Ethiopian Journal of Economics

Volume XIV | Number 2 | October 2005

Ethiopian Journal of Economics

Volume XIV Number 2 October 2005

ETHIOPAN ECONOMIC ASSOCIATION

ISSN 1993-3681

Volume XIV Number 2 October 2005

Ethiopian Journal of Economics

A Publication of
THE ETHIOPIAN ECONOMIC ASSOCIATION
(EEA)

ETHIOPIAN JOURNAL OF ECONOMICS

VOLUME XIV NUMBER 2 October 2005

Published: May 2008

Simultaneous Random Effect Models of Poverty and Childbearing in Ethiopia

Abbi M. Kedir[1], Arnstein Aassve[2], Habtu Tadesse Woldegebriel[3]

Abstract

The incidence and severity of poverty in urban and rural Ethiopia are similar – both extremely high. In contrast, urban and rural fertility rates differ substantially. Whereas the Total Fertility Rate (TFR) in rural areas is as high as 5.5, it is as low as 1.9 in Addis Ababa. The declining fertility rate especially in the capital city is paradoxical to economic demographers. This paper analyses the complex relationship between childbearing and poverty in urban and rural Ethiopia. We model child bearing and poverty as joint random effect models, controlling for initial conditions. Using panel data for three (comparable) waves both for rural and urban Ethiopia, our analysis examines the inherent differences in the poverty and fertility relationship.

Acknowledgement

We thank the participants of the "**Reducing Poverty and Inequality: How can Africa be included?"** 2006 CSAE Conference (19-21st March, Oxford) participants for their comments. The project is funded under the framework of the European Science Foundation (ESF) - European Research Collaborative Program (ERCPS) in the Social Science, by Economic and Social Research Council (award no. RES-000-23-0462), the Italian National Research Council (Posiz. 117.14), and the Austrian Science Foundation (contract no. P16903-605). We are also very grateful to the Department of Economics, Addis Ababa University for giving us access to the data used in the analysis.

[1] Corresponding Author; Department of Economics, University of Leicester, UK;
[2] Institute of Social and Economic Research, University of Essex, UK and,
[3] Land Economy and Environment Research Group, SAC Kings Buildings, West Mains Road Edinburgh, UK, EH9 3JG

Introduction

The relationship between poverty and fertility is a long contested issue among demographers and economists. The general empirical observation that poorer countries tend to have higher population growth rates and that larger households tend to be poorer, underlies the presumption of a positive causal relation between poverty and fertility at the national and household levels respectively. The macro level argument relies on the neo-classical paradigm that higher population growth rate depresses capital accumulation and wages, where poverty in turn is considered a key factor driving high fertility and therefore high rates of population growth, consequently delaying the demographic transition. The standard micro argument is that households relying on primitive farming technologies have a greater need for cheap labour, and therefore a higher demand for children. Lack of state benefits and pensions may also increase demand for children is a means of insurance or security in old age. Consequently perceived costs and benefits of children, and thus fertility behaviour, do not only depend on economic forces and social organisations, but also on cultural patterns.

The issue of poverty and fertility is of course highly relevant in most sub-Saharan countries, including Ethiopia. At an estimated population of 77 million people, Ethiopia is second only to Nigeria - currently sub-Saharan Africa's most populous nation. Moreover Ethiopia's population is growing at a rapid pace, adding some two million people every year. By the year 2050, Ethiopia's population is estimated to grow by an astounding 120 percent, implying that in 44 years, the population of Ethiopia is expected to be around 169 million (Population Reference Bureau). Given that poverty is already dramatically high in Ethiopia and that economic growth has remained modest over the last few decades, suggest that the country may not be prepared to handle the consequences of such a population boom.

In this paper we use longitudinal information and binary response models as means to tap into the causality issue underlying the observed positive correlation between poverty and fertility. A common observation in both developing and developed countries is that those currently poor are also more likely to be poor in the future. This might be due to the simple fact that these households have certain characteristics which might make them particularly prone to poverty. These characteristics may be observed, such as their health status or human capital accumulation, but also unobserved, such as ability, aspirations or intelligence. But the positive relationship between current and future poverty experiences may also be due to state dependence, which is interpreted as a direct causal effect running from current poverty itself. Identification of state dependence from heterogeneity is crucial in order

to assess the effectiveness of policies. In the case of strong state dependence (i.e. current poverty causes future poverty independent of other causes) then poverty reduction policies will be powerful since reducing current poverty will also reduce future poverty experiences. In a *poor* country with *high fertility* rates, such as Ethiopia, the key question is whether fertility provides a causal feedback mechanism onto future poverty experiences, and vice versa. Establishing such causal feedback mechanisms is crucial for appropriate implementation of sensible population and poverty reduction policies. For instance, if the aim is to reduce fertility levels in rural areas, say, then poverty reduction policies might be effective in doing so in so far there is a positive feedback effect from poverty onto fertility. Additionally (or alternatively), in so far fertility has a causal feedback mechanism on reducing future poverty experiences, fertility policies, such as improved family planning, will have an impact on reducing overall poverty. Establishing the magnitude of the two effects is informative since it tells us the extent to which poverty drives high fertility and vice versa.

By using panels from both rural and urban Ethiopia, we specify and estimate a simultaneous and dynamic random effect model of poverty and fertility, controlling for state dependence that allows for feedback mechanisms through poverty and fertility. Clearly, fertility and poverty are not the only intervening factors, so we include a range of background variables, as well as control for unobserved heterogeneity. Whereas poverty is very high in both rural and urban areas, there are substantial differences in terms of fertility. Total fertility rate is as high as 5.5 in rural Ethiopia, but only 1.9 in Addis Ababa, which is by far the largest urban concentration in Ethiopia. Given these rural/urban differentials, we make separate estimates for the two samples.

We find that…. Bla bla

Background

In the traditional micro-economic framework children are considered as an essential part of the household's work force to generate household income, as well as insurance against old age. In rural underdeveloped regions, which largely rely on primitive farming technology and with no or little access to state benefits, this argument makes a great deal of sense. Whereas newly born children may decrease the productivity of the mother either by taking more resources (such as food) from her or hampering her work prospects, children may bring more resources as they grow older through work. Thus deprived households, lacking essential state services and residing in highly primitive farming communities, might have higher demand for

children. However, a high number of children and their participation in household production are likely to impede investment in their human capital (i.e. education), maintaining the low-income status of the household, and thereby creating or perpetuating a poverty - fertility trap. As households gain higher income and wealth, they tend to have fewer children either through quantity-quality trade-off as suggested by Becker and Lewis (1973) or by higher opportunity cost of women associated with higher income as suggested by Willis (1973). These demand side arguments rely of course on the fact that couples are able to make choices and to control fertility outcomes. One crucial component in this respect regards access and take-up of family planning. Poor availability of family planning means that women are less able to plan their fertility careers, implying a significant amount of unintended pregnancies (Easterlin and Crimmins (1985)). In so far family planning is not available, the power of the demand side arguments become weaker, and it becomes difficult to identify the demand side effect from supply side effects. A related issue concerns women's status and empowerment in society. Expansion of female education, thereby reducing women's willingness to give up work for childbearing, is possibly the most important driver behind increased opportunity cost and fertility decline. Consequently fertility reduction is often seen as a direct result of increased empowerment of women through education. Educational infrastructure and educational policies are clearly important as higher compulsory childhood schooling will delay the onset of a young adult's working life, thereby reducing child labour (Livi-Bacci (2000); Badeer (2001)). Lack of education opportunities for women is also a factor that reinforces social norms of women's role and position in society. In many traditional and primitive societies, men's status depends very much on their ability to foster a large family and the household head is considered more successful if they have many children. Such perceptions are likely to be stronger in rural and primitive areas, where there is also stronger gender bias in terms of education (boys go to school – girls stay at home). The consequence is that women's role tend to be limited to childrearing and other household activities. With economic progress and urbanisation, women gain higher education and independence and empowerment (Drovandi & Salvini (2004)). Social norms become weaker, and traditional demographic patterns fade, which is reflected by the demographic transition. Moreover, economic progress reduces labour intensive technologies, which reduces the demand for child labour**.**

