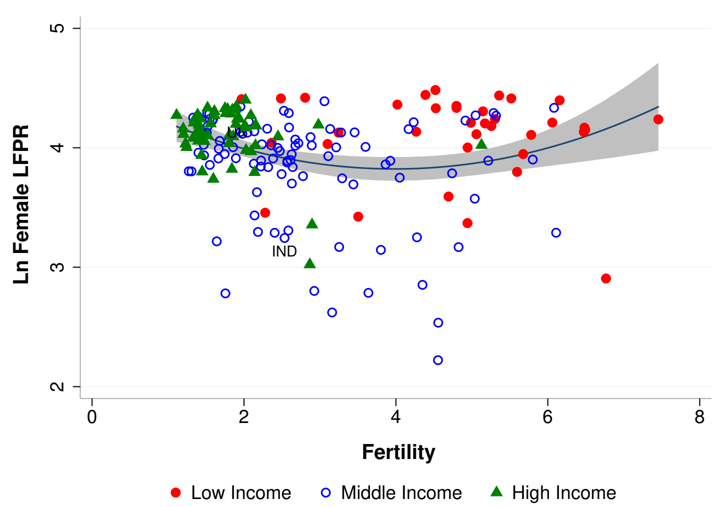
A Additional Analysis

Figure A.1 Cross-country Women's LFPR: Education, Fertility and GDP per capita

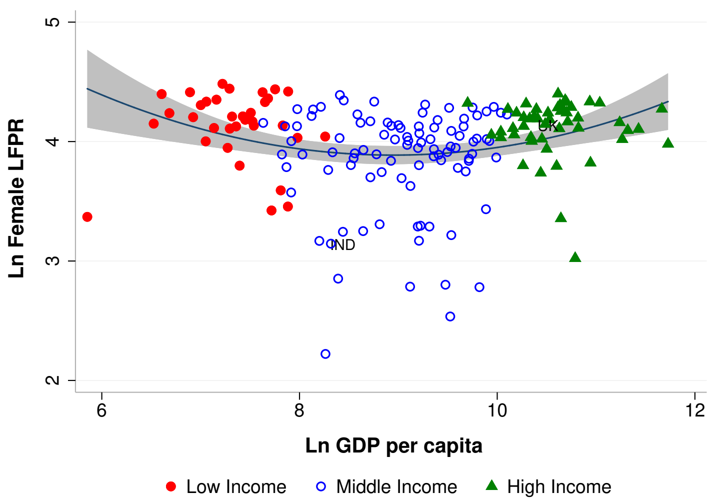
(a) Women's LFPR and women's education



(b) Women's LFPR and fertility



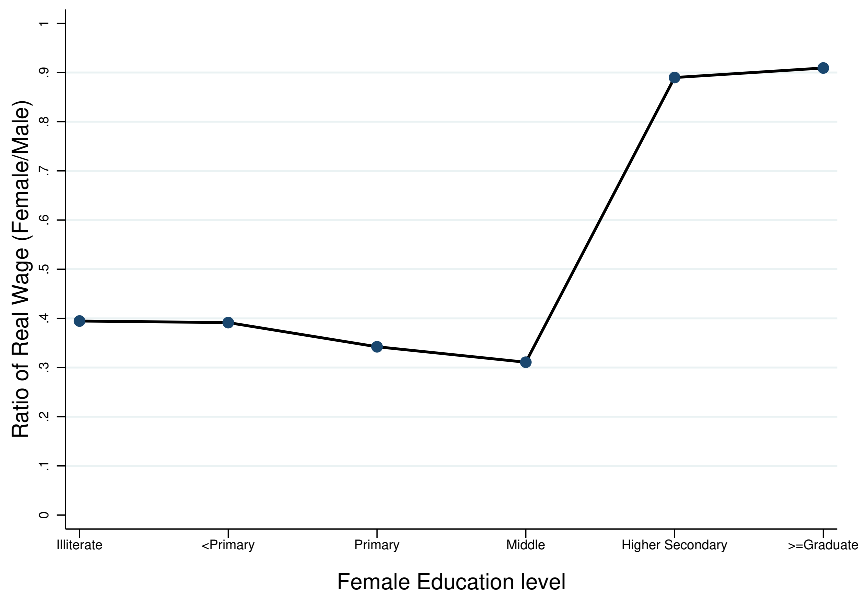
(c) Women's LFPR and per capita income



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.

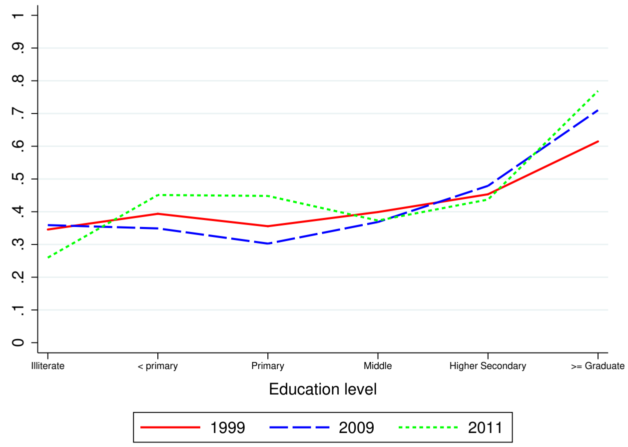
Figure A.2 Wage ratio over Female Education using Spousal Data



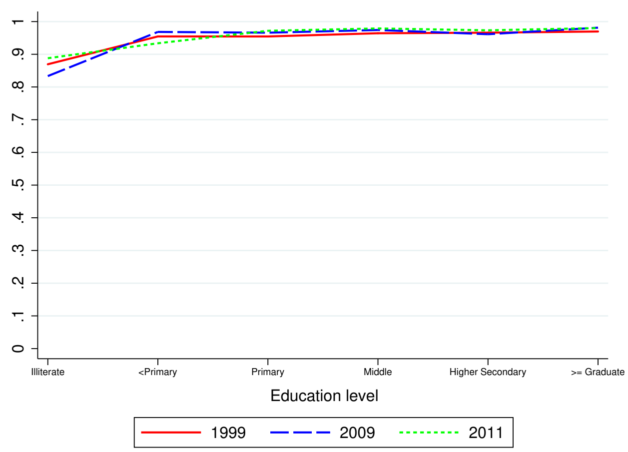
Source: National Sample Survey, Employment and Unemployment Schedules 1999, Time Use Survey 1998 (Authors' own calculations).
Note: Daily wage calculated from the NSS data 1999 for each education-gender cell and attached to the spousal data from Time Use. Based on this the gender wage ratio is calculated.

