# A Simple Theory of Female Labor Supply*

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**Abstract**

Empirical studies find significant differences between the decisions taken by men and women in similar situations. The reason behind this may be the difference between their preferences. It is thus necessary to study the patterns of economic behavior, such as decisions pertaining to labor supply, recognizing their gender-specificity. This leads to important policy insights. This paper develops a theory of female labor supply where decisions are taken by the households and the power distribution among the members is determined endogenously. It is shown that female labor supply can take different shapes due to behavioral differences between economies and multiple equilibria might occur in the female labor market. Effects of children, tax-benefit and technological improvement on female labor supply are also studied. The results found here seem to resonate well with previous empirical findings.

**Keywords:** female labor supply, collective utility model, household equilibrium, power

**JEL Classification Codes:** J16, J22, D13

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*"Men are from Mars, women are from Venus."*

- John Gray (1992)

# 1 Introduction

There exist differences between the preferences of men and women. These lead them to take different decisions in similar situations. Many empirical studies find that giving household subsidies to a woman rather than a man leads to different outcomes in the household expenditures, notably, child nutrition and schooling (see Senauer, Garcia & Jacinto, 1988; Hopkins, Levin and Haddad, 1994; Hoddinott and Haddad, 1995; Handa, 1999; Duflo, 2003; Gitter and Barham, 2008). Recently, there have been empirical studies suggesting differences in the household-decisions that can be attributed to differences in the power distribution between husbands and wives within households (Felkey, 2005; Lancaster, Maitra and Ray, 2006; Gitter and Barham, 2008). It is, therefore, necessary to study the economic issues driven by decisions of women separately from those influenced by men; labor supply is one of them.

Labor supply plays a very important role in an economy's development. A robust and ample labor force promotes development, and development, in turn, feeds back on labor market conditions. Studying the behavior of labor market can give rise to important policy implications. There have been many studies focusing on labor supply and in recent times, there has also been a fair amount of works on female labor supply in particular. Most of these studies are, however, empirical (Blundell, Ham and Meghir, 1987; Arellano and Meghir, 1992; Nakamura and Nakamura, 1994; Eissa and Liebman, 1996; Greenwood, Seshadri and Yorukoglu, 2005). The theoretical foundations of this topic has not been well explored in the existing literature and this paper attempts to make amends for that.

The goal of this paper is to develop a general theory of female labor supply—a theory that shows how the nature of female labor supply can take different forms and shapes due to the cultural or behavioral differences between economies. Hence similar policies might have different economic implications. Therefore, before considering any proposal for policy reforms targeting the rise in female labor force, it is necessary to understand its behavior in that particular economy. Usually a woman's labor supply decision is not taken by herself alone. All adult members of the household typically participate in this decision. To study the behavior of female labor supply, it is thus important to understand the household's decision making process. On one hand, a working woman's income adds to the household's total income which increases the collective utility; on the other hand, working outside leaves a woman

with less time to spend for household-work which in turn decreases the household-utility. Therefore a woman's labor supply decision depends on the collective utility of the household, the power distribution between the members of the household and, of course, the market wages. The power of a woman may be determined endogenously. The more a woman contributes to the family income compared to the other members of the family, the more power she gains; again, as the power of the woman increases in the household, she has more freedom to do what she prefers—household work or outside job.

This paper works with a model in which decisions are made by households and power is determined endogenously. Using this model, we show that female labor supply can be increasing, or decreasing, or backward-bending, with respect to a rise in the market wage rate. Under some circumstances, multiple equilibria might occur in the female labor market so that two economies with exactly same fundamental characteristics might end up at two very different equilibria: one with a high female labor force participation and the other with a low participation. Sometimes multiple equilibria might occur within households which give rise to the female labor supply taking the form of a correspondence. In such a situation, a slight fall in female labor demand may cause a huge amount of job-loss. The paper also derives some important comparative statics results. With this model, it can be shown that female labor supply decreases, as it is expected to be, when women have young children or children with disabilities. We can analyze the effects of tax-benefit programs or technological improvements in consumer durable goods on female labor force participation (in hours). It can be shown, using the model in this paper, that these effects are not necessarily positive, contrary to the usual notion held.

There is a growing literature on collective models of household behavior (Bourguignon and Chiappori, 1992, 1994; Vermeulen, 2002; Lundberg, 2005). However, very few papers relate female labor to the structure of household decision making. Francois (1998), Basu (2006) and, hopefully, mine are contributions to this. Francois' (1998) paper was focused on gender discrimination. He showed that even in the absence of any gender-specific inefficiencies, gender discrimination in the labor market may arise just "from the interaction between women and men within the household."

The model developed in the present paper is more closely related to the one in Basu (2006). Using a collective utility model, he showed how a household might end up with multiple equilibria while choosing the effort-level of the woman for working outside home. However, he assumed that wages are fixed which can be justified as long as we are considering one household at a time. One household (consisting of one woman) cannot have any significant impact on the wages. But when we aggregate all

the household decisions to get the total female labor supply, we cannot take female and, for that matter, male wages to be fixed because market wages are determined endogenously. They depend on the labor demand and the total labor supply. Allowing wages to vary, it can be shown that the multiplicity of household equilibria described in Basu's model might vanish. And, more interestingly, we might have multiple equilibria in the female-labor market although there is a unique equilibrium for each of the identical households.

The rest of the paper goes as follows. Section 2 describes the main model and equilibria in the households and in female labor market. In Section 3, I discuss how the female labor supply may change when there exist some substitutability between male labor and female labor. Effects of children on the labor force participation by women are discussed in Section 4. In Section 5, it is discussed how technological innovations in households' consumer durable goods may change the female labor supply. I then discuss, in Section 6, the changes due to some tax-benefits targeted at working women. Section 7 concludes the paper.