Table 1 gives summary data on the demographic and economic conditions prevailing in Ethiopia since 1980[1]. It is immediately clear that Ethiopia is a country where poverty is severe in which more than two-thirds of the population live on less than $2 per day. Despite a series of economic reforms gradually being introduced in the late eighties, the Ethiopian economy remains heavily agriculture-centred with around 85% of households being classified as farmers and by any measure the mode of production is primitive and labour intensive. Provision of family planning services is

also poor, especially in rural areas, and by 2000 the contraceptive prevalence rate (CPR) in rural Ethiopia was only six percent, whereas it was around 45 percent in urban areas[2]. The political history of Ethiopia has obviously hindered progress in health provision and promoting economic reforms. After the traditional monarchy was replaced in 1974 by the provisional military government, much of the Ethiopian economy was nationalised. The 1980s followed with political unrest and upheavals, and the country was plagued by a series of famines, all with devastating effects (Lindstrom and Berhanu (1999)). The fertility rates during this period remained high. However, fertility rates differ dramatically between urban and rural areas. For instance, TFR in Addis Ababa, by far the largest urban concentration in Ethiopia, is as low as 1.9, which is below replacement level. In rural areas, in contrast, the TFR is as high as 6.5 (Kinfu (2000); Sibanda et al (2003)). One issue concerns child labour which is still high in Ethiopia and remains critically important in a heavily agricultural based economy (Admassie (2002)). Moreover, school enrolment and literacy rates, though improving, remain critically low, especially in rural areas.

Table 1: Demographic and economic indicators, Ethiopia

	1980	1990	2000	2003
Total Fertility Rate (TFR)	6.6	6.9	5.7	5.7*
Life expectancy at birth (years)	42.0	45.0	42.3	42.1*
Population Growth (% annual)	2.7	3.7	2.4	2.1
Total Population (in millions)	37.7	51.2	64.4	68.6
Rural population (% of total)	89.5	87.3	85.1	84.4
GDP per capita ($US in 1995 prices)	..	107.3	115.1	115.0
Child labour (% of 10-14 age group)	46.3	43.5	41.1	40.4

*Data refer to 2002, last year available (Source: *World Development Indicators* database)

The dire population problems facing Ethiopia were laid out in the National Population Policy of Ethiopia (NPPE) introduced in 1993. One of the main problems facing Ethiopian Society is that the population has been growing at a faster pace than the economy itself, and the major demographic factor behind this development is the high fertility rate. It also voices concern over the fact there is little indication that fertility rates are bout to decline. A key element of the document is that the policy implications related to the ever growing population should not be limited to provision of health. Rather, population growth, and in particular high fertility rates, is a multifaceted issue that is both a cause and consequence of economic development issues, and is related to education, health provision, private investment, food insecurity, environmental problems, and last but mot least, issue concerning social norms and traditions related to women's role in society. In fact, the document emphasises that the economic, social and political status of women have direct

bearings on the level of fertility. In so far women's roles are defined in terms of household management and matrimonial duties, fertility decisions lies primarily with the household head. Although there are no laws restricting women attending school, the traditional roles of women are reflected and reinforced through a strong gender bias in school attendance. The weak role of women and its relationship to high fertility rates are exacerbated through inadequate family planning. Inefficiency in its delivery together with restrictive legislation has certainly not encouraged the use and spread of modern contraceptives. Objectives of the Ethiopian NPPE encapsulate a range of issues, including closing the gap between population growth and low economic productivity, reducing current TFR from 7.7 down to 4.0, raising the social and economic status of women and increase women's participation in education and removing legal customary practices which currently restrict women's economic and social rights.

Whereas the NPPE emphasises the importance of economic growth and poverty reduction as a means to tackle population growth, mainly through high fertility rates, the Sustainable Development and Poverty Reduction Program (SDPRP) introduced in 2002, and followed up by another SDPDR in 2005, does not say much about the role of population and fertility for poverty reduction. In fact, reduction in population growth through reduced fertility does not appear as a crucial policy instrument to combat poverty. The SDPRP does however make a strong commitment to combat and reduce gender imbalances in Ethiopian society. The SDRPR also put strong focus on education, through increasing enrolment rates and educational infrastructure, though not much emphasis is put on how to reduce strong gender imbalances in education. The SDPRP also emphasises the importance of improving health provision at the community level, but it also states that the health programmes will give priority to prevention of diseases. Very little is said about improving family planning and increasing the use of modern contraceptives. Though, the SDPRP does not mention the population issue specifically, clearly improvements in health provision and education, certainly if the gender dimension is properly addressed, its implementation should have an impact on reducing fertility which is line with the objectives stated in the NPPE.

Urban poverty in Ethiopia is on the increase, and is almost as high as it is in rural areas. The issue of poverty reduction urban areas is therefore important and specifically mentioned in the SDPRP. However, given that around 85 percent of the Ethiopian population lives in rural areas, the overriding priority is put on rural poverty reduction. Naturally agriculture plays a key role and numerous instruments are introduced to improve the economic situation for farmers. Land is state owned and the land policy states that anyone who wants to farm should be given access to land free of charge. This policy, at least in part, explains the domination of small holder

farms. Whereas the SDPRP highlights the importance of cooperation and the need for improved productivity in the agriculture sector, the structure of small land holdings is likely to persist. In other words, the labour intensive dimension of farming is likely to prevail in the future.

Given the data available, it is clear we are unable to address all the policy issues highlighted in the NPPE and the SDPRP. However, using longitudinal data and appropriate econometric techniques, we are able to assess the causal relationship between poverty and fertility, and we are able to do so separately for urban and rural areas. Consequently, the analysis will provide useful information which may complement the policy planning currently adopted.

Empirical Framework

Data

We use both the Ethiopia Urban Household Survey and the Rural Household Survey. Appendix II gives an overview of both surveys. Our analysis is based on the three waves for the urban survey which were conducted in 1994, 1995 and 1997. We also use three waves from the rural survey which are comparable in terms of the period of collection (i.e. first one of the two surveys conducted in 1994, 1995 and 1997). Ethiopia was at war with neighbouring Eritrea from 1998 – 2000. This represents important shock to the economy, and as a result we did not include waves coinciding with this period.