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

(a) Women



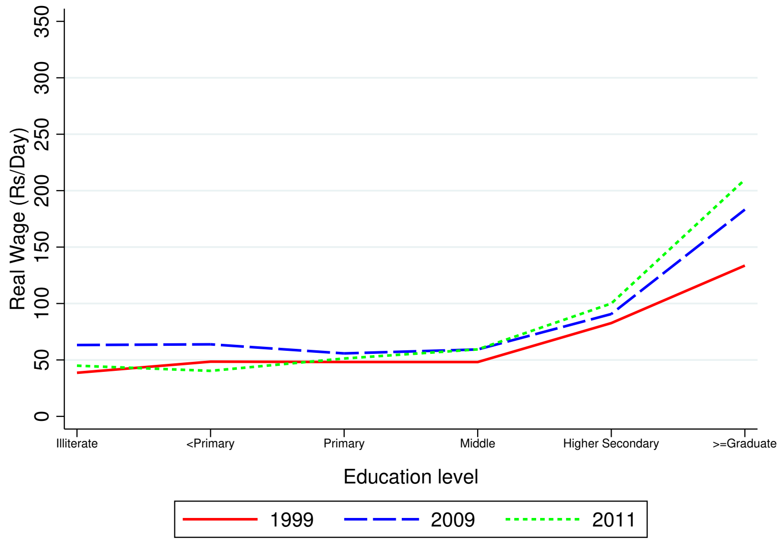
(b) Men



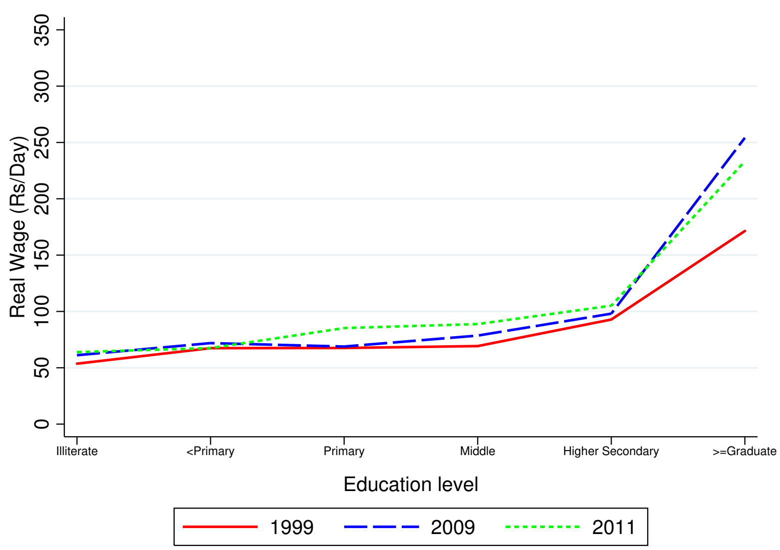
Source: National Sample Survey, Employment and Unemployment Schedules 1999, 2009 and 2011 (Authors' own calculations). *Note*: LFPR is calculated using the usual status definition of employment in the NSS data for those not currently enrolled in education. The sample size is 12,253 (in 1999), 9424 (in 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 A.4: Returns to education (urban, never married, age 20-45)

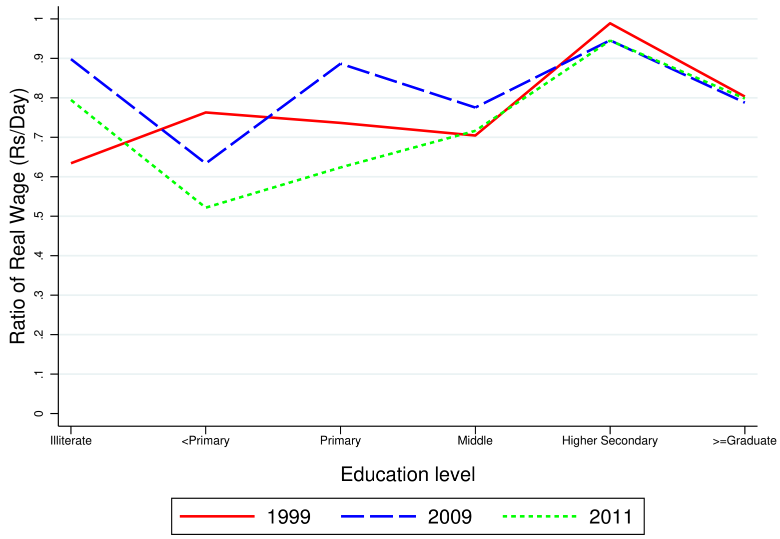
(a) Women



(b) Men



(c) Gender Wage Ratio

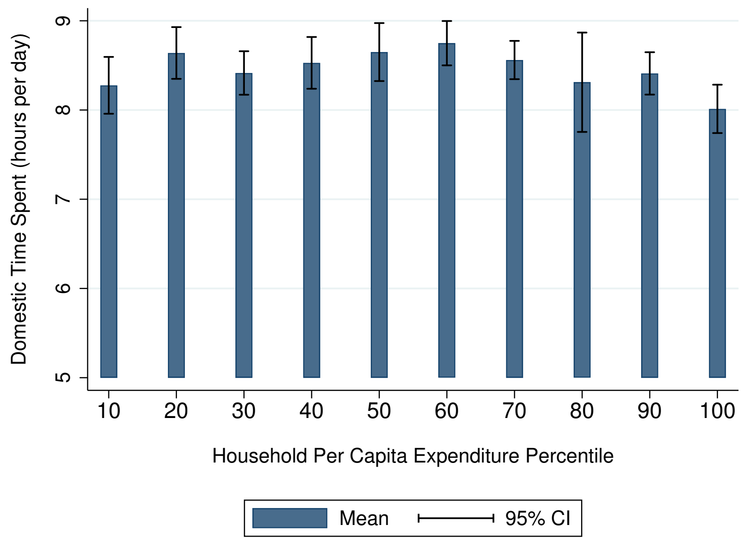


Source: National Sample Survey, Employment and Unemployment Schedules 1999, 2009 and 2011 (Authors' own calculations).

