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The Value of a Bangladeshi Woman's Time: An Econometric Analysis

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The unpaid labor of women in any country holds substantial economic value. This research aims to estimate the value of time for non-working women in Bangladesh, and the wage rates that they would face in the labourmarket. In this quest, it generates the probability that a woman works, her shadow wage, and her offered wage from a set of common parameters. This paper adopts the approach utilized in Heckman (1974, 1976, and 1979) and applies it in the context of Bangladesh by utilizing cross sectional data that was collected as part of the Bangladesh Quarterly Labor Force Survey 2015. There has been no research on estimating the value of non-working women's time in Bangladesh using the econometric methodology that has been used in this paper. This study aims to fill in this research gap by conducting a systematic investigation on the unpaid labor of women in Bangladesh. The results of this study show that there is a negative and statistically significant relationship between the number of children and a woman's probability of working. A woman'soffered wageis found to have a positive and statistically significant relationship with her years of schooling. The findings of this study provide hard evidence of the economic contribution of women in Bangladesh. The recognition that the unpaid labor of women has economic value is the stepping stone towards greater female empowerment.

Field of Research: Labor economics

1. Introduction

The word "economics" originates from the Greek "oikonomikos", which roughly means management and care of the household". From this etymology, it may appear that women, who are often in charge of managing and caring for the household, would be highly regarded in the discipline of economics. Yet in conventional economics, the unpaid housework of women is completely disregarded. This major flaw in national income accounting methodology is a globally pervasive phenomenon which is also prevalent in Bangladesh. Since the unpaid labor of Bangladeshi women is not counted, it sends a distorted message about women to policymakers. Thus unpaid work is tantamount to unacknowledged work and unappreciated work. When a woman chooses to become a homemaker, she becomes the subject of discrimination by family and society simply because she does not work. Such discrimination gradually evolves into domestic violence. Lack of true valuationof women's unpaid work is holding back a transformation in the social attitudes towards women. In light of this, it has become imperative that the unpaid labor of women in Bangladesh be measured using a scientific approach.

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Women are disproportionately under-represented in the national income accounts since most women work in the informal sector, or work at home for no pay. According to the International Labor Organization, globally around one third of the total workers in the informal sector are female. In Bangladesh, 95.4% of women work in the informal sector(BBS, 2017). Since wages are low in the informal sector and non-existent in the household, the economic contribution of women is misrepresented. Nevertheless, the work that women do at home – such as household chores, caring for children, and looking after the elderly – inherently has immense value since it creates social capital. Failure to recognize the value of women's unpaid work is failure to recognize the value of women themselves. Therefore, unpaid work is a quintessential element defining the power structure between men and women (Thompson & Walker, 1995)and often forms the premise for female subjugation.If women's unpaid work is recognized, then their actual contribution to the economy could be evaluated.

Unpaid work refers to the production of goods or services that are consumed by those within or outside a household, but not for sale in the market (Miranda, 2011). Since household labor is not sold in the labor market, there is no clear market determined price for it. Therefore, we must utilize the concept of shadow price. Shadow price is the imputed price or value of a good or service where such a price or value cannot be accurately determined because of the absence of an ordinary market determined price (Pass, 2014). In an attempt to measure the shadow price of women's unpaid labor, we estimate the reservation wage of housewives in Bangladesh. The reservation wage is the wage below which a person will not work, and in the labor-leisure context represents the value placed on an hour of lost leisure time(Ehrenberg & Smith, 2009). It is important to emphasize that when market wage is equal to the reservation wage, a woman is indifferent between joining the labor market and staying at home. Therefore, a housewife's reservation wage is the lower bound of the value of her time. It represents the minimum value of her time, and the actual value may be far higher.

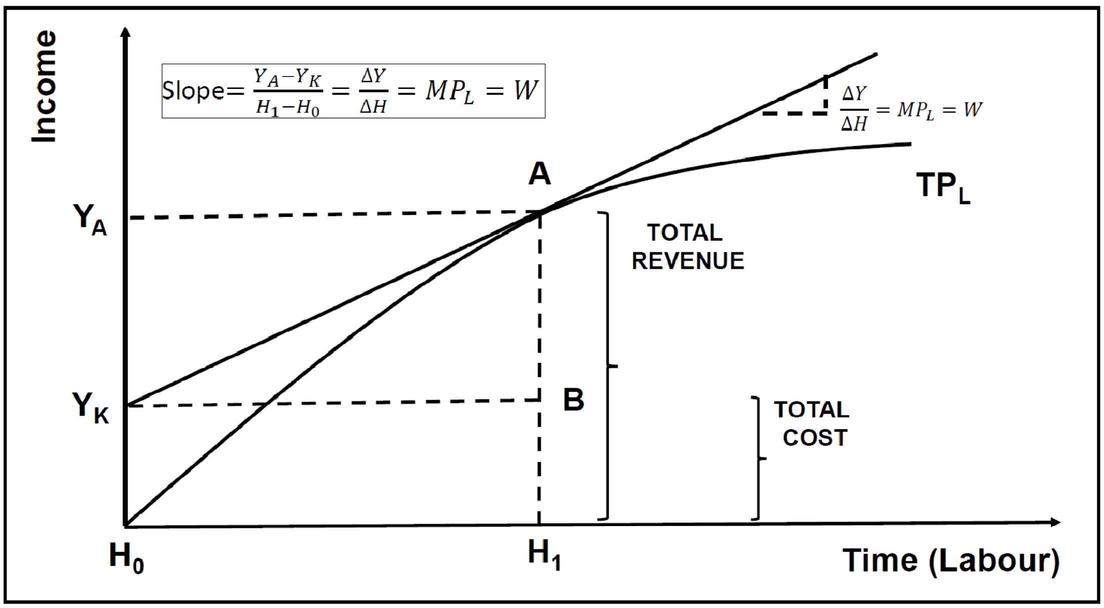
Themain research questions of this paper are: (i) "is there any economic value of the unpaid work of Bangladeshi housewives?"; (ii) "how can the economic value of the unpaid work of Bangladeshi housewives be found?"; (iii) "what is the economic value of the unpaid work of Bangladeshi housewives?".Most of the studies so far are flawed in terms of methodology and narrow in terms of sample size. The novelty of this paper is that it utilizes econometric estimation techniques to calculate the value of the unpaid labor of women in Bangladesh, which has hitherto not been done by any other study. The new findings of this research fill up the existing knowledge gap by providing a measure of the value of a Bangladeshi woman's unpaid labor.