We use several measures of the economic wellbeing of the household. Given the continued focus on poverty, we construct a poverty variable that is based on households' level of consumption expenditure. Poverty status is specified as a discrete state, and is derived from the more general FGT family of poverty measures (Foster, Greer and Thorbecke (1984)). Let ν be the number of household members, y be the household's welfare indicator (per capita expenditure) and let τ be the poverty line. In population terms, the FGT index is defined as follows:

$$FGT_{\alpha} = \frac{E\left(\nu\delta_{\alpha}(y)\right)}{E\left(\nu\right)}$$

where E is the expectations operator and $\delta_{\alpha}(y)$ is the function:

$$\delta_\alpha(y) = \begin{cases} (1 - y/\tau)^\alpha & \text{if } y < \tau \\ 0 & \text{if } y \geq \tau \end{cases}$$

and $\alpha \geq 0$ is the coefficient of poverty aversion. We operate with two definitions of poverty status. The first is the headcount which is given by $\alpha = 0$ above. This assumes that each household member consumes equal amounts, which of course is a strong assumption. Rather, consumption levels will depend on the age and gender of the household members. Consequently we use the World Health Organisation (WHO) equivalence scale (see Appendix …). The poverty line τ is constructed using the 'cost of basic needs' approach following Ravallion and Bidani (1994). In brief this involves estimating the cost of a certain expenditure level which corresponds to a minimum calorie requirement. A food poverty threshold is defined as the expenditure needed to purchase a basket of goods that will give the required minimum calorie intake. Following FAO recommendations this threshold is set at 2100 calories[3]. Consumption expenditure includes auto-consumption. We use unit conversions as suggested by Dercon (####). More details needed here.

A drawback of the two surveys is that they do not include full retrospective fertility histories. Instead we rely on the household roster which gives the number and ages of children living in the household in addition to recording new births between waves. For the initial conditions (to be explained shortly) we use the number of children as the dependent variable. Clearly this is an approximation to the number of children actually born to the household head, and is strictly speaking not a direct measure of fertility. Children might have died or moved away from the household head, which is not well controlled for in a retrospective sense. However, childbearing between waves refer to actual births and are a reasonable precise measure of fertility outcomes.

Tables 1 to 3 provide descriptive statistics of children and poverty and how they are related to some key variables. Starting with Table 1, which includes the urban sample only, shows that poverty increases with the number of children. Homeownership is also positively associated with children whereas the household head's subjective poverty assessment does not vary much with children. Interestingly, deprivation is lower the more children present in the household. Moving onto Table 2, which gives similar statistics for the rural sample, shows again a positive relationship with the number of children, though the gradient is not as strong as it is in the urban sample. Both land size and amount of livestock are positively related with children, whereas deprivation again declines with higher number of children.

Table 1:
Descriptive statistics urban sample: Means

# children	Poverty	Ownership	Subjective poverty	Deprivation
0	0.261	0.381	0.555	0.668
1	0.335	0.416	0.543	0.642
2	0.393	0.424	0.563	0.650
3	0.462	0.443	0.525	0.630
4	0.503	0.470	0.563	0.630
5	0.604	0.527	0.538	0.629
	0.453	0.456	0.546	0.640

Table 2:
Descriptive statistics rural sample: Means

# children	Poverty	Land size	# livestock	Deprivation
0	0.309	0.774	23.680	0.688
1	0.457	0.796	23.840	0.686
2	0.445	0.846	25.436	0.674
3	0.522	0.995	30.973	0.641
4	0.592	0.936	27.340	0.623
5	0.516	0.947	30.724	0.613
	0.485	0.899	27.905	0.645

Table 3:
Descriptive statistics: Correlations

		Deprivation	High education	Ratio of high education	Land size	Livestock	Subjective poverty	Owner of dwelling
URBAN	Number of children	**-0.069**	**-0.111**	0.045	-	-	-0.01	0.104
	Poverty	**0.395**	**-0.215**	**-0.181**	-	-	**0.334**	**-0.063**
RURAL	Number of children	**-0.258**	-0.045	**0.061**	**0.091**	**0.217**	-	-
	Poverty	**0.210**	**-0.073**	**-0.132**	**-0.096**	**-0.143**	-	-

Table 3 shows simple correlations between key variables where figures in bold are significant at the five percent level. The figures suggest that education is negatively associated with both poverty and childbearing, though the correlation is stronger in urban areas. Interestingly, land size and livestock is positively associated with children in rural areas, but at the same time negatively correlated with poverty.

The econometric specification

There are numerous studies tackling the issue of state dependence and heterogeneity. Examples range from unemployment issues (e.g. Heckman (1978, 1981); Arulampalan et al. (2000)), studies of persistence in low pay (Stewart and Swaffield (1999)) and analysis of poverty persistence (Biewen (2004)). A common approach in these studies is to employ a dynamic binary response model with controls for unobserved heterogeneity. The approach taken here is based on Woodridge (2005), but we make extensions in order to facilitate possible reversed causality between fertility and poverty, and as such the approach is similar to that of Biewen (2004). We start by specifying a simple dynamic random effect probit model for poverty[4]:

$$\Pr(p_{it} = 1 \mid x) = \Phi\left(\beta^{p} x_{it}^{p} + \delta^{p} p_{it-1} + \gamma^{p} k_{it-1} + \eta_{i}^{p}\right) \qquad (1)$$

where x_{it}^{p} is the set of assumed exogenous variables, p_{it-1} is the lagged poverty status, k_{it-1} is an indicator for lagged child bearing events, possibly endogenous with respect to poverty status, whereas η_{i}^{p} is the time-invariant and unobserved household effect. As was outlined in the previous section, poverty status is based on the household consumption expenditure, whereas the poverty threshold is derived from a food basket equivalent of 2100 Kcal. Since the consumption expenditure is readily available, we also estimate a specification where economic wellbeing is defined by the log consumption expenditure of the household:

$$\log\left(E_{it}\right) = \beta^{E} x_{it}^{E} + \delta^{E} E_{it-1} + \gamma^{E} k_{it-1} + \eta_{i}^{E} \qquad (1b)$$

[4] With information on the history of poverty and childbearing events, we could (in theory) estimate hazard models in a simultaneous estimation framework. Clearly, in a panel of three waves the poverty history will necessarily be incomplete. Moreover, none of our data sets contain fertility histories, though they could be (incompletely) reconstructed from the household roster.

An obvious advantage of estimating the log consumption expenditure is that we use the whole distribution. The estimates of the log consumption expenditure are reported along side the poverty process in Tables 6, 7 and 8.