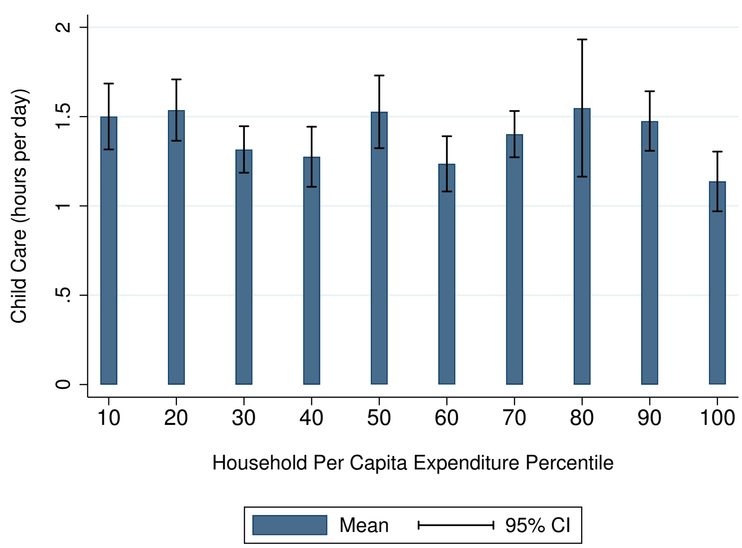
Note: Mean daily wage is calculated from the NSS data for each education-gender cell and deflated at 1999 price levels using the All India Consumer Price Index for Industrial Workers. The sample size is 5271 (in 1999), 4850 (in 2009) and 4607 (in 2011) for men and 985 (in 1999), 914 (in 2009) and 1076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

Figure A.5: Household Time Allocation (hours per day)

(a) Domestic Work



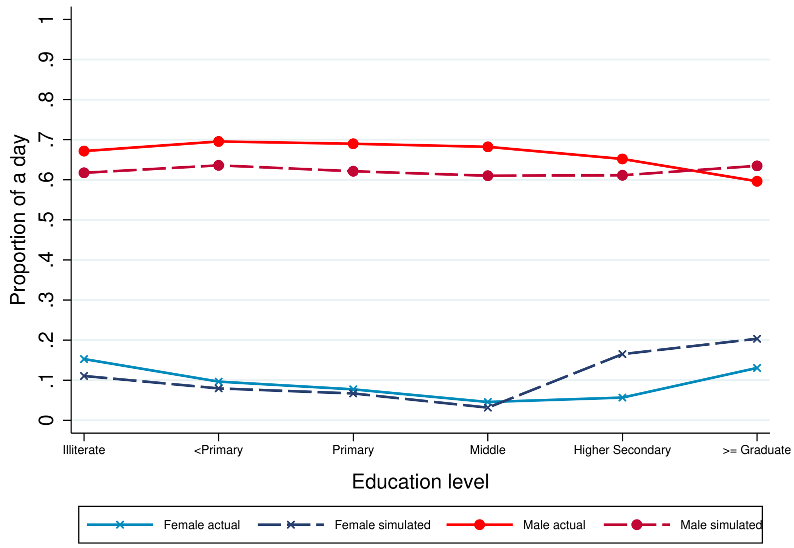
(b) Child Care



Source: Time Use Survey 1998 (Authors' own calculations).
Note: Time spent on domestic work by a household is defined as the sum of husband's and wife's time on all home production activities on the reference day. Time spent on exclusive child care is a sub-category of domestic work. It is the sum of husband's and wife's time on physical care, teaching, supervision and travel directly related to child well-being.

Figure A.6 Simulations for time spent in labor market, home production, leisure (with $\bar{H}$ fixed across education groups) with wealth effects

