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JEL Classification: D00; D13; I00; I20
Keywords: Gender-bias, Hurdle models, children's education, rural, Ethiopia.

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Andinet Delelegn[2]

Abstract

Qualitative and quantitative evidence reveals pervasive gender discrimination in many social and economic aspects in least developing countries, including Ethiopia. Investment in child schooling is an important dimension of this discrimination, which has a lasting consequence on both the child and the country's economic development as a whole. The main objective of this study is to uncover if there is any intra-household gender-bias in the decision to enrollment and allocation of resources to child education. Using a panel data set from Ethiopian Rural Household Survey (ERHS), spanning from 1994-2004, we applied a panel hurdle models consisting of random effects probit for the initial decision in enrollment and conditional linear autoregressive model for the proportion spent. We found statistically significant gender-bias during the initial decision to enrollment against girls, especially those corresponding to secondary school cycle. Since the bias occurs inside the household, public investments should not only focus on facilitating access to school but also work towards altering the demand side as parents have differential preference towards siblings' education. Policies that increase returns to girl's education, increasing intrahousehold productivity, legislations that prohibit early marriage, etc. could mitigate the observed level of intra-household gender-bias against girls aged 15-19 years.

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1. Introduction

Education is broadly considered as critical in income generation, in altering inequality and it is an essential part of personal welfare (Behrman, 1997). Since the works of Mincer (1974) in labor economics, voluminous works regularly confirm that a return to schooling is associated with higher individual earnings. The return to schooling is also much more significant in economies of considerable liberalization and macro stabilization that have become increasingly integrated into international market (Behrman, 1997). In developing countries, education is also crucial in augmenting earnings and improving survival strategies (Dercon and Krishnan, 1999).

Evidence from developing economics shows the importance of investing in female education, which reduces fertility rate (Cochrane, 1979), ameliorates children's health conditions (Thomas 1990, 1994, Subbarao and Raney, 1995), and changes the patterns of households' consumption with a reduction in income share for adult goods (Rosenzweig and Wolpin, 1988; Haddad and Hodinott, 1995). Nevertheless, still there are significant gender differentials in human capital status. For instance, net enrollment ratio in the year 2000-2005 is 70 % and 66% for primary school while it is 30% and 24% for secondary school in Sub-Saharan Africa, for male and female children, respectively (UNICEF, 2007).

For parents in poor economies, children are both *consumption good* as they gives utility, a *production good* as they help in productive and domestic activities and *insurance good* for parents during old age (Dasgupta, 1993). However, a growing concern for many has been the possibility of increasing inequality as parents have different preferences in allocation of resources to boys and girls schooling. This differential treatment may arise from difference in returns of sibling human capital investment (Rosenzweig and Schultz, 1982; Berhman, 1982) because most of women's work is limited within the family for household survival. Women not only have few opportunities to find jobs because of the low level of economic development and the consequent low labor demand but also because of discrimination in the labor market and wage differential. Parents may prefer a particular type of child irrespective of investment (Berhman, 1982). Variation in the costs of investment among siblings also induces differential treatment of children schooling (Strauss and Thomas, 1995).

Following recent development in intra-household models and availability of data, the literature has attempted to scrutinize individual-level outcomes due to differential treatment by gender in different countries. For instance, Rosenzweig and Schultz (1982) explained the excess female mortality in India to be associated with low female labor market participation in terms of the reinforcement of productivity difference. Afridi (2005) from India has found that mothers' autonomy has a significant impact on reducing the gap in educational attainment of girls and boys. Hazarika (2000) for Pakistan, Quisumbing and Maluccio (2000) for Bangladesh, Indonesia, Ethiopia and South Africa are also among the most notable empirical studies.

In the literature there are two commonly applied techniques to detect gender bias in the intra-household resource allocation. The first method, based on availability of individual level data, is the direct comparison of expenditure on males and females. The second methodology is to use the Engel curve approach in situations where reliable data is only available at the household level. In most cases, the former method can not be practical due to absence of such disaggregated survey data. The Engle curve approach has been applied by a number of researchers such as Deaton and Subramanian, 1990 (India), Deaton, 1989 (Thailand and Cote d'Ivoire), Subramanian, 1995 (India), Ahmad and Morduch, 1993 (Bangladesh), Case and Deaton, 2003 (India) and the like.

Using data from rural India and consequently Pakistan, Kingdon (2005) and Aslam and Kingdon (2006) have used a variant of the Engle curve method hurdle models approach to confirm the existence of intra-household gender-bias. According to Kingdon (2005), gender-bias in child educational investment can be explained through two possible channels. First, through positive purchase for males and zero purchase for females. Second, conditional on positive purchases for both, lower expenditure on girl's schooling than boys.

Empirical studies from rural Ethiopia confirm the existence of gender-bias in child education. For instance, a very good work by Tekabe (2005) has attempted to explain differences in the cost of investment in terms of the child's inherent health endowment and their ability to receive education. The result suggests that educational investments are allocated to reinforce initial differences confirming the significance of bias in favor of the able children as they are motivated by return maximization. However, the study doesn't tell us at which stage does this bias occur.
The objective of this study is to identify if there is any intra-household difference in household schooling investment among school age siblings. As there are two different channels of gender bias, bias at the initial stage of deciding on whether to enroll a child and the magnitude of resource allocated among enrolled siblings, we used a panel hurdle model that account for unobserved individual heterogeneity and initial conditions problem. To this end, we have used the Ethiopian Rural Household

Survey (ERHS) panel data set spanning from 1994 to 2004 that enables us to control for a number of observed supply and demand factors as well as unobserved factors. The unique nature of our panel data set enables us to robustly detect the existence and magnitude of intra-household gender bias.

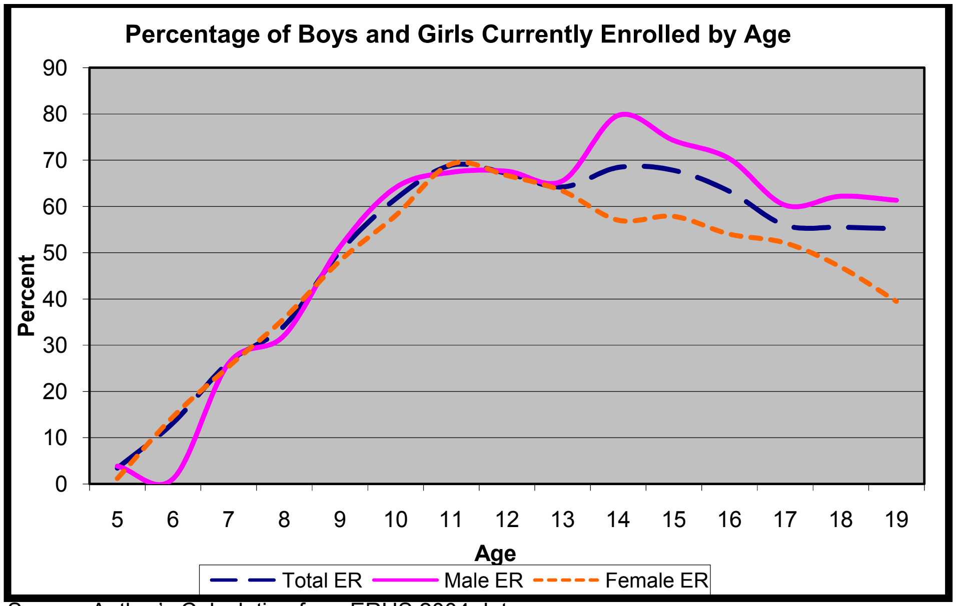
The rest of the paper is organized as follows. In the next section, we briefly present the current education policy and profile in Ethiopia. Section three discusses theoretical underpinning of intrahousehold resource allocation while section four presents the empirical strategies and data used in the study. Having discussed the descriptive and empirical findings in section five, the paper concludes with some policy implications in section six.

2. Background and profile of educational system in Ethiopia

There have been a number of international instruments geared towards gender equality in access to education, which Ethiopia has also ratified. Besides, the country's Education and Training policy aims at providing education on equal basis and in fact attention is given to gender issues through school materials and affirmative actions to girls in educational enrollment. In fact, Ethiopia has made progress in improving access to primary education since the 1990s. For instance, evidence from ERHS shows that it were only 67% of the sampled villages in 1997 that had access to primary school while the coverage has grown to 93% in 2004 (see Table 5).

However, low enrollments, high gender and regional disparity, and low quality of education remained the major challenges of the education system (Chaudhury *et al*., 2006). There is a wide gender gap, both at the secondary and primary level. While the gap is declining for the primary cycle (grades 1-8) from that of 20% in 2000/01 to 16.5% in 2004/05, it is consistently increasing from as low as 4% in 2000/01 to 14.8% in 2004/05 for the secondary cycle (grades 9-12) (see Table 1 in Annex). Trend of both the Gender Gap (GG) and Gender Parity Index (GPI) reflect consistently rising gender gap at the secondary cycle over time. In fact the micro data from the sixth wave of ERHS data (2004) shown in Figure 1 also confirm this claim that the divergence in gross enrollment rate (ER) between boys and girls increases for children 14 years and above, which corresponds with the secondary school cycle.

Figure 1: Percentage of boys and girls currently enrolled by age - 2004



Source: Author's Calculation from ERHS 2004 data

There are multitudes of social, economic and cultural factors that deter girls' education. Economic factors like extreme poverty, socio-cultural nuisances such as harassment and violence including rape and early marriage; household discriminations and overburdened with household chores as girls time is close substitute to mothers' time in domestic activities, lack of follow-up and encouragement and unequal treatment compared to boys; etc increase the dropout rate of girls as well as hinder new enrollment (MoWA, 2005).

3. Theoretical model of intrahousehold resource allocation and gender-bias

If women, children, or old people are systematically worse off than other members of the household, the reported social welfare will be overstated (Deaton, 1997). Cognizant, in the development theory of intrahousehold resource allocation, there are different hypothesis as to how resources are allocated within the household. The simplest is the dictatorial/monotonic entities model, where households are assumed to be endowed with preferences as a single individual and the *paterfamilias* decides on behalf of everyone so that consumption behavior of the household will look like the behavior of individual consumer of the textbook. On the other extreme, we have the bargaining model, which considered households as a group of individuals who bargain with each other over resources (Deaton, 1997). The consequences of these different assumptions have been explored in the literature.

There are different presumptions as to why parents invest in their children human capital, the wealth model and the pure investment model, for instance. The wealth model presumes that parents can and are willing to substitute bequests for human capital investment and vice versa in order to maximize certain level of total life time wealth. The implication from this model is that, given differences in endowment, human capital and bequest of children, human capital investments reinforce initial endowment differences among siblings. The pure investment model, on the other hand, presumes that investments in human capital, like any other assets, depend on their net return. The marginal benefit and the marginal cost determine the level of investment in children, which is less influenced by the distributional consequences it involve (Behrman *et al.*, 1982; Becker 1991, 1993). Depending on genetic endowments and supply of funds, parents influence the shape and the specific position of the marginal cost and the marginal benefit curves (Taubram, 1996 in Tekabe, 2005).

Models dealing with investment in children are mainly based on unitary household models that maximize a single parental utility. They focused on the distribution of parent-provided resources among children. It is deemed that parents care for the distribution of resources, human capital resources and bequests, among their children (Behrman 1997). Under this framework, parents maximize the household utility function with respect to parental consumption, bequests and children's earning's function. If the household is divided into two groups of members, parents (A) and children (B), the decision making rests on parents. Say, q_a and q_b are vectors of consumption goods for parents and children, respectively. The utility functions for the parents is given by $u_a(q_a, z)$. Given efficiency, the optimal choice of parents can be written as the solution to the problem;

$$\text{Max } u_a(q_a, z^*) \quad \text{s.t.} \quad p_a.q = l_a(p, p_z, y) \qquad \textbf{[1]}$$

Where, z* is the optimal choice of public goods available for both groups, p is the price vector for all goods, p_a is the price of goods consumed by parents, p_z is the price vector of public goods, and $l_a(p, p_z, y)$ is the sharing rule function that determines the total amount that parents gets conditional on the prices of goods, and total household resources y. The solution to the maximization problem is a set of demand functions of parents given by:

$$q_{ai} = f_{pi}(x_a, p, g_a, g_b) \text{ and } x_a = l(p, y, g_a, g_b) \qquad [2]$$

Where, g_a and g_b are characteristics of parents and children, respectively. The argument x_a is the total expenditure that is allocated to adults by the sharing rule. As it is discussed in Deaton (1997), this is a well behaved demand function that holds widely for allocations based on bargaining or altruism. Here, children characteristics affect parents demand in two separate ways, through the amount that parents get through the sharing rule (income effects) and directly though the demand functions (substation effects).

Any change in child characteristics, say the addition of a child to the household, result in a reduction of adult consumption through income effect and rearrangements in adult consumption due to substitution effect which is required to feed, cloth or educate the child. If the sharing rule approach works, we should expect to find a greater negative effect on adult consumption of additional boys than of additional girls (Deaton, 1997).

4. Model and empirical strategy

4.1 Empirical strategy

From the theoretical underpinning of the demand function of parents for different household consumption goods, we have the standard Engle curve method appropriate to the problem under investigation. However, as there are different levels of decisions, the empirical model should be specified so as to account for the difference in decision behavior. The rationale behind the Engle curve approach is that household member composition according to different characteristics (sex, age, education, religion, ethnicity, etc) are a variables that exerts an impact on household consumption allocation pattern. In other words, household expenditure allocation to different purchases depends on the individual demand for a specific commodity and hence the household composition. Based on this economic rationale, an additional household member with specific individual characteristics affects the household's expenditure pattern in such a way as to increase expenditure on items of consumption associated with the additional member. By implication, the budget share of a good consumed by children increases as much when additional girl is added to the household as it does when an additional boy is added (Kingdon, 2005).

The Engle curve can be specified using the extended Working (1943) specification:

$$\omega_{it} = \alpha + \beta \ln(\frac{y_{it}}{n_{it}}) + \sigma \ln n_{it} + \sum \delta_k (\frac{n_{kit}}{n_{it}}) + \gamma Z_{it} + \varepsilon_{it} \qquad [3]$$

Where, ω_{it} is household budget share of education, y_{it} is total monthly consumption expenditure of the household, n_{it} is household size, n_{kit} is the number of individuals in the *k*th age-gender class within household *i*, Z_{it} is a vector of other household level characteristics, ε_{it} is the error term and t is survey round. α, β, σ, δ_k and γ are parameters to be estimated. The coefficient δ_k captures the effect of household composition on household budget allocations. The difference across gender can be tested using an F-test for the hypothesis that $H_0 : \delta_{kmi} = \delta_{kfi}$. Where, *m, f* and *k* denote males, females and a given age group, respectively.

In many optimization problems corner solutions are common. For instance, amount of life insurance coverage chosen by an individual; family contribution to an individual retirement account; expenditure on some consumption goods like alcohol, cigarette; and firm expenditure on research and development, etc are circumstances of corner solutions. Likewise, we observe a significant proportion of the surveyed households reporting zero educational expenditure resulting in censoring of the dependent variable (see Table 3). Consequently, OLS estimation of Equation 3 is not appropriate, which yields biased parameters. First, when $y \geq 0$, $E(y \mid x)$ cannot be linear in x unless the range of x is fairly limited. Second, it also implies constant partial effects. Third, predicted values of y can be negative for many combinations of x and β, which yields downward biased parameters. Although, the tobit model is suggested as an alternative, it is identified only if the assumption of normality and homoskedaticity are fulfilled. In addition, it assumes a single mechanism to determine the choice between $\omega = 0$ versus $\omega > 0$ and the amount of ω given $\omega > 0$. Specifically, $\frac{\partial P(\omega > 0 \mid x)}{\partial x_j}$ and $\frac{\partial E(\omega \mid x, \omega > 0)}{\partial x_j}$ have the same sign (Wooldridge 2002).

Because of the two-tier nature of such a decision of whether to choose a positive ω or a zero ω and the decision of how much to spend conditional on purchasing a positive amount ($\omega \mid \omega > 0$), a Hurdle model is appropriate that allows initial decision of $\omega = 0$ to be separate from the decision of how much ω given positive ω (Wooldridge, 2002). The model can be written as follows:

$$prob(\omega_{it} = 1 \mid x_{it}) = \Phi(x_{it}\theta) \qquad \textbf{[4]}$$

$$\log(\omega_{it}) \mid (x_{it}, \omega_{it} > 0) \sim normal(x_{it}\psi, \sigma^2) \qquad \textbf{[5]}$$

Where, x_{it} is a vector of explanatory variables, θ and ψ are parameters to be estimated and σ^2 is the variance.

We use random effects panel probit model for tier-one decision model and linear panel autoregressive random effects model for the second decision level, the decision on the magnitude of expenditure conditional on positive spending. The underlying specification of the **tier-one hurdle model** can be written as follows:

$$prob(\omega_{it} = 1 \mid x_{it}, \alpha_i) = F(x_{it}\theta + \varepsilon_{it}) \qquad \textbf{[6]}$$

$$\varepsilon_{it} = \alpha_i + e_{it}$$

Where, ω_{it} is budget share of education in the total annual consumption expenditure of household *i* in period *t.* It takes 1 if $\omega_{it} > 0$ and zero, otherwise. α_i captures household and individual specific time invariant and unobserved effects, e_{it} is a transitory error term assumed to be *iid* over time with a distribution $e_{it} \sim normal(0, \sigma_e^2)$.

There are a number of alternative techniques in a limited dependent variable panel data model to estimate Equation 6 that controls for the initial conditions problem and unobserved individual heterogeneity. Here, we use a two-step procedure suggested by Orme (1997) and Wooldridge (2005).

The traditional random effects models assumes that unobserved effects term is normally distributed and it is strictly independent from other regressors, i.e., , $\alpha_i \mid x_i \sim Normal(0, \sigma_c^2)$, which is a strong assumption. As in the linear case, in many applications the point of introducing the unobserved effects, α_i , is to explicitly allow unobservable to be correlated with some elements of x_{it}. Using the Chamberlain's (1980) general specification to allow correlation between α_i and x_{it} and the Mundlak (1978) version, it can be assumed to have the following linear relation:

$$\alpha_i = c_0 + c_1 \overline{x}_i + u_i \qquad \textbf{[7]}$$

Assuming $u_i \sim IN(0, \sigma_u^2)$, which is independent of x_{it} and $e_{it} \forall$ i and t , c_0 is the intercept and $\overline{x}_i$ is a vector of means of the time-varying covariates for household i over time. Another problem is the initial conditions problem due to the correlation between ω_{i1} and the unobservable, u_i , which needs to be controlled. It arises simply because the start of the observation period is different from the start of the stochastic process. Following Heckman (1981) and Wooldridge (2002), the reduced form random effect probit model for the tier-one expenditure process can be written as:

$$prob(\omega_{it} = 1 | x_{it}, ...) = F(x_{it}\theta + c_1\overline{x}_i + \delta\eta_i + \sum \varphi_{tv} D_{tv} + \xi_i + e_{it}) \qquad \textbf{[8]}$$

Due to Orme (1997)[3], Equation 8 is a two-step estimable equation using standard statistical software, where η_i is the Generalized Probit Error obtained from a probit estimation of the initial observation[4]. We also include regional and time dummies in Equation 8.

[3] For a detailed discussion and application of a two-step random effect probit model readers can consult Arulampalam et al., 1997.

[4] The correlation $corr(\alpha_i, \eta_i) = \rho$ can be assumed to be linearly related as $u_i = \delta\eta_i + \xi_i$, where, η_i and ξ_i are assumed to be orthogonal to one another. The error term η_i is obtained form $prob(\omega_{i1} = 1 | G_i, ...) = F(G_i\lambda + \eta_i)$.

Tier-two hurdle model

We can specify the positive educational spending Engle curve in panel data setting. In this specification, we allow the error terms to be correlated overtime. The model, which can be estimated using GLS, is written as:

$$\log(\omega_{it}) \mid (\ldots, \omega_{it} > 0) = \alpha + \beta \ln(\frac{y_{it}}{n_{it}}) + \sigma \ln n_{it} + \sum \delta_k (\frac{n_{kit}}{n_{it}}) + \gamma Z_{it} + \sum \varphi_{tv} D_{tv} + v_{it} \qquad \textbf{[9]}$$

$$v_{it} = \mu_i + \varepsilon_{it}$$

$$\mu_i = c_0 + c_1 \overline{x}_i + \zeta_i$$

$$\varepsilon_{ti} = \rho \varepsilon_{it-1} + e_{it}$$

Where, $e_{it} \sim N(0, \sigma_e^2)$ is orthogonal to μ_i, $|\rho| < 1$, $\zeta_i \sim iid(0, \sigma_\zeta^2)$ and $corr(x_{it}, \zeta_i) = 0$. Like we did for the non-linear model, we allowed the unobservable to be correlated with some of the time varying correlates. All variables are as defined before. Finally, the complete models which can be computed using STATA or any other standard software packages are Equation 8 and Equation 9. To better control for observed and unobserved village level factors we have introduced village by round interaction terms, $\sum \varphi_{tv} D_{tv}$. The gain in efficiency of the overall model after the inclusion of these terms is dramatic. Besides, the term control for the role of covariate shocks and any market, infrastructure, political or socio-cultural developments as well as other supply side factors across villages and overtime. In fact, otherwise, gender-bias will be overstated. Since our observation is large, introducing these 14x5 terms should not be a concern to loss of degrees of freedom.