In order to ensure consistent and unbiased parameter estimates, η_i^p is assumed independent of the observed covariates. This assumption implies that there is no feedback from the dependent variable onto future values of the explanatory variables, including children and future child bearing events[5]. Several methods have been suggested to deal with these issues. Mundlak (1978) propose a parameterization of the random effect consisting of the mean values of the explanatory variables. Chamberlain (1984) suggests an approach whereby the random effect is specified as a linear regression of all explanatory variables. If there is sufficient within-household variation, separate estimates of the β vector can be obtained and used to identify the correlation between the household specific term and the covariates. Another issue concerns the time dimension of our sample. The observed fertility and poverty histories are certainly incomplete since our sample only includes three waves. As pointed out in Heckman (1981), with lagged response variable and unobserved heterogeneity, a small time dimension relative to the cross-sectional dimension produces inconsistent maximum likelihood estimates. This is commonly known as the initial condition problem and is certainly an issue that needs addressing in this application. Moreover, the random effect η_i^p is unlikely to be independent of the initial values of the poverty process p_{i0}. The initial conditions problem can be solved in different ways. One is to specify the initial conditions to be non-random constant, but implies that the initial conditions are assumed independent of unobserved and observed heterogeneity. The other is to let the initial conditions be random by using the joint distribution of all outcomes on the response conditional on unobserved and observed heterogeneity (Wooldridge, 2005). This approach implies computational challenges, but can be simplified for some important non-linear models. Wooldridge (2005) shows that for the probit, logit, tobit and the poisson, rather than specifying the distribution for the initial conditions separately, the distribution of heterogeneity, including unobserved, can be done by specifying an auxiliary regression for the random effect that includes the initial value of the response variable and strictly exogenous covariates. Whereas this approach offers computational convenience, it also omits interesting information about the initial conditions. Rather than simply specifying an auxiliary regression for the initial condition we estimate its distribution, together with the processes itself, integrating out over the random effect. Though the

[5] This is also known as the strict exogeneity assumption.

approach is computationally less convenient than the Wooldridge (2005), estimation can be done easily in software packages such as aML and MLwin.

In our application concern lies in whether fertility decisions are exogenous with respect to poverty and vice versa. If there is feedback from fertility onto future poverty status, then this violates the strict exogeneity assumption, implying that the random effect is not independent from the explanatory variable measuring fertility. The same will be the case of course if there is feedback from poverty onto future fertility outcomes. As a result we specify a model where poverty and fertility processes are estimated jointly. Whereas the specification of poverty is given according to equation (1), the specification of the fertility process is given the probit specification as follows:

$$\Pr(k_{it} = 1 \mid x) = \Phi\left(\beta^k x_{it}^k + \delta^k k_{it-1} + \gamma^k p_{it-1} + \eta_i^k\right) \tag{2}$$

where x_{it}^k is the set of exogenous covariates, which may or may not be the same as x_{it}^p in equation (1), k_{it-1} is the lagged birth event variable, p_{it-1} is the lagged poverty status and potentially endogenous with respect to childbearing, and η_i^k is the time-invariant household random effect related to childbearing. The initial condition for poverty status is also implemented by a probit model:

$$\Pr(p_{i0} = 1 \mid x_0) = \Phi\left(\beta^{p0} x_{i0}^{p0} + \gamma^{p0} K_{i0-1} + \eta_i^p\right) \tag{3}$$

Similarly, the initial condition for the log of consumption expenditure is given as:

$$\log\left(E_{i0}\right) = \beta^{E0} x_{i0}^{E0} + \gamma^{E0} k_{i0-1} + \eta_i^E \tag{3b}$$

Whereas a probit model can suitably be used for the poverty status in the initial time period, the same is not true for childbearing. Here the initial value will refer to the *number* of children in the first time period and as result we use the Poisson model. In general the Poisson regression model specifies that each outcome, K_{i0}, here the number of children in the initial period, is drawn from a Poisson distribution with parameter λ_i, that is related to the covariates. Using the log-linear model we specify the initial condition for fertility as:

$$\lambda_{i0}^K = \exp\left(\beta^{k0} x_{i0}^{k0} + \gamma^{k0} p_{i0} + \theta \eta_i^k\right) \tag{4}$$

Identification and estimation of equations (1) - (4) entail several important issues. First, equation (3) and (4) require exclusion restrictions over equations (1) and (2) respectively, which implies that for the poverty process some of the variables contained in the set x_{i0}^{p0} are excluded from x_{it}^{p}. Similarly has to be true for the fertility process. Second, note that the initial conditions for poverty, as specified in equation (3), and the poverty process itself, equation (1), contain the same random effect η_i^p. This is also the case for the initial condition for childbearing and the childbearing process, but since the parameters of the Probit enter in a different way than the parameters in the Poisson model, we allow for a scale parameter θ. The lagged variable of the number of children in the household is included in the poverty process, and lagged poverty status is included in the childbearing process, both of which likely to be endogenous, and therefore correlated with the random effects. In order to encompass the correlation, we estimate equations (1) – (4) in a joint Maximum Likelihood procedure, in which then random effects are specified with a joint normal distribution:

$$\begin{pmatrix} \eta_i^F \\ \eta_i^P \end{pmatrix} \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_k^2 & \rho_{pk} \\ \rho_{pk} & \sigma_p^2 \end{pmatrix} \right) \tag{5}$$

In order to ensure identification, rather than including the contemporaneous poverty status, we use the lagged value (see Maddala 1983 for details on identification of simultaneous discrete choice models). By integrating out over the random error components, the observed outcomes are independent and can therefore be estimated by Full Information Maximum Likelihood (FIML). Integration of the error components is done by using quadrature approximation, and estimation is performed by the software package aML.

Though the specification encompasses endogeneity between poverty and fertility, it is assumed that the random effects are still independent of the remaining covariates. This can be dealt with by following Biewen (2004) who parameterize the random effect over the mean (over time) of the remaining covariates.

Results

Initial conditions

We start by presenting the estimates for the initial conditions (IC hereafter) for the rural and urban samples in Tables 5a and 5b, respectively. It is worth noting that the

estimates for the fertility IC remain rather stable with respect to the poverty measure used in the poverty process. In other words, estimation based on per capita poverty, poverty defined over the WHO equivalence scale, or even log of consumption expenditure, does not affect the IC fertility estimates much. As a result we report only one version of the IC fertility estimates (column (1)). In contrast, the parameter estimates of the poverty processes, are more sensitive to the equivalence scale, so here we present estimates based on per capita poverty (column (2)), poverty using the World Health Organisation (WHO) equivalence scale, and the log consumption expenditure – again using the WHO equivalence scale (column (4))[6].

The initial conditions require exclusion restrictions with respect to the dynamic poverty and fertility processes expressed by equations (3) and (4). We construct variables from the first wave that describes characteristics of the household which are of a semi-permanent nature. These include a deprivation index based on possessions of durables and physical characteristics of the dwelling (see Appendix I for a detailed description of the variables). For the urban sample (Table 5a) we include an indicator for home ownership, whether the income situation has improved (based on household head's subjective assessment) over the last five years, whether income levels are deemed sufficient to cover expenditure, and also a subjective poverty assessment, in which the household head is asked to express his view on the household's economic situation. For the rural sample (Table 5b) we control for land size and the amount of livestock, and whether the income situation worsened over the last five years. Unsurprisingly we find the deprivation index to be a strong predictor for poverty levels in both urban and rural areas. Conditional on deprivation (and other covariates) we find land size and livestock to have little impact on poverty levels in rural areas, but significant impact on fertility. Thus, the larger farm in terms of land size and livestock, the higher the demand for children. Having experienced a worsened income situation over the last five years, is associated with higher poverty, but no impact on fertility. For urban areas, unsurprisingly, we find home owners, those with increased income (over the last five years), and sufficient income levels to cover expenditure, to have lower poverty. The estimates also indicate that higher income households (in urban areas) have lower fertility, which reflect higher investment in child quality.