(a) Labor Supply



(b) Domestic Work

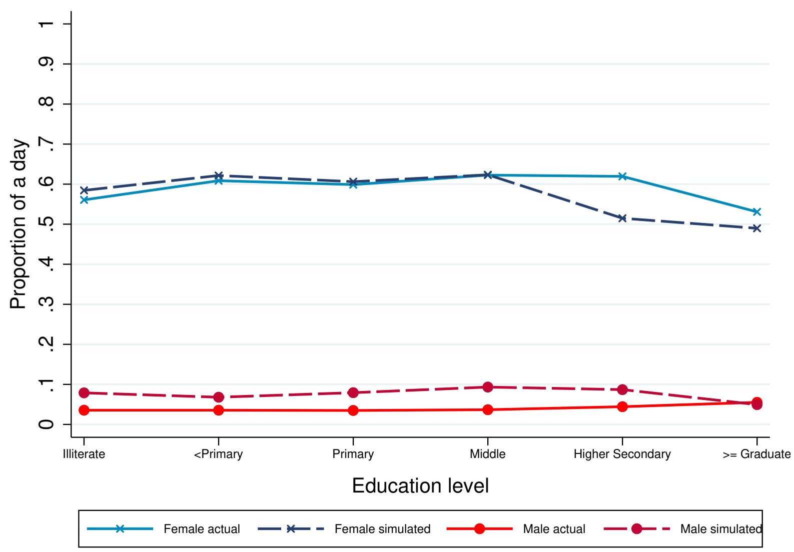
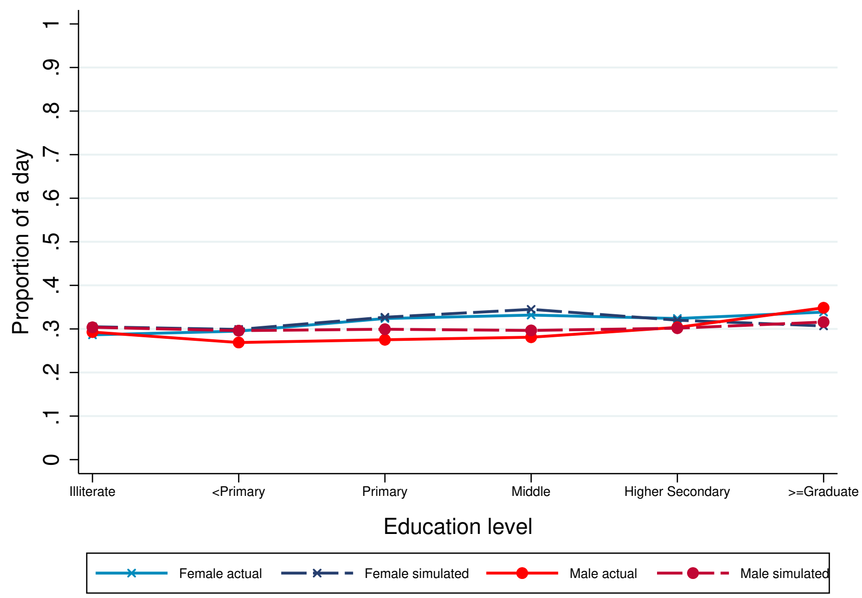


Figure A.6 (contd.)Simulations for time spent in labor market, home production, leisure (with $\bar{H}$ fixed across education groups) with wealth effects

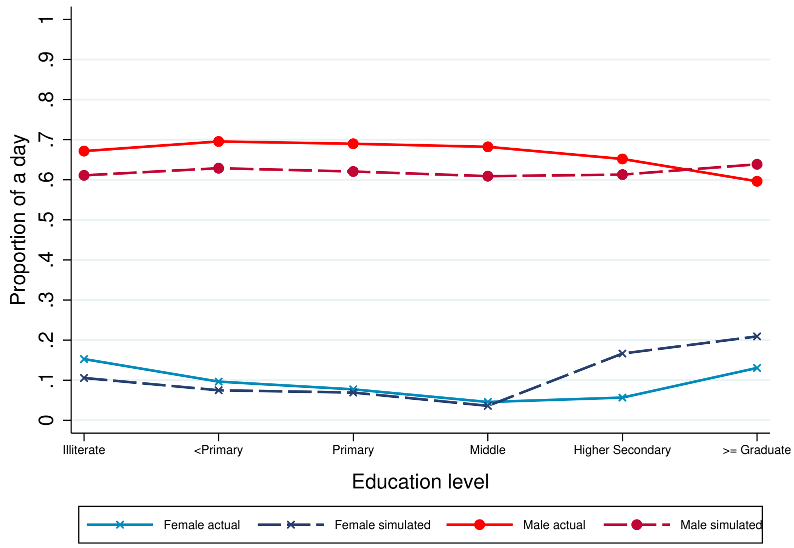
(c) Leisure



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.

Figure A.7 Simulations for time spent in labor market, home production, leisure (with $\bar{H}$ varying across education groups)

(a) Labor Supply



(b) Domestic Work

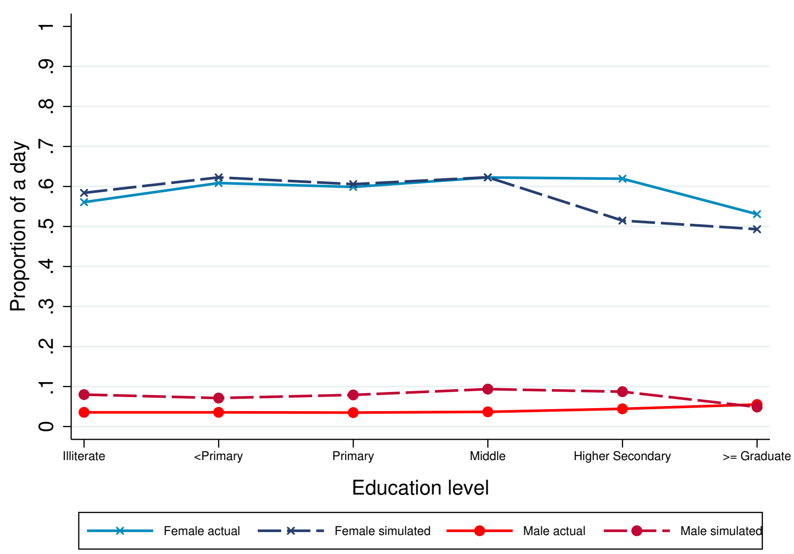
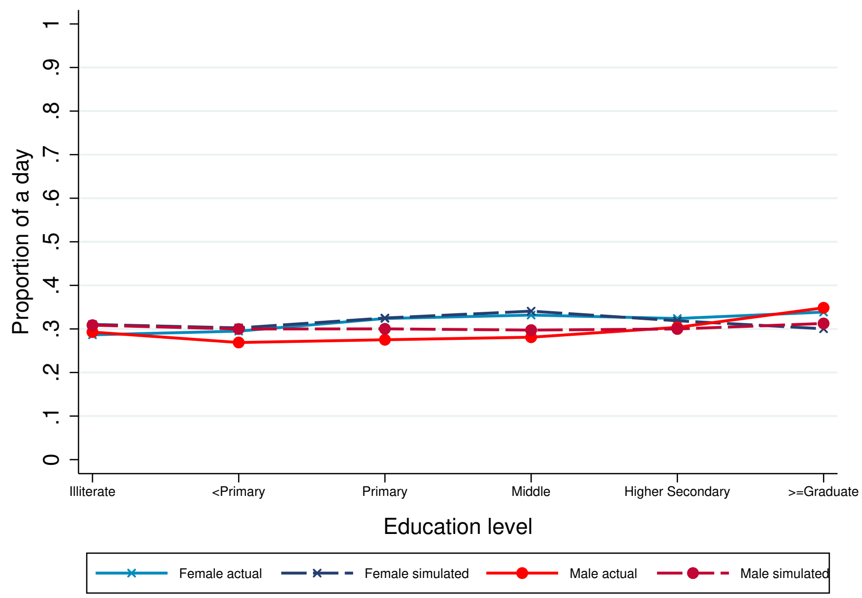