The remainder of this paper is structured as follows. Section 2 contains a review of the literature on the topic, which includes a detailed analysis of relevant research work on the topic that was conducted in the past. Section 3 explains the research methodology used in this paper, by describing the data, the variables used, and the specification of the econometric model. Section 4 contains the results of the estimation output of the regression analysis, the calculation of the value of a Bangladeshi woman's time, and a discussion about the results. Section 5 ends the paper with a conclusion.

2. Literature Review

Carmel U. Chiswick puts forward a theoretical framework for the value of a housewife's time (Chiswick, 1982) which is important to understand in order to better appreciate the findings of this paper. Chiswick proposes that becoming a housewife is an occupational decision. Hence a housewife is, in essence, a self-employed entrepreneur who produces goods and services for own consumption. Since the value of time is the opportunity cost, we can view the value of a housewife's time as her forgone earnings. The utility function of the housewife is defined as: $U = f(Leisure, Income)$, where utility is derived from either leisure or income. The housewife must allocate time between leisure and income generation. Income can be generated either from wage work in the labor market or from being self-employed as a housewife at home. It is assumed that the housewife is indifferent between wage work and self-employment, as long as the income generated is the same. The value of a housewife's time who is self-employed at home is illustrated in Figure 1.

Figure 1: Value of a Housewife's Time in Self-Employment (Author's Illustration based on Chiswick, 1982)



In Figure 1, TP_L represents the total product of labor of the housewife, which is a function of her time. The slope of the TP_L curve is decreasing, indicating diminishing marginal product of labor. It is assumed that the total product of labor of the housewife is derived from a constant returns to scale production function. Hence factor rewards are equal to the marginal products of the factors. So it follows that if the total value of the housewife's time is represented by the total product of labor curve, then the marginal value of her time is represented by her marginal product of labor. The marginal value of a housewife's time is quintessentially the opportunity cost of her time. Suppose, a housewife who is self-employed at home works H_1 hours and earns an income equal to Y_A. In order to find her marginal product of labor, we draw a line which is tangent to the TP_L curve at point A. The slope of this tangent line gives us the marginal product of labor of the housewife, and her implicit wages in self-employment.

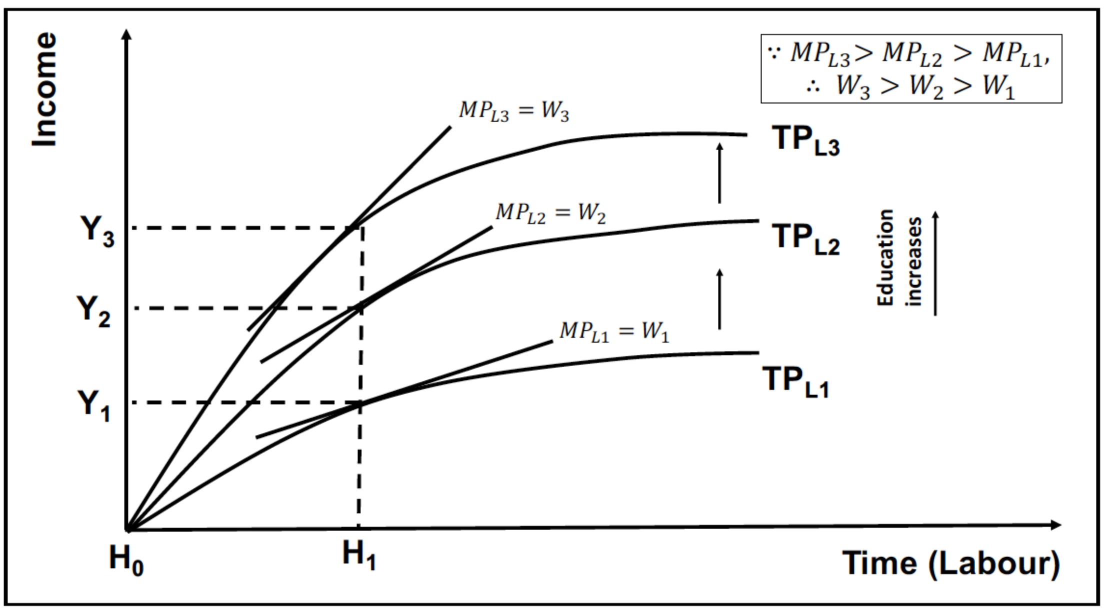
$$\text{Slope}=\frac{\Delta Y}{\Delta H}=MP_L=W$$

Thus the value of a housewife's time is the slope of her total product of labor curve at the number of hours worked. If we go back to the proposition that a housewife can be viewed as a self-employed entrepreneur, then we can calculate the value of her time in an alternate fashion. Under the entrepreneurship of the housewife, the area $Y_AAH_1H_0$ represents the total revenue generated by the household, and the area $Y_KBH_1H_0$ represents the total costs incurred. Therefore, the profit of the housewife or the value of her time is given as:

$$Profit = TotalRevenue - TotalCost$$
$$Profit = \frac{Y_A - Y_K}{H_1 - H_0}$$

From the previous analysis, we can see that this is exactly equal to the slope of the line tangent to the total product of labor curve. We can use this analysis to show the effect of education on a housewife's time.