Moving onto the remaining IC parameters, it is interesting to see that once other factors are controlled for, children in *rural* households are not associated with higher poverty, which is in contrast to the pattern reported in Table 2. In urban areas (Table 5b), in contrast, children have a strong positive association with poverty, and there is a clear age gradient; the older the children, the higher the poverty rate. The effects of

[6] Appendix … provides details of the WHO equivalence scale.

children are reflected in the regression where log consumption expenditure is the dependent variable. Again, there is not significant effect of children in rural areas, but a significant negative effect in urban areas. Household composition also matters; more adults are associated with higher fertility, and also higher poverty, though there is a clear difference between rural and urban areas: a large number of women in rural households are linked with higher poverty, whereas in urban households large number of men is associated with higher poverty. Being married is naturally associated with higher fertility in both samples, but no significant effect on poverty or consumption expenditure. Extended households in urban areas, here measured by the number of generations living in the household, tend to be poorer. In rural areas, where extended families are more common, there is not strong association with poverty. In both cases, extended households, possibly reflecting more traditional family norms, have higher fertility.

The work ratios are calculated as the number of working household members over the total household members. Note however, that these are specific to adult men, adult women, and children. A high ratio of men working (in the household) is associated with lower fertility and poverty in urban areas and lower fertility in rural areas. A high female work ratio in rural areas is strongly associated with lower poverty, whereas there is little effect in urban areas. Child labour is also important, and for rural areas, we find that households where children are more likely to work also have higher fertility and higher poverty. Among urban households, the relationship is the opposite; households where children work have lower fertility and also lower poverty, though the latter is not precisely estimated.

The role of education is as expected and in general we find higher education to be associated with lower poverty and lower fertility. However, the parameters are not estimated precisely throughout. Especially in rural areas, we find evidence of non-linear effects, and in terms of the consumption expenditure, there is not much effect from higher education. This is in contrast to urban areas, where higher education is clearly associated with higher levels of expenditure.

Table 5a: Initial Conditions for rural sample

	FERTILITY (1) (who Eq.Sc.)		POVERTY (2) (Per capita)		POVERTY (3) (who Eq.Sc.)		CONS. EXP. (4) (who Eq.Sc.)	
Constant	0.3730		0.6505		-0.1653		3.7880	***
	(0.2601)		(0.7052)		(0.6822)		(0.8190)	
Level of deprivation	-0.1564		1.2467	***	1.5250	***	-1.0469	**
	(0.1353)		(0.3887)		(0.3839)		(0.4116)	
Land size	0.0136	***	-0.0041		-0.0025		0.0176	**
	(0.0032)		(0.0076)		(0.0075)		(0.0081)	
Amount of livestock	0.0034	***	-0.0056	*	-0.0048		0.0003	
	(0.0011)		(0.0032)		(0.0032)		(0.0033)	
Worsened income situation	0.0399		0.4880	***	0.5387	***	-0.2376	**
	(0.0344)		(0.0938)		(0.0916)		(0.1062)	
Children 0 to 4			-0.0067		-0.1093	*	0.0734	
			(0.0640)		(0.0622)		(0.0753)	
Children 5 to 9			0.0593		0.0481		-0.0789	
			(0.0510)		(0.0524)		(0.0632)	
Children 10 to 14			0.0039		0.0410		-0.0612	
			(0.0600)		(0.0587)		(0.0715)	
Age of HH head	-0.0035	***	0.0001		-0.0005		-0.0036	
	(0.0012)		(0.0032)		(0.0032)		(0.0035)	
Number of men in HH	0.1405	***	0.0091		0.0707		-0.0686	
	(0.0146)		(0.0513)		(0.0496)		(0.0566)	
Number of women in HH	0.1264	***	0.1572	***	0.1742	***	-0.0765	
	(0.0117)		(0.0483)		(0.0479)		(0.0608)	
Ration of working men	-0.1425	**	-0.1292		-0.0782		0.1272	
	(0.0566)		(0.1461)		(0.1445)		(0.1557)	
Ratio of working women	0.1187		-0.4835	**	-0.4898	**	0.1897	
	(0.0764)		(0.2007)		(0.1983)		(0.2322)	
Ratio of working children	0.3449	***	0.2100		0.2385	*	-0.1850	
	(0.0517)		(0.1414)		(0.1402)		(0.1575)	
HH head low education	-0.0620		-0.2952	**	-0.3111	**	0.1216	
	(0.0454)		(0.1260)		(0.1253)		(0.1512)	
HH head medium education	-0.1107	*	-0.3725	**	-0.0946		0.0340	
	(0.0570)		(0.1716)		(0.1664)		(0.1936)	
HH head high education	-0.2567	***	-0.7963	*	-0.5846		0.2585	
	(0.0944)		(0.4137)		(0.3884)		(0.4845)	
# of other HH members with			-0.0978	*	-0.1159	**	0.0893	
high education			(0.0563)		(0.0558)		(0.0795)	
# of other HH members with			-0.1109		-0.1163		0.0038	
medium education			(0.1024)		(0.0991)		(0.1140)	
HH head married	0.3973	***	0.0853		0.0268		0.0554	
	(0.0438)		(0.1272)		(0.1284)		(0.1348)	
Number of generations	0.1377	***	0.0257		0.0282		0.0182	
	(0.0310)		(0.0889)		(0.0890)		(0.0965)	

Table 5b: Initial Conditions urban sample

	FERTILITY (1) (WHO Eq.Sc.)		POVERTY (2) (Per capita)		POVERTY (3) (WHO Eq.Sc.)		CONS. EXP. (4) (WHO Eq.Sc.)	
Constant	0.4543	***	-1.8757	***	-1.8841	***	5.2228	***
	(0.1167)		(0.3902)		(0.3929)		(0.1716)	
Level of deprivation	0.1229	***	0.9289	***	1.0052	***	-0.4747	***
	(0.0458)		(0.1911)		(0.2023)		(0.0867)	
Home owner	0.0674	**	-0.3238	***	-0.3055	***	0.1986	***
	(0.0322)		(0.0924)		(0.0957)		(0.0422)	
Income increased	-0.1048	***	-0.5040	***	-0.6010	***	0.2377	***
	(0.0362)		(0.1050)		(0.1136)		(0.0510)	
Income sufficient to cover exp.	-0.0843	***	-0.3718	***	-0.3698	***	0.2017	***
	(0.0304)		(0.0882)		(0.0919)		(0.0402)	
Subjective poverty assessment			0.2681	***	0.2675	**	-0.1605	***
			(0.0986)		(0.1052)		(0.0488)	
Children 0 to 4			0.1828	**	0.0750		-0.0917	**
			(0.0926)		(0.0990)		(0.0418)	
Children 5 to 9			0.1536	**	0.1592	**	-0.1083	***
			(0.0670)		(0.0653)		(0.0313)	
Children 10 to 14			0.2406	***	0.2509	***	-0.1250	***
			(0.0538)		(0.0555)		(0.0256)	
Age of HH head	-0.0073	***	0.0085	**	0.0039		-0.0002	
	(0.0014)		(0.0042)		(0.0042)		(0.0019)	
Number of men in HH	0.1466	***	0.1117	*	0.1636	***	-0.0886	***
	(0.0108)		(0.0580)		(0.0596)		(0.0251)	
Number of women in HH	0.1589	***	0.0968		0.1065	*	-0.0404	
	(0.0115)		(0.0611)		(0.0634)		(0.0275)	
Ratio of working men	-0.0958	**	-0.2952	**	-0.2811	**	0.1981	***
	(0.0444)		(0.1294)		(0.1328)		(0.0581)	
Ratio of working women	-0.0802	*	0.0003		-0.0232		0.0653	
	(0.0485)		(0.1367)		(0.1411)		(0.0577)	
Ratio of working children	-0.7388	**	-2.2314		-1.6372		0.1477	
	(0.3002)		(1.3926)		(1.3232)		(0.3988)	
HH head low education	0.1271	***	-0.1436		-0.1622		0.1725	***
	(0.0479)		(0.1363)		(0.1355)		(0.0621)	
HH head medium education	-0.0182		-0.1237		-0.2492		0.1837	**
	(0.0544)		(0.1729)		(0.1738)		(0.0801)	
HH head high education	-0.1264	**	-0.5156	***	-0.5805	***	0.3681	***
	(0.0515)		(0.1727)		(0.1736)		(0.0769)	
# of other HH members with high education	0.3812	***	-0.0714		-0.0788		0.0279	
	(0.0366)		(0.0562)		(0.0580)		(0.0258)	
# of other HH members with medium education			0.0273		0.0524		-0.0156	
			(0.1005)		(0.0960)		(0.0447)	
HH head married			0.0004		-0.0558		0.0447	
			(0.1161)		(0.1171)		(0.0533)	
Number of generations in HH	0.1304	***	0.3735	***	0.2637	***	-0.1897	***
	(0.0314)		(0.0965)		(0.0980)		(0.0421)	