4.2 The data

Our analysis is based on the Ethiopian Rural Household Survey (ERHS) panel data set spanning from 1994-2004 collected by Addis Ababa University, Department of Economics in collaboration with the University of Oxford Center for the Study of African Economies (CSAE) and other institutions like the International Food Policy Research Institute (IFPRI). The survey was undertaken for six waves; 1994a, 1994b, 1995, 1997, 1999/2000 and 2004 consisting of a panel of 1400 households. The sampling was stratified to represent the main sedentary farming system in the country, the plough-based cereals farming system of the Northern and central Highlands, mixed plough/hoe cereals farming system and farming system based on *enset* in the southern parts of the country. Further more, sample size in each village was chosen so as to approximate a self-weighting sample, when considered in terms of the farming system. Fifteen Peasant Associations (PAs) in four regions are included in the panel. The survey is aiming at generating a multi-purpose data set comprising a range of household, community and market variables during each survey period. There are a number of modules included in the questionnaire. The attrition rate was very low, below 7%, attributed to the fact that households in rural Ethiopia can not obtain land when moving to other areas (Dercon and Hodinot 2004). However, the survey does not cover pastoral areas in the country, which accounts for 10% of the total rural population.

4.3 Description and definition of variables

In this study, we used a household level data to identify intra-household gender-bias in the allocation of educational spending. Although, the ERHS data have information on some individual level variables, we preferred to use household level data to minimize measurement error. The dependent variable is share of spending on education. For the first-tier hurdle model, we used a dichotomous variable taking unity, if household allocate resources on child schooling. While for the tier-two model, we used log transformation of the share of educational spending in the total household consumption budget, conditional on positive spending. As can be shown in Figure 1, this is a valid transformation that reduces noise in the regression. The log transformed share of education (panel 4), after scaling up, is normally distributed than the unconditional and conditional level forms (panels 1 and 2). In the questionnaire, all school related direct expenses such as fees, uniforms, materials like book, contributions and club fees, accommodation and transportation to school are merged under school fees and other educational expenses. It should be noted that for primary cycle, there is no school fee in public schools. Besides, mindful of the indirect costs of sending children to school in rural areas, we included variables that capture the opportunity cost such as land ownership, livestock owned, oxen and the level of welfare of the household.

In the right hand side of our equations, we have the proportion of boys and girls in the household in each age-sex grouped into fourteen categories (below 4, 5-9, 10-14, 15-19, 20-24, 25-60, and over 60 years old) for both sexes as regressors. Age-sex group over 60 years are considered as reference group. Other household level characteristics like sex of the head (dummy=1 if male and zero otherwise), age of the head, level of education of the head, mean age in the household, lagged value of log of consumption per adult equivalent unit, size of land holding in hectare, number of livestock owned, number of oxen owned, and interaction of round by village dummies, over time mean values of time-varying household level variables and first difference of these variables are included. Summary statistics of these variables are shown in Table 3.

5. Discussion of results

5.1 Descriptive statistics

In this section the descriptive part of the analysis is presented. Spending on child education is an important aspect of human capital investment. However, evidences from rural Ethiopia, such as Assefa (2002) show that sending children to school has an opportunity cost as their labor is needed for domestic, farm activities or activities. As can be shown in Table 3, the percentage of households with one or more school age children (5-19 years) spending a positive amount of educational expenditure is around 21.64%. The worst figure is observed in the case of Ankober in Amhara Region, where the percentage of households who have school age children in the household that allocate positive amount on child education is only 13%.

Of those who allocate resources to siblings schooling, the level of budget share on education is only 1.3% of total expenditure in the survey areas. Conditional on enrollment, from the sample *weredas* households residing in Kedida Gamela spend the highest proportion of their budget, 2%, on child schooling. While households in Ankober spend very small, only 0.6%, proportion of their household budget. It is very interesting to figure out that compared to other regions, households residing in Amhara region (Ankober, Debre Birhan, Enemayi, and Bugna) have the lowest budget share for education, less than 1%, given households have already decided to spend some positive amount on child education. This could be due to a variety of supply, demand and policy factors on the ground. We cannot simply generalize that households in these areas have lower preference to child education and we need to assess all other factors.

Table 4 presents the proportion of children in households with positive educational spending by gender and age. We can observe that, in the three school age categories; 5-9 years, 10-14 years and 15-19 years, it is those households with the highest proportion of boys who incur the largest magnitude of positive educational expenditure.

5.2 Empirical results

5.2.1 Determinants of resource allocation to child schooling

It is imperative to understand the determinants of intra-household allocation of resources to child education. Beside supply side factors, demand side factors are important in determining the level of school enrollment, completion and rate of success. The demand side is determined by a number of factors; social, cultural, economic and household level preference and characteristics. As can be seen from the regression results in Table 6, sex and age of the individual as well as a number of household level factors determine the behavior of household resource allocation to child education investment.

It is appealing to note that the coefficient of male headship is negative but insignificant in the random effects probit regression equation while negative and significant at 5% on the decision of how much to spend. This implies that male headed households shift away resources from investment in child education. That is, cetirus paribus, male headed households have negative taste to child schooling presumably due to higher preference to adult commodities than children education. It reflects the uneven bargaining power of men and women in the household on intrahousehold resource allocation and reinforces the evidence that women headed households tend to allocate more resources to siblings schooling.

The level of education of the head, on the other hand, has a positive impact on the decision to allocate resources to education and its magnitude. We observe households with higher proportion of pre-school age children, below 4 years, tend to shift away their resources from child schooling, usually to nutrition, health, clothes and other purchases.

Although, in column [1] enrollment increases with the increase in household size, from the coefficient of the squared variable it is shown that very large household size discourages enrollment significantly. Except in Tigray, the coefficient on natural log of household size is positive and significant in Amhara, Oromia and SNNP[5]. However, from the conditional regression, we found a negative and statistically significant impact of household size on the magnitude of share of education in Tigray and Oromia region. The elasticity of share of education to household size is -2.21 and -1.1 implying a 1% decrease in the household size leads to 2.21% and 1.1% increase in the share of educational budget in Tigray and Oromia, respectively.

[5] SNNP stands for Southern Nations Nationalities and People

From the whole sample and Oromia region, we found that having more of both oxen and land have a negative impact on the initial decision to send children to school, which echoes the importance of farm opportunity cost of sending children to school. However, once they have decided to send their children to school, having more land and oxen have positive and statistically significant impact of increasing the magnitude of resource allocated to schooling. This is because the most important rural productive assets are land and oxen. Land is the central source of livelihood while oxen are the major source of traction power and store of wealth. Having more of these assets, increases the capacity of the households to cover school expenditure.

Land ownership has significant and negative impact on school enrollment in Tigray and Amhara regions, again reflecting the opportunity cost of sending children to school. On the other hand, the result from Oromia region is contrary to this finding where owning more of cultivable land increases the probability of child enrollment. Possible reasons may be productivity differences in adult labor and agro-ecological setup as Oromia and SNNP are surplus regions in the country resulting in less demand for child labor on farm activities. As the number of oxen owned increases by one unit, the probability of allocating positive educational resources is 5%, 3% and 6% in Tigray, Amhara and Oromia regions respectively. Generally, the direction and level of significance of asset holding is mixed across regions and stages of decision.
As it can be shown in column [1], the lagged value of log of consumption has positive sign in both stages of decision and it is significant at 1% in tier-two decision. Households with higher welfare, invest more on education, where doubling the level of consumption (total budget) leads to 10.4%, 25.8%, 15.8% and 12.7% increases in share of educational expenditure in Ethiopia as a whole, Tigray, Amhara and SNNP regions, respectively. This implies that for high income households, children are not needed to engage in income generating or productive activities to augment household income at the expense of their schooling.

5.2.2 Detecting gender-bias

When trying to identify intra-household bias, one has to be cautious not to overstate/understate it since bias may arise due to a number of factors and model specification. A number of factors should be controlled both spatially and overtime. There are observed and unobserved, individual, household and village level effects that may lead to the observed level of gender-bias. For instance, individual talent or intelligence in schooling, behavior, level of effort and success in school and other factors may influence the preference to allocate positive or zero sum of resources to child schooling. Along with deciding on the appropriate empirical model, one has to better suit to panel data set that tracks the same household over a long period of time as it enable to control for time invariant individual, household and community specific effects. The salient feature of our analysis is to make use of this advantage.

From the probit regression model of the whole sample, we observe that there are positive and statistically significant coefficients on male and female children aged between 5 and 19 years. That is, households with one or more member of this age category tend to allocate resources to education. However the magnitude and level of significance of these coefficients vary among different age-sex groups and regions like in Amhara and Oromia. Except in Tigray, magnitude of the coefficients is larger for boys than girls. For instance, the probability of allocating a positive resource to male children aged 10-14 years is 60.68%, 39.27%, 75.06% and 78.6% as compared to female children whose probability of getting enrolled is 47.99%, 14%, 46.44% and 62.86% for the whole sample, Amhara, Oromia and SNNP regions, respectively. That is, the probability of allocating a positive educational resource is 0.61 for the next boy and 0.5 for the next girl aged 10-14. Likewise, the magnitude of these probabilities in age group 5-9 and 15-19 years are higher for male children.

From regionally disaggregated marginal coefficients of probit estimation, we observe that the direction of most of the coefficients is theoretically consistent. However, it is only in the case of age-sex categories of male_10-14 and female_10-14 for Tigray; male_10-14 for Amhara; male_5-9, male_10-14 and female_10-14 for Oromia; male_5-9, male_10-14, female_10-14, male_15-19 and female_15-19 for SNNP that these coefficients are positive and statistically significant. This implies that an additional child of that specific age category to the household and region has a positive probability of being enrolled to school.

To give statistical validity of our claim over the existence of gender-bias in the intrahousehold resource allocation in child educational investment, we test the hypothesis $H_0 : \delta_{kmi} = \delta_{kfi}$, which can be accomplished by a Wald-test on the marginal effects of the coefficients of interest (school age children; 5-9 years, 10-14 years and 15-19 years). From the probit marginal effects of the whole sample and SNNP, in Table 7, we found that there is statistically significant pro-boy bias in educational enrollment in the age category of 15-19 years. That is households in rural Ethiopia discriminate against girls who are in the age range of 15-19 years. This age category corresponds to the secondary school (secondary cycle). Unlike other regions, households in Amhara significantly discriminated against girls school enrollment compared to boys aged 10-14 years. The risk in this discrimination is that it denies girls their very chance of being enrolled in school. However, except in

Oromia, test result from the conditional regression indicates that those households who have initially decided to incur positive school expenses do not discriminate against girls by reducing the magnitude of the resource.

One reason why we couldn't verify pro-boys bias in primary and junior school age children in most of the regions and the whole sample is that in many places there is no school fee at these levels. Besides, in most of the sample areas access to primary schools is relatively better, which will have positive impact by reducing transport cost, allowances, and other expenses. However, when children are promoted to high school, they have to travel to the nearest town. In most cases, they have to stay for a week or more. From Table 5, we can see that it is only 20 % of the sampled villages which have a secondary school in the village and the average distance to the nearest town with high school is about 11km in 2004. In this case, the cost of sending children to school becomes significant. Further more, traveling long distance to school in cases where there is no suitable road infrastructure is difficult for girls, which forces them to frequently dropout school.

Households are also reluctant to send their girls far from home fearing abuses and sexual harassment by schoolmates and men teachers. Hence, lack of access to school infrastructure in the village by itself may induce endogenous bias against sending girls to school. In addition, girls' role in the household is important and their time is a close substitute to mothers' time in domestic activities. This age category also corresponds to girls' marriage in most rural areas forcing them to dropout. Parents also may hesitate to invest on their daughters' than their sons' education as they expect low rate of return and low expected transfer to parents during old age. However, as we have observed, if households have found way of sending girls to school, no statistically significant evidence is found to reduce the resource against them. However, it is important to note that once households have decided to incur positive child educational expenditure, there is pro-girls bias in the age category of 10-14 years and significant pro-boy bias in the age category of 15-19 years in Oromia region.

Tigray region is the only exception with no statistically significant gender-bias against girls in both the decision to enroll and the decision on the magnitude of share of budget allocated to child schooling. Interestingly, our finding is consistent with the official macro data, where the Gender Gap and Gender Parity Index is consistently rising at the secondary cycle. Figure 2 also indicates that the enrollment rate for boys diverges significantly from that of girls aged 14 years and above. As we have discussed above, the pro-boys bias is pervasive during the initial decision to enroll children to school (or whether to incur positive educational expenditure or zero) in the age category of 15 – 19 years, which corresponds to secondary school in Ethiopian educational system.

6. Conclusion and policy implications

In this study, we examined whether there is any intra-household gender-bias in household educational resources allocation to boy and girls. Gender-bias may occur at two stages, the initial decision to enroll children to school and conditional on enrollment, whether households discriminate on the amount of the resource based on gender. This is of interest because at the national level, official data reveals the existence of gender gap both at the primary and secondary cycles. The trend shows that this gap is falling for the primary cycle, while it has been rising in the secondary cycle. This bias could be an outcome of a number of multiplicative factors, both from the supply and demand side. Micro evidence from the ERHS 2004 data also reveals divergence in gross enrollment rate between boys and girls for those aged 14 years and above.

The main objective of this study has, therefore, been to uncover if there is any intra-household gender bias on the allocation of resources to child education and during which stage of decision. Using a panel data set from ERHS, spanning from 1994-2004, we have tried to detect any intra-household gender bias in rural areas. The panel nature of our data set enabled us to control for observed and unobserved effects and initial condition problems. We applied panel hurdle model consisting of two regressions; random effects probit for the initial decision on enrollment and linear autoregressive random effects model on the proportion of the educational resource conditional on enrollment.

From the descriptive results we note that the percentage of households in rural Ethiopia with one or more children who allocate positive amount of resource to their children's education is around 21.64% of the sample. The average budget share of spending on child schooling of these households is only 1.3%. We have also observed that it is those households with the highest proportion of boys who frequently incur positive educational expenditure or send their child to school.

Irrespective of the gender of the child, households with male headship have negative taste to child educational investment. Although, large family size has positive and significant impact on child school enrollment, it has an inversely proportional impact on the budget share allocated to education. Having more of both rural farming land and oxen has negative impact on enrollment signifying the opportunity cost of sending children to school. Nevertheless, once they are enrolled, more of rural productive assets have positive and significant impact on the magnitude of the share allocated to child schooling. Households with high level of welfare allocate higher share of their budget expenditure to schooling.

After controlling for a number of observed and unobserved effects, we found that coefficients on male and female children aged between 5 and 19 years are statistically significant. From the whole sample, the observed probability of an additional school age child getting enrolled is higher if it is a boy as compared to a girl. The Wald-test on the marginal coefficients indicates that there is a significant gender bias during the initial decision against girls in the age range of 10-14 years in SNNP and in the age range of 15-19 years for the whole sample and SNNP. However, significant pro-boy bias in the primary school cycle ages, 5-9 years is not observed. From the whole sample, we couldn't also find gender-bias on the budget share allocated, once households have decided to enroll their child. However, there are mixed results in some places. Such as in Oromia region, we found significant pro-girls bias on the share of education allocated to enrolled children in the age category of 10-14 years and pro-boy bias in the age category between 15 and19 years. The existence of gender-bias in the secondary cycle age children could be due to the absence of high school in the village that buttressed the gender discrimination in enrollment and resource allocation against girls in the age range of 15-19 years. The only region that we couldn't detect significant gender-bias during both decisions is Tigray.

The implication of our study is that policies that are geared towards increasing human capital should take into account the existence of significant intrahousehold bias against girl's education, especially among those who are aged 14 years and above. Since the bias occurs inside the household, public investments should not only focus on facilitating access to school but also work from the demand side as parents have different preference towards siblings' education. Gender specific direct and indirect policy interventions are important at correcting the demand side bottlenecks in poor areas. Policies that increase the returns to girl's education in the labor market could increase parents' preference towards daughter's educational investment. Besides other affirmative actions, supply side targeting of girls in through scholarships and incentives could also mitigate the problem. Besides, a broader objective of increasing labor productivity in rural areas it should also consider increasing intrahousehold productivity so as to reduce the overburden of mothers since girls labor could be a close substitute to their domestic activities. This can be accomplished by increasing access to clean water, grain mill, market infrastructure, alternative sources of energy, etc. Legislations that prohibit early marriage could also reduce the incidence of girls' dropout from school.

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Annexes

Table 1: Trends in Gross Enrollment Ratios at Primary and Secondary Education by Sex

	Year	2000/01	2001/02	2002/03	2003/04	2004/05
Primary Cycle (1-8)	Total	57.4	61.6	64.4	68.4	79.8
	Boys	67.3	71.7	74.6	77.4	88
	Girls	47	51.2	53.8	59.1	71.5
	GG	20.3	20.5	20.8	18.3	16.5
	GPI	0.7	0.71	0.72	0.76	0.81
Secondary Cycle (9-10)	Total	14.1	17.1	19.3	22.1	27.3
	Boys	16.1	20.4	24	28.2	34.6
	Girls	12.1	13.7	14.3	15.9	19.8
	GG	4	6.7	9.7	12.3	14.8
	GPI	0.75	0.67	0.6	0.56	0.57

Source: Author's Calculation from ERHS data Note: Values in bracket are Standard Deviations

Table 2: Educational spending in households with one or more children aged between 5-19 years: 1994-2004

	Wereda	Share of Education in Total Budget among all HHs	% of HHs Spending Positive Educ'l Expenditure	Share of education in Total Budget among HHs spending Positive Amount
Tigray	Atsbi	0.003	20.12%	0.011
		(0.007)	(.401244)	(0.011)
	Sebhaassahsie	0.004	25.36%	0.014
		(0.011)	(.4356109)	(0.016)
Amhara	Ankober	0.001	12.92%	0.006
		(0.003)	(.3357506)	(0.005)
	Derbe Birhan	0.002	25.77%	0.007
		(0.007)	(.4375416)	(0.011)
	Enemayi	0.003	26.72%	0.009
		(0.008)	(.4430819)	(0.012)
	Bugena	0.002	17.48%	0.009
		(0.007)	(.3799863)	(0.015)
Oromoria	Adaa	0.002	18.73%	0.011
		(0.007)	(.3904634)	(0.013)
	Kersa	0.004	24.24%	0.016
		(0.012)	(.4289108)	(0.019)
	Dodota	0.004	30.22%	0.013
		(0.010)	(.4595619)	(0.014)
	Shashemene	0.008	45.15%	0.016
		(0.014)	(.4980211)	(0.017)
SNNP	Cheha	0.004	30.91%	0.013
		(0.010)	(.4627142)	(0.014)
	Kedida Gamela	0.008	37.08%	0.020
		(0.015)	(.4835319)	(0.019)
	Bule	0.002	13.02%	0.013
		(0.007)	(.3367171)	(0.013)
	Boloso	0.004	25.53%	0.015
		(0.010)	(.441872)	(0.015)
	Daramalo	0.005	31.32%	0.014
		(0.012)	(.4681633)	(0.017)
Whole Sample	Total	0.003	21.64%	0.013
		(0.009)	(.4118043)	(0.015)

Table 3: Summary descriptive statistics

Variable	Description	Mean	Std. Dev.
	Dependent Variables		
Monthly Educ Expenditure-Conditional	Monthly Expenditure on School fees and Other school related expenses	7.220138	24.5932
Share of Education - Unconditional	Share of Monthly Educational expenditure in total consumption expenditure	0.002782	0.0088
Share of Education - Conditional	Share of Monthly Educational expenditure in total consumption expenditure conditional on positive expenditure	0.010845	0.014645
Dummy of positive educ spending	Dummy =1, if the household spends positive expenditure on education	0.216393	0.411804
	Ratio of Age-Sex Category to Household Size		
Male_below4	Ratio of number of male children aged below 4 years to total household size	0.043624	0.092472
Female_below4	Ratio of number of female children aged below 4 years to total household size	0.040729	0.088702
Male_5-9	Ratio of number of male children aged between 5-9 years to total household size	0.05847	0.097007
Female_5-9	Ratio of number of female children aged between 5-9 years to total household size	0.059446	0.096026
Male_10-14	Ratio of number of male children aged between 10-14 years to total household size	0.058933	0.102086
Female _10-14	Ratio of number of female children aged between 10-14 years to total household size	0.057296	0.103536
Male_15-19	Ratio of number of male children aged between 15-19 years to total household size	0.0522	0.107183
Female_15-19	Ratio of number of female children aged between 15-19 years to total household size	0.052441	0.108422
Male_20-24	Ratio of number of male children aged between 20-24 years to total household size	0.039464	0.100251
Female_20-24	Ratio of number of female children aged between 20-24 years to total household size	0.041516	0.102122
Male_25-60	Ratio of number of male children aged between 25-60 years to total household size	0.144622	0.15154
Female_25-60	Ratio of number of female children aged between 25-60 years to total household size	0.165181	0.155925