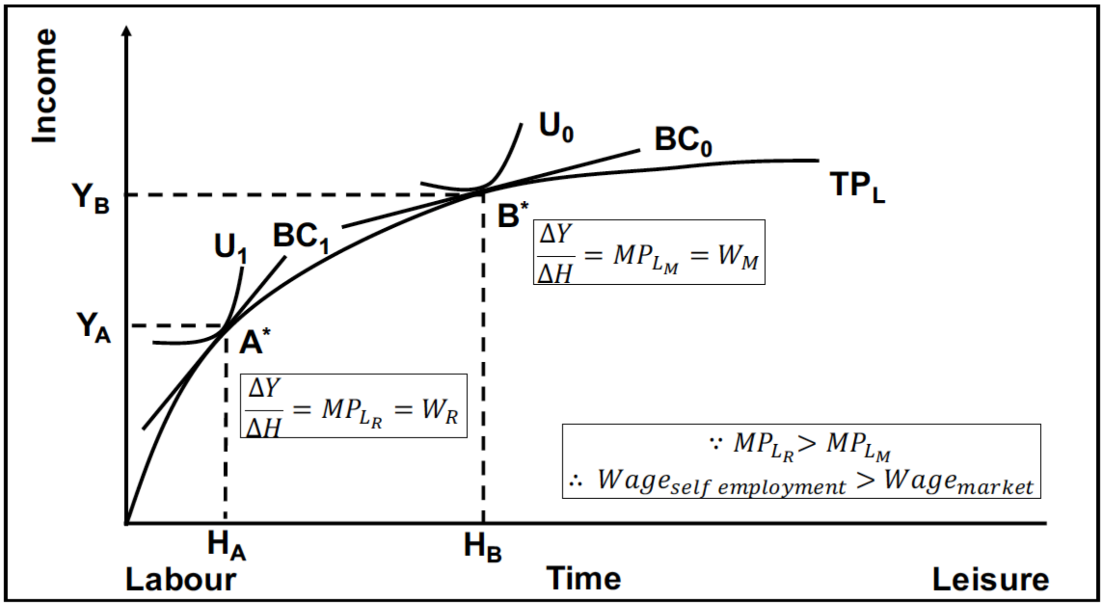
Figure 2: Effect of Education on a Housewife's Time
(Author's Illustration based on Chiswick, 1982)



When a housewife's education increases, the total value of her time increases as represented by an upward shift of the total product of labor curve from TP_{L1} to TP_{L2} to TP_{L3} in Figure 2. Since the marginal product of labor for a more educated housewife is higher than a less educated housewife, so the marginal value of time or the implicit wages in self-employment are also higher. So for the same number of hours worked H_1, the slope of the TP_L curve increases with increase in education.

Chiswick's (1982) basic framework represented above can easily be expanded to account for a housewife who faces a tripartite choice of wage employment in the labor market, self-employment at home, and leisure. Suppose the wage rate in the labor market, W_M, is such that it is equal to the marginal product of labor of the housewife MP_{LM} at point B^* in Figure 3.

Figure 3: Optimal Allocation of Time for a Housewife (Author's Illustration based on Chiswick, 1982)



For a housewife who specializes in self-employment at home, the reservation wage is higher than the market wage offered in the labor market. Optimal allocation of time for such a housewife would be at point A*. At this point, the marginal product of labor from self-employment at home is higher than the marginal product of labor from wage employment in the labor market. Therefore, a housewife values her time more highly at home than in the labor market. Under such circumstances, the housewife chooses not to enter the labor market, but rather work at home as a self-employed entrepreneur. The housewife derives utility from her income and leisure, as represented by the indifference curve U_1. At point A^*, the slope of the total product of labor curve and the slope of the indifference curve both represent the marginal product of labor or the implicit wage of the housewife. If a housewife's reservation wage is equal to the wage offered in the labor market, then she is indifferent between self-employment at home and wage employment in the labor market. This means that she values her time at home and her time in the labor market equally. It is exactly this value that this study intends to calculate.

Only five published works have attempted to measure the value of the unpaid labor of womenin Bangladesh. The pioneering study in this field was a collection of three essays published in one volume (Hamid, 1996). In the first essay, Hamid (1996)points out that women are missing from traditional measures of aggregate economic output, and that such measurements are urgently required. Hamid utilizes a replacement cost approach on primary data collected through a survey of 30 villages in Bangladesh. The noteworthy feature of Hamid's work is that he estimates that the average woman in Bangladesh contributes BDT 4,765 annually through her unpaid work. Hamid also finds that if the unpaid labor of women were to be incorporated into national income accounting, then the 1989-1990 Gross Domestic

Product (GDP) of Bangladesh would increase by 29 percent. Although it was a step in the right direction, Hamid's study used a sample which contained exclusively rural households. Such a sample is clearly not representative of the entire population of Bangladesh. Hence, his inferences about the average Bangladeshi woman's contribution are unreliable.

Table 1: Review of Literature

Authors	Year	Sampling strategy	Methodology	Results
Shamim Hamid	1996	Time budget survey through cluster sampling of 30 villages	Replacement cost	Inclusion of non-market work in official calculations would have increased national GDP 1989-90 by 29 per cent.
Debra Efroymson, Buddhadeb Biswas, and ShakilaRuma	2007	Survey of 630 men and women	i)Replacement cost ii)Government salaries	i) US $131 billion ii) US $152 billion
Debra Efroymson, Julia Ahmed, ShakilaRuma	2013	Survey of 630 men and women	i)Replacement cost ii)Government salaries	i) US $227.93 billion per year ii) US $258.82 billion per year
Rashed Al Mahmud Titumir, K.M. Mustafiqur Rahman	2014	Survey of 520 households in 7 districts	i) Replacement cost ii) Opportunity cost	i) 3.25 percent of FY2012-2013 GDP ii) 10.75 percent of FY2012-2013 GDP
FahmidaKhatun, Towfiqul Islam Khan, ShahidaPervin, HosnaJahan	2015	Survey of 5,670 households	i) Replacement cost ii) Willingness to accept	i) 76.8 percent of FY2013-2014 GDP ii) 87.2 percent of FY2013-2014 GDP

Subsequently, four other studies have attempted to estimate the value of women's unpaid labor in Bangladesh using the replacement cost approach(Efroymson, et al., 2007 and 2013; Titumir & Rahman, 2014 and Khatun, et al., 2015). Although there are some discrepancies in the findings of these studies, all of them unanimously point out the fact that women in Bangladesh make a significant contribution to the economy.

However, the replacement cost approach employed in these studies rests on a set of flawed assumptions. Some of these assumptions include: i) there are suitable persons in the labor market who can be paid to do every task in the household that the housewife does, ii) the productivity of a housewife is the same as that of a person paid to do household work, iii) domestic household production is as capital intensive as production in the market. Due to these deficiencies, the replacement cost approach is a far from ideal methodology to measure the unpaid labor of women.