# 2 Model

There are $N$ identical households in a society. Each household consists of two adults: a male ($m$) and a female ($f$). They have different utility functions. However, they take the household-decisions collectively. Their objective is to maximize a weighted average of the utility each of them get from their collective decisions. The weights depend on the power distribution in the household. Let $\theta \in [0,1]$ denote the power of the woman in the household. Hence $(1-\theta)$ is the power of the man. Following the arguments of Agarwal (1997) and Basu (2006), it will be assumed that this index of power is endogenous to the household, that is, while $\theta$ influences household decisions, the decisions in turn influence $\theta$. The woman may gain more power by earning money from outside job and thus increasing the total household income; on the other hand, she can choose to do more what she likes—outside job or household work—if she has more power. This endogeneity of power is not at odds with empirical findings; see Bittman, England, Sayer, Folbre and Matheson (2003). Let $e \in [0,1]$ denote the woman's effort put to work outside home and $h \in [0,1]$ be her effort on household work, $(e+h) \in [0,1]$. Let $\alpha$ denote the woman's efficiency at outside job in terms of household work, i.e., the output from working for one hour outside is equivalent to the output from working $\alpha$ hours in the household, $\alpha > 0$. Basically, working at home or outside are perfectly substitutable choices for the woman and $\alpha$ works as an efficiency correction parameter here. Hence working one hour at home and one hour outside is equivalent to working $(1+\alpha)$ hours at home.

Let $w$ be the market wage rate for female labor and fix, for the time-being, the wages for men at $\overline{w}$. Unlike Basu (2006), wages in this paper are not fixed. This allows us to study the labor markets, especially the female labor supply and to do comparative statics with more general equilibrium features. I initially assume that the labor markets for women and men are two completely separate markets independent of each other—changes in the wages and employment in one has no influence on the other. This of course is not true in reality and later on I relax this assumption to allow for dependence between them. To focus on the analysis of female labor supply, assume that the man always puts effort 1 for outside work.

Let $x$ be the consumption good and normalize its price at 1. For technical ease, assume that there is only one consumption good and both agents gain some utility from it. Let $v_i(.)$ denote the utility of $i, i \in \{m, f\}$, from the household work done by the woman and assume $v_i'(.) > 0, v_i''(.) \leq 0$. By $c_i(.)$, let us denote the pain caused by $i$'s effort on outside work, where $c_i'(.) > 0, c_i''(.) \geq 0$, i.e., the disutility increases at an increasing rate. Now we can write down the utility functions for the female and the male in the following form:

$$\begin{aligned} u_f(x, e, h) &= x + v_f(h) - c_f(h + \alpha e), \\ u_m(x, h) &= x + v_m(h) - c_m(1), \end{aligned}$$

Assume that $v_i'(1) > c_f'(1), i \in \{m, f\}$, i.e., the household's marginal utility from the woman's work at home is more than her marginal pain from that. This guarantees that the optimum choice of $e$ and $h$ by the household are such that $h > 0$ and $(e + h) = 1$, i.e., the woman puts her entire effort 1 on work—household and outside. Hence the household's objective is to choose $(x, e)$ such that the weighted average of the utilities of the man and the woman

$$\begin{aligned} U(x, e) &= \theta u_f(x, e, 1 - e) + (1 - \theta) u_m(x, 1 - e) \qquad (1) \\ &= x + \theta [v_f(1 - e) - c_f(1 + (\alpha - 1) e)] + (1 - \theta) [v_m(1 - e) - c_m(1)] \end{aligned}$$

is maximized subject to the household's budget constraint

$$x \leq \overline{w} + ew.$$

Since the household's collective utility is strictly increasing in $x$, the budget constraint will hold with equality. Therefore, when the woman's power is $\theta$ and the market wage rate for her labor is $w$, the collective utility maximizing effort $(e)$ by the woman for outside job is given by the solution of the first order condition:[1]

$$w = \theta \left[v_f'(1 - e) + (\alpha - 1) c_f'(1 + (\alpha - 1) e)\right] + (1 - \theta) v_m'(1 - e). \qquad (2)$$

[1] If $w < \theta \left[v_f'(1) - c_f'(1)\right] + (1 - \theta) v_m'(1)$, then $e = 0$.

The equation above gives us the household-utility maximizing effort supplied by the woman for outside job, $e$, as a function of $\theta$ for a given wage $w$ :

$$e = e(\theta, w)$$

where

$$\frac{\partial e}{\partial \theta} \gtreqless 0$$

accordingly as

$$\frac{\partial u_f(x, e, 1-e)}{\partial e} \gtreqless \frac{\partial u_m(x, 1-e)}{\partial e} \text{ for all } e.$$

The above condition simply means that if the woman's marginal utility from her outside job is more than the man's marginal utility from it, i.e., if the woman prefers working outside, then the more power she gains, the more she can choose to work outside.

The woman can acquire more power by earning more. Suppose the power of a woman ($\theta$) in the household depends not only on the relative wages she earns compared to the man $\left(\frac{ew}{\overline{w}}\right)$, but also on the prevailing relative market wage for female labor $\left(\frac{w}{\overline{w}}\right)$. If $\frac{w}{\overline{w}}$ is very high, then even though the woman does not actually go outside for a job (i.e., $e = 0$), the woman can enjoy a pretty high power by the mere availability of a very good outside option. On the other hand, if $\frac{w}{\overline{w}} = 0$ (or a very low value), then the woman cannot gain a lot of power by working outside even for full-time. Therefore, since $\overline{w}$ is fixed, we can write the power of a woman ($\theta$) to be a function of $(e, w)$ so that $\theta$ is increasing in $e$ and as $w$ increases, $\theta$ shifts up.

$$\theta = \theta(e, w).$$

**Definition 1** *A household equilibrium in this model, for a given market wage rate for female labor $w$, is described by $(e^*(w), \theta^*(w))$ where*

$$\begin{aligned} e^*(w) &= e(\theta^*(w), w) \text{ and} \\ \theta^*(w) &= \theta(e^*(w), w). \end{aligned}$$