Table 3 contd…

	Household Characteristics		
Head_sex	Dummy=1, if the household head is male, zero otherwise.	0.769687	0.421061
Head_age	Age in years of head of the household	48.06955	15.56917
Head_agesqr	Age in years squared of head of the household	2491.08	1653.932
Head_primedu	Dummy=1, if the household head 's level of education is primary school	0.151524	0.358583
Head_junedu	Dummy=1, if the household head 's level of education is Junior school	0.028954	0.167688
Head_secedu	Dummy=1, if the household head 's level of education is Secondary school	0.019027	0.136628
Head_teredu	Dummy=1, if the household head 's level of education is Tertiary school	0.004136	0.064185
Household Size	Household size	6.218494	3.122065
ln of hh size	Natural logarithm of household size	1.687668	0.566128
ln of hh size sqr	Natural logarithm of household size squared	3.168691	1.722574
Household_mean age	Mean age in the household	24.41835	10.59169
land	Size of land owned by the household measured in hectar.	1.827598	2.125061
livstk_no	Number of livestock owned, except oxen and bulls	8.941679	11.66209
Oxen_no	Number of oxen and bulls owned	0.946643	1.98277
lncons_lg	Natural logarithm of lagged value of total consumption.	5.797525	1.007634
Regions			
Tigray		0.085153	0.279122
Amhara		0.274199	0.44613
Oromia		0.360171	0.480072
SNNP		0.280477	0.449253

Source: Author's Calculation from ERHS data set

Table 4: Proportion of children in households with positive educational spending

Wereda	Proportion of children 5-9 years		Proportion of children 10-14 years		Proportion of children 15-19 years	
	Mal e	female	male	female	male	female
Atsbi	0.079	0.059	0.085	0.069	0.042	0.058
	(0.113)	(0.102)	(0.120)	(0.103)	(0.087)	(0.095)
Sebhaassahsie	0.062	0.081	0.067	0.092	0.052	0.049
	(0.083)	(0.107)	(0.108)	(0.117)	(0.087)	(0.095)
Ankober	0.089	0.049	0.069	0.052	0.046	0.022
	(0.103)	(0.094)	(0.106)	(0.085)	(0.102)	(0.055)
Debre Birhan	0.073	0.065	0.082	0.078	0.068	0.058
	(0.114)	(0.099)	(0.106)	(0.105)	(0.122)	(0.088)
Enemayi	0.062	0.084	0.072	0.069	0.046	0.059
	(0.094)	(0.098)	(0.091)	(0.088)	(0.088)	(0.086)
Bugena	0.086	0.089	0.063	0.075	0.053	0.041
	(0.115)	(0.118)	(0.099)	(0.128)	(0.099)	(0.115)
Adaa	0.050	0.055	0.075	0.042	0.058	0.046
	(0.075)	(0.082)	(0.084)	(0.061)	(0.079)	(0.084)
Kersa	0.090	0.075	0.073	0.072	0.056	0.043
	(0.100)	(0.094)	(0.088)	(0.115)	(0.076)	(0.105)
Dodota	0.067	0.061	0.097	0.080	0.079	0.043
	(0.089)	(0.086)	(0.112)	(0.107)	(0.122)	(0.077)
Shashemene	0.058	0.055	0.086	0.068	0.075	0.054
	(0.090)	(0.080)	(0.110)	(0.099)	(0.118)	(0.089)
Cheha	0.065	0.048	0.087	0.092	0.057	0.073
	(0.099)	(0.079)	(0.101)	(0.137)	(0.113)	(0.105)
Kedida Gamela	0.053	0.064	0.081	0.074	0.074	0.062
	(0.084)	(0.083)	(0.110)	(0.091)	(0.103)	(0.077)
Bule	0.093	0.078	0.089	0.096	0.067	0.025
	(0.103)	(0.089)	(0.108)	(0.129)	(0.097)	(0.055)
Boloso	0.076	0.078	0.100	0.076	0.081	0.061
	(0.097)	(0.142)	(0.158)	(0.131)	(0.118)	(0.089)
Daramalo	0.062	0.068	0.082	0.099	0.082	0.061
	(0.104)	(0.092)	(0.124)	(0.129)	(0.161)	(0.094)
Total	0.070	0.067	0.082	0.077	0.066	0.051
	(0.099)	(0.097)	(0.111)	(0.111)	(0.111)	(0.090)

Source: Author's Calculation based on ERHS data. **Note**: Values in bracket are Standard Deviations.

Table 5: Availability of school and distance to the nearest town with high school: 2004

Region	Wereda	Peasant Association	1997 Primary school	1997 Junior School	1997 Secondary School	1997 Distance to the Nearest High School (km)	2004 Primary school	2004 Junior School	2004 Secondary School	2004 Distance to the Nearest High School (km)
Tigray	Atsbi	Harasaw	Yes	No	No	18	Yes	Yes	No	16
	Sebha Selassie	Geblen	Yes	No	No	18	Yes	No	No	19
Amhara	Ankober	Dinki	No	No	No	?	Yes	No	No	?
	Debre Birhan	Debrebirhan	Yes	No	No	10	Yes	No	No	5
	Enemay	Yetmen	Yes	Yes	No	17	Yes	Yes	No	15
	Bugna	Shumsha	Yes	No	No	10	Yes	No	No	9
Oromia	Ad'a	Sirbana Goditi	No	Yes	No	15	Yes	Yes	No	10
	Kersa	Adel Keye	Yes	No	No	7	Yes	No	No	8
	Dodota	Koro Degaga	Yes	No	No	25	Yes	No	No	15
	Shashemene	Tirurife Ketchema	Yes	Yes	Yes	2	Yes	Yes	Yes	0
SNNP	Cheha	Imdibir	No	No	No	4	Yes	Yes	Yes	4
	Kedida Gamela	Aze Adebo	Yes	No	No	5	Yes	Yes	No	?
	Bule	Adado	No	No	No	22	Yes	Yes	No	29
	Boloso	Gara Godo	No	Yes	No	13	No	No	No	12.5
	Daramalo	Doma	Yes	No	No	?	Yes	Yes	Yes	0
		Percentage Yes	**66.67%**	**26.67%**	**6.7%**	**12.69**	**93.33%**	**53.33%**	**20%**	**10.96**

Source: Author's computation from ERHS community data

Table 6: Random effects probit and autoregressive estimates

Variables	Whole Sample				Samples in Tigray Region			
	[1]		[2]		[3]		[4]	
	Marginal Effects after RE Probit Estimation		Linear Autoregressive Model (AR(1))		Marginal Effexts after RE Probit Estimation		Linear Autoregressive Model (AR(1))	
	Coef.	z-value	Coef.	z-value	Coef.	z-value	Coef.	z-value
Constant	**-2.5904*****	4.9	**4.0944*****	7.98	**-4.249*****	-2.04	2.4443	-1.02
Household Age-sex group ratio								
Male_below 4	**-0.3481*****	2.7	-0.641671	1.26	**0.077*****	0.26	-1.2138	0.79
Female_below 4	-0.1639	1.3	0.0466068	0.1	**-0.075*****	0.23	1.0336	0.51
Male_5-9	**0.2017****	2.03	0.2845792	0.86	0.0673	0.28	-1.5204	1.29
Female_5-9	0.0195	0.2	0.0060587	0.02	0.1133	0.54	**-2.4023****	2.09
Male_10-14	**0.6068*****	6.6	**0.5176797***	1.85	**0.599*****	2.47	-0.3688	0.33
Female_10-14	**0.4799*****	5.51	**0.834276*****	3.11	**0.824*****	3.55	-0.3573	0.37
Male_15-19	**0.3504*****	4.1	**0.5807817****	2.03	0.6172	2.53	-0.7495	0.64
Female_15-19	**0.1535***	1.76	**0.7048582****	2.17	0.6433	2.68	0.0928	0.08
Male_20-24	-0.0091	0.1	-0.1307145	0.37	-0.0031	0.01	0.1086	0.09
Female_20-24	**-0.2782*****	2.7	0.1796455	0.44	-0.0639	0.22	-0.9389	0.62
Male_25-60	**0.1323***	1.6	-0.2242455	0.77	0.0328	0.13	-0.0926	0.08
Female_25-60	0.0182	0.22	**-0.5816122***	1.93	-0.0673	0.26	0.8763	0.61

Table 6 continued…

				Household Characteristics				
Head_sex*	-0.0206	0.8	**-0.180022****	2.11	0.0454	0.71	-0.0775	0.28
Head_age	0.0049	1.47	0.0133734	1.21	0.0032	0.36	0.0481	0.93
Head_agesqr	-0.0001	1.2	-0.0001287	1.31	-0.0001	0.7	-0.0006	1.13
Head_primedu*	**0.1118*****	3.82	0.0116446	0.15	0.0449	0.8	0.0418	0.11
Head_junedu*	**0.1708*****	2.59	0.0261754	0.16				
Head_secedu*	0.0909	1.33	-0.0511498	0.26				
Head_teredu*	**0.2863****	2.18	**0.6051018***	1.71				
ln of hh size	**0.3199*****	3.57	-0.4631516	1.36	0.2123	0.85	**-2.2137***	1.86
ln of hh size sqr	**-0.0433***	1.7	0.0973039	1.05	0.0162	0.21	**0.5578****	2
Household_mean age	-0.0037	1.3	-0.0021751	0.2	-0.0079	1.27	0.0138	0.44
				Household Asset				
landXox	**-0.0043***	1.8	**0.0161301****	1.96	-0.0331	0.73	-0.0441	0.26
landXlivskt	0.0004	1.35	0.001195	1.18	-0.0002	0.03	**-0.0551***	1.64
land	-0.0059	0.6	-0.0264461	0.7	**-0.197*****	1.44	0.9413	1.55
livstk_no	-0.0024	1.2	-0.0084601	1.31	0.0018	0.28	0.0322	1.04
oxen_no	0.0171	1.47	-0.0282252	0.79	**0.047*****	0.85	-0.1328	0.58

Table 6 continued…

			Household Welfare level					
Incons_lg	0.0155	1.55	**0.104056*** **	3.15	0.0474	2.01	**0.2575*** **	2.84
GPE (Generalized Probit error)	-0.0444	1.3			0.0407	0.51	-	-
Rho		0.2			0.1917*			
sigma_u		0.49			0.4871			
/lnsig2u		1.4			-1.4388			
number of obs.		4897		1786	545		173	
Loglikelihood		-2383.52			-202.598			
Wald Chisquare		958.56*		606.66	101.65		314.34*	
R-squared - Within				0.21			0.6459	
- Between				0.3			0.4112	
- Overall				0.27			0.5651	
rho_ar (estimated autocorrelation				0.31			0.4319	
sigma_u				-			0	
sigma_e				1.05			0.8658	
rho_fov (fraction of variance due to u_i)				-			0	

Note: Reported constants are from the main regression result coefficients (not the marginal effects). ***=Significant at 1%, **=Significant at 5% and *=Significant at 10%. Over time mean and Change of time varying household level variables are included in the regression but not reported here and they are available at request from the author Village by round dummies interaction terms are included in the regression and most of these terms are statistically significant. However, the coefficients are not reported here. Coefficients on education are dropped due to co linearity in Tigray and Amhara region.

Table 6 Random effects…, cont'd

Variables	Samples in Amhara Region				Samples in Oromia Region			
	[5]		[6]		[7]		[8]	
	Marginal Effexts after RE Probit Estimation		Linear Autoregressive Model (AR(1))		Marginal Effexts after RE Probit Estimation		Linear Autoregressive Model (AR(1))	
	Coef.	z-value	Coef.	z-value	Coef.	z-value	Coef.	z-value
Constant	-3.11***	2.89	1.7489	1.23	-1.2569	1.2	**4.9621*****	4.17
Household Age-sex group ratio								
Male_below 4	**-0.87*****	5.21	-1.3622	1.24	-0.4432	1.57	-0.34088	0.36
Female_below 4	**-0.91*****	5.13	-0.8584	0.79	**-0.5326***	1.97	-0.28585	0.31
Male_5-9	-0.0014	0.01	-0.189	0.29	**0.3909***	1.89	0.797052	1.26
Female_5-9	0.0502	0.41	-0.0746	0.12	0.1347	0.61	0.489877	0.74
Male_10-14	**0.39*****	3.14	**1.2657****	2.04	**0.751*****	3.9	0.074034	0.14
Female_10-14	0.1403	1.2	**0.9963***	1.66	**0.464*****	2.55	**1.31783****	2.46
Male_15-19	0.1201	1.14	-0.3841	0.07	0.224	1.28	**1.5102*****	2.93
Female_15-19	0.058	0.53	0.5492	0.86	0.1283	0.7	0.11024	0.19
Male_20-24	-0.0406	0.3	0.4411	0.56	-0.0803	0.41	**1.10906***	1.8
Female_20-24	-0.0727	0.49	-0.5428	0.66	-0.1855	0.85	0.823557	1.13
Male_25-60	-0.0523	0.4	0.3211	0.43	**0.3351****	2.06	-0.02867	0.06
Female_25-60	0.1644	1.51	-0.4424	0.67	0.0203	0.11	0.130802	0.24

Table 6 continued…

				Household Characteristics				
Head_sex*	-0.0368	0.89	**-0.3852****	2.07	0.015	0.31	**-0.2324***	1.74
Head_age	**0.013****	2.3	0.0078	0.26	-0.0016	0.19	-0.01702	0.69
Head_agesqr	**-0.001****	2.36	-0.0001	0.31	0.00001	0.17	0.000236	1.02
Head_primedu*	**0.099****	2.2	**0.2705****	1.6	0.0315	0.57	-0.03449	0.24
Head_junedu*	0.1225	0.98	-0.1548	0.32	0.2159	1.55	0.273903	0.96
Head_secedu*		-	-		-0.0744	0.72	**0.58932***	1.74
Head_teredu*		-	-		0.2592	1.04	0.440635	0.64
ln of hh size	**0.2873****	2.27	-0.4396	0.59	**0.347*****	1.95	**-1.0738***	1.71
ln of hh size sqr	-0.0592	1.44	0.1696	0.76	-0.0327	0.64	0.245212	1.56
Household_mean age	**0.009****	2.37	-0.0025	0.11	**-0.01*****	1.88	-0.01142	0.6
				Household Asset				
landXox	-0.002	0.86	0.0017	0.12	**-0.02*****	3.2	**0.03974****	2.01
landXlivskt	**0.0006***	1.75	**0.0030****	1.97	0.0012	1.52	-0.00122	0.68
land	**-0.0197***	1.73	-0.0494	0.94	**0.0304***	1.63	-0.01635	0.21
livstk_no	**-0.0039***	1.93	**-0.0188****	1.96	-0.0004	0.1	0.014336	1.22
oxen_no	**0.0305****	2.36	0.0494	0.99	**0.0562***	1.87	**-0.235*****	2.69

Table 6 continued…

Household Welfare level								
lncons_lg	-0.0218	1.34	**0.1584****	2.35	0.0019	0.1	-0.02025	0.05
GPE (Generalized Probit error)	0.0381	0.84			**-0.106**	1.59		
Rho		0.2306*			0.1519*			
sigma_u	0.55				0.4232			
/lnsig2u	-1.2				-1.7198			
number of obs.	1674		499		1343			554
Loglikelihood	-717.77				-608.105			
Wald Chisquare	271.77*		100.53*		298.55*			97.22
R-squared – Within			0.1757					0.1003
- Between			0.1708					0.2396
- Overall			0.179					0.1727
			0.217					0.2487
sigma_u			0					0
sigma_e			1.0766					1.0527
			0					0

Table 6 Random …, cont'd

Variables	Samples in SNNP			
	[9]		[10]	
	Marginal Effexts after RE Probit		Marginal Coefficients from Linear	
	Coef.	z-value	Coef.	z-value
Constant	-1.7185	1.5	3.579831***	3.9
Household Age-sex group ratio				
Male_below 4	-0.418	1.35	**-1.663432***	1.64
Female_below 4	0.3605	1.3	**-1.414165***	1.67
Male_5-9	**0.5332****	2.34	0.4818685	0.76
Female_5-9	0.1542	0.64	-0.0409092	0.06
Male_10-14	**0.786*****	3.98	0.5448037	1.03
Female_10-14	**0.629*****	3.31	0.3615266	0.75
Male_15-19	**0.89**	4.12	0.6904884	1.25
Female_15-19	**0.3924***	1.79	0.3104279	0.46
Male_20-24	**-0.3792***	1.77	-0.9416805	1.43
Female_20-24	**-0.4314***	1.89	0.568111	0.72
Male_25-60	0.0625	0.32	-0.0738633	0.14
Female_25-60	-0.1875	1.03	-0.0612614	0.12
Household Characteristics				
Head_sex*	0.0209	0.32	-0.0703695	0.39
Head_age	-0.0099	1.15	0.0129079	0.73
Head_agesqr	0.0001	1.55	-0.0000709	0.5
Head_primedu*	**0.0986***	1.88	-0.0128374	0.1
Head_junedu*	0.0632	0.66	-0.0713425	0.29
Head_secedu*	0.1408	1.3	-0.1549146	0.6
Head_teredu*	**0.3892****	2.16	0.2540834	0.59
ln of hh size	**0.3495***	1.69	0.4165212	0.67
ln of hh size sqr	-0.0369	0.6	-0.1475452	0.85
Household_mean age	0.0032	0.42	-0.0044824	0.2
Household Asset				
landXox	0.0223	1.17	-0.0055352	0.15
landXlivskt	0.0016	0.4	**0.0211251****	2.27
land	-0.0331	1.06	-0.0833169	0.9
livstk_no	0.0062	0.53	-0.0349553	1.21
oxen_no	0.0296	0.55	-0.0240563	0.19
Household Welfare level				
lncons_lg	**0.0461***	1.87	**0.1267691***	1.83
GPE (Generalized Probit	-0.0829	1.11		
Rho	0.16			
sigma_u	0.43			
/lnsig2u	-1.67			
number of obs.	1335			560
Loglikelihood	-552.73			
Wald Chisquare	310.26*			70.13
R-squared - Within				0.11
- Between				0.1
- Overall				0.11
				0.41
sigma_u				-
sigma_e				1.09

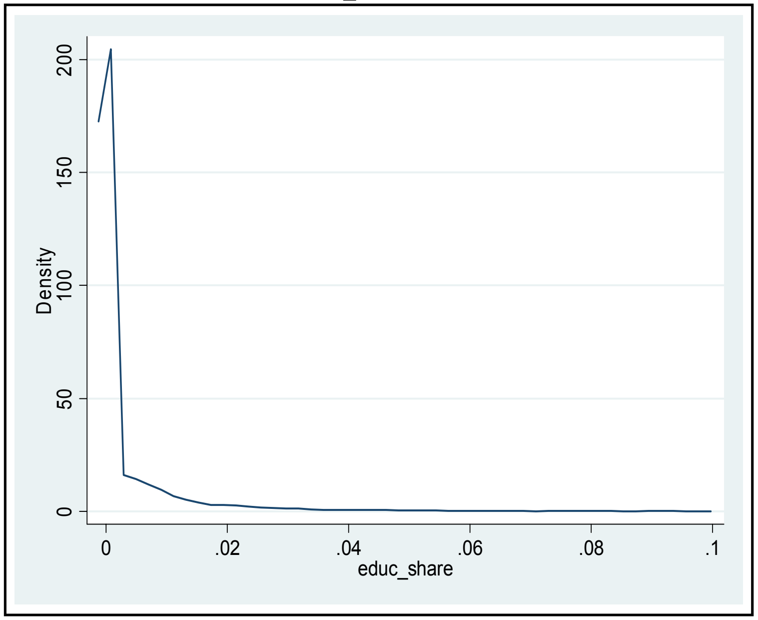
Table 7: Wald-test results on H0: The marginal effects of coefficients for male and female are statistically equal

Age Categories	Marginal Effects after RE Probit Estimation		Linear Autoregressive Model (AR(1))		Marginal Effects after RE Probit Estimation		Linear Autoregressive Model (AR(1))	
	Whole Sample				Samples in Tigray Region			
	Chisqrd	p-value	Chisqrd	p-value	Chisqrd	p-value	Chisqrd	p-value
Age 5-9	2.3	0.13	0.16	0.69	0.03	-0.86	0.57	-0.45
Age 10-14	1.23	0.27	0.69	0.41	0.66	-0.42	0	-0.99
Age 15-19	**2.97***	0.08	0.51	0.48	0.01	-0.93	0.32	-0.57
	Samples in Amhara Region				Samples in Oromia Region			
	Chisqrd	p-value	Chisqrd	p-value	Chisqrd	p-value	Chisqrd	p-value
Age 5-9	0.1	0.75	0.03	0.87	0.94	-0.33	0.14	-0.7
Age 10-14	**2.99***	0.08	0.15	0.7	1.38	-0.24	**3.14***	-0.08
Age 15-19	0.2	0.66	0.65	-0.42	0.16	-0.69	**3.56***	-0.06
	Samples in SNNP							
	Chisqrd	p-value	Chisqrd	p-value				
Age 5-9	1.99	0.16	0.46	-0.5				
Age 10-14	0.39	0.53	0.08	-0.78				
Age 15-19	**3.31***	0.07	0.26	-0.61				