Figure A.7 (contd.)Simulations for time spent in labor market, home production, leisure (with $\bar{H}$ varying across education groups)

(c) Leisure

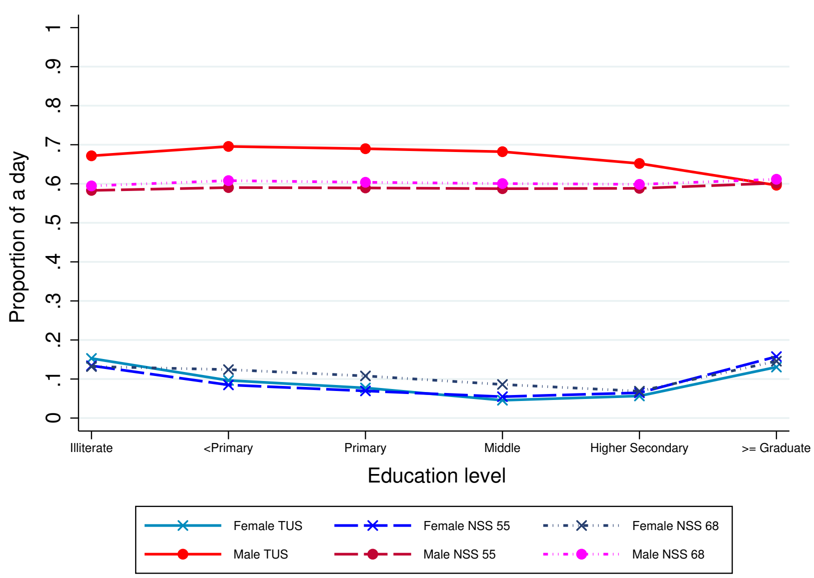


Note: Time spent in labor market, home production and leisure is shown as a fraction of the total time endowment of one. See data appendix for details on Time Use data.

Recent Employment Data

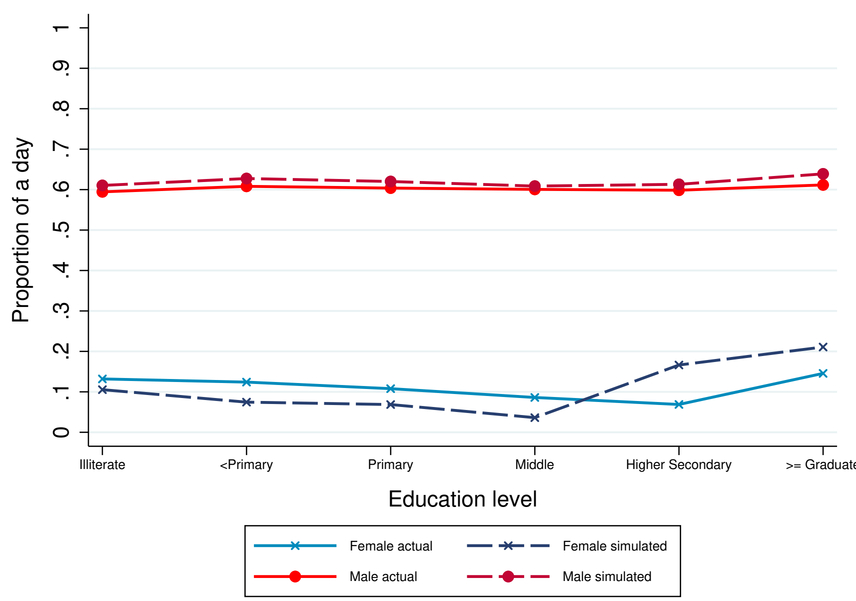
To calculate labor supply using NSS, consistent with the definition used in the TUS, we use the daily status definition of employment which captures the number of days a person was employed in the previous week. These are captured as half (0.5) or full (1) day. Assuming an eight hour work day, the total 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.8 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.8 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.9 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.

Table A.1 Impact of mother's education on child learning outcomes

Dependent variable ⟶	(1) Reading Test Score	(2) Writing Test Score	(3) Math Test Score
Less than Primary	0.245**	0.085**	0.127
	(0.097)	(0.037)	(0.088)
Primary	0.296***	0.047	0.213***
	(0.080)	(0.029)	(0.060)
Middle	0.374***	0.067**	0.217***
	(0.077)	(0.028)	(0.059)
Higher Secondary	0.421***	0.119***	0.262***
	(0.077)	(0.028)	(0.065)
Graduate and Above	0.403***	0.130***	0.328***
	(0.103)	(0.036)	(0.077)
Observations	3,401	3,374	3,381
R-squared	0.300	0.251	0.367
Mean Scores	2.923	.776	1.851
Child's gender	Yes	Yes	Yes
Child's age	Yes	Yes	Yes
Caste	Yes	Yes	Yes
Religion	Yes	Yes	Yes
Household consumption expenditure	Yes	Yes	Yes
Father's education	Yes	Yes	Yes
District FE	Yes	Yes	Yes

Source: Indian Human Development Survey 2004 (Authors' own calculations).
Note: The dependent variable is the score of a child in reading (0 to 4), writing (0 to 1) and math (0 to 3) in a standardized test administered in the nationally representative Indian Human Development Survey (IHDS) 2004. The coefficients represent the marginal effect of mother's education level on these outcomes, with an illiterate mother as the reference group. Other controls include indicator variables for age category and gender of the child, indicator variables for caste, religion and consumption expenditure per capita (quintiles) of the household, father's education and district fixed effects. The sample is restricted to households residing in urban areas and children aged 8-11 (the learning scores are captured only for this age group in the IHDS survey). Robust standard errors reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2 Calibrated values of α when $\bar{H}$ varies by education group