**Definition 2** *An equilibrium in the female labor market, or simply market equilibrium, occurs when total female labor supply equals the demand for female labor.*

Let $L_f^D(w)$ be the female labor demanded when market wage rate for female labor is $w$ and let $L_f^S(w)$ be the female labor supply at that wage rate. Hence, given that there are $N$ identical households (and thus $N$ women) in the economy, from the

household equilibrium described above, we can say that total female labor supply in the economy is

$$L_f^S(w) = N \cdot e^*(w).$$

Therefore, the market equilibrium is given by the equilibrium wage rate for female labor $w^*$ such that

$$L_f^D(w^*) = N \cdot e^*(w^*).$$

## 2.1 Case I: $\frac{\partial u_f(x,e,1-e)}{\partial e} < \frac{\partial u_m(x,1-e)}{\partial e}$ for all $e$

In this case, the marginal utility of the woman for her household work is more than the marginal utility of the man. We have discussed earlier that in such a situation the household's collective utility maximizing effort supplied by the woman for outside job decreases as her power increases: $\frac{\partial e}{\partial \theta} < 0$. Since the woman prefers her household work, she chooses to work less outside the more power she gains in the household. However, the woman can acquire more power by working more outside (thus earning more): $\frac{\partial \theta}{\partial e} > 0$. Thus, plotting $e(\theta, w)$ and $\theta(e, w)$ in the $e - \theta$ space, it is easy to see that there exists a unique household equilibrium in this case, as shown in Figure 1.

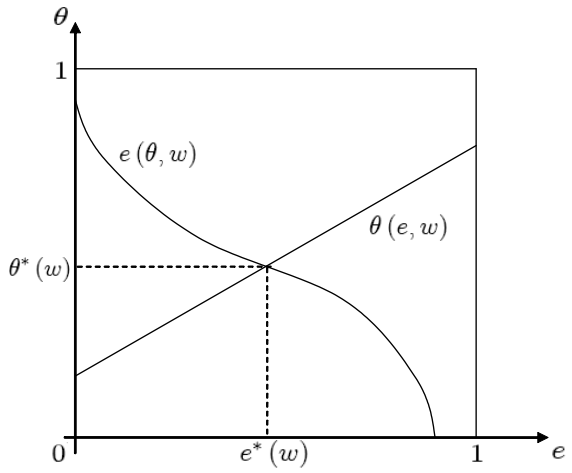


Figure 1: Unique household equilibrium in Case I

To find the market equilibrium in this case, we first need to construct the female labor supply from the household equilibria at different market wages for female labor. From the first order condition of the household's utility maximization problem (2),

it is easy to check that

$$\frac{\partial e}{\partial w} > 0$$

and as we argued earlier, the more the market wage is, the more power the woman earns:

$$\frac{\partial \theta}{\partial w} > 0.$$

Hence, as the wage-rate for female labor rises, both $e(\theta, w)$ and $\theta(e, w)$ shift up in the $e-\theta$ space. This may cause $e^*$ to either increase or decrease or remain unchanged. If $e^*(w)$ increases as $w$ increases, then the female labor supply curve is increasing as usual. But if $e^*(w)$ decreases as $w$ increases, then interesting outcomes may occur since the female labor supply curve is now decreasing. In Figure 2 we can see a situation where the effort-level in the household-equilibrium falls as female-wages increase.

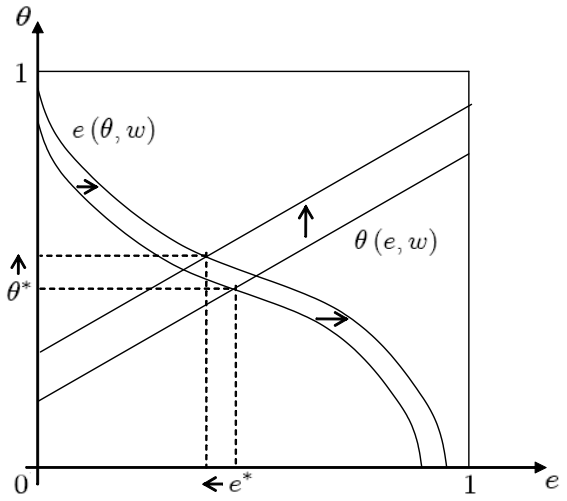


Figure 2: Changes in household equilibrium with increase in $w$

This gives rise to a downward sloping or backward bending supply curve for female labor. Assuming downward sloping demand curve for female labor, we might have multiple equilibria in some situations in the female labor market although there exists a unique household equilibrium. One such situation is shown in Figure 3.

Therefore, two economies, similar in every fundamental aspect, might end up at two different equilibria and thus they look very different from outside. One of

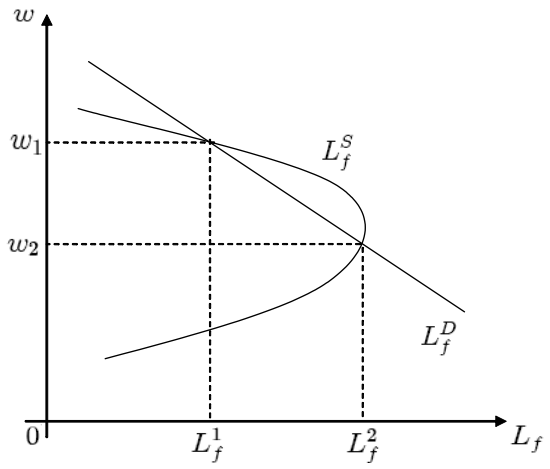


Figure 3: Multiple equilibria in female-labor market

them might have a very high female labor force participation at equilibrium and low market wage rate. And in the other one, women may spend more time at household work in equilibrium although the market wage rate is very high.