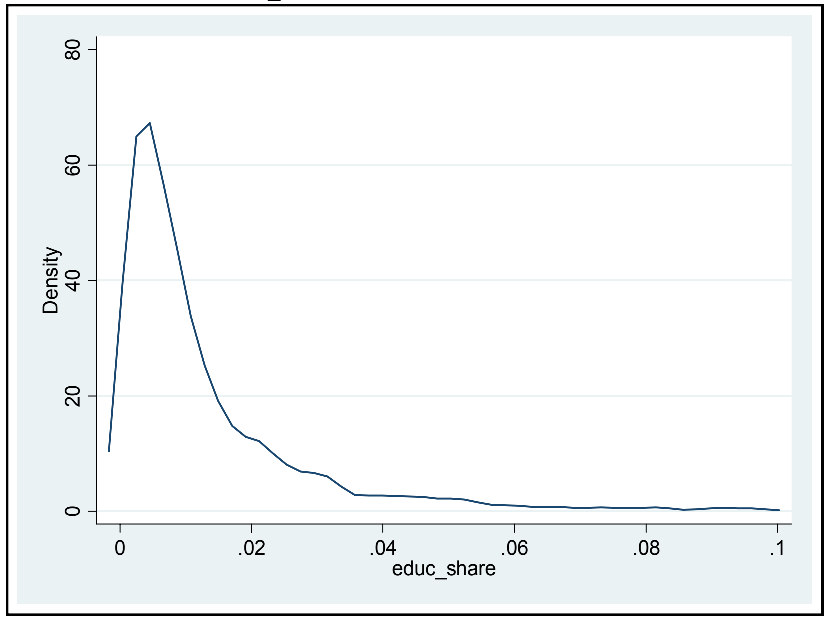
Note: ***=Significant at 1%, **=Significant at 5% and *=Significant at 10%

Figure 1: Kernel Density of educational spending

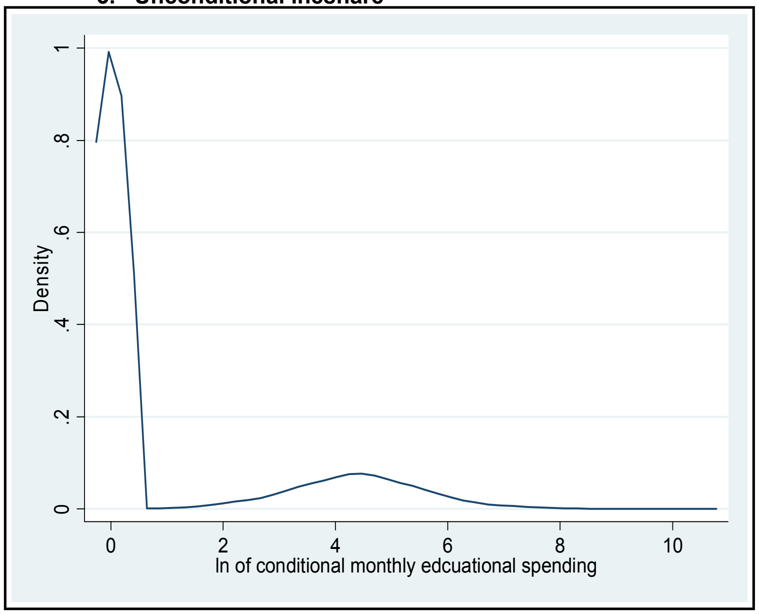
1. Unconditional educ_share



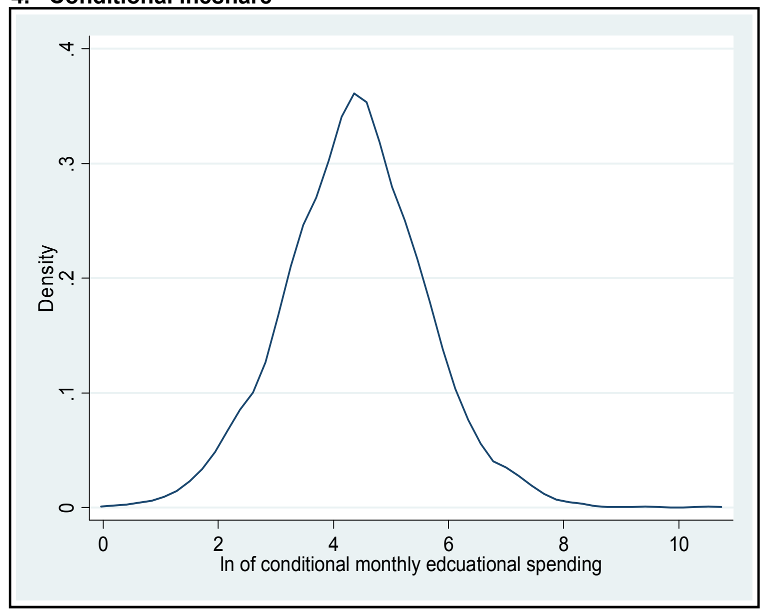
2. Conditional educ_share



3. Unconditional lneshare



4. Conditional lneshare



VALUING WATER SUPPLY SERVICE IMPROVEMENTS IN ADDIS ABABA[1]

Kinfe G.Egziabher[2] and Berhanu Adnew[3]

Abstract

In many cities of developing countries, such as Addis Ababa, water supply service is poor. At the moment, Addis Ababa city which accounts for over a quarter of the nations urban population is facing unreliable and inadequate supply of water and sanitation services. The paper raises crucial issues regarding the necessity to better understand the demand for improved water supply service in the absence of market and tries to link in relation to customers' participation in the provision of improved water supply service. In an attempt to examine the determinants of the value of improved water service and to establish how much consumers are willing to pay, we use a contingent valuation method (CVM). *The tobit model shows socio-economic and demographic variables such as Income of the household, sex of the respondent dummy (female = 1), Family size, education (both secondary and tertiary level), households' year of stay, households not using tank as a storage, wealth of a household, employment status of the respondent dummy (employed = 1) , households satisfaction with the existing service dummy (unsatisfied=1), and location of the study site (Addis Ketema) are significant variables that explain the willingness to pay. The mean willingness to pay (WTP) values are 15.34 and 20.20 cents per bucket (a 20 liter container) above the exiting average tariff of 7.14 cents per bucket as calculated from the tobit and probit model, respectively. The empirical evidence is an important input for strategic planning to ensure that improvements proposed potentially improve cost recovery initiative and increase the level of customer satisfaction.*

[1] The final version of this article was submitted in October 2008

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1. Introduction

The world faces severe and growing challenges to sustain water quality and meet the rapidly growing demand for water resources. In 2006, 1.1 billion people lack access to water and 2.6 billion are without adequate sanitation. The lives of these people are blighted by disease, poverty and indignity. Worldwide, a child dies every fifteen seconds from water-related diseases (Water Aid, 2006).

Many urban water supplies provided by public utilities are facing an acute crisis in many low-income countries. Capacity has fallen far lower than the exponentially rising demand; 450 million urban dwellers, particularly in marginal settlements, are excluded from piped water network which compromises their health and productivity (WEDC, 1999).

Water supply service in Ethiopia is found far below the required level. According to MoWR (2003) for all the water development activities achieved so far, the average access to safe water supply is 33.7% of the total population of Ethiopia. The average per-capita consumption in urban areas is close to 15 liter per capita per day. This can be taken as an example of a very low supply and coverage level.

As in other urban cites of developing countries, Addis Ababa, is also characterized by poor water supply services. Lack of adequate and safe water supply and sanitation remain two of the main transmitters of disease in the city, which are potential causes of the loss of life especially in the case of children. Moreover, water and sanitation inadequacies hinder economic and social development that constitutes a major impediment to poverty alleviation.

In general, lack of access to safe water is at the heart of the poverty trap, especially for women and children, who suffer in terms of illness, boring in collection water, and high opportunity cost of time for fetching water. However, the recent focus on poverty assessment research has consistently shown that improvements in water services are a critical element in designing and implementing effective strategies for poverty alleviation.

In relation to this, to improve water service in Ethiopia, the government has implemented integrated short term and long term plans. The Millennium Development Goals (MDGs) have been constituted as an integral part of the government's Sustainable Development and Poverty Reduction Program (SDPRP). One of the development target of the MDGs is to increase access to clean water from 30% in 2000 to 72.9% by 2015 (MoFED and UNDP, 2005).

This phenomena call for immediate efforts to improve the existing water service and promote the construction of new supplies so as to cope up with the increasing demand for water. To find solution to the existing water supply problems, the water utility needs to link itself with its customers and stakeholders for the communal advantage of the whole residents of the city.

Nevertheless, most previous studies made on the city water supply system focus on the development of supply-oriented approach. In line with this, to attain an improved water service in the city the demand oriented approach is imperative. This demand oriented approach asserts that water utility bodies need to understand actual household water use behaviour and the observed ability and willingness to pay for improved water service.

Different studies indicate that customers are willing to pay to avoid water shortages, and many customers value water supply reliability quite high if it is affordable. According to Carson and Mitchell (1987) a contingent valuation study was conducted in southern and northern California residential customers. The result showed that customers were willing to pay $142 per year to avoid 30% to 35% shortage twice out of 5 years.

Therefore, the objective of this paper is to examine the determinants of the willingness to pay of water consumers for improved water service in the city. To estimate the willingness to pay for changes in water supply service, the contingent valuation method (CVM) was used. Closed-ended with a follow up was employed as the monetary elicitation tool. Thus, the result of the study is believed to help policy makers to design appropriate water pricing for full cost recovery systems under the proposed improvements.

The remaining part of the paper is structured as follows: section two deals with review of literature. The third section gives the data, elicitation method and empirical models. In the fourth section, description of variables, descriptive analysis, econometric results and discussion is presented. The last chapter deals with the summary and conclusion of the study.

2. Review of literature

2.1 Conceptual framework

This section deals with ways in which how economists attach values to the resources provided by the natural environment. In relation to this, we deal with the theoretical foundations for the techniques that economists have developed for environmental valuation in connection with the resources. The economic approach to the valuation of resources is also discussed based on the contribution of the resources to human welfare. Whether the good or service is marketed or non-marketed, its unit economic value is determined by the welfare contributions that it makes to humans. Consequently, the need to demonstrate the importance of environmental policy is the ultimate objective of the valuation.

2.1.1 Theoretical foundation

The change in utility due to change in prices, quantities or both leads to a change in welfare of the society. Changes in welfare are measured in terms of each individual's personal assessment of changes in well-being. For traded commodities, the demand curve depicts the marginal WTP for the good or service. The household will consume all units of the commodity where the marginal WTP exceeds the market price. The consumer enjoys a consumer surplus for all points where the marginal WTP is higher than the market price. The welfare change associated with a change in the price of a marketed commodity is often measured using the change in consumer's surplus, derived from the Marshallian demand curve with a constant level of income.

For non market ecosystem service, the maximum WTP for an improvement in quantity or quality is the area between the initial and new levels of the resource under the demand curve. Value estimation then involves determining directly or indirectly the shapes of these marginal WTP curves for the ecosystem services.

According to Shiferaw et al. (2005) a given household maximizes its welfare (U) from consumption of a vector of marketed goods (c), ecosystem goods and services (q) and has a fixed budget y, such that :

$$\text{Max } U = U(c,q) + \mu(\mu - p'c) \qquad \textbf{(1)}$$

The standard utility-maximizing solution to this problem will give the Marshallian demand function for the tradable commodity:

$$c^* = c\,(p,q,y) \qquad \textbf{(2)}$$

which is a function of a vector of market prices (p), the disposable income (y) and the ecosystem services (q) considered to be a public good. If this is substituted in to the utility function it could be derived:

$$v\,(p,q,y) = U\,(c(p,q,y),\, q) \qquad \textbf{(3)}$$

The marginal effect of the change in the level of the public good q_i on household welfare can be derived as:

$$\frac{\partial v(p,q,y)}{\partial q} = \frac{\partial U\big(c(p,q,y),q\big)}{\partial q} \qquad \textbf{(4)}$$

This is equal to the marginal valuation of the environmental good. For a given change in q from q^o to q^1, the welfare effect on household **h** can be estimated as

$$\Delta U^h = v^h(p,q^1 y) - v^h(p,q^0,y) = \int_{q^0}^{q^1}\left[\frac{\partial v^h(p,q,y)}{\partial q}\right] \qquad \textbf{(5)}$$

The total welfare effect summed over all the affected households (h) can be calculated as:

$$\sum_h \Delta U^h = \sum_h \int_{q^0}^{q^1}\left[\frac{\partial v^h(p,q,y)}{\partial q}\right] \qquad \textbf{(6)}$$

The compensating surplus (CS) and equivalent surplus (ES) measures (analogous to the compensated variation (CV) and equivalent variation (EV) for price changes) can also be directly derived from the indirect utility function. For an improvements in q from q^o to q^1 the compensating surplus (CS) and equivalent surplus (ES) measures can be computed as:

$$v\,(p,q^1{}_{,}\, y - CS) = v(p,\, q^0,\, y) \qquad \textbf{(7)}$$

$$v\,(p,\, q^1,\, y) = v(p,\, q^0,\, y + ES) \qquad \textbf{(8)}$$

The expenditure function for household h is given by e^h (p, q). The aggregate welfare change measures for a change in q from q^o to q^1 for compensating surplus (CS) can be

$$CS = \sum_h (e^h(p,q^0,u^0) - e^h(p,q^1,u^0) = \sum_h \int_{q^0}^{q^1} \left[\frac{\partial v^h(p,q,u^0)}{dq} \right] dq \qquad \textbf{(9)}$$

The aggregate equivalent surplus (ES) measure for a change in q from q^o to q^1 can be given as:

$$ES = \sum_h (e^h(p,q^0,u^1) - e^h(p,q^1,u^1) = \sum_h \int_{q^0}^{q^1} \left[\frac{\partial v^h(p,q,u^1)}{dq} \right] dq \qquad \textbf{(10)}$$

The compensating surplus (CS) is the maximum amount of money that the individual is willing to pay to secure an increased provision of the public good q. The equivalent surplus (ES) measures the minimum sum of money that must be given to individuals (willingness to accept) before the change to make them as well-off as they would have been following an increase in q. This forms the basis for valuation of non-marketed ecosystem services.

The measure of welfare change can be either positive (a welfare gain) or negative (a welfare loss). For a proposed welfare gain the compensated variation measure tell us how much money income the individual would be willing to pay to ensure that the change occurs; while the equivalent variation measure tell us how much extra money income would have to be given to an individual for the person to attain the final improved utility level in the absence of provision change occurring.

2.1.2 Valuing water

Economics literature indicates that the total economic value of an environmental good is composed of two types: use-value and non-use value. The total economic value of water can be broadly defined as the maximum amount the user would be willing to pay for the use of water.

Water was involved in one of the most famous intellectual conundrums in the history of economic thought: the water-diamond paradox. This problem was resolved in the eighteenth century with the concept of a distinction between value in-use and value in-exchange. Although its price is low, water has an enormous value in-use to humans since it is a necessity to survive, while diamonds have a high value in-exchange (Borgoyary M., 2002).

Historically, water was available in ample supply and therefore was treated as a free good, and continued to remain so even with increases in population and economic growth. As a consequence, many rivers and ground water sources have become polluted and water is now a scarce resource. Water has been traditionally provided to meet demand. However, it is becoming prohibitively expensive to resort to large-scale infrastructural solutions for providing water to meet ever-increasing demand. Hence, effective water resource management requires that water be treated as an economic good.

To argue for water to be treated as an economic good does not necessarily imply that a market price must be paid for it. What it means is that water is a scarce and valuable resource that should not be wasted, and that proper pricing (valuation) will ensure efficient utilization. But this misinterpretation of “water as an economic good” leads to a serious misunderstanding in many debate. Some people feared that the adoption of this principle would lead to economic pricing of water, which would damage the interests of the poor and make irrigated agriculture virtually unfeasible. As a result, a number of disclaimers were stating that water is also “social” good and that it should be affordable to the poor (Borgoyary M., 2002).

In a net shell, treating water as an economic good or ensuring proper valuation of it will provide powerful decision and management tools. At a macro level it will ensure efficient utilization of water both at the user level and at the project level., thereby enabling sustainable water resource management.

2.1.3 Methods for valuing environmental resources

Economics literature indicates that the total economic value of an environmental good is composed of two types: Use value and non-use value. The total economic value of water can

be broadly defined as the maximum amount the user would be willing to pay for the use of water.

In relation to this, various valuation methods are available to attach economic values to non-marketed environmental resources. According to Callan and Thomas (1996), these methods can be discussed under two categories: indirect method and direct methods.

The indirect method

Economists use indirect methods to make inferences about markets that are linked to the environmental good under investigation. Although there are many indirect estimation methods, in this study, the two common valuation methods are: the travel cost method (TCM) and the hedonic price method (HPM).

The travel cost method depends on information about the amount of money and time people spent getting in to a site to infer a value for that site. According to Callan and Thomas (1996) the travel cost method has a primary advantage of measuring environmental benefits based on actual behavior, but it ignores non-use value. Furthermore, this method focuses on recreational use, making it ineffective for estimating any incremental benefits that might be accrued to commercial users of a resource.

The hedonic price method is based on the theory that a good or service is valued for the attributes or characteristics it possesses. This perception of value suggests that implicit or hedonic price exist for individual product attributes, and these can be determined from the explicit price of the product. According to Carson (2000), however, this method does not capture non-use values that are very important when we deal with environment and hence underestimate the total economic value.

The direct method

The direct method estimates environmental benefits according to responses or observed behaviors directly tied to the environmental quality. The common method in this approach is CVM.

When market data are unavailable or unreliable, economists can use alternative estimation methods that rely on hypothetical market conditions. Such methods typically use surveys to inquire about individuals' WTP for some environmental policy initiative. This survey approaches to benefit estimation is known as the CVM because the results are dependent up on the hypothetical market devised. CVM is based on classical economic theory using Hicksian technique, that is, either compensation variation (willingness to pay) for improved environmental services or equivalent variation (willingness to accept) compensation for environmental deterioration.

The CVM first came into use in the early 1960s by Economist Robert K. Davis in 1963 when he used questionnaire to estimate the benefits of outdoor recreation in a Marine backwoods USA. Since then, the contingent valuation technique has been utilized by various economists to measure the benefits of a variety of goods including recreation, hunting, water quality and toxic waste dumps (Mitchell and Carson, 1989).

Although a number of researchers have employed the CVM, using such survey method has some basic problems in the sense that survey respondents could give biased information[4]. However, CVM is widely applicable and applied monetary valuation method despite its limitations. It has potential application to a wider range of environmental goods than any other valuation techniques. It has strong theoretical basis with unique advantage that it estimates income compensating welfare measures. When surveys are properly planned and executed, most of the CVM problems can be eliminated and it would be one of the best methods for estimating environmental benefits. In this study, the value of improved water supply service in Addis Ababa city is estimated by using CVM to measure WTP. Domestic water consumers' were asked questions on their willingness to pay for improved water services.

In general, CVM helps researchers to capture the total value of the good: both use and non-use values and its flexibility facilitate valuation of a wide range of non-marketed goods. As a result, this method is becoming the most preferred valuation at present. Thus, based on the reasons mentioned above CVM is employed for this study.

2.2 Empirical review

The contingent valuation method has found extensive application in recent years in valuing of environmental benefits, the benefit of reduced air pollution, valuing of water quality, valuing of improved solid waste management and the option or existence valve of ecologically important species.

According to Carson et al. (1996) and Hanemann (1994,1996) a number of theoretical and methodological issues and criticisms have been raised concerning the application of the CVM in general and in valuation in developing countries in particular. A look in to a literature indicates that, at least at the theoretical level, a large number of criticism were linked with problems in the details of specific studies, such as how the questionnaire is prepared and data are collected and analyzed.

However, according to Whittington (1998) it is now assumed by many environmental and resource economists and policy analysts working in developing countries that contingent valuation surveys are straight forward and easy to do.

[4] For a detailed discussion of the critiques on CVM, see Callan and Thomas (1996).

2.2.1 CVM applications in water supply studies: the Ethiopian experience

The Ethiopian experience reveals that limited CVM studies have been conducted to investigate factors that influence households' willingness to pay for improved water supply in rural and urban areas. Some of the studies are given as follows.