Paramater	Value	Description	Source
		Ratio of $\bar{H}$ to H : Male	
$\alpha^{i,1}$	0.030	Illiterate	calibrated
$\alpha^{i,2}$	0.027	Less than primary	calibrated
$\alpha^{i,3}$	0.025	Primary	calibrated
$\alpha^{i,4}$	0.024	Middle	calibrated
$\alpha^{i,5}$	0.025	Higher Secondary	calibrated
$\alpha^{i,6}$	0.026	Graduate and above	calibrated
		Ratio of $\bar{H}$ to H : Female	
$\alpha^{1,j}$	0.025	Illiterate	calibrated
$\alpha^{2,j}$	0.024	Less than primary	calibrated
$\alpha^{3,j}$	0.025	Primary	calibrated
$\alpha^{4,j}$	0.023	Middle	calibrated
$\alpha^{5,j}$	0.024	Higher Secondary	calibrated
$\alpha^{6,j}$	0.039	Graduate and above	calibrated

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

B Data Appendix

We draw on the following datasets in the analysis:

B.1 National Sample Survey (Employment)

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 A.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.

B.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 & Hurst (2007)). Classification of activities into leisure is more subjective [42]:

(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,

[42] Different definitions are proposed by Aguiar & 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 & 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.

B.3 National Sample Survey (Consumption expenditure)

The consumption expenditure round of India's National Sample Surveys (NSS) conducted in 1999-2000 for urban India is used to calculate the education expenditure of household per child. Education expenditure in NSS entails the annual expenditure incurred by households on books, journals, newspapers, periodicals, library charges, stationery, tuition and institution fees, private tutoring and coaching fees and other miscellaneous expenses. We first create a couples data and assign education categories to individuals in this dataset following the steps discussed in Appendix B.1. The sample for couples with children in age group 5-18 in the NSS stood at 22,991. We calculate the average education expenditure per child for a couple in a given education category (for each of the 36 education categories of couples) and the first percentile value of the annual education expenditure per child incurred by a couple where both have no education. The latter value is used to benchmark the minimum home good production or the social norm. This benchmarked minimum value of home good is assumed to be constant across all education groups. We then calculate the ratio of benchmark minimum home good to the actual education expenditure per child incurred by a couple belonging to education category (i,j). This gives the calibrated value of $\alpha^{i,j}$.

C Theoretical Model

We provide a detailed solution to the household optimization problem in this section.

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 $U_g = \log(c_g^e) + \phi_L \log(1 - n_g^e - h_g^e) + \phi_H \log(H_g^e - \bar{H})$, $g \in \{m, f\}$. 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:

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

$$c_f^{i,j} \ : \frac{1-\theta^{i,j}}{c_f^{i,j}} = \lambda_1, \tag{C.2}$$

$$q \ : \frac{\delta \phi_H}{q} \Big[\frac{1}{1 - \frac{\bar{H}}{H_g}} \Big] = \lambda_1,$$

and given $\frac{\bar{H}}{H_g} = \alpha^{i,j}$, we have

$$q \ : \frac{\delta \phi_H}{q} \Big[\frac{1}{1 - \alpha^{i,j}} \Big] = \lambda_1, \tag{C.3}$$

$$n_m^{i,j} \ : \frac{\theta^{i,j} \phi_L}{1 - n_m^{i,j} - h_m^{i,j}} = \lambda_1 w_m^j, \tag{C.4}$$

$$n_f^{i,j} \ : \frac{(1-\theta^{i,j}) \phi_L}{1 - n_f^{i,j} - h_f^{i,j}} = \lambda_1 w_f^i, \tag{C.5}$$

$$h_m^{i,j} : \frac{\theta^{i,j} \phi_L}{1 - n_m^{i,j} - h_m^{i,j}} = \frac{\phi_H}{H_g - \bar{H}} \left(\frac{q^\delta (1-\delta)(z_m (a_m^j h_m^{i,j})^{1-\rho} + z_f (a_f^i h_f^{i,j})^{1-\rho})^{(\frac{1-\delta}{1-\rho} - 1)} z_m (a_m^j h_m^{i,j})^{1-\rho}}{h_m^{i,j}} \right), \tag{C.6}$$

$$h_f^{i,j} : \frac{(1-\theta^{i,j}) \phi_L}{1 - n_f^{i,j} - h_f^{i,j}} = \frac{\phi_H}{H_g - \bar{H}} \left(\frac{q^\delta (1-\delta)(z_m (a_m^j h_m^{i,j})^{1-\rho} + z_f (a_f^i h_f^{i,j})^{1-\rho})^{(\frac{1-\delta}{1-\rho} - 1)} z_f (a_f^i h_f^{i,j})^{1-\rho}}{h_f^{i,j}} \right). \tag{C.7}$$

Using (C.4) in (C.6) and (C.5) in (C.7) we get

$$\lambda_1 w_m^j = \frac{\phi_H}{H_g - \bar{H}} \Big[\frac{q^\delta (1-\delta)(z_m (a_m^j h_m^{i,j})^{1-\rho} + z_f (a_f^i h_f^{i,j})^{1-\rho})^{(\frac{1-\delta}{1-\rho} - 1)} z_m (a_m^j h_m^{i,j})^{1-\rho}}{h_m^{i,j}} \Big], \textit{and} \tag{C.8}$$

$$\lambda_1 w_f^i = \frac{\phi_H}{H_g - \bar{H}}\Big[\frac{q^\delta(1-\delta)(z_m(a_m^j h_m^{i,j})^{1-\rho} + z_f(a_f^i h_f^{i,j})^{1-\rho})^{(\frac{1-\delta}{1-\rho}-1)} z_f(a_f^i h_f^{i,j})^{1-\rho}}{h_f^{i,j}}\Big]. \tag{C.9}$$