## 2.2 Case II: $\frac{\partial u_f(x,e,1-e)}{\partial e} > \frac{\partial u_m(x,1-e)}{\partial e}$ for all $e$

Recall that, in this case, when the marginal utility from the outside job for the woman is more than the marginal utility of the man for her effort put outside, then as the power of the woman increases, her effort supply for outside job increases: $\frac{\partial e}{\partial \theta} > 0$. Since both the "power-earning curve" $\theta(e, w)$ and "effort supply curve" $e(\theta, w)$ are increasing in this case, we might have multiple equilibria in a household as shown in Basu (2006). Plotting $e(\theta, w)$ and $\theta(e, w)$ in the $e - \theta$ space as we did earlier, we can get the following figure which shows one such instance where for a given wage $w$ for female-labor, there exist three household equilibria: $E_1 = (e_1, \theta_1), E_2 = (e_2, \theta_2)$ and $E_3 = (e_3, \theta_3)$.

As we did in the previous case, let us now find the market equilibrium in this case. For that, we need to construct the female labor supply first, that is, allow the wages to change and check what happens to the household equilibrium.

If we incorporate changes in wages for female-labor, the multiplicity of household equilibria might not exist even in the example shown in Figure 4. To see this, first note that as wage-rate $w$ increases, the power-earning curve $\theta(e, w)$ shifts up and

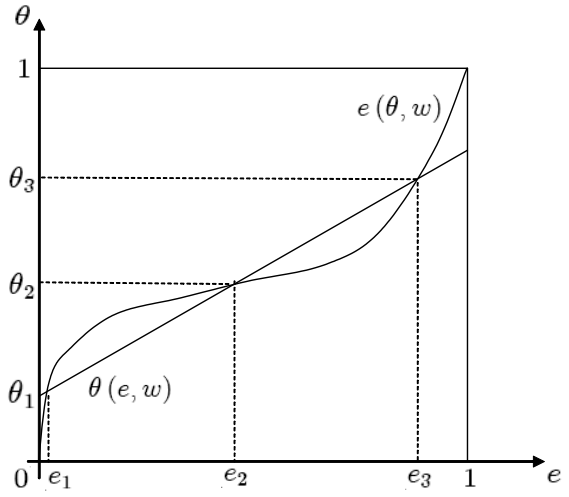


Figure 4: Multiple household equilibria in Case II

the effort-supply curve $e(\theta, w)$ moves to the right (or down) (see Figure 5) since for $w'' > w'$, we have

$$\begin{aligned} \theta(e, w'') &> \theta(e, w') \text{ for all } e \text{ and} \\ e(\theta, w'') &> e(\theta, w') \text{ for all } \theta. \end{aligned}$$

Hence the equilibrium effort-levels $e_1$ and $e_2$ come closer and $e_2$ and $e_3$ move farther apart. After a sufficient increase in $w$, two of the three equilibria $E_1$ and $E_2$ vanish and the household ends up at the unique equilibrium with a very high effort-level $e$. Similarly, for sufficiently low wages for female-labor, the household may have a unique equilibrium with very low effort-level. Since for wages in some particular range we might have multiple equilibria for each household, the female labor supply for each household in such a situation is given by a correspondence as shown in Figure 5.

Households mimicing each other is not a very unusual behavior in a small society. If each household mimics each other in choosing one of the multiple equilibria, i.e., if all the households choose exactly the same equilibrium at a given wage, then the total female labor supply looks exactly like the effort supply correspondence for each household (as in Figure 5). The total labor supply is $N$-times the effort exerted by the woman from each household where $N$ is the total number of households in the society. In this case, a slight fall in female labor demand might cause huge amount

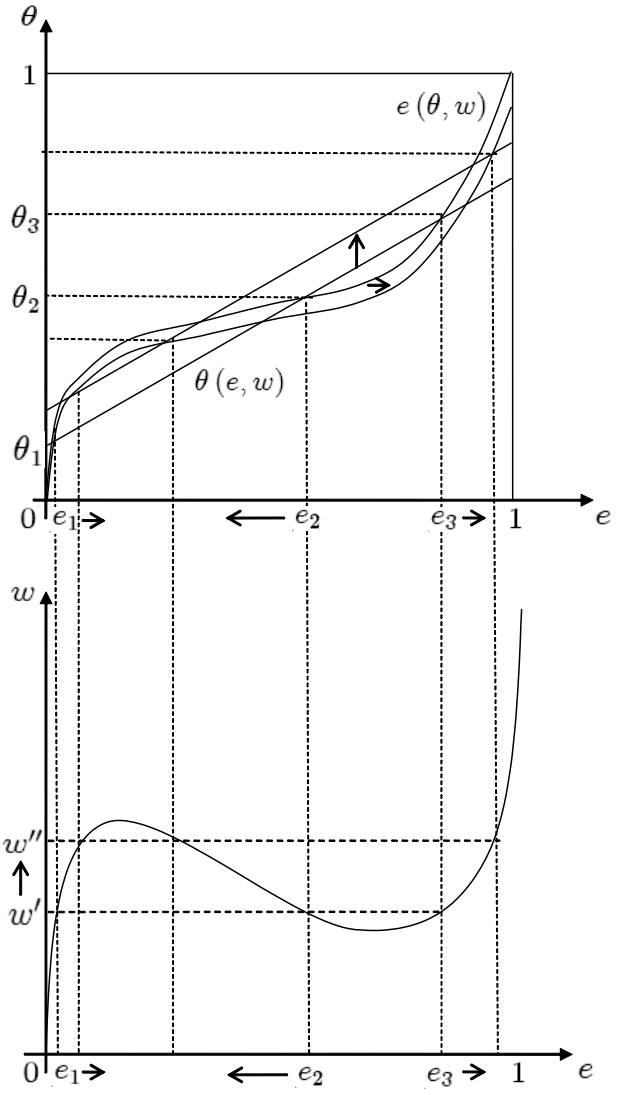


Figure 5: Changes in household equilibria with increase in $w$ and female labor supply correspondence per household