Fisseha (1997) used a contingent valuation method to assess consumer's willingness to pay for an improved water supply service, on Meki town, Ethiopia. The study selected a sample of 246 households which were chosen randomly. The study used multinomial ordered probit model. The result showed only income and the time cost of fetching water to be significant determinants of WTP for improved water in the town.

Dunfa (1998) also employed contingent valuation method on estimating willingness to pay for rural water supply Ada'a-Liben district with a sample of 228 households, central Ethiopia. The study employed an iterative bidding game. The study employed order probit model. The study result showed the peasant households' willingness to pay for improved rural water provision was positively influenced by income of the household, distance (time it takes to fetch water), quality of current water source and credit.

In Harar town eastern Ethiopia, Genanew (1999) analyzed determinants of households' willingness to pay and demand for improved water services. The study used iterative bidding game. Multivariate regression based on the ordinary least squares and the ordered probit models were used to analyze the determinants of WTP for improved piped water service. Variables such as: household income, education level, sex, location of study site, starting point of the bidding game, main sources of water and serious problem of the existing water service were found statistically significant on willingness to pay for both models.

Using a contingent valuation method, Alebel (2004) also examined the affordability and willingness to pay for improved water supply in urban areas of Ethiopia taking Nazareth town as a case study. The value elicitation method used in the study was bidding game and a total of 307 sample households were covered during the survey. The study used a censored least absolute deviation (CLAD) which does not need the normality and homoscedasticity assumption of the distribution of the error term to get consistent estimate. The results of the CLAD regression showed that income, monthly expenditure for water consumption, quality and time taken to fetch water from the existing source significantly affects the respondent's willingness to pay.

2.2.2. CVM applications in water supply studies: the developing countries' experience

Whittington et al. (1990) estimated individuals' WTP for improved water services in rural areas of southern Haiti using the ordered probit model. The study concluded that WTP of individual respondents were affected by household wealth, education level of respondents, distance of the household from the existing water sources, quality of water and sex of respondent. The results of the study also suggested that it is possible to do a contingent valuation among a very poor, illiterate population and obtain reasonable answers.

In rural areas of Punjab in Pakistan Altaf et al. (1992) conducted a contingent valuation study with the main objective of identifying determinants of households' WTP for improved rural water supply and comparing the contingent valuation study results with market-based results. The authors found that wealth and education of respondents were among the major factors that affect respondents' WTP for improved rural water services. Empirical results of the study also confirmed that the contingent valuation study results seem consistent with revealed preference results.

Montes et al. (2003) conducted a study on assessing the willingness to pay for maintained and improved water supplies in Mexico city. The result showed the poorer households were primarily concerned with securing reliable services, while wealthier households which already enjoy better services were willing to pay higher amounts to avoided services deterioration than for improvements. The study demonstrates how WTP results can be used to create equity based policy of water tariff reflecting income distribution. The aggregated WTP amounts show that the authorities could collect sufficient resource for both service modernization and could also reduce existing subsidies by about 70%.

Abdalla (2003) also used CVM to estimate the value of improvements in water supply reliability in Zanzibar town. Random samples of 300 households were drawn from the survey. The study implements probit model and OLS regression model to statistically estimate the influence of different households socio-economic and other variables on the household decision on WTP for water services. The probit analysis indicated that three variables were significantly correlated with the household decision to pay for improved services. These are education, past payment and experience on availability problem. Similarly, OLS analysis indicated that only one factor (experience on water availability problem) was significant.

3. The data, elicitation method and empirical models

3.1 The data

In order to fulfill the above mentioned objective, the study was designed to gather information and necessary data from various sources. The study uses a combination of primary and secondary data. The data used in this study are mainly primary and cross sectional for the year 2006/07 from Addis Ababa. The secondary data was collected from Addis Ababa Water and Sewerage Authority (AAWSA), Ministry of Water resources (MoWR), Central Statistical Authority (CSA), Bureau of Finance and Economic Development (BoFED), and other various published sources including journals, development reports, research articles and websites.

The main data source is a contingent valuation survey conducted in Addis Ababa city. The study employed CVM to solicit the respondents' WTP for improved water services. The contingent valuation survey questionnaire used in this study was designed to include hypothetical description of the good being valued, socio-economic and demographic characteristics of household, existing water supply situation, water usage and general perception questions. The sample for the study was drawn from three out of ten administrative sub-cities in Addis Ababa, covering a total of six kebeles[5]. A stratified proportional random sample of 240 households was used in the survey, out of which 235 of them were found usable. In-person interview was used in the administration of the survey which was feasible option to the inhabitants of the city[6].

A stratified two-stage sample design was adopted. At the first stage 3 sub-cities based on CSA (2004a) study of the economic establishment standards were selected which called Primary Sampling Units (PSUs). Accordingly, Addis-Ketema, Nefas-Silk Lafto, and Bole were selected from lower, medium and higher economic standards, respectively. The household in each sub-city was selected proportionally. From the total 126,108 households, Addis Ketema, Nefas-Silk Lafto and Bole were selected 44,921 (35.6%), 42,978 (34.1%), and 38,209 (30.3%) households, respectively.

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[5] Kebele is the smallest administrative unit in the city. The city is divided in to sub-cities which in turn divided in to kebeles. According to BoFED (2004) there are 10 sub-cities and 203 kebeles in Addis Ababa city.

[6] A total of five enumerators and two supervisors including the researcher participated in the actual survey. All the enumerators were selected based on their previous experience in household survey. Both enumerators and supervisors were given two day training. Cooperation to be interviewed was managed through kebele officials.

Accordingly, from the sample of 240 households 85, 84 and 71 were from Addis-Ketema, Nefas-Silk Lafto and Bole, respectively.

At the second stage, 2 kebeles were selected from each sub-city based on the water supply availability (Table1 column 6), which is the Second Stage Unit (SSU). AAWSA map indicates that each kebele of the city is segregated to the respective water supply availability (Zerihun, 2005). Hence, from Addis-Ketema sub city both, kebele 14 and 19 were selected based on water supply availability which is 7-16 and 17-24 hrs/day, respectively. Moreover, out of the total 16,268 households of the six kebele, 1,287 and 1,670 households were drawn from kebele 14 and 19, respectively. Finally, from a sample of 85 households in Addis-Ketema, 37 and 48 households were drawn from kebele 14 and 19 on the base of stratified proportionate random sampling, respectively. The sampling procedure for both Nefas-Silk Lafto and Bole sub-cities were similar steps to that of Addis-Ketema sub-city (Table1).

Table 1: Summary of sample households (HHs) from each sub-city and kebele

Sub-cities	Total * No. of HHs	% of ** HHs from total	No. of ** HHs in the sample	Sampled ** Kebele based on water services	water supply *** availability (hrs/week)	Total No. **** of HHs in each kebele	No. of ** sampled HHs each kebele
1	2	3	4	5	6	7	8
Addis ketema	44921	35.60	85	14	7-16hrs/day	1287	37
				19	17-24hrs/day	1670	48
Nefas-Silk Lafto	42978	34.10	84	03	7-16hrs/day	2228	35
				05	1-6hrs/day	2631	49
Bole	38209	30.30	71	05	7-16hrs/day	2232	19
				14	Least of all	6220	52
Total	**126108**	**100**	**240**			**16268**	**240**

Source: * CSA (2004a),
** Computed by the authors
*** Zerihun (2005).
**** Kebele administration report (unpublished)

To select the respondent from every kebele, the kebele itself was chosen as a reference point during the survey. After the stratified two-stage sample design, the first household was selected around the kebele based on random method. After the selection of the first household, the remaining households were selected on equal paced interval (every 15th) based on spatial distribution till the households in each kebele were drawn completely.

3.2 Elicitation method

In this study, among various elicitation formats, the single-bounded dichotomous choice format with a follow up question was chosen to obtain a household's willingness to pay for a proposed scenario[7]. Green et al. (1995) indicated that the main reason for using this format is to provide far more information on WTP and information on plausibility of responses than other alternatives. The WTP scenarios' questionnaire that was used for this paper is presented in Appendix (1).

In this study we used three different scenarios. The first is households who have private tap connection and willing to have improved water service. The second is households who do not have private tap connection but willing to connect for improved water service. The third is households with no private tap connection but willing to have improved public tap service. Note that households that are going to connect either private tap or public tap may not be required to pay initially the costs of connection to the new scheme. Instead, the authority will cover the costs of provision with insignificant increase in the monthly tariff rate. And every household will have improved water supply service. By an improved provision of water, we mean good quality of water which is safe for health and good quantity of water which is available for 24 hours per day.

Before implementing the final survey we conducted the pilot survey using open-ended elicitation format to set up starting bids[8] In the actual survey the total sample households were randomly divided in to three groups of equal size and each

[7] In using a single-bounded dichotomous choice format with a follow up question the respondents are asked simple "Yes" or "No" questions of the stylized form to the initial bid and are asked to state their maximum willingness to pay. Other methods include open ended, bidding game, and payment card. For details on these, see Mitchell and Carson (1989).

[8] Pre-testing was made in each of the 6 kebeles. We selected a random sample of three households from each kebele and a total of 18 household heads were interviewed under the pilot survey. This was done by three experienced interviewers and the researcher himself. The purpose of the pre-testing was to make some possible modification in the design of the questionnaire based on the responses so as to make it understandable for respondents. Furthermore, the pilot survey helps to set the starting price in the elicitation part of the questionnaire. During the pilot survey, the willingness to pay part was open ended. During the pilot survey on willingness to pay, different answers were observed ranging from 2.5 cents to 20 cents per *bucket*. However, the pilot survey revealed that 5, 10 and 15 cents per *bucket* were the most frequent prices. Out of 18 sample households that were used during pilot survey, the frequency of 5, 10 and 15 cents per bucket were 6, 5 and 4, respectively. The frequency for 2.5 and 20 cents per bucket were found to be 1 and 2, respectively. Thus, we used the most frequent prices as starting points of the WTP for a single bounded dichotomous choice.

contained 80 households and the three different starting bids (5, 10 and 15 cents per bucket of water) were assigned to households in the different groups.

3.3 Empirical models

3.3.1 The Tobit Model

The tobit model is a censored regression model. Observations on the Latent variable **Y** are missing (or censored) if **Y*** is below a certain threshold level. One of the applications of the tobit model is when the dependent variable (for our case maximum WTP) is zero for some individuals in the sample (Maddala, 2002).

The tobit model is used to identify factors that affect the willingness to pay of households for the proposed improvements in water supply services. In addition to this, in the tobit model our interest is in finding out the amount of money a respondent spends on improved water services in relation to socio-economic and demographic variables. According to Greene (1997), the general formula of the tobit model is given as follows:

$$Yi^* = \beta' X_i + u_i \tag{11}$$

Suppose Y* is observed if Yi* > 0 and is not observed if Yi*≤0.Then the observed Yi* will be defined as

$$Yi = Yi^* = \beta' X_i + u_i \quad \text{if} \quad Yi^* > 0$$

$$= 0 \quad \text{if} \quad Yi^* \leq 0 \tag{12}$$

Where

β' = A vector of coefficients

$\mathbf{X_i}$ = A vector of explanatory variables

$\mathbf{u_i}$ = The error terms that are independently and normally distributed with mean zero and a common variance δ^2 .

Estimation of the tobit model is similar to that of truncated regression. Following Greene (1997) the log likelihood for the censored regression model is

$$LnL = \sum_{yi>0} -\frac{1}{2}\left(\ln(2\pi) + \ln \delta^2 + \frac{(yi - B^1 \, xi)^2}{\delta^2} \right) + \sum_{yi=0} \ln\left[1 - \phi \frac{(B^1 x_i)}{\delta} \right] \tag{13}$$

The two parts correspond to the classical regression for the non limit (continuous) observations and the relevant probabilities for the limit (zero) observations, respectively.

Based on the above behavior of the model, tobit analysis is appropriate for this study. The equation in this tobit model is indicated as follows.

$$\mathbf{MWTP_i*} = B_0 + B_1INCH + B_2FAMS + B_3WEAH + B_4SEXR + B_5\ AGER + B_6\ EMPR + B_7\ ATTR + B_8LOC_{AK} + B_9\ TANK + B_{10}\ STAT + B11\ INFO + B_{12}\ IB + B_{13}\ STAY + B_{14}\ SATI + B_{15}EDUC_1 + B_{16}\ EDUC_2 + B_{17}\ EDUC_3 + B_{18}\ LOC_{BO} + U_i \quad \textbf{(14)}$$

$MWTP_i$* = maximum willingness to pay for improved water services. And MWTP* is a latent variable which is not observed when it is less than or equal to zero but is observed if it is greater than zero.

$B_{0,}$ $B_{1,}$ ----- = are coefficients, i = 1, 2, 3, -------

The description of all variables of the above regression are given in Appendix (2)

3.3.2 The Probit Model

In the probit model of single bounded dichotomous format, households are given initial bid which they may accept or reject. The basic model for analyzing dichotomous contingent valuation responses is the random utility model. A study by Hanemann (1984) indicates that he had constructed the basic model. The central theme of this theory is that although an individual knows his/her utility certainly, it has some components which are unobservable from the view point of the researcher. As a result, the researcher can only make probability statement about respondent’s "yes" or "no" responses to the proposed scenario.

The indirect utility function for the j^{th} respondent can be specified as follows:

$$\mathbf{U_{ij} = U_i\ (Y_j, X_j, \varepsilon_{ij})} \quad \textbf{(15)}$$

Where Y_j= j^{th} respondent’s income

i=1 denotes the final state and i=0 the status quo (the initial state)

X_j= vector of household characteristics and attributes of a given choice

ε_{ij}= random component of the given indirect utility

If a payment (the initial bid, β_i^*) is introduced due to improvement in water supply service, the household accepts the proposed bid only if the utility with the contingent valuation program , net of the required payment, exceeds utility of the status quo.

$$\mathbf{U_1\ (Y_j\text{-}\beta_i^*, X_j,\ \varepsilon_{1j}\ ) > U_0\ (Y_j, X_j,\ \varepsilon_{0j}\ )} \qquad \mathbf{(16)}$$

For the researcher, however, the random components of preferences cannot be known and s/he can only make probability statement of "yes" or "no" responses. Thus, the probability that the respondent says "yes" or "no" is the probability that s/he thinks that s/he is better off in the proposed program. For individual j, the probability is:

$$\mathbf{Pr\ (Yes_j\ ) = Pr\ (U_1\ (Y_j\text{-}\beta_i^*, X_j,\ \varepsilon_{1j}\ ) > U_0\ (Y_j, X_j,\ \varepsilon_{0j}\ )} \qquad \mathbf{(17)}$$

This probability statement provides an intuitive basis to analyse binary responses. Assuming the utility function is additively separable in deterministic and stochastic preferences:

$$\mathbf{U_i\ (Y_j, X_j,\ \varepsilon_{ij}\ ) = U_i\ (Y_j, X_j) + \varepsilon_{ij}} \qquad \mathbf{(18)}$$

with the additive specification of Equation 18, the probability statement for respondent j becomes:

$$\mathbf{Pr\ (Yes_j\ ) = Pr\ [U_1\ (Y_j\text{-}\beta_i^*, X_j) + \varepsilon_{1j} > U_0\ (Y_j, X_j\ ) + \varepsilon_{0j}\ ]} \qquad \mathbf{(19)}$$

The goal of estimating econometric (or parametric) models from dichotomous choice of contingent valuation responses is to calculate mean WTP for the services described. In addition, parametric models allow for the incorporation of respondent characteristics in to the willingness to pay functions (Haab and McConnell, 2002). In this study we discuss the effect of socio-economic and demographic factors of the respondent on WTP with the help of tobit model. In connection to this, the probit model in this study is used to calculate mean willingness to pay for the closed -ended format.

The Probit model can be defined as:
$Ti^* = \beta' X_i + u_i$

Where
β' = Vector of the parameter of the model coefficients
X_i = Vector of explanatory variables
u_i = The error term assumed to have normal distribution with zero mean and a common variance δ^2 (Greene,1997)

Ti*= Unobservable households' actual WTP for improved water supply services. Ti*is simply a latent variable. What we observe is a dummy variable WTP_i, which is defined as: $WTP_i = 1$ if $Ti^* \geq \beta_i^*$ $WTP_i = 0$ if $Ti^* < \beta_i^*$.

In the single bounded elicitation format, the i^{th} respondent is asked if s/he would be willing to pay the initial "bid", **(β_i*)** to get improved water supply services.

4. Description of variables, descriptive analysis, econometric results and discussion

4.1 Description of explanatory variables

The hypothesis that is being tested in this analysis indicates how households' socio economic and demographic factors affect the household's decisions on WTP for improved water services. This study collected several households' demographic and socioeconomic factors as well as current status of water services. Therefore, those variables are considered to determine the willingness to pay and willingness to connect to the new improved water supply services are given in Appendix(2).

4.2 Summary of descriptive analysis of the CVM survey

A total of 240 sample households were interviewed in the survey. Out of this total sample, only 235 were analyzed and the remaining 5 were removed due to protest zero[9]. Thus, from the total of 235 sample respondents, 140 (59.6%) are head of the households and the rest 95 (40.4%) are not. Out of total respondents, 167 (71%) are female and the rest 68 (29%) are male. The average family size of the total sample household is 4.79 and ranges from 1 to 10. Their level of education ranges from none to higher education graduates. Out of the total respondents, 52 (22.1%) were categorized under illiterate group. Those with formal education of grade 1 to 6 grades (primary education) constitute 57 (24.3%) of the total respondents. Those with formal education from grade 7 to 12 grades are 81 (34.4%) and grouped under secondary school. Only 45 (19.1%) of the respondents have attained formal education above grade 12 of higher education (tertiary school).

[9] From the total 240 observations of the sample, 14 (5.83 %) of the households were not willing to pay any amount. To know the reason why they are not willing to pay any amount, and to decide whether their response is protest or true zero, a follow up question was asked. From the result of the study, it indicated that only 5 (2.08 %) of the respondents can be classified as a protest zero. These are the once who believe that the existed water service was satisfactory or the government should pay. Thus, we say both these responses are protest zero and they are eliminated from analysis. However, 9 (3.75 %) of the respondents were not willing to pay any amount for the reasons such as inability to pay (too poor to pay). These are a true zero and all are included in our analysis.

The average monthly income of the sampled household was Birr 1339.33 ranging from the minimum of Birr 110 to the maximum of Birr 8,500 per month[10]. The mean household consumption of water was 9 bucket (180 litters) per day. Based on this information, the average household's water consumption per month was 5,400 liters (which is 5.4 m^3/month). For the year 2006/07, the minimum water consumption block tariff rate of AAWSA for less than 7 m^3 is birr 1.75/m^3. Thus, on average, the household's water consumption expenditure is Birr 9.45 per month.

As compared to the mean monthly income of the households (that is, Birr 1339.33), households in the sampled area spend only 0.71% (excluding meter fees) of their income on water. Though, this is with in the range of the World Bank's recommendation, which states a household should not spend more than 5% of his monthly income on water, it is far below the recommended level. This suggests that the households in the sampled area can spend for improved and reliable water supply services.

The other finding of the study showed the mean per capita consumption of the sample household was around 37.6 liters per day. However, according to Gleick (2001) the absolute minimum per capita per day of water is 50 liters based on the United Nation's target. The amount in the study area is below this minimum requirement.

Data for the wealth of the households, which was proxy by whether the household owns house or not, showed that 99 (42.2%) live in rented houses from individuals, kebeles and government while 136 (57.8%) of the interviewed households live in their own houses. Among those who live in their own houses 65 (47.79%), 45 (33.08%) and 26 (19.135) were from higher, medium and lower economic standard groups, respectively.

The study also tried to look whether the household uses tank as storage of water or not. The survey finding indicated that out of total households in the survey area, 71 (30.21%) of the respondents said they own tanks for water storage to cope with low water pressure and water outage. Out of those households who have tanks as a storage of water 42 (59.15%) of the respondents said the storage allow them continuous water supply while the remaining 29(40.85%) of the respondent said the storage does not allow them continuous water supply.

[10] The exchange rate at the time of survey was 1USD = Birr 8.38

Out of those households who know tariff rate increment, 73(39.89%) said AWSAA'S tariff rate increment is high, 99(54.09%) said AAWSA'S tariff rate increment is medium, the remaining 11(6.01%) of the households said the tariff rate increment is low. With regard to households' water consumption due to increase in tariff rate, 148(80.88%) of the household responded that no change in their consumption, 35(19.12%) said their consumption decrease. This implies that the households' water consumption would not be affected by tariff rate increment. Hence, if AAWSA revised a new tariff rate for cost recovery system, the households' water consumption may not be affected and, hence, might be affordable by the majority of the residents.

The mean willingness to pay for the whole sample is 15.34 cents (ranging from 0 to 50 cents) per bucket of water, which implies that the sample sub-cities were willing to pay more than the current tariff rate which is 3.50 cents per bucket of water for the lowest consumption block and 7.60 cents per bucket for the highest consumption block.