Random effects

The estimated standard deviations of the random effects and its correlations are presented in Tables 6a and 6b for the rural and urban samples, respectively. The estimated standard deviations of the random effects are highly significant for both processes, both in rural and urban samples. There is also a strong positive correlation between the poverty and fertility processes, though the correlations are weaker in the rural sample. The correlations between the poverty and fertility random effects also reflect the way poverty is defined, and in particular it depends on the equivalence scale used. Comparing columns (2) and (3) in Tables 6a and 6b demonstrates this point clearly. Column (2) shows the correlation when using per capita (or head count) poverty, whereas column (3) shows the correlation when imposing the WHO equivalence scale. Since it gives a smaller weight to younger children, the correlation naturally declines, and in general, the smaller weight assigned to children, the smaller the correlation between the two processes.

Table 6a: Random effects, rural sample

	Without IC (Per capita)		With IC (Per capita)		With IC (who Eq.Sc.)		With IC (Cons. Exp)	
	(1)		**(2)**		**(3)**		**(4)**	
S.D. of RE in fertility process	0.9857	***	1.0164	***	0.9986	***	1.0025	***
	(0.0888)		(0.0907)		(0.0896)		(0.0889)	
S.D. of RE in poverty process	0.3908	***	0.6360	***	0.6043	***	0.6213	***
	(0.1033)		(0.0656)		(0.0671)		(0.0683)	
Correlation of RE	0.0000		0.3326	***	0.2383	**	-0.0730	
			(0.0873)		(0.0935)		(0.1192)	
Theta (scale parameter)			0.2342	***	0.2349	***	0.2319	***
			(0.0337)		(0.0342)		(0.0339)	

Table 6b: Random effects, urban sample

	Without IC (Per capita)		With IC (Per capita)		With IC (who Eq.Sc.)		With IC (Cons. Exp)	
	(1)		(2)		(3)		(4)	
S.D. of RE in fertility process	3.1620	***	3.2886	***	3.3273	***	3.2590	***
	(0.4348)		(0.4547)		(0.4656)		(0.4287)	
S.D. of RE in poverty process	0.3991	***	0.6030	***	0.5964	***	0.5645	***
	(0.1141)		(0.0919)		(0.0905)		(0.0301)	
Correlation of RE	0.0000		0.4562	***	0.3977	***	-0.0517	
			(0.1126)		(0.1113)		(0.0587)	
Theta (scale parameter)			0.0566	***	0.0571	***	0.0545	***
			(0.0107)		(0.0108)		(0.0103)	

It is also worth noting the significance of the scale parameter θ. Specifications where the scale parameter is omitted (not shown here) produces very different correlations between the random effects (generally much stronger). Omitting the scale parameter also influence the parameter estimates of the covariates of interest.

Poverty and fertility processes – rural sample

We move next to analysing the fertility and poverty processes. Tables 7a and 7b provide estimates for the fertility and poverty processes, respectively, for rural households, tables 8a and 8b for the urban sample.

We start by considering the fertility process reported in Table 7a. The dependent variable is birth events occurring between waves and is estimated by probit according to equation (4). Of particular interest, is to assess the effect of lagged childbearing events (state dependence) and the lagged poverty status, the latter reflecting a possible feedback mechanism of poverty on future values of childbearing events. It is immediately clear that controlling for the initial conditions is important; the effect of previous children (i.e. state dependence) changes significantly once IC is estimated jointly with the process itself. In general we find presence of young children to have a strong effect on having another child, whereas the presence of older children has a negative effect. The effect of introducing the IC is not unexpected. Recall that the dependent variable of the IC is the number of children present in the household. Controlling for the IC should therefore weaken the effect of the children in the fertility process, as they themselves reflect the initial conditions. However, independent of the IC, lagged poverty status has no significant effect on childbearing events, suggesting that there is no causal feedback mechanism from poverty onto childbearing. Out of the other variables, we find child labour (here measured by the ratio of children working) to have a positive and significant effect on fertility. We also find household composition to matter, in particular, households with higher number of women present, have a lower likelihood of experiencing a childbearing event. This somewhat counterintuitive result is driven by the positive correlation between household composition and the number of generations living in the household, which has a positive effect on childbearing events. Other important variables include education, and in general we find those with higher education, net of other factors, to have a higher likelihood of experiencing a childbearing event.

Table 7b shows that there is positive state dependence in poverty, though the estimate is sensitive both to the IC and the equivalence scale. Without the IC, state dependence in poverty is over-estimated, whereas it is underestimated when using the head count poverty status. We also see some evidence of feedback from children onto poverty. Introduction of the IC has important effect on the estimates. For

instance, most of the children effects disappear, whereas the effect of having a child birth in the previous time period remains significant. Interestingly, the effect is negative which would suggest that there is some degree of planning of fertility decisions. In other words, child bearing might be more likely if the household experiences more favourable economic circumstances.

It is clear however, after controlling for state dependence and unobserved heterogeneity, only a limited of covariates have powerful explanatory power on poverty. Household composition is again important, larger households measured by the number of men and women, and also the number of generations living in the households, have higher poverty risk. The mechanisms underlying the significant effects are less clear. The use of equivalence scales is behind part of the story, but not all. Larger households may be a reflection of economic hardship. If it is the case that individuals choose to share the dwelling as a means to cope economically, then this would explain the positive relationship to poverty. To some extent this would also explain the negative effect with respect to fertility, since couples might try to reduce their fertility during extreme economic hardship. Certainly, in an environment where family values are important and where there are no social support schemes run by the state, living arrangement in extended families are common. As a coping mechanism relatives and friends who face economic hardships rely on each other for support, one solution being shared accommodation. The fact that extended families (again measured by the number of generations living in the households) are positively associated with poverty is therefore not unexpected. Interestingly, these households also face higher fertility levels (i.e. Table 7).