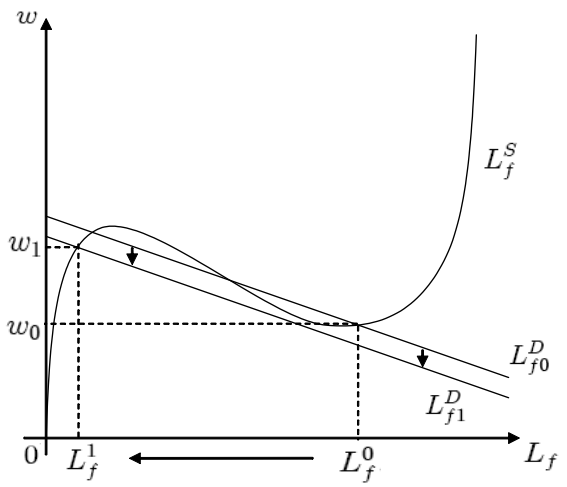


Figure 6: Crisis in female labor market due to a slight fall in female labor demand

of job-losses or cut-back in work-hours. In Figure 6, consider a situation where an economy starts with a labor demand $L_{f0}^D$ and it is at a high equilibrium $L_f^0$. Then, due to a recession or some technological changes, suppose the demand for female labor falls to the one given by $L_{f1}^D$ in Figure 6. As a result, the economy reaches at a new equilibrium $L_f^1$ where both the supply and demand for female labor are much lower compared to the initial equilibrium causing a massive fall in female labor force participation (in hours).

Instead of mimicing, if households are assigned one of the multiple equilibria, then the total female labor supply correspondence (denoted by $L_f^S$) looks like the one in Figure 7. For each $w$ for which there exist multiple equilibria in the household, the total female-labor supply can be any rational number between $Ne_{\min}(w)$ and $Ne_{\max}(w)$ where $e_{\min}(w)$ is the minimum effort-level supplied by a woman at wages $w$ according to the multiple household-equilibria and $e_{\max}(w)$ gives the maximum effort-level by a woman in the household-equilibrium for the same wages. If $N$ is very large, then since rational numbers are dense on real line, the total female labor supply correspondence $L_f^S$ has a dense area as shown in Figure 7. Let $L_f^D$ be the demand curve for female-labor which is down-ward sloping. Then, from Figure 7, it is evident that a society might have a continuum of equilibria in the female labor market.

In the entire analysis above we have seen some situations where multiple equilibria may occur in the female labor market and in some other instances we may have a

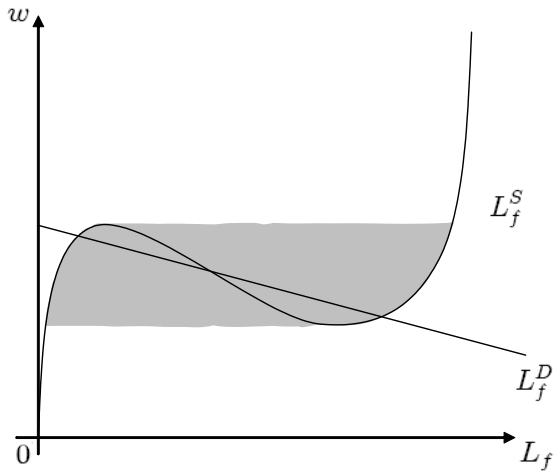


Figure 7: Continuum of equilibria in female-labor market

continuum of equilibria. However, all these analyses have been done keeping the labor market for men out of the picture. We assumed that movements in the labor market for women does not have any impact on the market wage for men. I shall analyze how to get rid of this assumption in the following section.

# 3 Dependence between Labor Markets for Men and Women

In the previous section, female labor market and male-labor market were two completely separate markets, changes in one had no influence on the other. In this section, I allow for some substitutability between male and female labor. To see the impact of this, we first need to modify the model a little bit. Let $w_f$ be the wages for female labor and $w_m$ be the wages for male labor. As before, assume that the man always works full time, however, the woman's effort for outside job ($e$) is chosen in the household equilibrium by maximizing household utility. The utility functions take the same form as before (given by equation (1)), but the budget constraint is now different. The household's objective function is

$$\max_{x\geq 0, e\in[0,1]} U(x,e) = \theta u_f(x, e, 1-e) + (1-\theta) u_m(x,e)$$

subject to the budget constraint

$$x \leq (w_m + ew_f).$$

As in the previous section, the first order condition is given by

$$w_f = \theta \left[ v_f' (1-e) + (\alpha - 1) c_f' (1 + (\alpha - 1) e) \right] + (1-\theta) v_m' (1-e)$$

which in turn gives us the effort supplied by the woman for outside job, $e$, as a function of $\theta$ for a given wage $w_f$ :

$$e = e(\theta, w_f)$$

where

$$\frac{\partial e}{\partial \theta} \lesseqgtr 0$$

accordingly as

$$\frac{\partial u_f (x, e, 1-e)}{\partial e} \gtreqless \frac{\partial u_m (x, 1-e)}{\partial e} \text{ for all } e.$$

Suppose the power of a woman ($\theta$) in the household depends on her total earnings relative to the man $\left(\frac{ew_f}{w_m}\right)$ and also on the prevailing relative market wage $\left(\frac{w_f}{w_m}\right)$. At very high relative wages, the woman can exercise a lot of power in the household even though she does not actually go outside for a job (i.e., $e = 0$) just because she has a very good outside option available. On the other hand, if relative wages are very low, then the woman cannot gain a lot of power by working outside even for full-time. Therefore,

$$\theta = \theta \left( e, \frac{w_f}{w_m} \right).$$

A household equilibrium in this model, for given wages $(w_f, w_m)$, is described by $(e^*(w_f, w_m), \theta^*(w_f, w_m))$ where

$$\begin{aligned} e^*(w_f, w_m) &= e(\theta^*(w_f, w_m), w_f) \text{ and} \\ \theta^*(w_f, w_m) &= \theta \left( e^*(w_f, w_m), \frac{w_f}{w_m} \right) \end{aligned}$$

and, as in previous section, the female labor market equilibrium is described by the equilibrium wage rate for female labor $w_f^*$ where the demand for female labor equals its supply.