Of the three strata, it was found that the highest mean WTP of 18.96 cents per bucket in area with higher economic standard. The mean WTP from the medium economic standard and lower economic standard groups were 12.33 and 15.34 cents per bucket, respectively. The result showed that households from the low economic standard group were willing to pay more than households in the medium economic standard group. The reason is out of the total public taps in the sample, 81.85 % of the public tap users were in the low economic standard group. Thus, these households are more willing to pay for improved water service to avoid long queue.

The other finding of the survey indicated that, out of the total observations 91 (38.72%) of the households have no private pipe lines, out of which 11(12.09%), 27 (29.67%) and 53 (58.24%) are from higher, medium and lower economic standard groups, respectively. Out of 91 respondents with no private tap connection, 44 (48.3%), 30 (32.9%) and 17 (18.6%) of the households get water from public tap, shared tap and private vendors, respectively. Where as the remaining 144 (61.28%) of the households have private pipe lines, out of which 61 (42.36%), 56 (38.89%) and 27 (18.75%) were from higher, medium and lower economic standard groups, respectively.

The other observation from the study result indicated that households' with no access to private pipe line were more willing to pay than households' with access to private pipe lines. The reason is probably households who don't have private pipe line spend a lot of time to fetch water from outside source. Moreover, these households may buy water from vendors at relatively higher price than the authority's tariff rate. Hence, households with no access to private pipe lines show more preference to the improved service than the counter part. The summary of descriptive statistics for the variables used in the multivariate regression analysis is given in Appendix (3).

4.3 Econometric results and discussions

In this section, results obtained from regression estimation of willingness to pay equation are presented. As mentioned above, two maximum likelihood estimates has been undertaken.

According to the rule of thumb if the variance inflation factor (VIF) of a variable exceeds 10, that variable is said to be highly collinear. However, a test was made to check whether or not the problem existed is severe or nor. The result indicated multicollinearity is not a serious problem as the VIF lies in a range 1.10 – 2.40 with mean VIF of 1.63.

A test for the presence of heteroscedasticity problem in the model was also done. The test result shows that the null hypothesis of homoscedasticity is rejected implying that there is heteroscedasticity problem in the model, which is expected from survey of the cross sectional data (see Appendix 4). Because of this problem the study can not use a simple tobit model but a hetroscedastic tobit model (results corrected for hetroscedasticity) using LIMDEP Version 7.0.

A test for measures of model goodness of fit was also done with model chi-squared statistic (LR_{Model}). The likelihood ratio (LR) chi-squared measures the overall significance of the model with the null hypothesis that all parameters associated with covariates are zero is rejected at 1% significance level. Thus, the model is statistically acceptable. It implies that the model is acceptable to explain the relation between willingness to pay and its explanatory variables[11].

To check for the existence of starting price bias, the starting bid is used in the model as an explanatory variable. To check whether or not asking representatives of the households rather than the heads affects the willingness to pay responses, a dummy variable (status of the respondent) taking 1 if the head is the respondent; 0 otherwise is included in the model. To capture the effect of stratification, the location of the study area LOC_{Bo} is dummy variable taking 1 if it is Bole sub-city, 0 otherwise. LOC_{AK}

[11] For a detailed discussion of goodness of fit, see Habb, T.C., an McConnell, K.E. (2002).

is dummy variable taking 1 if it is Addis-Ketema sub-city, 0 otherwise are included in the model.

4.3.1 Tobit Model: Results and discussion

The Tobit results obtained using a Limdep Version 7.0 are given in Table 2

Income of the household

The variable consistent with a priori expectations is monthly income of the household. It is significant at 1% and has the expected positive sign. This result confirms with economic theory, which states that an individual's demand for a particular commodity depends on his/her income, and that income and quantity demanded are positively related, except in the case of inferior goods. The result of the survey shows higher income group are more willing to pay for an improved water supply service than lower income group. Hence, the income of the households needs to be considered to introduce a new tariff rate structure which will help to cover the financial costs of the proposed improvements.

Education level of the respondent

From the four categories of educational level, the illiterate group is taken as a bench mark group to avoid a dummy variable trap. The other three educational dummies show positive effect on willingness to pay amount as compared to the bench mark group. The primary education dummy is not significant at 10% level of significance. The secondary and tertiary education dummies are significant at 10% level of significance. This may be due to the fact that as compared to the bench mark group the households of secondary and tertiary education groups are more aware about health and sanitation benefits of the improved water services.

Employment status of the respondent

The variable employment status of the respondent is found to be positive and significant at 10%, as expected. The result is consistent with the idea that those respondents who are employed in government organization, private organization, NGO’s, own business and other related areas are more willing to pay than unemployed respondents. This is because the exposure of household that is working in different sectors is expected to understand the benefits of improved water services and their effect on human being than the other group.

Wealth of respondent

In this study ownership of house is used as a proxy to wealth. As expected, this variable is found positive and highly significant at 1% level of significance. That is, those households living in their own houses are more willing to pay for the proposed improvements than those living in rented houses. This may be the fact that households who own private houses are concerned more to pass the improved water services to their children (bequest value) than those households who do not own private houses.

Table 2: Tobit estimates for the determinants of WTP for improved water supply services (Heteroscedastic Tobit) [12]

Variable	Coefficient	Std. Er	b/St.Er.	P-Values	Mean of X
CONST	4.449472436	2.2901043	1.943*	.0520	
INCH	.0001715432	.0000533710	3.214***	.0013	1339.3285
SEXR	.2582252614	.14324646	1.803*	.0714	.71063830
AGER	-.0022208961	.0059684669	-.372	.7098	34.974468
FAMS	-.0845664581	.036997020	-2.286**	.0223	4.7872340
EDUC1	.2114814859	.18721616	1.130	.2586	.24255319
EDUC2	.3564540480	.21652342	1.646*	.0997	.34468085
EDUC3	.4393207847	.22956193	1.914*	.0557	.19148936
STAY	.01643804708	.0056196780	2.925***	.0034	19.952837
TANK	.5254671750	.16506017	3.183***	.0015	.69787234
ATTR	-.1906904134	.14743595	-1.293	.1959	.78297872
WEAH	.5896728854	.16945571	3.480***	.0005	.57872340
EMPR	.2621695535	.15043565	1.743*	.0814	.37446809
INFO	.1029382746	.16798658	.613	.5400	.77446809
SATI	.3998056983	.17182031	2.327**	.0200	.83829787
IB	.02389464906	.015496762	1.542	.1231	9.9787234
STAT	.1276074785	.16764284	.761	.4465	.59574468
LOC_{AK}	.6530232215	.18891336	3.457***	.0005	.34042553
LOC_{BO}	.1933452929	.17510182	1.104	.2695	.30638298
No of Observations = 235					
Log likelihood=-773.2196 Restricted log likelihood =-836.6690					

Source: Own survey result, 2006

***, **, * indicate significance at 1%, 5%, and 10% levels respectively.

[12] Some literatures indicate that direct interpretation for the marginal effect of tobit model is not easy, since the change in Xi has two effects. It affects the conditional mean of the dependent variable Yi* (in our case maximum WTP) in the positive part of the distribution and it affects the probability that the observation will fall in that part of the distribution, see Greene (1997).

Sex of respondent

This variable has a positive sign as expected and is significant at 10% level of significance. This shows that female respondents are more willing to pay to connect improved water services than male. This result really tells us the experience of most developing countries with regard to gender. It indicates that female headed households are primarily responsible for the task of fetching water and hence greater preferences for improved water services by paying more as compared to their counter male headed households.

Family size of the household

Family size of the household variable was found to be significant at 5 % with a negative parameter estimates. This suggests willingness to pay for improved water services decreases as family size of the household increases. The reason could be large family size of households' increase their water consumption which could discourage the family due to high bill charge services and hence willing to pay less for the proposed improvements than small size households.

Household use of tank for water storage

Households who do not use tank as storage for water was another variable found to be significant at 1% level of significance. Since the parameter estimate is positive, it implies that households who don't use tank as storage for water tend to be willing to pay more as compared to households who own tank. This indicate that households who do not use tank as a storage for water frequently suffer from low water pressure and water tap interruptions than households who use tank as a storage. These households are forced to buy water from vendors at higher price than the AAWSA tariff rate.

Household year of stay in the house

The variable household's year of stay in the house is positive and it is significant at 1% level of significance. That is, those households who have been stayed in a particular house for long year are more willing to pay for the proposed improvements than their counter parts. The possible reason could be those households that are staying for a long year in that house are mostly in the older quarter of the city. The majority of the houses in this old quarter of the city are poor in terms of infrastructure and social facilities.

A related problem especially in the old quarter of the city is that un-planned houses and overlapping lots contribute to a high rate of unaccounted for water (UFW) due to leakage and illegal connection. The replacement and maintenance services due to old age of pipe for the household in the old settlement is poor since AAWSA at this time focuses on expanding service for un-served households. The above mentioned reasons exacerbate the existing water supply problem in the old quarter of the city and thus the households that are staying long in that area are more willing to pay for improved water services as compared to short stayed households.

Location of the study sites

Addis Ketema site dummy was positive and significant at 1% level of significance, suggesting that household in this site is willing to pay more than the bench mark (Nefas-Silk Lafto) site , keeping all other things constant. The possible reason could be that considerable part of the households in the former sub-city use public tap and hence they incur high costs in terms of time and labour for fetching water from the existing water sources. Thus, households from Addis Ketema site are more willing to pay for the new improved water systems to avoid the high opportunity costs than the bench mark site.

Level of satisfaction the household with the existing water services

The coefficient for the level of satisfaction the household with the existing water services has the expected sign and statistically significant at 5% level of significance. One possible reason could be those households who are dissatisfied with the current water service due to poor quality, less quantity, unreliability and absence of own private pipe are likely to pay for improved water services than those households who are satisfied with the existing services.

4.3.2 The Probit Model: Calculating Mean WTP

In this study we have already discussed the effect of socio-economic and demographic factors of the respondent on WTP using the tobit model. Thus, the probit model in this study is used to calculate mean willingness to pay for the closed-ended format. According to Hanemann et al. (1991) one of the main objectives of estimating an empirical WTP model based on the contingent valuation survey responses is to derive a central value (mean) of the WTP distribution. According to Carlsson et al. (2002) the main reason for estimating the probit model is to obtain an estimate of mean WTP. The result is obtained through regression of the willingness to pay variable on intercept and initial bid variable. The regression result shows the following values.

Table 3: The probit model to calculate mean WTP

Variable	Coefficient	Std. Er	b/St.Er.	P-Values	Mean of X
CONST	2.330989231	.34074517	6.841	.0000	
IB	-.1154249357	.027824861	-4.148	.0000	9.9787234
Dependent variables = yes/no (Y/N)		Mean =.8553191489		S.D.=	.3525296318

Source: Own survey result, 2006

Mean WTP (μ) using the model for the closed -ended format is defined as follows:

$$\mu = -\frac{\alpha_0}{\alpha_1}$$

Where:

$\alpha_0 =$ the constant term

$\alpha_1 =$ the bid coefficient

$$\mu = -\frac{2.330989231}{-.1154249357}$$

$= 20.20$

Thus the mean WTP (μ) calculated from the closed-ended probit model is 20.20 cents per bucket of improved water services. However, the mean WTP is 15.34 cents per bucket of water from responses to the open-ended contingent valuation survey questions, which is a bit lower than the mean values obtained from the closed-ended probit model estimates. Thus, the finding of the study showed the respondents willingness to pay was in the range of 15.34 – 20.20 cents per bucket for the proposed improvements of water supply services. The similarity of the mean WTP under the open-ended and closed-ended formats indicates the validity and reliability of the contingent valuation outcomes in the empirical analysis. Based on the mean WTP of open-ended format, the total values of water services have been estimated in the following section under the improved scenario.

4.3.3 Estimating total willingness to pay and total revenue

In this section, the total willingness to pay and the total revenue at different prices that households in the three sub-cities of Addis Ababa are willing to pay is computed. The demand curve for improved water service has also been derived.

There were around 432,967 households and 2,211,552 residents in Addis Ababa in 2004 with an average family size of 5.1 (CSA, 2004b). In the study area, the three sub-cities (Bole, Nefas-Silk Lafto and Addis Ketema) were included with a total of 126,108 households and 678,645 residents. The average family size of the study area was found 5.38, which is similar with the CSA result mentioned above. To make the aggregation, class boundaries for the maximum willingness to pay values have been utilized (Table 4).

From the class boundaries for the willingness to pay amounts, the class marks have been calculated and the results are shown in the second column of Table 4. The third and the fourth columns show the number and the percentage of the sample households whose maximum willingness to pay amounts fall within the given intervals, respectively.

Table 4: Total WTP and total revenue from improved water services

Class bound. of WTP (in cents)	Class mark of WTP (cents/bucket)	Sample Dist. of households	Total No. HHs	Total WTP (in cents)		Sample HHs WTP at least that amount (cumulative)		Total HHs WTP at least that amount (Cumulative)	Total Revenue (in cents)
(1)	(2)	(3) No.	(4) %	(5)	(6)	(7) No.	(8) %	(9)	(10)
0-5	3	27	11.48	14,477	43,431	235	100	126,108	378,324
6-10	8	69	29.36	37,025	296,200	208	88.51	111,618	892,944
11-15	13	54	22.97	28,967	376,571	139	59.14	74,580	969,540
16-20	18	57	24.25	30,581	550,458	85	36.17	45,613	821,034
21-25	23	13	5.53	6,974	160,402	28	11.91	15,019	345,437
26-30	28	8	3.40	4,288	120,064	15	6.38	8,046	225,288
31-35*	33	0	0	0	0	7	2.97	3,745	123,585
36-40	38	3	1.27	1602	60,876	7	2.97	3,745	142,310
41-45*	43	0	0	0	0	4	1.70	2,144	92,192
46-50	48	4	1.74	2,194	105,312	4	1.70	2,144	102,912
Total		**235**	**100**	**126,108**	**1,713,314**				

Source: Computed based on own survey, 2006

* indicate class boundary of WTP where there is no sample distribution of households.

The total number of households in the three sub-cities of Addis Ababa has been multiplied by the proportion of sample households falling in each boundary to obtain the total number of households whose WTP amount lies in each boundary (column 5 of Table 4). Total willingness to pay (Column 6 of the Table 4) has been obtained by multiplying the mid willingness to pay amount by the total number of households willing to pay that amount.

Summation of the total WTP values in column 6 gives the grand total willingness to pay amount. Thus, 126,108 households in the three sub-cities of Addis Ababa are expected to pay Birr 17,133.14 if every household use only one bucket of water. But survey data on 235 households indicate that the mean water consumption per household per day to be 9 bucket (180 liters). Based on this calculation the total willingness to pay is estimated to be Birr

154,198.26 per day[13]. This is, on average, 13.59 cents per household per bucket if the proposed improvement in water supply services is implemented. This result is almost similar with the average WTP of 15.34 cents per household per bucket from the open-ended format mentioned previously.

Columns 7 and 8 of Table 4 indicate the number and the proportion of sample households willing to pay at least the amount in each boundary and the figures continuously diminish as class mark for WTP amount increases (with the exception of * in Table 4). Similarly, the total number of households who are willing to pay at least the amount in each interval (column 9) falls as the mid willingness to pay amount rises. This relationship can be easily depicted by deriving a demand curve for the improved water supply services.

Total revenue (10th Column of the Table) has been obtained by multiplying the mid WTP amount (column 2) by the corresponding total number of households willing to pay at least that amount (column 9). As can be seen from the total revenue columns, total revenue initially increases as payment per bucket increases and reaches a maximum of 969,540 cents per Bucket with the payment of 13 cents per Bucket per household. After that it decreases and reaches a minimum of 102,912 cents per bucket at the highest service charge of 48 cent per bucket per household due to relatively small number of households (only 2,144) willing to pay these amounts.

[13] The total WTP for 126,128 households is Birr 17, 133.14 assuming every household uses only one bucket. However, sample survey indicated that every household uses 9 bucket per day. Thus, the total WTP for the total households is Birr 17,133.14 $\times$ 9 = Birr 154,198.26 per day.

The revenue estimation in this study is very important since it allows water utility to determine how many households can afford the provision of improved water services on charge base. The administrative body can also undertake cost-benefit analysis of a project which is meant to improve the water services in the city. From Table 4 there is a very wide room for cost recovery by improving the existing water supply services in the city.

4.3.4 Derivation of aggregate demand and estimation of consumer surplus for improved water services

The aggregate demand for this study has been derived from the above WTP payment scenario. The aggregate demand curve is derived using the mid willingness to pay per bucket along the vertical axis and the number of households' willingness to pay at least that mid value per bucket along the horizontal axis[14] (Figure 1). The figure shows the aggregate demand curve for the improvements in water supply services using the observations in the study. Any point on the curve shows all the households that prefer the improved water service but do not bid more than the corresponding value on the mid WTP axis.

The demand schedule that has been obtained from our survey is basic information for policy makers. The information helps them to make sound water tariff decisions and investment. The information on the frequency distribution of WTP bids is also useful information in estimating the demand for improved water services in terms of the tariff versus number of households.

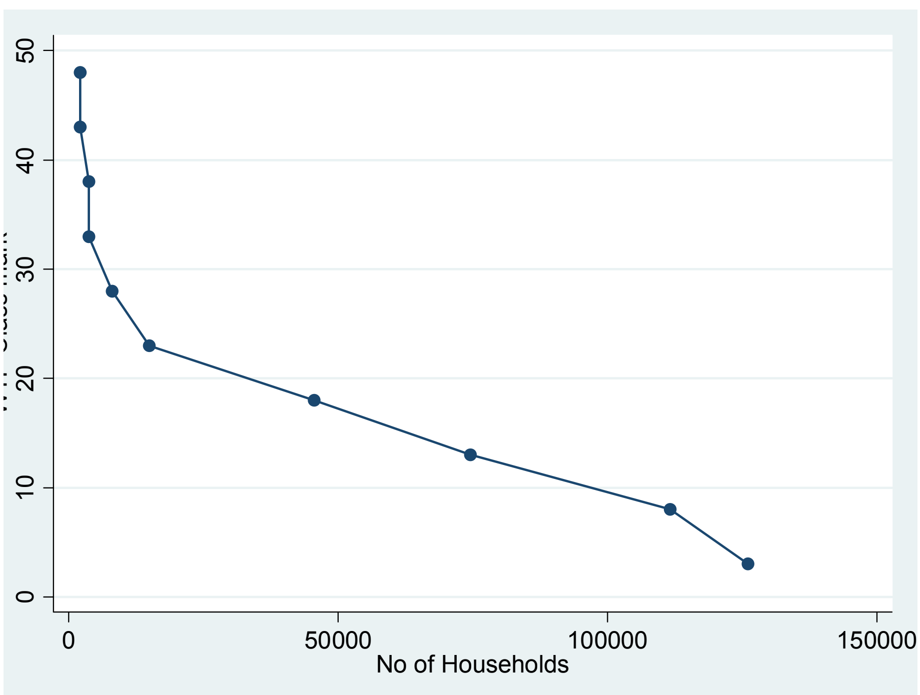
As shown in Figure 1, the demand curve is negatively sloped indicating the fall of the demand for improved water supply service as user charges increase, like most other economic goods, other things remaining the same. If water is considered as a free resource to the society, the consumers' surplus would be the total area under the demand curve. The area under the demand curve represents the gross value of consumers' surplus if the tariff rate of the authority is zero. The sum of all the areas under the demand curve (A_1-A_{10}) is 2,021,504 cents per Bucket (Figure 1). This shows the gross consumer surplus is estimated 2,021,504 cents (Birr 20,215.04) if every household is using only one Bucket per day for the improved water services,

[14] The number of household represents the total quantity demanded for improved water supply measured in bucket, assuming every household uses only one bucket of water per day. For calculation of the total benefit for improved water supply, see Figure 1 and Appendix 4. For related application, see Boardman et al., (2001).

with supply left unrestricted (see Appendix 5). But based on the survey data the gross consumer surplus has been estimated to be 18,193,536 cents (Birr 181,935.36) per day.

The study further analyses the allocation of the total benefits which has been derived from the service charge fees on each household per bucket by improving water supply services. The current tariff rate of AAWSA is 3.50 cents per bucket of water for the lowest consumption block (which is less than 7 m^3 /month) and 7.60 cents per bucket for the highest consumption block (for more than 20 m^3 /month) that cover only operation and maintenance costs. But the current tariff policy of the water authority could not meet financial sustainability. Thus, if AAWSA proposes a new flat tariff rate for the improved water at 8 cents per bucket (which is well below the mean WTP of own survey) with supply left unrestricted, it may help to cover the authority's costs (operation and maintenance costs plus capital investments). This will help to implement the proposed improved water supply service.