Moreover, most of these studies use a limited sample size which cannot adequately represent the population. Furthermore, there exists a serious theoretical vacuum in the research on women's unpaid labor that has been carried out hitherto in Bangladesh. At the time of writing, we did not find any paper in Bangladesh which studied the unpaid labor of women based on solid microeconomic foundations. Quite to the contrary, most papers seemed to be obsessed about finding women's contribution to the GDP through their unpaid labor. We feel that this approach is self-defeating. This is because, no ordinary person can effectively visualize "GDP". Since GDP is a hard to relate for most people, expressing women's unpaid labor as a percentage of GDP does not achieve the aim of emphasizing women's importance in society. Hence such approaches fail to achieve a favorable transformation of social attitudes towards women. More importantly, none of the existing research uses any robust methodology for estimating the value of women's unpaid labor. In most cases, the calculations are limited to crude arithmetic and lengthy summations(Titumir & Rahman, 2014). Therefore, the accuracy of the findings from these studies is a matter of debate.

Despite the drawbacks of past studies, it is intuitively clear that the unpaid work of Bangladeshi housewives has economic value. Therefore, in accordance to the research questions mentioned in the previous section, our hypothesis is that the economic value of the unpaid work of Bangladeshi housewives, as measured by their reservation wage, is greater than zero.It is in the backdrop of this literature that we feel our research can fill up the existing gap in the knowledge regarding the unpaid labor of women in Bangladesh. Our research fills up this gap in two main ways: theoretical and methodological. Firstly, our research is the first of its kind in Bangladesh which is grounded on firm microeconomic foundations. Throughout this paper, we have made an attempt to draw close links between our analysis and the established theories of labor economics. It is our belief that the individual Bangladeshi housewife is easier to relate to than the GDP, especially for the general public. Therefore, by estimating the value of a Bangladeshi housewife's time we feel we can successfully usher in a reformation of the social attitudes towards women in Bangladesh. On top of that, the novelty of this paper lies in the methodology it uses to estimate the value of unpaid labor of women. To the best of our knowledge, there has been no other research on the unpaid labor of Bangladeshi women which utilizes the methodology that we employ. The justification behind using this particular methodology is provided in the subsequent section of this paper.

3. Methodology

3.1 Data

This study is based on the cross-sectional data collected by the Bangladesh Bureau of Statistics as part of its first Quarterly Labor Force Survey (QLFS) 2015(BBS, 2017). All the variables are drawn from this dataset, except the data for the variable fCPI, which was collected from the 2015Annual Report of Bangladesh Bank(Bangladesh Bank, 2016).

Table 2: Variables

Variable	Definition	Mean	Std. Dev.
fwage	weekly female wage in cash and kind from both primary and secondary job	2479.155	1936.994
feducation	years of schooling for females up to 12 years 0 = no education 6 = class-VI 1 = class-I 7 = class-VII 2 = class-II 8 = class-VIII 3 = class-III 9 = class-IX 4 = class-IV 10 = SSC 5 = class-V 11 = HSC	4.259556	3.88348
fexperience	potential experience of females fexperience = [female age] – [6]	31.26629	11.93601
fhours1	total number of hours worked per week at both primary and secondary job	31.88131	21.37751
mwage	weekly husband wage in cash and kind from both primary and secondary job	2747.009	2154.392
fCPI* ***(BB Data)**	Consumer price index (CPI) fCPI = 220.12 if rural fCPI = 219.37 if urban fCPI = 219.86 if neither rural or urban (national)	219.9138	0.1692468
fchildren	number of children aged less than 6 per	0.1664183	0.4758965
fasset	female asset dummy measured as total amount of land owned by households, measured in acres		
	fasset1; 1 = no land, 0 = all else	.1890322	.3915362
	fasset2; 1 = 0.01-0.04 acres land, 0 = all else	.4180809	.4932461
	fasset3; 1 = 0.05-2.49 acres land, 0 = all else	.3434959	.4748777
	fasset4; 1 = 2.50-7.49 acres land, 0 = all else	.0407771	.1977744
	fasset5; 1 = 7.50 acres or more land, 0 = all else	.0086139	.0924108

The QLFS 2015 was implemented by the national statistical office (NSO) of Bangladesh, Bangladesh Bureau of Statistics (BBS). The World Bank provided technical assistance in developing the sampling design as well as the questionnaire.

3.2 Sampling Strategy

In order to form the sampling frame for the survey, 1284 primary sampling units (primary sampling units) or enumeration areas (EAs) were created. Each PSU/EA was defined as a geographical area of contiguous non-overlapping land with identifiable boundaries. The country was divided into regions based on 7 divisions: Barisal, Chittagong, Dhaka, Khulna, Rajshahi, Rangpur, and Sylhet. Each division was further disaggregated into 3 kinds of localities: City Corporation, Urban, and Rural. Thus the country was stratified into 21 different strata. Households were classified as “strong”, “semi-strong”, and “not strong”, based on the quality of the house building materials. Each PSU/EA had approximately 225 households, so that the total sampling frame included roughly 300,000 households. The PSUs/EAs were scattered across every corner of the country, and encompassed every socio-economic class of people in order to obtain a representative sample of the entire population of Bangladesh.

The sampling strategy used was multi-stage cluster random sampling. The method was as follows:

- Stage 1: Random selection of 1284 PSUs/EAs from all of the 64 districts and21 regional strata, such that households residing in all three categories of houses are covered. A total of approximately300,000households are selected at this stage.

- Stage 2: Systematic random sampling of clusters of 24 households from eachof the 1284 PSUs/EAs with strict prohibition of replacement of non-responding households. A total of exactly 30,816 households areselected at this stage.

The QLFS 2015 is the first labor force survey to be conducted in Bangladesh that has employed a rotational panel strategy. This means that some of the households selected in each cluster will be replaced by new households in each quarter of the year. QLFS 2015 had a total of 503,756 observations. From this, a subset of 101,966 observations were used to draw a sample of 36,006 married, spouse present women for the purpose of this research.

3.3 Econometric Estimation Technique

The econometric estimation techniques used in this paper are based on the work of James Heckman(Heckman, 1974; 1976; and 1979). Hence the following exposition draws heavily from Heckman's papers, with minor changes that have been highlighted. We do not claim to have discovered these estimation techniques ourselves. For a more detailed analysis, refer to Heckman's original papers.