Before going into analyzing the dependence between the two labor markets, recall that the supply of labor in the labor market for men is fixed in this model. Hence any

shift in demand for male labor will just cause the market wages for men to change. A rise (or fall) in demand for male labor at a given wage will lead market wage rate for men $w_m$ to rise (or fall).

Now suppose that male labor and female labor are substitutes. Then, as female-wages rise, the demand for female labor decreases (movement along the female labor demand curve) which in turn raises the demand for male labor (male labor demand curve shifts up). Since male labor supply is fixed, this rise in demand causes the male wages to go up. Since both $w_f$ and $w_m$ go up, the relative wages $\left(\frac{w_f}{w_m}\right)$ might rise or fall (or remain unchanged).

If increase in market wage rate for female labor causes the relative wages for female labor to rise, then the female labor supply looks almost similar to that in Section 2. This happens since the entire analysis is the same because the rise in relative wages cause the "power earning curve" $\theta\left(e, \frac{w_f}{w_m}\right)$ to shift up and the "effort supply curve" $e\left(\theta, w_f\right)$ of each household to shift right as they did in Section 2.

However, if increase in male wages due to rise in female wages is higher than the latter, i.e., if relative wages $\left(\frac{w_f}{w_m}\right)$ fall due to the rise in female wages, then the analysis gives different outcome. In this situation, as the market wage rate for female labor rises, the "power earning curve" $\theta\left(e, \frac{w_f}{w_m}\right)$ shifts down. Hence, when the marginal utility from the household work is more for the woman than for the man, i.e., in case $\frac{\partial u_f(x,e,1-e)}{\partial e} < \frac{\partial u_m(x,1-e)}{\partial e}$ for all $e$ (recall the analysis in Section 2.1), then the female labor supply curve comes out to be upward rising always, it has no downward sloping stretch as was in Section 2.1. And thus we have all the usual labor market analyses in this case. However, in the other case, when the woman's marginal utility from the outside job is more than the man's marginal utility from her job, i.e., when $\frac{\partial u_f(x,e,1-e)}{\partial e} > \frac{\partial u_m(x,1-e)}{\partial e}$ for all $e$ (recall the analysis in Section 2.2), then as relative wages $\left(\frac{w_f}{w_m}\right)$ fall due to rise in female wages $w_f$, the equilibrium effort supply of the woman from a household may increase or decrease. In Figure 8, an instance is shown where it decreases. If the equilibrium effort supply of a woman decreases as a result of an increase in her wage rate, then there exists a downward sloping stretch in the female labor supply curve. Note that in the absence of any dependence between female labor and male labor, the female labor supply will be strictly rising in case of the situation shown in Figure 8. Adding the dependence may cause a downward stretch to the female labor supply and given a downward sloping female labor demand, multiple equilibria in the labor market may arise.

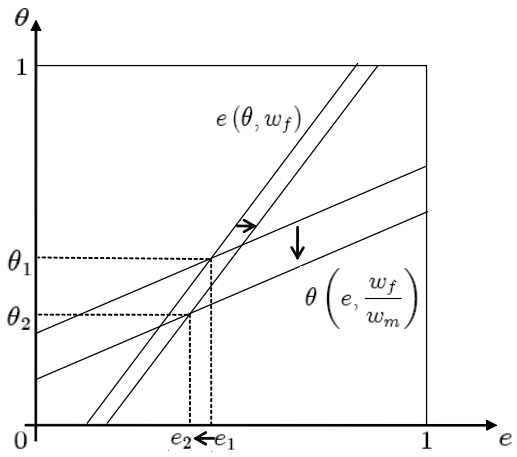


Figure 8: Woman's effort supply for outside job falls as her wages increase

# 4 Impact of Children on Female Labor Force Participation

Let us go back to the set-up used in Section 2 where women's labor market is independent from men's. While studying women and their labor force participation (as hours of work outside home), one usual question arises always: how does it change when women have kids? Many people have studied empirically the effect of children on the work choices of the mothers (Nakamura and Nakamura, 1994; Porterfield, 2002; Boushey, 2008). All of them, unsurprisingly, found a negative impact, specially when a child is young or with disabilities. Young children or children with disabilities usually require more attention of their mothers compared to the older healthier children. Hence a woman with a young child[2] (along with the entire household) face more difficulties if the woman spends more time for the outside job. The marginal utility of the household from the woman's household-work is now larger than before. Hence the household ends up choosing more time at house-work (and less time outside) for the woman.