Figure 1: Estimated Demand Curve for Improved Water supply Service in Addis Ababa

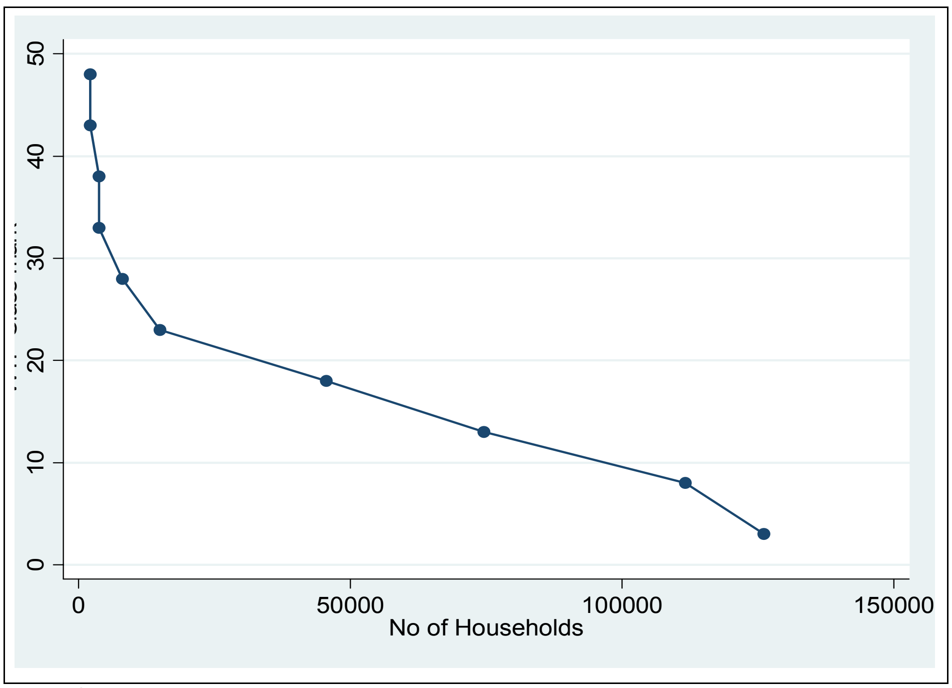


Source: Computation based on own survey, 2006

The finding indicated that out of the total 126,108 households in the study area, 111,618 (88.51%) of households are assumed willing to pay at least the new proposed tariff rate of 8 cents per bucket for the improvement in water services. In relation to this, a rise in revenue of the authority is anticipated and a large increase in the consumers' surplus, in turn, will help for implementing an improved water project. The allocation of the total benefits of improved water services at the proposed tariff rate can be depicted using Figure 2.

The total benefits of the improved water supply services are the sum of expected revenue of AAWSA, consumer's surplus of the society, and the dead weight loss. If tariff is set for water supply services, the consumers' surplus discussed previously can be minimized by shifting consumer surplus partly to dead weight loss and partly to the revenue of AAWSA.

Figure 2: Estimated total benefit for improved water supply service in Addis Ababa



Source: Computation based on own survey, 2006

As indicated in Figure 2, if a new tariff rate of 8 cents per bucket is implemented, the consumers' surplus decreases from 2,021,504 cents to 1,048,865 cents per bucket or from Birr 181,935.36 to Birr 94,397.85 per day. The rest of the benefit is distributed to AAWSA, 892,944 cents in the form of revenue and 79,695 cents as a dead weight loss (DWL)[15] per bucket, which is equivalent to Birr 80,364.96 in the form of revenue and Birr 7,172.55 as a dead weight loss per day. The dead weight loss of the study result indicate that only 14,490 (11.49%) out of 126,108 households could not afford for the proposed new tariff rate. The dead weight loss is part of the aggregate benefit of improved water service that belongs neither to the consumer surplus nor revenue to the service delivery authority. However, there is a possibility of cross subsidy to those households who are unable to pay by those who are willing to pay more.

In general, the results of the study in this unit open a room to any interested individuals or groups in the area of improving water supply services in the city. The aggregate WTP amount shows that the authorities could collect sufficient resource for both service modernization and could also reduce existing subsidies.

5. Summary and conclusion

In this study we have used a contingent valuation method to analyze determinants of households' WTP, estimate total WTP, and derive aggregate demand and aggregate benefit for improved water supply service. CVM helps to estimate the value that households in Addis Ababa attach to the proposed improvement in water supply service. For this purpose, a total of two hundred forty (240) households were interviewed after stratifying sub-cities and kebeles based on economic standard and water supply availability, respectively. A closed-ended with open-ended follow-up elicitation technique was used.

The empirical analysis we conducted and its findings show that controlling for the other variables in the model, income of the household, sex of the respondent, education dummies (both secondary and tertiary education), households year of stay, households not using tank as a storage, wealth of a household, employment status of the respondent, households' satisfaction with the existing service, and location of the study site (Addis Ketema) affect the willingness to pay for improved water service positively. On the other hand, family size affects the willingness to pay negatively.

The total willingness to pay amount from the total of 126,108 households in the study area of Addis Ababa is Birr 17,133.14 per bucket or Birr 154,198.26 per day at different service fees. The maximum total revenue that can be collected per bucket is

[15] DWL- measures the value to the consumer of the lost output (Varian, 1992).

969,540 cents when a service fee of 13 cents per bucket is charged. The area under the demand curve represents the gross value of consumers' surplus which is Birr 20,215.04 per bucket if water is considered as a free good (zero tariff rates for water). Based on the survey data of the mean water consumption per household per day the gross consumer surplus is estimated to be Birr 181,935.36 per day. But water is an economic good and if a new tariff rate of the authority is supposed to be 8 cents per bucket the consumers' surplus will be reduced to Birr 94,397.85 per day. The rest of the benefit is distributed to the water authority Birr 80,364.96 in the form of revenue and Birr 7, 172.55 is a dead weight loss per day. This proposed new tariff rate can help the water authority to implement the proposed improvement of water supply service.

The mean willingness to pay value is 15.34 and 20.20 cents per bucket for the improved water supply service as calculated from the tobit and probit model, respectively. Hence, the mean willingness to pay value ranges between 15.34 and 20.20 cents. The similarity of the mean WTP under tobit and probit models indicate the validity and reliability of the contingent valuation outcomes in empirical analysis.

It may be safely recommended from this study that income and willingness to pay for the proposed improvement in water supply service is positively related, development policies should target at increasing income per household that address the low income members of the society. Income source diversification strategies and expansion of small scale enterprises which can employ households in the lower income strata are the possible areas of intervention

This study, however, lack the comprehensiveness as it has limited water supply service for domestic purpose only. Thus, further study needs to incorporate water supply for industrial, institutional and commercial purpose to have more real image on water supply service in Addis Ababa.

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Appendix 1: Willingness to pay for Improved Water Supply Service

For all scenarios by an improved provision of water, we mean:
- Good quality of water which is safe for health is provided.
- Good quantity of water is available for 24 hours per day, throughout the year.
- Collection of water need not take much of your time and effort.

C_1.What is the main source of water for this household for domestic purpose?
a) Private piped water
b) Shared piped water
c) Others

IF "PRIVATE PIPED WATER" TO Q.C_1 ASK Q.C_2. OTHERWISE SKIP TO Q.C_3

SCENARIO I: Willingness to Pay for Improved Water Supply Service
(For Households with Private Pipe Connection)

C_2.Are you willing to pay any amount to the improved water provision?
___1. yes **GO TO Q. C_{2a} (C2a-C2b)**
___2. No **SKIP TO Q. C_5 (C_5 only)**

C_{2a}. If "yes" suppose that AAWSA presented the improved Water service, would you be willing to
pay ___cents per bucket to obtain improved water from this new scheme?
___1. yes **GO TO Q.C_{2b}**
___2.No **GO TO Q.C_{2b}**

C_{2b}.What is the maximum you could pay for one bucket of water for the improved water scheme?____ cents per bucket.

IF "b" OR "c" TO Q. C_1 ASK Q. C_3

SCENARIO II: Willingness to Pay for Improved Private Pipe Connection (For Households with No Private Pipe Connection)

Assume also that you have private water connection together with the improved water supply scheme. Notice also that you may not be required to pay initially the costs of connection to the new scheme.

Instead, the WASA (water and sewerage authority) will cover the costs with insignificant increase in the tariff rate.

$C_{3.}$ Are you willing to pay any amount to have private pipe connection with the improved water provision?

___1. yes **GO TO Q. C_{3a} (C_{3a}-C_{3b})**
___2. No **SKIP TO Q. C_4 (C_4-C_{4b})**

C_{3a}.If "yes" suppose the authority presented the improved water service with private pipe connection,

would you be willing to pay___ cents per bucket to connect improved pipe water from this new scheme?

___1.Yes **GO TO Q.C_{3b}**
___2.No **GO TO Q.C_{3b}**

$C_{3b.}$ What is the maximum you could pay for one bucket of water for this improved pipe

water scheme?____ cents per bucket.

SCENARIO III: Willingness to Pay for Improved Public Tap Service
(For Households with No Private Pipe Connection)

C_4.Are you interested in the provision of public tap?

___1. Yes **GO TO Q. C_{4a} (C_{4a}-C_{4b})**

___2. No **GO TO Q. C_5 (C_5 only)**

C_{4a}.If "yes" suppose that a new scheme of improved water system will be provided using a public tap

as near as possible to your home. You will not pay initially the costs of connection to the new

scheme but the authority will cover the costs with insignificant increase in the tariff rate. Would

you be willing to pay ___cents per bucket of water for such public tap?

___1. yes **GO TO Q. C_{4b}**

___2.No **GO TO Q. C_{4b}**

C_{4b}. What is the maximum you could pay for one bucket of water for this improved water

scheme?____ cents per bucket.

C_5. Are you totally not willing to pay because you believe that:

a) The existing system is satisfactory
b) You can’t afford the new scheme
c) The government should pay
d) Other reasons (specify)____________________

Appendix 2: Description of Explanatory Variables

Dummy Variables	Explanatory Variables
WEAH	Ownership of house- is a proxy for wealth. Wealthy households are more willing to pay and prefer to have a private connection to the improved water service. It is a dummy variable, 1 if the house is owned by the household, 0 otherwise (that is, if rented from individuals, kebeles or public agency. Thus a positive sign is expected.
SEXR	Sex of Respondent -fetching water primarily depends on women in most developing countries. Thus, it is hypothesized that women are more likely to pay for improved water supply than men. It is a dummy variable, 1 if the respondent is female, 0 other wise.
EMPR	Employment status of Respondent- This is a dummy variable, taking 1 if the respondent is employed in a government or private organization, NGO's, owns a business, and other related areas ; 0 otherwise (that is if not employed). The employed respondents are expected to be more willing to pay than their unemployed counter parts. This is because the exposure (the state of having the true facts) of those who are working in different sectors to the improved water service is more than the other group. Thus we expect a positive sign.
ATTR	Attitude of Respondent about the Responsibility of Water Supply- It is a dummy variable, and takes 1 if the respondent says the government should administer, 0 otherwise. We expect a negative sign. If the respondent says the government should administer (manage) the water service, it might be expected that the government will provide the service at lower price and thus less WTP.
LOC	Location of the Study Sites-LOC_{Bo} is dummy variable taking 1 if it is Bole sub-city, 0 otherwise. LOC_{AK} is dummy variable taking 1 if it is Addis-Ketema sub-city, 0 otherwise. It is expected that households in a sub-city with more problem of water supply are willing to pay more for improved water supply scheme than sub-city with less problem of water supply service.
EDUR	Education Level of the Respondent -WTP for improved water service is expected to have a positive relation with the level of education, since respondents with higher education have more awareness of the value of water services. $EDUC_1$ is a dummy variable taking 1 if the respondent's educational level is primary education; 0 otherwise. $EDUC_2$ is a dummy variable taking 1 if the respondent's educational level is secondary education; 0 otherwise. $EDUC_3$ is a dummy variable taking 1 if the respondent's educational level is tertiary education; 0 otherwise.
TANK	Household use of Tanks as Storage for Water -It is assumed that households with no tank as a storage for water may be willing to pay more for improved water services than households who use tank for water storage, since the severity of water supply disturbance is higher for the former. A dummy of 1 is specified for household with no tank as a storage for water; 0 otherwise. The coefficient is expected a positive sign.
STAT	Status of the Respondent- This variable helps to examine whether the representative of the household gives similar opinion with that of the head of the household on willingness to pay or not. It is a dummy variable taking 1 if the

	respondent is the head of household; 0 otherwise. We expect a negative sign since the head of the household is concerned more about the management of his /her limited finance that s/he could allocate, based on prioritized activities.
INFO	Respondent's Information about Tariff Increment on Domestic Water Consumption- Dummy variable 1 if the respondent has the information, 0 otherwise. We expect a positive sign. Households who know tariff increment are more responsible about cost sharing than their counter parts. Hence, respondents that have the information regarding tariff increment on domestic water consumption are more willing to pay for improved water service than respondents with no information.
SATI	Level of Satisfaction of the Household with the Existing Water Services- dummy variable 1 if the household is not satisfied with the existing water service; 0 other wise. It is expected with a positive sign. This is since households that are not satisfied with the existing water services show grater preference for improved services and more willing to pay to connect for improved water service.
Continuous variables	
INCH	Total monthly income of the household. The monthly income of the household includes the income of the head and all other members of the household from different sources. Households with higher income have a greater ability to pay and have a grater preference for an improved water services. This is based on previous empirical studies and economic theory that shows quantity demanded and income are positively related for normal goods. So we expect a positive coefficient. We are looking at the household's disposable income (in birr).
FAMS	Family Size of the Household-two rationales are forwarded. The first indicate that as family size is higher, there will be a higher need for water in the family and hence more preference for an improved water provision, and WTP is higher. The second indicate that for large family size it is expected to increase their water consumption for improved water service which could discourage the family due to high bill charge services and hence willing to pay less for the proposed improvements than small size households. Thus we can not determine its sign a priori.
AGER	Age of Respondent- continuous variable in number of years. Older people who used to live with free water supply or less prices, may be reluctant to prefer new improved services and could be less willing to pay for it. Thus, a negative relationship is expected between the age of a respondent and WTP for new improved scheme.
IB	Initial Bid- this will help to examine whether the initial bid do have an impact on the respondent's WTP for improved water services or not. It is to be tested for initial bid bias.
STAY	Household Year of Stay in the House -continuous variable in a number of years. It is expected to be a positive coefficient. Those households who have stayed in the house for long year are mostly in the older quarter of the city where there is more serious problem of water supply service and thus are willing to pay more for improved water services than those households who have stayed short in the house.

Appendix 3: Summary of Descriptive Statistics of Variables

Dummy Variables	Observ.	Mean	Std.Dev	Min	Max
Primary education of the respondents ($EDUC_1$)	235	.24	.43	0	1
Secondary education of the respondents($EDUC_2$)	235	.34	.48	0	1
Tertiary education of the respondents($EDUC_3$)	235	.19	.39	0	1
Information about tariff (INFO)	235	.77	.42	0	1
Status of the respondents (STAT)	235	.59	.49	0	1
Wealth of the households (WEAH)	235	.58	.49	0	1
Employment status of the respondents (EMPR)	235	.37	.48	0	1
Attitude of the respondent (ATTR)	235	.78	.41	0	1
Yes/no (Y/N) to initial bid	235	.85	.35	0	1
Sex of respondents (SEXR)	235	.71	.45	0	1
Households use of tank as a storage of water (TANK)	235	.69	.46	0	1
Location of the study site Bole (LOC_{BO})	235	.31	.46	0	1
Location of the study site Addis-Ketema (LOC_{AK})	235	.34	.47	0	1
Location of the study site N. Silk Lafto (LOC_{NL})	235	35	.48	0	1
Level of satisfaction to the existing water services (SATI)	235	.84	.37	0	1
Continuous Variables					
Income of the households (INCH)	235	1339.32	1481.21	110	8500
maximum WTP	235	15.34	8.53	0	50
Initial bid (IB)	235	9.98	4.15	5	15
Age of respondents (AGER)	235	34.98	14.89	17	85
Family size of the households (FAMS)	235	4.79	1.89	1	10
Households year of stay in the house (STAY)	235	19.95	12.57	.75	60

Source: Own survey result, 2006

Appendix 4: Test of Heteroscedasticity

One of the important methods used to test the existence of hetroscedasticity in Tobit model is the log –likelihood ratio test (LR) test. The LR statistics of testing the null hypothesis of homoscedasticity assumption is obtained by

λ_{LR} = 2[Log Lu-LogLr]; Where
log Lu is the value of unrestricted log-likelihood function and
log Lr is the value of restricted log –likelihood function

λ_{LR} has a $X^2(n)$ distribution with n degrees of freedom where n is the number of explanatory variables. If the data do not support the null hypothesis (homoscedasticity assumption), then the value of the test-statistic becomes large and null hypothesis is rejected; i.e, if $\lambda_{LR} \geq X^2$ (n). The result of the test for the model is shown below.

λ_{LR}=2[Log Lu-LogLr]
=2[-773.2196 – (-836.6690)]
=2[63.4494]
=126.8988

The critical value of the chi-square at 18 degree of freedom is 28.87 at 95% level. Comparison of the result (test statistic) with critical table value shows that the test statistic (computed value) is found to be larger than the critical table value. This implies that the null hypothesis of homoscedasticity is rejected, i.e. hetroscedasticity is the problem for the model. But this hetroscedasticity problem has been corrected using LIMDEP version 7.0 software.

Appendix 5: Estimating consumer's surplus using Figure 1

Area	Computation	Value of consumer's surplus (in cents)
A_1	2144×5	10,720
A_2	(2144×5) + ½(1601×5)	14,722.5
A_3	3745×5	18,725
A_4	(3745×5) + ½(4301×5)	29,477.5
A_5	8046×5 + ½(6973×5)	57,662.5
A_6	15019×5 + ½(30594×5)	151,580
A_7	(45613×5)+ ½(28967×5)	300,482.5
A_8	(74580×5) + ½(37038×5)	465,495
A_9	(111618×5) + ½(14490×5)	594,315
A_{10}	126108×3	378,324
Total		**2,021,504**

Source: Computed based on own survey, 2006

AID AND THE DUTCH-DISEASE IN ETHIOPIA[1]

Teferi Mequaninte Tensay[2]

Abstract

The paper analyses the "Dutch Disease" effect of foreign aid on the Ethiopian Economy. After a brief review of aid theory, it goes on reviewing the available evidences about the Dutch disease effects aid has in the other countries. Then illustrative model is presented. The study employed three stage-least square methods in estimating the real exchange rate and aid variable, on the one hand, and export performance and aid, on the other. The finding is that external aid inflows to Ethiopia result in appreciation of exchange rate and hence loss of export competitiveness, that is, "Dutch Disease" problem has been identified. The study concludes that for external aid inflows to be an effective investment, economic policy needs to focus infrastructure development and the government needs to subsidize firms in the tradable sector.

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1. Introduction

Following the introduction of the Structural adjustment program (SAP) in 1992 to the Ethiopian economy, there was a massive inflow of foreign aid in the form of grants, concessional loans and technical assistance. Net aid[3] inflows to Ethiopia during the Derg period were around 7 percent of GDP and are doubled to 14 percent of GDP during the EPRDF regime. These elevated flows have raised a number of concerns, ranging from fears about the effect of aid inflows on the real exchange rate and export performance. The source of anxiety for all this is the Dutch disease problem of foreign aid. While seemingly beneficial foreign aid inflows may generate undesirable effects in the economy. These undesirable effects include a decline in export performance and manufacturing production caused by appreciation of the real exchange rate and resources moving out of manufacturing into other sectors (Timothy, 1997). There are also concerns about aid sustainability. Specifically, while LDCs have been forced to take on greater burden of global adjustment, most donor countries have been unwilling to expand financial support for adjustment in the LDCs (Bigsten, 2003). These could be due to different motives by the donor countries. Instead of addressing the most developmental constraints of a recipient country, donors may wish to enhance the military prow ness of a recipient country, to promote their commercial interest, to support a friendly government in power, and/or to acquire goodwill in the expectation that it would be politically valuable later (Krueger, 1993). As has been well documented in the works of Adams et al (1994), foreign aid inflows cannot continue indefinitely given donor fatigue and the growing competition for aid funds among LDCs.

Still, there are concerns about the absorptive capacity of the recipient economy, and particularly of the government itself. The impact of aid is rather complex, since there are direct effects of aid disbursement as well as indirect effect on the spending patterns of the public sector of the recipient country and on government policy. The government may use aid to escape the burdens of their foolish economic policy. (Mosley et al, 1992). The more general concern of Dutch disease is that whether external aid inflows have been temporary or permanent and weather they were spent on imports or domestically produced goods and services.

The principal economic rationale for aid is to increase growth rates in recipient countries, usually measured by its impact on real exchange rate. Yet, after decades of capital transfer to Ethiopia, the effectiveness of achieving this objective remains

[3] Aid according to the OECD definition is both grant and a loan with grant element of 25 percent or above.

questionable as conformed by numerous studies of the empirical relationship between aid and growth. In an effort to boost Ethiopia's economic growth the real exchange rate and its interplay with external aid inflows have been crucial for purposes of strategic economic decision making and efficient policy management.