The optimization problem of the household is to maximize:

$$U(X_1, X_{2,\ldots\ldots,} X_n)(1.1)$$

whichis twice differentiable quasi-concave utility function with positive first partial derivatives for all its arguments. X_1 is the housewife's leisure, A is the asset income, P is the price of good i, T is the amount of time available to the housewife, and h is the hours of work, $T - X_1$, with associated wage rate P_1. The household is assumed to maximize equation (1.1) for a fixed h, subject to the following constraints:

$$\sum_{i=2}^{n} P_i X_i - A - P_i h = 0 \; (1.2)$$
$$T - X_i - h = 0 (1.3)$$

The Lagrangian is

$$U(X_1, X_{2,\ldots\ldots,} X_n) - \lambda(\sum_{i=2}^{n} P_i X_i - A - P_i h) - \mu(X_i + h - T)$$

where λ and μ are Lagrange multipliers.

The first order conditions are

$$U_1 - \mu = 0$$
$$U_2 - \lambda P_i = 0, (i = 2, \ldots\ldots, n)$$
$$\sum_{i=2}^{n} P_i X_i - A - P_i h = 0(1.2)$$
$$T - X_i - h = 0(1.3)$$

Equation (1.3) will always hold if the marginal utility of leisure is positive. From these equations, a system of equations for$X_{2,......,}X_n, \lambda, and \mu$ may be solved as functions of $P_2, \ldots\ldots, P_n,$ and $P_1h + A$. The shadow price of a housewife's time may be defined as:

$$\frac{U_1}{\lambda} = \frac{\mu}{\lambda}$$

For any arbitrary P_1, we may write $\frac{U_1}{\lambda} = W^*$ as

$$W^* = k\left(h, P_1h + A, P_{2,......,}P_n\right)(1.4)$$

It is important to note that (1.4) is defined whether or not labor supply functions exist. For a particular configuration of h, $P_2, \ldots\ldots, P_n$, A to be an equilibrium solution to the utility maximization problem with h voluntarily chosen, it is necessary that $P_1 = W^*$, that is, that the income flow from the parametric wage P_1, given the value of A, $P_2, \ldots\ldots, P_n$, yield a value of the shadow price equal to the parametric wage. The relationship between the equilibrium values of W^* and h, defines the labor supply relationship. Assuming that the labor supply function exists and is a positive monotonic relationship, we can solve out the adjoined labor supply function for equilibrium values of W^* and hence reach the following function for the asking wage or shadow price of time

$$W^* = g(h, W_m, P, A, Z)(1.5)$$

Where,

W^* = asking wage rate (shadow price of time)
h = hours of work
W_m = wage of husband
P = vector of goods prices
A = asset income of the household
Z = vector of constraints (which would arise from previous economic choices or chance events, such as number of children, education of family members, state of household technology)

W^* is the value the household places on the marginal units of a housewife's time. For the purpose of this research, the vector of goods prices is defined as the consumer price index (CPI), and the vector of constraints is defined as the total number of children in the household aged less than six years.

The offered wage or market wage function is

$$W = B(E, S)(2.0)$$

Where,
W = market wage rate (offered wage rate)
E = extent of labor market experience
S = number of years of schooling

And given that $B_E>0$ and $B_S>0$ from previous research

Using these two functions, Heckman derives a common set of parameters such as the probability that a woman works, a woman's hours of work, a woman's observed wage rate, and a woman's asking wage rate or shadow price of time(Heckman, 1974). It is assumed that:

- Offered wage rate is independent of the hours worked
- Asking wage rate increases with hours worked
- At zero hours of work, offered wage rate exceeds asking wage rate (equilibrium condition)

If a woman is free to adjust her working hours, then asking wage rate is equal to offered wage rate, or $W^* = W$. In this case, the woman is working. If a woman is not free to adjust her working hours, then asking wage rate is greater than or equal to offered wage rate, or $W^* \geq W$. In this case, the woman is not working. For all women free to choose their working hours,$h(W^* - W) = 0$.If a woman works, then equations (1.5) and (2.0) become a recursive system determining the hours worked.

For estimating the model, we specify the following functional form:

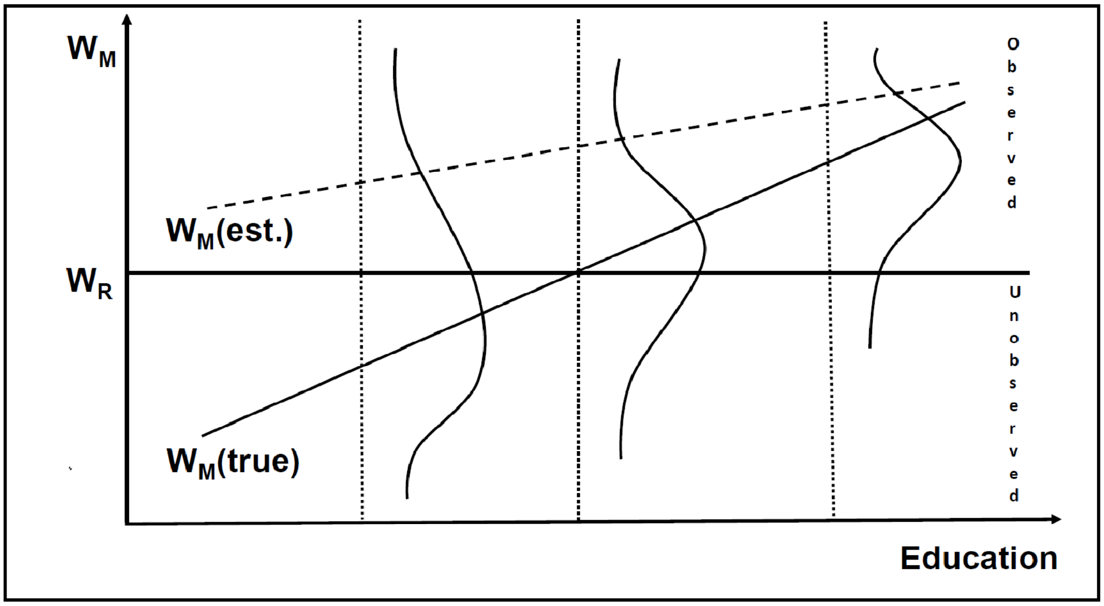
$$\ln\left(W_i^*\right) = \beta_0 + \beta_1 h_i + \beta_2 (W_m) i + \beta_3 P_i + \beta_4 A_i + \beta_5 Z_i + \varepsilon_i \text{(3.0)}$$
$$\ln\left(W_i\right) = b_0 + b_1 S_i + b_2 E_i + u_i \text{(4.0)}$$

It is assumed that ε_i and u_i are jointly normally distributed, each with zero mean, and that there is correlation between ε_i and u_i. It is also assumed that the error terms are not correlated with lagged values of themselves, so there is no autocorrelation.