To see this outcome from the model in this paper, suppose a new baby is born and thus the marginal utilities from the woman's household-work for both the man and the woman rise. In terms of the notations of the model in Section 2, this means

[2]Note that fertility is exogenous in this model.

an increase in $v'_m(h)$ and $v'_f(h)$ at given $h$ and this is true for all $h$. Now recall the first order condition of the household's collective utility maximization problem (1) :

$$w = -\left[\theta \frac{\partial u_f(x, e, 1-e)}{\partial e} + (1-\theta)\frac{\partial u_m(x, 1-e)}{\partial e}\right].$$

Suppose $\eta$ is a parameter in the model which captures the changes in $v'_m(.)$ and $v'_f(.)$. To find out what happens to the household's utility maximizing effort supply $e$ of the woman as $\eta$ changes, we first need to differentiate the first order condition with respect to $\eta$ : [3]

$$\begin{aligned}
\frac{\partial w}{\partial \eta} &= -\frac{\partial}{\partial \eta}\left[\theta\frac{\partial u_f}{\partial e} + (1-\theta)\frac{\partial u_m}{\partial e}\right] - \left[\theta\frac{\partial^2 u_f}{\partial e^2} + (1-\theta)\frac{\partial^2 u_m}{\partial e^2}\right]\frac{de}{d\eta} \\
&\Rightarrow -\left[\theta\frac{\partial^2 u_f}{\partial e^2} + (1-\theta)\frac{\partial^2 u_m}{\partial e^2}\right]\frac{de}{d\eta} = \frac{\partial}{\partial \eta}\left[w + \theta\frac{\partial u_f}{\partial e} + (1-\theta)\frac{\partial u_m}{\partial e}\right] \\
&\Rightarrow sign\left(\frac{de}{d\eta}\right) = sign\left[\frac{\partial}{\partial \eta}\left(w + \theta\frac{\partial u_f}{\partial e} + (1-\theta)\frac{\partial u_m}{\partial e}\right)\right], \qquad (3)
\end{aligned}$$

since $u_f$ and $u_m$ are concave. As increase in $\eta$ means shift in $v'_m(.)$ and $v'_f(.)$ upwards, it is easy to check that $\frac{de}{d\eta} < 0$. So a baby causes the household's utility maximizing effort supply of the woman to fall, i.e., $e(\theta, w)$ shifts left. We are not done yet. To find out the effect on the female labor supply, we have to find out what happens to the household equilibria. From Figure 1 in Section 2.1 and Figure 4 in Section 2.2, it is easy to check that given $w$, equilibrium effort supply (and thus total female labor supply) falls as $\eta$ increases.[4] Hence, the model in this paper is able to establish theoretically, the same result as expected by all intuitively and shown empirically, that existence of children, who need more attention of their mothers, reduces the female labor supply.

# 5 Effects of Tax Benefit on Female Labor Supply

In many countries, there are policy programs specially aimed at increasing the participation of women in the labor force. One of these policies include giving tax-benefits to women on their incomes. To see the implications of this policy in our model, we can do similar exercise as we have done in the last section.

[3] Dropping the variables in brackets for the functions $u_f$ and $u_m$, for notational ease.

[4] In Figure 4, $e_2$ (the equilibrium effort supply in the middle one of the three equilibria, $E_2$) goes up, but we can ignore it since it is an unstable equilibrium.

In this case, $\eta$ represents $w$ because $w$ is basically the net wage rate (gross wage rate minus taxes) and a tax-benefit simply means a rise in net wages. As a result, from Equation (3) , it is easy to find that given $\theta$, the household's utility maximizing effort supply of the woman rises or $e(\theta, w)$ shifts right. Again, since her net wage rate is now higher, she can gain more power from the same amount of effort put on outside job, i.e., $\theta(e, w)$ shifts up. This exercise has been worked out in Figure 2 in Section 2.1 and in Figure 5 in Section 2.2. From these figures, it is evident that the equilibrium effort supply of the woman (and thus total female labor supply) might go up or go down as a result of the tax-benefit to women. Note that since a tax-benefit of value $\tau$ on net wage-rate $w$ is equivalent to a rise in the net wage rate by the same amount, the entire female labor supply curve (or correspondence) shifts down by that amount:

$$L_f^S(w + \tau) = \widetilde{L_f^S}(w),$$

where $L_f^S$ and $\widetilde{L_f^S}$ denote the female labor supply before and after the introduction tax-benefit, respectively. Hence, in an economy with a backward-bending female labor supply curve as shown in Figure 3 and multiple equilibria in the female labor market, introduction of a tax-benefit program for women might have different outcomes depending on which market equilibrium the economy is at. In Figure 9,

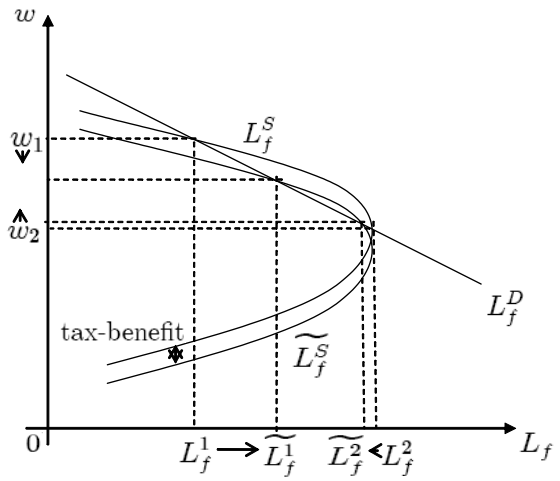


Figure 9: Introduction of tax-benefit might have different effects at different equilibria

we can see that a tax-benefit causes a huge increase in female labor force participa-

tion (in terms of hours) in one equilibrium (from $L_f^1$ to $\widetilde{L_f^1}$), whereas, in the other equilibrium, it falls, $\widetilde{L_f^2} < L_f^2$. There have been many empirical works for measuring the effectiveness of some tax-benefit programs (Eissa and Liebman, 1996; Blundell, Duncan and Meghir, 1998; Grogger, 2003). Most of them find a positive impact on women's labor force participation. Eissa and Liebman (1996) found that for one group of women, the effect is positive and for another group of women, it is zero. But, to the best of my knowledge, the negative impact of tax-benefits on the equilibrium female labor force participation has not been observed by any empirical work yet.