Child labour also play an important role, as we find a strong and significant effect of child labour on poverty. As we have already seen from Table 7, households with high levels of child labour also increases fertility. The effect of child labour in rural areas is particularly interesting. It is positive, and become stronger once we control for the IC. The estimates suggest that higher child labour produces higher poverty, and is interesting given that child labour is also associated with higher fertility

Table 7a: RANDOM EFFECT MODELS OF CHILDBEARING, RURAL SAMPLE

	Without IC		With IC Per capita Pov.		With IC WHO Eq.Sc.		With IC WHO Eq.Sc.	
Constant	-0.6760		-0.6518		-0.7279	*	-0.6674	
	(0.4177)		(0.4300)		(0.4232)		(0.4346)	
Lagged poverty status	-0.0039		-0.0049		-0.0051			
	(0.0057)		(0.0053)		(0.0053)			
Lagged log consumption exp.							0.0020	
							(0.0265)	
Children 2 to 4	0.1990	***	0.1251	**	0.1409	***	0.1422	***
	(0.0513)		(0.0521)		(0.0517)		(0.0516)	
Children 5 to 9	0.2064	***	0.0172		0.0230		0.0309	
	(0.0505)		(0.0523)		(0.0513)		(0.0512)	
Children 10 to 14	0.0035		-0.1822	***	-0.1921	***	-0.1969	***
	(0.0567)		(0.0578)		(0.0572)		(0.0566)	
Age of HH head	-0.0432	***	-0.0465	***	-0.0453	***	-0.0456	***
	(0.0039)		(0.0039)		(0.0038)		(0.0038)	
Number of men in HH	-0.0826	*	-0.0751		-0.0789	*	-0.0751	
	(0.0479)		(0.0466)		(0.0461)		(0.0462)	
Number of women in HH	-0.2028	***	-0.1825	***	-0.1703	***	-0.1733	***
	(0.0557)		(0.0564)		(0.0558)		(0.0550)	
Ratio of working men	-0.1582		-0.1234		-0.0699		-0.0998	
	(0.1736)		(0.1706)		(0.1656)		(0.1658)	
Ratio of working women	0.0715		0.0816		0.0714		0.0734	
	(0.1905)		(0.1930)		(0.1903)		(0.1892)	
Ratio of working children	0.3787	***	0.5005	***	0.4586	***	0.4663	***
	(0.1439)		(0.1459)		(0.1418)		(0.1423)	
HH head low education	0.2300	*	0.2108		0.2183	*	0.2106	*
	(0.1299)		(0.1303)		(0.1268)		(0.1277)	
HH head medium education	0.3554	**	0.3448	**	0.3555	**	0.3464	**
	(0.1471)		(0.1428)		(0.1386)		(0.1401)	
HH head high education	0.1893		0.1944		0.1829		0.1796	
	(0.1515)		(0.1485)		(0.1409)		(0.1411)	
HH head married	1.4523	***	1.5590	***	1.5440	***	1.5659	***
	(0.1722)		(0.1729)		(0.1686)		(0.1682)	
Number of generations	0.4118	***	0.4744	***	0.4883	***	0.4847	***
	(0.1019)		(0.1014)		(0.1006)		(0.1010)	
Farm household	0.0256		0.0455		-0.0012		-0.0144	
	(0.1578)		(0.1541)		(0.1521)		(0.1509)	
Fhhhamh	-0.1799		-0.1779		-0.2184		-0.2797	
	(0.2381)		(0.2381)		(0.2298)		(0.2304)	

Table 7b: RANDOM EFFECT MODELS OF POVERTY, RURAL SAMPLE

3	(1) Without IC		(2) With IC Per capita Pov.		(3) With IC WHO Eq.Sc.		(4) With IC WHO Eq.Sc.	
Constant	0.4884		0.6477	*	0.4675		3.3786	***
	(0.3212)		(0.3713)		(0.4125)		(0.5415)	
Lagged poverty status	0.2049	***	0.0076		0.1396	*		
	(0.0566)		(0.0809)		(0.0764)			
Lagged log consumption exp.							-0.0284	
							(0.0265)	
Children 0 to 1	-0.1787	***	-0.0701		-0.1422	**	0.0022	
	(0.0541)		(0.0673)		(0.0644)		(0.0852)	
Children 2 to 4	-0.0948	**	-0.0231		-0.0430		0.0499	
	(0.0483)		(0.0542)		(0.0545)		(0.0862)	
Children 5 to 9	0.0750	**	0.0924	**	0.0511		-0.0300	
	(0.0366)		(0.0419)		(0.0414)		(0.0707)	
Children 10 to 14	0.0879	**	0.0395		0.0670		-0.0643	
	(0.0400)		(0.0474)		(0.0454)		(0.0691)	
Age of HH head	-0.0038	*	-0.0026		-0.0008		-0.0002	
	(0.0021)		(0.0024)		(0.0024)		(0.0032)	
Number of men in HH	0.0341		0.0292		0.0927	**	-0.0433	
	(0.0352)		(0.0395)		(0.0390)		(0.0640)	
Number of women in HH	0.0845	**	0.0876	**	0.0872	**	-0.0603	
	(0.0346)		(0.0392)		(0.0376)		(0.0571)	
Ratio of men working	-0.0151		0.0089		0.0262		0.1362	
	(0.1030)		(0.1173)		(0.1111)		(0.1787)	
Ratio of women working	0.1456		0.1746		0.0868		-0.1570	
	(0.1151)		(0.1293)		(0.1303)		(0.1595)	
Ratio of children working	0.1765	**	0.3127	***	0.3422	***	-0.2494	**
	(0.0868)		(0.0955)		(0.0953)		(0.1267)	
HH head low education	0.0062		-0.0351		-0.0044		0.0278	
	(0.0873)		(0.1020)		(0.1039)		(0.1467)	
HH head medium education	0.1658		0.1154		0.0914		-0.1545	
	(0.1080)		(0.1237)		(0.1264)		(0.1638)	
HH head high education	0.0919		0.0209		0.0972		0.0011	
	(0.1179)		(0.1340)		(0.1275)		(0.1885)	
# of other members with	-0.1505	***	-0.1435	***	-0.1534	***	0.0983	
high education	(0.0392)		(0.0434)		(0.0429)		(0.0699)	
# of other members with	-0.0965		-0.0845		-0.1168		0.1349	
medium level education	(0.0676)		(0.0777)		(0.0766)		(0.1294)	
HH head married	0.1734	*	0.1657	*	0.0409		-0.0373	
	(0.0892)		(0.1001)		(0.0961)		(0.1128)	
Number of generations	0.2624	***	0.2780	***	0.1870	***	0.0096	
	(0.0598)		(0.0672)		(0.0640)		(0.0937)	
Farm household	-0.2217	**	-0.2597	**	-0.2178	**	0.1564	
	(0.0908)		(0.1062)		(0.1041)		(0.1671)	

Poverty and fertility processes – urban sample

Starting with the fertility process, we see again that lagged poverty status has no impact on fertility outcomes. The role of past childbearing events is however, very different to those of the rural sample. Whereas, in the rural case, the presence of young children encouraged further childbearing, the opposite pattern is the case in urban Ethiopia. Of course, this is a reflection of the very different fertility patterns in urban and rural Ethiopia. As was the case in the rural sample, controlling for the initial conditions have the expected effect of reducing the impact of past childbearing events. Other than past fertility events, age of the household head, and marital status, not many covariates appear important in explaining urban fertility. The most important is the male work ratio, which reflects an income effect.