Equation(4.0) suffers from unobserved heterogeneity or the problem of omitted variables. This means that there are unobserved omitted variables which affect the dependent and independent variables of these equations. The effect of these unobserved variables is captured through the error terms, and so the errors of the equation (4.0) are correlated with the independent variables. The underlying reason behind this unobserved heterogeneity or omitted variable bias is the fact that the samples used for estimating these equations were not randomly collected. Market wages are only observed for women who are working. However, the women's decision to work is not a random decision. It is a rational decision and a conscious choice. Hence women who choose to work self-select themselves into the sample.

The distribution of market wages is censored at the reservation wage threshold. This can be illustrated using a simple example. Suppose education is the only variable that determines offered wage or market wage for women. Assume that education has no effect on reservation wage. If we now plot a graph of market wage against education, then we get the following diagram shown in Figure 4:

Figure 4: Sample Selection Bias
(Author'sIllustration based on James P Smith's "Female Labor Supply: Theory and Estimation" (Smith, 2014)**)**



The vertical axis represents wage, and the horizontal axis represents level of education. The horizontal line dividing the plot space is the reservation wage. The three curves represent the distributions of market wages for women, at different levels of education. Note that the curve on the left represents women with a comparatively low level of education and is thus skewed downwards so that most women earn a relatively low wage. Alternatively, the curve on the right represents women with comparatively high level of education and is thus skewed upwards so that most women earn a relatively high wage. Note also that the distribution of market wage runs from the top to the bottom, going across the reservation wage boundary in the middle. Since market wages are only observed for women who are working, we can only see the part of the market wage distribution that lies above the horizontal reservation wage line. Thus our sample is a censored sample, with the censoring occurring at the reservation wage. Any analysis which fails to account for the unobserved part of the market wage distribution is bound to be biased. In Figure 4, we can see that the estimated market wage line W_M(est) is much flatter than the true market wage line W_M(true). This means that the coefficients from an ordinary least squares (OLS) regression model will be lower than the coefficients from a Heckman selection bias corrected model. Hence the rate of return to education will be underestimated in a model which is not adjusted for sample selection bias.

Hence, it is not possible to obtain unbiased or consistent estimates of these equations using OLS estimation techniques. This is because the strict exogeneity assumption of the OLS model is

$$\boldsymbol{E(\varepsilon_i|X) = 0, \qquad \forall i = 1, \dots, n}$$

This means that the errors (ε) are exogenous of the independent variables (X). Violation of the strict exogeneity assumption has several implications:

- $\boldsymbol{E(\varepsilon_i) \neq 0, \forall i = 1, \ldots, n}$ (The unconditional mean of the error term (ε) is not zero.)
- **E** $\boldsymbol{(X_{jk}, \varepsilon_i) \neq 0, \ \forall ijk = 1, \ldots, n}$(The independent variables (X) are not orthogonal to the errors (ε) for all observations)
- $\boldsymbol{COV(X_{jk}, \varepsilon_i) \neq 0, \ \forall ijk = 1, \ldots, n}$(The independent variables (X) and errors (ε) are not uncorrelated for all observations.)

Therefore, if the strict exogeneity assumption is violated, then OLS will produce biased estimates. However, under such circumstances, estimating equation (4.0) is still possible. Heckman suggested that statistical models which feature truncation, censoring, sample selection, or limited dependent variables share a common structure which makes them vulnerable to unobserved heterogeneity or an omitted variable bias (Heckman, 1976). If the unobserved heterogeneity can be modelled separately, and the resulting information can be incorporated into the main model, then the problem can be resolved. Subsequently, Heckman proposed that selection bias due to using non-randomly selected samples could be viewed as an ordinary specification error(Heckman, 1979). Heckman proposed that the specification of the original biased model could be improved by using the estimated values of the omitted variables as additional regressors. By doing so, the model could be estimated using OLS, without violating the strict exogeneity assumption. Heckman outlined an ingenious two step estimation technique to correct sample selection bias(Heckman, 1979). This is the technique we will use for econometric estimation in this paper.

In the first step, we model the factors that influence a woman's decision to work by using a probit model. The general form of the sample likelihood function for this probit analysis is:

$$\mathcal{L} = \prod_{i=1}^{T} [F(\phi_i)]^{1-d_i} [1 - F\,(\phi_i)] d_i$$

where, d is a random variable, which is equal to one if the dependent variable is observed and equal to zero if the dependent variable is not observed. Suppose we use a sample of T married spouse present women, K of who work and T-K who do not work. Then, in the case of our model, the aforementioned likelihood function becomes:

$$\mathcal{L} = \prod_{i=1}^{K} j(h_i, \ln(W_i) | (W_i > W_i^*)_{h=0}). pr([W_i > W_i^*]_{h=0}) \times \prod_{i=K+1}^{T} pr([W_i < W_i^*]_{h=0})$$

From this we may extract an important ratio called the inverse Mills ratio, or the hazard function, denoted as λ. The inverse Mills ratio is the ratio of the standard normal probability distribution function of the selection equation to the standard normal cumulative distribution function of the selection equation.

$$\lambda_i = \frac{f(\phi_i)}{1 - F(\phi_i)}$$

Where f is the standard normal probability distribution function of the selection equation and F is the standard normal cumulative distribution function of the selection equation. The inverse Mills ratio is a monotone decreasing function of the probability that an observation is selected into the sample. The denominator of the inverse Mills ratio is the probability that an observation has data for the dependent variable. The lower the probability that an observation has data for the dependent variable, the greater the value of the inverse Mills ratio for that observation. We can therefore say that,

$$\frac{\partial \lambda}{\partial \phi_i} > 0$$

and

$$\lim_{\phi_i \to \infty} \lambda_i = \infty, \lim_{\phi_i \to -\infty} \lambda_i = 0$$