# 6 Impact of Technological Improvement on Time Spent by Women on Household-work

In the 20th century and late 19th century, following the industrial revolution, people observed a huge technological revolution in their homes. The introduction of household consumer durables like washing machine, vacuum cleaner, refrigerator, etc. made the household work a lot easier. Hence, many people argued, women could spend less time at household and work more outside. In 1912, Thomas Edison said in an interview that "(t)he housewife of the future will be neither a slave to servants nor herself a drudge. She will give less attention to the home, because the home will need less; she will be rather a domestic engineer than a domestic labourer, with the greatest of all handmaidens, electricity, at her service. This and other mechanical forces will so revolutionize the woman's world that a large portion of the aggregate of woman's energy will be conserved for use in broader, more constructive fields."

However, there has been a debate among social scientists over this issue. Some find that, as a result of the technological revolution, women indeed spent less time in the household and labor force participation had increased (Gershuny and Robinson, 1988; Greenwood, Seshadri and Yorukoglu, 2005). Others, on the other hand, show evidence that this was not the case. Vanek (1974) argued that women's time spent on household work has changed marginally since the revolution. Bittman, Rice and Wajcman (2004) showed that "domestic technology rarely reduces women's unpaid working time and even, paradoxically, produces some increases in domestic labour." It would be interesting what theory would have to say on this matter and that is what I proceed to investigate now.

First of all, recall the first order condition from the household's collective utility maximization problem, in terms of hours at housework ($h$) instead of outside work ($e$) :

$$w = \theta \frac{\partial u_f}{\partial h} + (1-\theta) \frac{\partial u_m}{\partial h}.$$

Suppose $\eta$ is a parameter in the model. Then for finding the comparative statics results of $\eta$ on $h$, we have to differentiate the first order condition, given above, with respect to $\eta$.

$$\begin{aligned}
\frac{\partial w}{\partial \eta} &= \frac{\partial}{\partial \eta}\left[\theta \frac{\partial u_f}{\partial h} + (1-\theta) \frac{\partial u_m}{\partial h}\right] + \left[\theta \frac{\partial^2 u_f}{\partial h^2} + (1-\theta) \frac{\partial^2 u_m}{\partial h^2}\right] \frac{dh}{d\eta} \\
&\Rightarrow \left[\theta \frac{\partial^2 u_f}{\partial h^2} + (1-\theta) \frac{\partial^2 u_m}{\partial h^2}\right] \frac{dh}{d\eta} = -\frac{\partial}{\partial \eta}\left[\theta \frac{\partial u_f}{\partial h} + (1-\theta) \frac{\partial u_m}{\partial h}\right] \\
&\Rightarrow sign\left(\frac{dh}{d\eta}\right) = sign\left[\frac{\partial}{\partial \eta}\left(\theta \frac{\partial u_f}{\partial h} + (1-\theta) \frac{\partial u_m}{\partial h}\right)\right].
\end{aligned}$$

Technological improvement in household's consumer durables helps reduce the marginal pain from household work. This means, in terms of our model, a lower $c_f'(.)$ .Since we know that $(e+h) = 1$ always, it is easy to check that when $\eta$ represents $c_f'(.)$, then

$$\frac{dh}{d\eta} \gtreqless 0 \text{ according to } \alpha \gtreqless 1.$$

Therefore, according to our model, if a woman is more efficient at outside job ($\alpha > 1$) compared to household work, then as $c_f'(.)$ falls, $h$ falls and $e$ rises, as found in Gershuny and Robinson (1988), Greenwood, Seshadri and Yorukoglu (2005). The opposite happens (as found in Bittman, Rice and Wajcman, 2004) when $\alpha < 1$. Hence, technological improvement causes an increase (decrease) in labor force participation for women who are more (less) efficient at outside job and they end up spending less (more) time at household work.

# 7 Conclusion

In this paper, I have tried to develop a theoretical model for studying the nature of female labor supply in an economy. Since the labor supply decision of a woman is taken by the entire household instead of just the individual herself, we have considered a collective utility model to explain the behavior of female labor supply. The power of the woman, and thus the power distribution between all members of the household, has been taken to be endogenous here. Under this setting, we have shown that female labor supply can take various shapes as the market wage rate changes. Sometimes multiple equilibria might occur in the female labor market. Hence we can

have different policy implications for different economies depending on the behavior (or shapes) of their female labor supply (and also their demand for female labor). Not only that, policy implications might differ for the same economy at different time-points depending on the initial equilibrium before the policy-imposition.

The paper also derives some important comparative statics results. It was found, somewhat unsurprisingly, that women reduce their labor force participation when they have child-birth, or if they have children with disabilities. Effects of tax-benefit programs on female labor supply have been studied also. We find an ambiguous effect. Even in economies with similar fundamental characteristics, the equilibrium female labor force participation may rise in one and fall in the other as a result of the tax-benefits given to women. This occurs because of the multiplicity of equilibria. We have also studied the effect of technological innovations of consumer durable goods, which help in reducing some household works, on the female labor supply and women's time spent at house-work. We find that, as a result, women tend to work more outside home only if they are more efficient at it compared to household work. However, contrary to the usual notion, women tend to spend more time on house-work after technological improvement, when they are more efficient in doing it. While analyzing all these, we assumed that labor markets between men and women are independent. But in Section 3, we worked out a situation, relaxing this assumption, where there exist some substitutability between female labor and male labor. As we have found there, this may cause a change in the behavior of female labor supply.

In the entire analysis above, we have assumed similar characteristics for all the households in an economy. We assumed that women have same efficiency-level across all the households which is far from reality. Further research on the theory of female labor supply can be done where women have heterogeneous abilities. We can think of the scope of education as well in this context. Education can help an individual in acquiring more skill and thus gain more power to bargain for higher wages from the employer. However, getting some education is costly. Even if basic primary education may be freely available in many countries, acquiring education may involve an opportunity cost because of the time spent for it. This might give rise to interesting outcomes in women's participation decisions in skilled or unskilled labor force and the literacy rate among them in an economy.

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