This paper attempts to develop an empirical model for the real exchange rate impact of foreign aid in Ethiopia. The paper then links this with an export performance model in order to identify policy implications and recommendation. Generally it is hypothesized, first, that whether external aid inflows to Ethiopia results in real exchange rate appreciation or depreciation is an empirical question, and second, that exports respond positively to a good policy management of foreign aid.

This paper has five sections. Following this introductory section, part two presents a review of the existing literature regarding pro-aid and contra-aid arguments. Section three is devoted to the discussion of model specification, data sources and methodology. The model specification is based on the Dutch disease model as reviewed in section two. Also in this section are, empirical result and interpretation of the coefficients. The last part summarizes the paper and provides conclusions and policy implications.

2. Literature survey

There is a substantial amount of literature on the macroeconomics of aid. The pro-aid argument focuses on the complementarity of aid to growth. Prolific writers like Griffin, Todarro and Chenery and Strout are in this group. The major themes covered in the pro-aid argument include the two-gap model; aid and growth; aid, investment and imports; and the saving debate.

The two-gap model was developed by Bruno and Chenery (1962) and then elaborated further in Chenery and Strout (1966). This model had three potentially binding constraints on growth: a saving constraint (which might limit investment), a foreign exchange constraint (which might limit investment because of the high import content of investment), and an absorption constraint (which set an upper limit for the rate of growth).

Griffin (1970) and Todarro (1989), for instance, stressed that whenever there is a foreign exchange gap as well as the saving gap, growth would be impaired unless that gap is filled by foreign aid. Development economists such as Rosenstient Rodan (1961), as cited in Hansen et al 2000, also assumed that each dollar of foreign resources in the form of aid would result in an increase of one dollar in total savings and investment. It is based on this belief that donors like European Economic Commission EEC and World Bank provide official development Assistance (ODA) to the Less Developed countries (see EEC, 1990; World Bank, 1994). Similarly, Chenery and Strout (1966) argued that aid's impact on growth is as a supplement to scarce domestic resource. Clark (1991) has also over emphasized the importance of foreign aid by saying that "foreign aid can be used on the immediate relief of poverty, infrastructure, and institutional building or on promoting agriculture and capital investment".

The two-gap model has been subject to a number of general criticisms and some directed more specifically at its application to analyzing aid's impact on the economy. Findlay (1971) was the first to criticize application of the two-gap model and Edwards and Van Wijnbergen (1989) heightened the attack on the ground that it ignores relative prices, and thus turns the focus towards the real exchange rate as a crucial variable influencing the effectiveness of foreign aid (Dutch disease theory).

Unlike the "two-gap" literature, the modern view of developmental aid theory focuses on both resource accumulation and improving the efficiency of resource use (Krueger O. 1985). In the new macroeconomics of aid, authors like Loxley (1998) point to the quality of assistance and direction of aid. Griffin (1970) underlined that if aid to developing countries displaces their saving rate or raises its capital out put ratios (x/k) to a sufficient extent, then it is just possible that aid may immiserise the recipient countries. Morrisey (1992) has argued that the link between aid and growth is in direct and that aid affects the real exchange rate, which in- turn may constrain any beneficial impact on the growth rate. Similarly Edwards and Van Wijnbergen (1989), Vos (1989), and Younger (1992), have focused on aid as causing Dutch disease.

Historically, the term "Dutch disease" was first used to reflect the decline in the Netherlands' export competitiveness following the discovery of the Groningen gas field in the early 1970s (Benjamin et al., 1989). Dutch disease refers to the coexistence within the traded goods sector of progressing and declining or booming and lagging sub-sectors (Corden and Neary, 1982). A boom is one of the traded goods sectors (due to for instance foreign aid) raises the marginal product of the mobile factors employed in that sector. Higher factor returns in the booming sector will draw mobile factors away from the other sectors and into the booming sector (resource movement effect). The non-booming sector will thus contract. The higher real incomes resulting from the boom leads to extra spending on the non-tradable, which raises their price (spending effect). The spending effect will, in turn, causes the real exchange rate to appreciate and hence a loss of export competitiveness in the international market. Most studies of Dutch disease literature since then have been used to analyze the problems associated with managing revenue from the booming sector of the economy.

From a structural adjustment and macroeconomics perspective, Edwards and Van Wijnbergen (1989) have stressed the similarity between increased income from natural resource and aid inflows by indicating that firstly both come in the form of additional foreign exchange, secondly the impact of both is temporary and third when spent on non-traded goods put upward pressure on the real exchange rate.

Van Wijnbergen (1986) using the Dutch-disease model to analyze the effect of foreign aid in Africa, arrived at the conclusion that, by partially spending on non-traded goods, increase in real volume of aid places upward pressure on the real exchange rate. Yet Ogun (1995) found that capital inflow to Ghana caused the real exchange rate to depreciate. Similarly, in their study of foreign aid and the Dutch disease in Tanzania, Adams et al. (1994) found that the aid inflows to Tanzania were buying economic reforms and policy changes that were pro-tradable and dampened the potential for the aid induced real appreciation. The stabilization program initiated by New Zealand in 1984 led to high interest rates, an inflow of foreign capital, and the appreciation of their exchange rate. Although trade liberalization initially resulted in depreciation of the real exchange rate in Chile, the real exchange rate began appreciating between 1979 and 1982 as a result of capital inflows and wage indexation (Schiff and Valdes, 1998).

3. Model specification and estimation

3.1 Model specification

The impact of external aid inflows on the real exchange rate (RER) is estimated using the model of real exchange rate developed by Edwards (1989). In the modern theory the real exchange rate, (RER) is defined as the domestic relative price of tradable goods (P_T) to non-tradable goods (P_{NT}), that is, $RER = (eP_{T}/P_{NT})$ compatible with the attainment of internal and external equilibrium.

Internal equilibrium presupposes that the market for non-tradable clears in the current period and is expected to be so in the future and it is attained when the supply and demand for non-tradable goods are equal (Montiel 1996, cited by Baffes et al, 1999).

$$Y_N(RER) = (1-\alpha)RERC + G_N, \qquad \partial Y_N / \partial RER < 0 \qquad \textbf{(1)}$$

Where,

Y_N is the production of non-traded goods,

G_N is government consumption of non traded goods,

α is the share of traded goods in total consumption, and

C is total private consumption measured in traded goods

e is the nominal exchange rate

External equilibrium (trade balance) implies that the current account balances both in the current and future periods are compatible with long-run sustainable capital flows (Elbadawi, 1994). Thus, using Montiel (1996, as cited by Baffes et al, 1999) equations below, the hypothesized relationships can be specified.

$$f = Y_T(RER) - G_T - \alpha C + A - rf \qquad \textbf{(2)}$$

Where,

f is net foreign assets, and f is change in net foreign assets over time,

$Y_T(RER)$ is the domestic supply of traded goods,

G_T is government spending on traded goods

A is net aid inflows and rf is external debt services.

The intersection of internal and external balance (Equation 1 and 2) produces the equilibrium real exchange rate. At such an intersection, both the internal and external balance are achieved. Setting the right hand side of Equation 2 to zero, and combining this with Equation 1 gives;

$$RER^* = RER^*(G_N, G_{T,} A, r_w) \qquad \textbf{(3)}$$

Where, r_w is the world interest rate.

The above derivation is for illustrative purposes and it serves us to show how the fundamentals (government consumption, Terms of trade, Capital formation, and technological progress) influence the movement of the real exchange rate. For practical application it is possible to extend the model in many ways. For example, Baffes et al (1999) discuss extension of the model involving rationing of foreign credit, change in the domestic relative price of traded goods, and short run rigidities in the domestic wages and prices. In the case of Ethiopia important extensions like Terms of Trade, trade policy and foreign reserve can be made. Incorporating all the fundamentals and short run macroeconomic policy variables, the model for the real exchange rate that is used for estimation can be formulated as:

$$LogRER_t = \beta_0 + \beta_1 \log(TOT)_t + \beta_2 \log(AID)_t + \beta_3 \log(GCN)_t + \beta_4 \log(CPS)_t + {}_5 \log(GRGDP)_t +$$
$$\beta_5 \log(GRGDP)_t + \beta_6 \log(INVGDP) + \lambda \log(CBR)_t + \alpha(\log NER_t - \log NER_{t-1}) + U_t \quad (4)$$

NER stands for nominal devaluation and U_t for the error term.

Where

RER^*_t = The equilibrium real exchange rate

TOT = External terms of trade

AID = External aid inflows (defined as real net ODA to Ethiopia)

GCN = Government consumption of non-tradable (measured by share of government consumption in GDP)

CPS = Commercial policy stance (measures the level of openness)

$GRGDP$ = The growth rate of real Gross Domestic product (as a proxy for technological progress)

$INVGDP$ **=** Investment to GDP ratio.

The expected theoretical impacts of the respective fundamentals are as follows:

TOT (?) - Its impact on the RER depends on the relative strengths of the direct income effect operating through the demand for non-tradables and the indirect substitution effects that operate through the supply of non-tradables. If the income effect associated with deterioration is stronger than the Substitution effect, a depreciation of the RER will occur. In Elbadawi and Soto's (1997) study of seven developing countries, in three case, an improvement in the term of trade appreciated the real exchange rate, while in four cases, an improvement in the terms of trade depreciated the real exchange rate.

AID (-) - By increasing real incomes and consequently the demand for both traded and non-traded goods, it tends to cause the RER to appreciate. In his study of twelve developing countries, Edwards (1989) found that an increase in capital inflows appreciated the real exchange rate, as expected.

GCN (?) - Increases in government expenditure on non-tradable appreciates the RER, while those on tradable causes the RER to depreciate. Edwards (1989) found that an increase in government consumption appreciated the real exchange rate in four of the equations he estimated for a group of twelve developing countries, while in the other two equations, an increase in government consumption depreciated the real exchange rate.

CPS (+) - Decreases in the parallel (or black) market premium tend towards RER depreciation. In their study of Cote d'Ivoire and Burkina Faso, Baffes et al (1999) found results consistent with the theory; reforms that are aimed at liberalizing trade are consistent with a depreciated real exchange rate.

$GRGDP$ (?) - Technological progress appreciates the RER if gains emanating from productivity enhancement in the tradable Sector override those in the non-tradable sector. Edwards (1989) found that an increase in technological progress depreciated the real exchange rate in all his regressions. Aron et al (1997), on the other hand, found that an increase in technological progress appreciated South Africa's real exchange rate.

CBR (?) - Central Bank reserve intervention indicates the capacity of the Bank to defend the currency (Aron et al, 1997). An increase in reserve has the effect of appreciating the real exchange rate, while a decrease in reserves depreciates the real exchange rate. In their study of the determinants of the real exchange rate for South Africa, Aron et al (1997) found results consistent with the theory; an increase in reserves appreciated the real exchange rate.

NER_t (+) - Nominal devaluation tends to depreciate the RER.

$INVGDP$ (?) - Its impact on the real exchange rate depends on whether an increase in investment changes the composition of spending on traded and non-traded goods. If an increase in the share of investment in GDP changes the composition of spending towards traded goods, it will lead to a depreciation in the real exchange rate (Baffes et al; Edwards, 1989). On the other hand, a change towards non-traded goods appreciates the real exchange rate. For example, Baffes et al (1999) found that an increase in the share of investment in GDP depreciated the real exchange rate in Cote d'Ivoire. Edwards (1989) also found that increases in the share of investment in GDP resulted in depreciation in the real exchange rate in his study of twelve developing countries.

Following the definition of the real exchange rate, a negative sign (i.e., -) represents an appreciation of the real exchange rate.

In estimating the relationship between export performance and real exchange rate, an expanded export performance model adopted from Vos (1993) is used. In this model, growth of real exports (EXP) is assumed to be a function of (change in) relative prices (i.e., RER), income or rate of output growth of the trading partners (YTP), real exchange misalignment (REMIS), and external aid inflows (AID). Thus export model to be estimated is:

$$LogEXP = f[LogRER, LogYTP, REMIS, LogAID] \quad \textbf{(5)}$$

The expected theoretical impacts are:

RER (+) - Increases in the real exchange rate are expected to result in exports expansion.

YTP (+) - Output growth of trading partners is envisaged to have a positive effect on Ethiopia's exports.

$REMIS$ (-) - Real exchange rate misalignment, measured by the deviation of the actual real exchange rate from its long run equilibrium level, has a disincentive effect on exports and is thus likely to reduce export growth.

AID (?) - A good or bad aid dispersement policy (proxied by real net ODA to Ethiopia) tends to elicit positive or negative response from the export sector.

The export model (Equation 5) shows a linkage with the real exchange rate model through the real exchange rate and aid variables. In addition to the RER effect in the export model, the aid variable permits the analysis of foreign aid on exports. Thus we have the indirect effect of aid on exports through the RER and the direct linear effect of aid.

3.2 Estimation of the model

In estimating the empirical relationship between the real exchange rate and external aid inflows on the one hand and the aid variable and export performance model on the other, the study employed three-stage least square methods. The source of the data were National Bank of Ethiopia (NBE), IFS-CDROM and OECD website. The data used is annual, covering the period 1970 to 2003. Given the fact that a substantial amount of government consumption contains foreign aid and that there is no disaggregated data for the government consumption of non-tradable, GCN is excluded from the empirical estimation. Similarly, since technological progress can be captured by investment to GDP ratio (see Jing Xu, 2003) and our economy is mainly agrarian, GRGDP has been also excluded from the empirical model.

The results of the three-stage least square estimation for the real exchange rate is provided in Equation 6 below. Figures in parenthesis under the equation represent t-values.

$$LogRER = 6.265 - 0.157 * \log(TOT) - 0.437 * \log(AID) + 0.918 \log(CPS) -$$

(t-value) (6.19) (0.89) (-3.49) (5.22)

$$0.366 \log(INVGDP) + 0.181 \log(CBR) + 0.734 \log(NER) \qquad \textbf{(6)}$$

(-1.62) (3.37) (1.45)

Adjusted $R^2 = 0.66$
DW statistic = 1.48

As one can see from the results, taken together, the fundamentals explain 66% of the variations in the real exchange rate. The positive parameters on commercial policy stance and central Bank reserve imply a tendency towards real exchange rate depreciation. However, aid variable exhibit negative coefficient and, therefore, tend to appreciate the real exchange rate. Variables found to be insignificant are: terms of trade, investment to GDP ratio and nominal exchange rate. Generally all significant variables, that is, commercial policy stance, central bank reserve and aid captured in the estimation bear the expected theoretical signs.

The major interest of this study is the impact of external aid inflows on the real exchange rate in Ethiopia. Consistent with the conventional “Dutch disease” effect of aid on the real exchange rate as postulated in theoretical real exchange rate model, Ethiopia’s experience exhibits a negative impact of on the real exchange rate. In other words, aid inflows lead to real exchange rate appreciations and hence the existence of Dutch disease problem of aid in Ethiopia. The appreciation impact of aid on the real exchange rate can be explained by the fact that aid inflows instead of being directly invested in the tradable sectors of agriculture and industry, is likely be invested in the non-tradable service sectors like public administration and defense, transport and construction and recurrent expenditures in general. Hence, the spending effect of aid inflows to the Ethiopian economy is likely to cause price increases in this sector that will invariably spill over to the other sectors as well. It is no surprising that the government is grappling with inflation. With the service sector being low on the extent of tradability, such inflationary tendencies have had a potential appreciation effect on the real exchange rate.

The results of the three-stage list square estimation on export performance model, as indicated in the Equation 7 below, revels the following. All figures in parenthesis under the equation represent t-values and probabilities respectively.

$$LogEXP = 1.739 + 0.531\log(RER) + 0.684\log(YTP) - 1.021\log(REMIS) + 0.225\log(AID) \quad \textbf{(7)}$$

t-value) (1.12) (1.98) (3.99) (-4.74) (1.16)

Adjusted R^2 = 0.89
DW statistic = 1.50

All together, 89% of the export performance model is explained by the explanatory variables. As expected, increases in out put or income of Ethiopia's trading partners positively affected the performance of exports. Changes in the real exchange rate variable also bear the expected positive sign but is insignificant. Generally, depreciations in the real exchange rate positively affect export performance. The negative coefficient on the real exchange rate misalignment term highlights the adverse effect it has on export performance. For the policy environment proxy (i.e., aid), an insignificant relationship is seen to exist. This suggests that for aid to have a significant positive impact on export performance, production subsidies to firms in the tradable sector, or simply export subsidies are required. The government could consider export promotion in the form of both price and non-price incentives. Alternatively, the government could try interest subsidies, that is, the introduction of a subsidy to banks to make it possible for them to charge lower interest rates for exporting firms. For this to be effective, however, donors should delegate more responsibility to the Ethiopian government, while at the same time creating an incentive structure for good performance. This would include among other things a shift towards ex post conditionality and aid allocation according to performance.

4. Conclusion and policy implications

The Ethiopian economy has been the recipient of substantial aid inflows for its development activities, and these inflows have been increased in recent years. Give donor fatigue and the growing competition for aid funds among less developed countries, any current curtailment of these inflows could have adverse effects on the Ethiopian economy. One implication for macroeconomic management is that rather than using aid for current consumption it is vital to use it in infrastructure developments like education, health services, road networks in the peripheral areas etc. In a situation with poor administrative capacity and a large debt burden, it would also make sense to shift aid resources to debt service and Balance of payments (or budget) support. This will make it possible for the Ethiopian government to use more of its own resources for development, at the same time as reduced debt should stimulate private investment. This will further pave the way for curtailment of aid dependence in the future. Global trends show that there is a tendency towards reduced aid flows from the donor community. For developing economies like Ethiopia, this trend has serious implications for the country's development activities. In order to prevent the economy against future losses, in the form of debt servicing for instance, it is appropriate to adopt strategies for reducing aid intensity and hence dependence by continuously improving the institutional mechanisms of aid delivery. This requires effective civil service reform, transparency, democratization and good governance.

The paper tried to develop an empirical model for the Dutch disease effect of foreign aid on the Ethiopian economy. The analysis emerges from the discussion of the 'spending effect' within a classic Dutch disease framework. By employing the three-stage estimation techniques, the study concludes that aid inflows lead to real exchange rate appreciation in the case of Ethiopia and hence the loss of export competitiveness in the international market. This calls for a sound policy environment so as to elicit good macroeconomic performance. Policy management thus needs to focus on ensuring the prevalence of sound macroeconomic fundamentals such as small black market premium, spending on infrastructure, openness to trade, providing credit to firms in the tradable sector, good governance and other policy measures. Ensuring of a sound macroeconomic management is a pre condition for aid eligibility in the face of donors. This implies that with a good policy environment, external aid could be an effective investment in the Ethiopian economy and could spur the realization of the country's poverty reduction strategy.

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Annex

System: FINALSYSTEM
Estimation Method: Iterative Three-Stage Least Squares
Date: 05/13/05 Time: 17:19
Sample: 1970 2001
Included observations: 32
Total system (unbalanced) observations 63
Instruments: CBR INVGDP TOT ODA YTP CPS REMIS NEER C
Convergence achieved after: 6 weight matricies, 7 total coef. iterations

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	6.262044	1.010992	6.193959	0.0000
C(2)	0.918235	0.175861	5.221382	0.0000
C(4)	-0.437671	0.125174	-3.496511	0.0010
C(6)	0.734067	0.504283	1.455666	0.1516
C(7)	0.181899	0.053918	3.373645	0.0014
C(3)	-0.157174	0.175684	-0.894644	0.3752
C(13)	-0.366198	0.225652	-1.622841	0.1108
C(8)	1.739559	1.552079	1.120793	0.2676
C(9)	0.225960	0.193693	1.166590	0.2488
C(10)	0.531618	0.268414	1.980587	0.0530
C(11)	0.684035	0.171202	3.995479	0.0002
C(12)	-1.020597	0.215283	-4.740727	0.0000
Determinant residual covariance		0.002023		

Equation: LOG(REER) = C(1) +C(2)*LOG(CPS) + C(4)*LOG(ODA) + C(6)*(LOG(NEER)-LOG(NEER(-1))) + C(7)*LOG(CBR)+C(3) *LOG(TOT)+C(13)*LOG(INVGDP)
Observations: 31

R-squared	0.734607	Mean dependent var	4.419524
Adjusted R-squared	0.668258	S.D. dependent var	0.368057
S.E. of regression	0.211990	Sum squared resid	1.078553
Durbin-Watson stat	1.487043		

Equation: LOG(REP) = C(8) + C(9)*LOG(ODA) + C(10)*LOG(REER) + C(11)*LOG(YTP) +C(12)*LOG(REMIS)
Observations: 32

R-squared	0.910814	Mean dependent var	7.361908
Adjusted R-squared	0.897602	S.D. dependent var	0.821014
S.E. of regression	0.262722	Sum squared resid	1.863619
Durbin-Watson stat	1.502982		

Annex: Estimated Result