Taking a ratio of above expressions, we get

$$\frac{\lambda_1 w_m^j}{\lambda_1 w_f^i} = \frac{z_m(a_m^j h_m^{i,j})^{1-\rho}}{z_f(a_f^i h_f^{i,j})^{1-\rho}} \frac{h_f^{i,j}}{h_m^{i,j}},$$

which implies

$$h_f^{i,j} = \gamma h_m^{i,j},$$

where $\gamma = \left(\frac{w_m^j z_f}{w_f^i z_m}\right)^{\frac{1}{\rho}} \left(\frac{a_f^i}{a_m^j}\right)^{\frac{1-\rho}{\rho}}$. Also using (C.3) in (C.1) and (C.2) we get

$$c_m^{i,j} = \frac{\theta^{i,j} q(1-\alpha^{i,j})}{\delta \phi_H}, \tag{C.10}$$

$$c_f^{i,j} = \frac{(1-\theta^{i,j}) q(1-\alpha^{i,j})}{\delta \phi_H}. \tag{C.11}$$

Using (C.10) and (C.11), we can re-write the budget constraint as:

$$q\left(\frac{1-\alpha^{i,j}}{\delta \phi_H} + 1\right) = w_m^j n_m^{i,j} + w_f^i n_f^{i,j}. \tag{C.12}$$

Adding (C.8) and (C.9) and substituting the value of λ_1 in terms of q from (C.3), we can re-write the budget constraint as:

$$w_m^j h_m^{i,j} + w_f^i h_f^{i,j} = q\left(\frac{1}{\delta} - 1\right). \tag{C.13}$$

Adding (C.12) and (C.13) we get,

$$w_m^j(n_m^{i,j} + h_m^{i,j}) + w_f^i(n_f^{i,j} + h_f^{i,j}) = q\left(\frac{1-\alpha^{i,j}}{\delta \phi_H} + \frac{1}{\delta}\right). \tag{C.14}$$

We can re-write (C.4) and (C.5) after eliminating λ_1 using (C.3) as follows,

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

and

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

Therefore we can solve for q using the above two equations and equation (C.14), giving us,

$$q = \frac{(w_m^j + w_f^i)\delta\phi_H}{(1+\phi_L)(1-\alpha^{i,j}) + \phi_H}. \tag{C.15}$$

Using $h_f^{i,j} = \gamma h_m^{i,j}$ we can solve for $h_m^{i,j}$ from (C.8), where we replace the LHS using (C.4) and substitute for λ_1 from (C.3) which gives us $h_m^{i,j} = \frac{q}{w_m^j}\left(\frac{1}{\delta} - 1\right)\left[\frac{1}{1+\frac{z_f(a_f^i\gamma)^{1-\rho}}{z_m(a_m^j)^{1-\rho}}}\right]$ or using the value of q from (C.15), rearranging

$$h_m^{i,j} = \frac{\left(1 + \frac{w_f^i}{w_m^j}\right)(1-\delta)}{\left(\frac{(1+\phi_L)(1-\alpha^{i,j})}{\phi_H} + 1\right)(\Psi_m^{i,j} + 1)} \tag{C.16}$$

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

$$h_f^{i,j} = \frac{\left(1 + \frac{w_m^j}{w_f^i}\right)(1-\delta)}{\left(\frac{(1+\phi_L)(1-\alpha^{i,j})}{\phi_H} + 1\right)(1 + \Psi_f^{i,j})} \tag{C.17}$$

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

$$n_m^{i,j} = 1 - \frac{\left(1 + \frac{w_f^i}{w_m^j}\right)(1-\delta)}{\left(\frac{(1+\phi_L)(1-\alpha^{i,j})}{\phi_H} + 1\right)(\Psi_m^{i,j} + 1)} - \frac{\left(1 + \frac{w_f^i}{w_m^j}\right)\theta^{i,j}}{\frac{(1+\phi_L)}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i,j})}}. \tag{C.18}$$

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

$$n_f^{i,j} = 1 - \left(\frac{\left(1 + \frac{w_m^j}{w_f^i}\right)(1-\delta)}{\left(\frac{(1+\phi_L)(1-\alpha^{i,j})}{\phi_H} + 1\right)(1 + \Psi_f)}\right) - \left(\frac{\left(1 + \frac{w_m^j}{w_f^i}\right)(1-\theta^{i,j})}{\frac{(1+\phi_L)}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i,j})}}\right). \tag{C.19}$$

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

$$l_m^{i,j} = \frac{\left(1 + \frac{w_f^i}{w_m^j}\right)\theta^{i,j}}{\frac{(1+\phi_L)}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i,j})}}, \tag{C.20}$$

and

$$l_f^{i,j} = \frac{\left(1 + \frac{w_m^j}{w_f^i}\right)(1-\theta^{i,j})}{\frac{(1+\phi_L)}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i,j})}}. \tag{C.21}$$

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,

$$\begin{aligned} n_f^{i+1,k} - n_f^{i,j} = & \underbrace{\left[\frac{(1-\theta^{i,j})}{\left(\frac{(1+\phi_L)}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i,j})}\right)} - \frac{(1-\theta^{i+1,k})}{\left(\frac{(1+\phi_L)}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i+1,k})}\right)}\right]}_{a} + \\ & \underbrace{\left[\frac{\frac{w_m^j}{w_f^i}(1-\theta^{i,j})}{\left(\frac{1+\phi_L}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i,j})}\right)} - \frac{\frac{w_m^k}{w_f^{i+1}}(1-\theta^{i+1,k})}{\left(\frac{1+\phi_L}{\phi_L} + \frac{\phi_H}{\phi_L(1-\alpha^{i+1,k})}\right)}\right]}_{b} + \\ (1-\delta) & \underbrace{\left[\frac{\left(1 + \frac{w_m^j}{w_f^i}\right)}{(1+\Psi_f^{i,j})\left(\frac{(1+\phi_L)(1-\alpha_{i,j})}{\phi_H} + 1\right)} - \frac{\left(1 + \frac{w_m^k}{w_f^{i+1}}\right)}{(1+\Psi_f^{i+1,k})\left(\frac{(1+\phi_L)(1-\alpha_{i+1,k})}{\phi_H} + 1\right)}\right]}_{c} \end{aligned} \tag{C.22}$$