For our model, the inverse Mills ratio can be defined as:

$$\lambda = j(h_i, \ln(W_i)|(W_i^* < W_i)_{h=0} = \frac{n(h_i, \ln(W_i))}{pr([W_i > W_i^*]_{h=0})} \because \varepsilon_i, u_i \sim N(0)$$

By using this inverse Mills ratio in our original likelihood function, we can further simplify it to:

$$\mathcal{L} = \prod_{i=1}^{K} n(h_i, \ln(W_i)) \prod_{i=K+1}^{T} pr([W_i < W_i^*]_{h=0})$$

We now maximize this likelihood function with respect to the parameters of the model, including the variances and covariances of the errors in equations (3.0) and (4.0) to get consistent, asymptotically unbiased, and efficient parameter estimates which are asymptotically normally distributed. Thus, our selection bias corrected now becomes:

$$\ln(W_i) = b_0 + b_1 S_i + b_2 E_i + b_3 \lambda_i + u_i \text{(5.0)}$$

Where, λ is the inverse Mills ratio.

4. Results

We begin our analysis by estimating equation (3.0) using OLS in order to check whether the model really is biased as claimed in the previous section. Weekly female wage has weak positive correlation with years of female education (r = 0.2209) and years of female potential labor market experience (r = 0.0219). Now that we are certain that our model is not merely depicting a spurious correlation, we proceed with estimation using OLS.

Table 3: Results from Ordinary Least Squares Estimation

VARIABLES	lnfwage
feducation	0.0458***
	(0.00134)
fexperience	0.00303***
	(0.000513)
Constant	7.426***
	(0.0175)
Prob > F	0.0000
R-squared	0.129
Adj R-squared	0.1289

Note: (i) Standard errors in parentheses, (ii) *** p<0.01, ** p<0.05, * p<0.1

From the results shown in Table 3, we can see that the coefficients for education and experience are both positive and statistically significant, in accordance with our a priori information. The coefficients are also jointly significant, since the probability>F is less than 0.05. However, the R-squared is 0.129, which means that only 12.9 percent of the variability in the wage is explained by education and experience. This implies that there are other variables that affect wage which we failed to include in our model. As a result of this, the effect of the unobserved omitted variables is being captured through the error term.

To check if our model is correctly specified, we now conduct a Ramsey Regression Specification Error Test (RESET). From the results of the Ramsey RESET Test we reject the null hypothesis that the model is correctly specified. We continue investigating the problem of omitted variables using “linktest”. “Link test” is based on the idea that if a regression is properly specified, one should not be able to find any additional independent variables that are significant except by chance. Link test creates two new variables, the variable of prediction, “_hat”, and the variable of squared prediction, “_hatsq”. The model is then refit using these two variables as predictors. “_hat” should be significant since it is the predicted value. On the other hand, “_hatsq” should not be significant, because if our model is specified correctly, the squared predictions should not have much explanatory power. That is we would not expect “_hatsq” to be a significant predictor if our model is specified correctly. So we will be looking at the p-value for _hatsq. Since we find that the prediction squared does have explanatory power, our specification is not as good as we thought.

We can continue our analysis by checking if the model can satisfy some of the other assumptions of the OLS model. In this regard, we check the variance inflation factor of the dependent variables of the model to see if there are any perfect linear relationships between them. Variance inflation factor measures the linear association between an independent variable and all other independent variables. The decision rule for variance inflation factor is as follows: i) if VIF >10: perfect multicollinearity is highly likely, ii) if 5 < VIF < 10: perfect multicollinearity is somewhat likely, iii) if 0 < VIF <5: perfect multicollinearity is unlikely. Multicollinearity is not a problem of existence, but a problem of severity. Since the variance inflation factor is 1.10, we can conclude that perfect multicollinearity is unlikely in this model. Next we check if the variance of the error term in our model is constant or homoscedastic.

We formally test for heteroskedasticity using the Breusch-Pagan (1979) and Cook-Weisberg (1983) test for heteroskedasticity. If $p < 0.05$, then we can reject the null hypothesis of no heteroskedasticity. In this case, since $p > 0.05$ we cannot reject the null hypothesis of no heteroscedasticity. The Breusch-Pagan (1979) and Cook-Weisberg (1983) test for heteroscedasticity assumes that the heteroskedasticity is a linear function of the independent variables. Failing to find heteroskedasticity with the Breusch-Pagan (1979) and Cook-Weisberg (1983) test does not rule out the possibility of heteroskedasticity. So we move on to a more robust test for heteroskedasticity, the White test. The White test allows the heteroskedasticity process to be a function of one or more independent variables. It allows the independent variable to have a non-linear and interactive effect on the error variance. If $p <0.05$, then we can reject the null hypothesis of no heteroskedasticity. In this case, since $p < 0.05$ we can reject the null hypothesis of no heteroscedasticity. Thus there is unrestricted heteroscedasticity in the model we have estimated.

If the conditional distribution of the errors is jointly normal, then OLS becomes the best unbiased estimator among both linear and non-linear estimators. Therefore, we run the Shapiro Wilk Test for normality of data. If $p < 0.05$ then we reject the null hypothesis that errors are normal. If $p > 0.05$ then we cannot reject the null hypothesis that errors are normal.Since our $p < 0.05$, we can conclude that our errors are not normally distributed.

Now that we have conclusively established that there are significant problems in our OLS model, we now move ahead with estimating our selection bias corrected Heckman model. The Heckman model is estimated in two steps. In the first step, we estimate a probit model of observing the dependent variable. In our case, this is the probability of a woman working. This is estimated using equation (3.0) which is our labor force participation equation. In other words, this is the selection equation which models the probability of women self-selecting themselves in the sample. Using the estimates from the probit model, we calculate the inverse Mills ratio. This inverse Mills ratio is used as an additional regressor in equation (4.0) to estimate the selection bias corrected Heckman model.