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

As discussed earlier in Section 3.1.1, the above expression shows that the base model is capable of generating a non-monotonic relationship of women's labor supply with their education. Note that as a special case, when $k = j$, the relevant wage, home productivity, Pareto weight and social norm ratios that matter in explaining the response of wife's labor supply to her education are shown in Appendix Table C.1. Clearly, as shown in the table, only the relative changes in parameters for the wife matter now and the parameters for the husband do not play any role. Row 1, columns (2)-(4) show the effect on wife's labor supply for each component when these components increase across education levels, i.e. the direction of change in these components is > 1. For instance, as wife's education increases from i to $i+1$, it is likely to result in an increase in the relative wage ratio for wife across education levels, resulting in an increase in her labor supply (denoted by > 0 in column 2, row 1). Similarly, home productivity ratio is likely to increase too, resulting in a decrease in her labor supply (column 3, row 1). The increase in bargaining power of women (column 4, row 2) will also lead to a decline in her labor supply. However, the effect of the social norm on time spent in the labor market would be ambiguous, as discussed in Section 3.1.1.

Change in time spent in home production by women: From the expression derived above for female time spent at home production (Equation C.17), 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

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

$$h_f^{i+1,k} = \frac{\left(1+\frac{w_m^k}{w_f^{i+1}}\right)(1-\delta)}{\left(\frac{(1+\phi_L)(1-\alpha^{i+1,k})}{\phi_H}+1\right)\left(1+\Psi_f^{i+1,k}\right)}.$$

This implies

$$h_f^{i+1,k} - h_f^{i,j} = (1-\delta)\left[\frac{1+\frac{w_m^k}{w_f^{i+1}}}{\left(\frac{(1+\phi_L)(1-\alpha^{i+1,k})}{\phi_H}+1\right)\left(1+\Psi_f^{i+1,k}\right)} - \frac{1+\frac{w_m^j}{w_f^i}}{\left(\frac{(1+\phi_L)(1-\alpha^{i,j})}{\phi_H}+1\right)\left(1+\Psi_f^{i,j}\right)}.\right] \tag{C.23}$$

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

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. Keeping other things constant, 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. It is also easy to verify that if α decreases with higher education of wife, her time spent in home production decreases. The final direction of change in home production time depends on the magnitude of the movements in relative wage, relative home productivity and relative norm responsiveness as wife's education increases. In a similar manner, we can perform the comparative static analysis for the changes in time spent by men in labor market and home production as their education level 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

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

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

$$\begin{aligned} n_m^{k,j+1} - n_m^{i,j} = (1-\delta)&\left[\frac{1+\frac{w_f^i}{w_m^j}}{\left(\frac{(1+\phi_L)(1-\alpha^{i,j})}{\phi_H}+1\right)(\Psi_m^{i,j}+1)} - \frac{1+\frac{w_f^k}{w_m^{j+1}}}{\left(\frac{(1+\phi_L)(1-\alpha^{k,j+1})}{\phi_H}+1\right)(\Psi_m^{k,j+1}+1)}\right] \\ &+ \left[\frac{\left(1+\frac{w_f^i}{w_m^j}\right)\theta^{i,j}}{\frac{(1+\phi_L)}{\phi_L}+\frac{\phi_H}{\phi_L(1-\alpha^{i,j})}} - \frac{\left(1+\frac{w_f^k}{w_m^{j+1}}\right)\theta^{k,j+1}}{\frac{(1+\phi_L)}{\phi_L}+\frac{\phi_H}{\phi_L(1-\alpha^{k,j+1})}}\right] \end{aligned} \tag{C.24}$$

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

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. Also, similar to the case of female labor supply, the effect of α on the labor supply by the husband is ambiguous. The final effect depends on the direction and the magnitude of each of the four 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

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

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

This implies

$$h_m^{k,j+1} - h_m^{i,j} = (1-\delta)\left[\frac{\left(1+\frac{w_f^k}{w_m^{j+1}}\right)}{\left(\frac{(1+\phi_L)(1-\alpha^{k,j+1})}{\phi_H}+1\right)(\Psi_m^{k,j+1}+1)} - \frac{\left(1+\frac{w_f^i}{w_m^j}\right)}{\left(\frac{(1+\phi_L)(1-\alpha^{i,j})}{\phi_H}+1\right)(\Psi_m^{i,j}+1)}\right] \tag{C.25}$$

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

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 $(\frac{a_f^k}{a_m^{j+1}} < \frac{a_f^i}{a_m^j})$. Also, if α decreases with higher education of the husband, time spent by him in home production decreases. The final direction of change depends on the direction and the magnitude of these two effects.

Table C.1 Theoretical predictions of effects on wife's labor supply (keeping husband's education constant)

Direction of Change	Δ Relative wage $(\frac{w_f^{i+1}}{w_f^i})$	Δ Relative home productivity $(\frac{a_f^{i+1}}{a_f^i})$	Δ Pareto weight (men) $\frac{\theta^{i+1,j}}{\theta^{i,j}}$	Δ in Norm responsiveness $\frac{\alpha^{i+1,j}}{\alpha^{i,j}}$
(1)	(2)	(3)	(4)	(5)
	Effect on wife's labor supply			
> 1	> 0	< 0	> 0	*Ambiguous*
< 1	< 0	> 0	< 0	*Ambiguous*
$= 1$	No change			

Note: Column 1 shows the direction of change in each of these four variables - relative wages (column 2), home productivity (column 3), Pareto weight (column 4) and norm responsiveness (column 5). Each cell in columns 2-5 shows the predicted direction of change in wife's labor supply for a given change in the corresponding variable (column 1) when her education increases. The predictions follow the theoretical decomposition of changes in wife's labor supply derived in Equation 8, when $k = j$.