From the results of the first step probit estimates, we can see that the coefficient of fCPI is positive and statistically significant at the 1 percent level. This implies that as prices increase, the probability of a woman working increases. This may be due to the fact that as basic necessities become too expensive, they may become hard to afford with only the husband's income. Thus the wife is compelled to work to maintain the household's standard of living. We can also see that the coefficient of fchildren is negative and statistically significant at the 1 percent level. This implies if the number of children aged less than six years increases in a household, the probability of a woman working decreases.

Table 10: Results from Heckman Two-Step Estimation

	Probit	Inverse Mills Ratio	Heckman
VARIABLES	**select**	**mills**	**lnfwage**
mwage	$-3.67*10^{-06}$ $(5.43*10^{-06})$		
fhours1	0.0342*** (0.000667)		
fCPI	0.700*** (0.0810)		
fasset1	0.616** (0.311)		
fasset2	0.260 (0.311)		
fasset3	-0.133 (0.311)		
fasset4	-0.259 (0.335)		
fasset5	(omitted)		
fchildren	-0.0793*** (0.0299)		
feducation			0.0348*** (0.00203)
fexperience			0.00108 (0.000810)
lambda		-0.0897*** (0.0172)	
rho			-0.19942
sigma			0.44970462
Constant	-155.8*** (17.83)		7.592*** (0.0272)
LR chi2(8)	3803.82		
Prob > chi2	0.0000		
Wald chi2(2)			324.93
Prob > chi2			0.0000

Note: (i) Standard errors in parentheses, (ii) *** p<0.01, ** p<0.05, * p<0.1;
(ii) fasset5 automatically dropped to avoid dummy variable trap due to perfect multi-collinearity

From the results of the Heckman two-step selection model, we can see that the coefficient of feducation is positive and statistically significant. This implies that as a woman is more highly educated, her offered wage in the labor market is higher. We can also see that both the coefficients of the probit model and the Heckman two-step model are jointly significant since the prob>chi2 is less than 0.05. In order to check the marginal effects of the independent variables on the dependent variable, we now estimate the average and conditional marginal effects of the Heckman two-step model.

Table 11: Marginal Effects of Heckman Two-Step Selection Model

	Average Marginal Effects	Conditional Marginal Effects
VARIABLE		
feducation	0.0347256***	0.0347256***
	(0.0020291)	(0.0020291)
fexperience	0.0010351	0.0010351
	(0.0008113)	(0.0008113)

Note: (i) Standard errors in parentheses; (ii) *** p<0.01, ** p<0.05, * p<0.1;
(iii) Conditional marginal effectscalculated at means; feducation=3.817771, fexperience=28.00424, mwage=2573.542,fhours1=33.78173,fCPI=219.9323, fasset1=.2702553, fasset2=.415983, fasset3=.2956033, fasset4=.015854, fasset5=.0023044, fchildren=.1669278

From the estimates of the Heckman two-step model, we can calculate the average wage of a Bangladeshi housewife for each level of schooling.

Table 12: Estimated Reservation Wage of the Average Bangladeshi Housewife

Years of schooling	Average Monthly Reservation Wage of Housewife (in BDT)	Average Monthly Reservation Wage as Percentage of Husband's Average Monthly Wage	Standard error	P>|z|
0	8502.88	72.22%	0.026569	0.000
1	8803.63	74.78%	0.0254757	0.000
2	9115.00	77.42%	0.0245018	0.000
3	9437.40	80.16%	0.023662	0.000
4	9771.20	82.99%	0.0229711	0.000
5	10116.81	85.93%	0.0224428	0.000
6	10474.63	88.97%	0.0220889	0.000
7	10845.12	92.12%	0.0219177	0.000
8	11228.70	95.38%	0.0219335	0.000
9	11625.86	98.75%	0.022136	0.000
SSC	12037.06	102.24%	0.02252	0.000
HHC	12462.81	105.86%	0.0230766	0.000

The results of our calculations show that the average monthly reservation wage of a Bangladeshi housewife who has completed high school is BDT12,462.80. Since in equilibrium, the reservation wage is equal to the market wage, the reservation wage can be thought to be a suitable proxy for the value of a housewife’s time.

Based onthe results of this study,we can accept the hypothesis that the economic value of the unpaid work of Bangladeshi housewives is greater than zero.These findings provide a lower value for the average monthly wage of a Bangladeshi housewife than was calculated by (Efroymson, et al., 2013). However, a key point must be kept in mind. The results from Efroymson’s2013 paper attempt to provide an approximation of average monthly wage of housewives directly through the replacement cost method. On the other hand, in this study, we have estimated the unpaid labor of housewives indirectly as the reservation wage.

5. Conclusion

The unfortunate tendency in economics is to take the monetary economy as the only basic thing to measure. Despite the fact that housewives probably work harder than anyone else in the population, they still do not get paid for it. In economics, unless there is a market price for something, it does not get measured in the national accounts. This leaves women's work in the household out of the national accounts. Women's housework is enormously productive work, both for human welfare and for the growth of the economy. Yet it does not get counted.

The findings of our research reveal the factors that influence the probability that a woman works, her offered wage, and her shadow wage. By doing so it provides an estimate of the value of a typical Bangladeshi housewife's time. It is important to point out that the reservation wage represents the lower bound of the value of a housewife's time. The actual value of a housewife's unpaid labor may be far higher than her reservation wage. Therefore, the results of this research represent a significant departure from the approaches taken by the hitherto existing literature on the topic.The main limitation of this study is that the results are not expressed in macroeconomic terms. However, subsequent research on the topic can be undertaken to circumvent this restriction.

Measuring the value of a housewife's time and her unpaid labor are prerequisitesfor highlighting women's silent contribution to the economy. The people who are visible as contributors to the economy are the people who will be visible when we make policy. If you are not visible as a contributor to a nation's economy, then you are not going to be visible in the distribution of benefits.

The results of this paper bring to attention the pressing issue of widening the realm of national income accounting in Bangladesh so as to incorporate the unpaid labor of women. The analysis herein makes it clear that urgent steps need to be taken to enhance the social stature of women by acknowledging that the work that women do has economic value. It is hoped that the results of this study will induce a revolution in the attitudes towards women in Bangladesh, which will subsequently spread all over the world.

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