There is considerably more action in the poverty process. Compared to the rural sample we find considerably stronger state dependence in poverty. The negative effect of childbearing might at first seem non-intuitive given descriptive statistics presented previously, which showed a positive relationship between poverty and the number of children. The explanation lies in the inclusion of the lagged dependent variable (i.e. state dependence). Since children are positively related to poverty, inclusion of the lagged poverty status brings about the negative coefficient associated with young children. However, older children (aged 10 to 14) bring about a positive effect on poverty. The effects of lagged poverty and children persist in the urban sample once controlling for the IC. The effects are, however, significantly weaker. Thus we observe a high level of poverty persistence in urban areas, and once controlling for this persistence, child bearing events do not bring about a higher level of poverty.

Several other factors explain poverty in urban Ethiopia. As with the rural sample, the number of adults and generations in the household is always associated with higher poverty. Thus pooling of resources and accommodation is an important coping mechanism also in urban areas. Employment is clearly important in alleviating poverty, as reflected in the negative coefficient on the make work ratio. The coefficients on the children and female work ratios are also negative, but never significant.

In contrast to rural Ethiopia, education has a much stronger impact on poverty alleviation. In urban areas, completing primary, secondary and higher education, all reduces the poverty incidence, and with completion of higher education has the most pronounced impact.

Table 8a: RANDOM EFFECT MODELS OF CHILDBEARING, URBAN SAMPLE

	Without IC		With IC Per capita Pov.		With IC WHO Eq.Sc.		With IC WHO Eq.Sc.	
Constant	-3.5650	**	-2.8931	**	-2.7876	**	-2.7731	**
	(1.4032)		(1.2606)		(1.2840)		(1.2379)	
Lagged poverty status	0.0100		0.0079		0.0090			
	(0.0087)		(0.0110)		(0.0110)			
Lagged log consumption exp.							0.0091	
							(0.0106)	
Children 2 to 4	-0.7997	***	-1.1301	***	-1.1666	***	-1.1457	***
	(0.2991)		(0.2925)		(0.2940)		(0.2922)	
Children 5 to 9	0.4518	***	0.1333		0.1210		0.1364	
	(0.1284)		(0.1456)		(0.1459)		(0.1472)	
Children 10 to 14	0.3665	**	-0.1082		-0.1074		-0.1013	
	(0.1760)		(0.1920)		(0.1925)		(0.1899)	
Age of HH head	-0.0912	***	-0.0895	***	-0.0962	***	-0.0922	***
	(0.0193)		(0.0212)		(0.0227)		(0.0224)	
Number of men in HH	-0.0823		-0.2401		-0.2441		-0.2345	
	(0.1448)		(0.1554)		(0.1578)		(0.1547)	
Number of women in HH	-0.2717	**	-0.1606		-0.1602		-0.1641	
	(0.1237)		(0.1280)		(0.1285)		(0.1283)	
Ratio of men working	1.0520	**	1.4155	***	1.4130	***	1.3297	***
	(0.4541)		(0.4486)		(0.4532)		(0.4385)	
Ratio of women working	0.2538		0.3244		0.3629		0.3578	
	(0.3695)		(0.4030)		(0.4124)		(0.3996)	
Ratio of children working	2.0269		3.3737		3.4526		3.4147	
	(3.2258)		(2.2817)		(2.3134)		(2.1769)	
HH head low education	0.2693		0.6530		0.6795		0.6103	
	(0.6635)		(0.6082)		(0.6117)		(0.6106)	
HH head medium education	0.1952		0.2308		0.1714		0.1913	
	(0.6803)		(0.5505)		(0.5529)		(0.5481)	
HH head high education	0.1201		-0.0772		-0.1524		-0.1750	
	(0.6428)		(0.5203)		(0.5198)		(0.5098)	
HH head married	2.5616	***	2.4028	***	2.4923	***	2.4319	***
	(0.6754)		(0.5946)		(0.6096)		(0.5789)	
Number of generations	0.5626		0.4821		0.5336		0.5050	
	(0.4100)		(0.3595)		(0.3664)		(0.3820)	

Table 8b: RANDOM EFFECT MODELS OF POVERTY, URBAN SAMPLE

	Without IC (Per capita)		With IC (Per capita)		With IC (WHO Eq.Sc.)		With IC (Cons. Exp)	
Constant	-0.1399		-0.0546		-0.2896		4.3249	***
	(0.2669)		(0.2979)		(0.2975)		(0.3636)	
Lagged poverty status	0.9568	***	0.7313	***	0.7341	***		
	(0.0578)		(0.0969)		(0.0909)			
Lagged log consumption exp.							-0.0168	
							(0.0131)	
Children 0 to 2	-0.6789	***	-0.5764	***	-0.5718	***	0.1101	
	(0.0902)		(0.1112)		(0.1009)		(0.1713)	
Children 3 to 4	-0.3118	***	-0.1951	**	-0.2005	**	0.0299	
	(0.0846)		(0.0980)		(0.0957)		(0.1690)	
Children 5 to 9	0.0222		0.0292		0.0265		-0.1042	
	(0.0489)		(0.0556)		(0.0545)		(0.0839)	
Children 10 to 14	0.2591	***	0.2371	***	0.2098	***	-0.1481	*
	(0.0476)		(0.0539)		(0.0520)		(0.0829)	
Age of HH head	-0.0017		-0.0002		0.0012		-0.0054	*
	(0.0030)		(0.0033)		(0.0033)		(0.0029)	
Number of men in HH	0.1214	***	0.1209	**	0.1913	***	-0.1758	***
	(0.0463)		(0.0519)		(0.0528)		(0.0601)	
Number of women in HH	0.1199	***	0.1262	**	0.1132	**	-0.1135	*
	(0.0454)		(0.0500)		(0.0502)		(0.0687)	
Ratio of working men	-0.2500	***	-0.2956	***	-0.3084	***	0.3096	**
	(0.0953)		(0.1058)		(0.1054)		(0.1408)	
Ratio of working women	-0.0747		-0.0994		-0.0768		0.2693	
	(0.1023)		(0.1132)		(0.1163)		(0.1728)	
Ratio of working children	-0.5508		-0.6946		-0.6999		0.2999	
	(0.5991)		(0.6967)		(0.6627)		(0.7842)	
HH head low education	-0.3131	***	-0.3552	***	-0.3628	***	0.3796	**
	(0.1065)		(0.1195)		(0.1188)		(0.1541)	
HH medium education	-0.2004		-0.2619	*	-0.2677	*	0.1900	
	(0.1293)		(0.1429)		(0.1448)		(0.1533)	
HH high education	-0.5282	***	-0.6771	***	-0.5769	***	0.4981	***
	(0.1259)		(0.1436)		(0.1450)		(0.1797)	
Ratio of other HH members	-0.1616	***	-0.1639	***	-0.1911	***	0.1811	***
with high education	(0.0436)		(0.0482)		(0.0488)		(0.0619)	
Ratio of other HH members	-0.0528		-0.0800		-0.1248		-0.0065	
with medium education	(0.0701)		(0.0791)		(0.0807)		(0.1186)	
HH head married	-0.0245		-0.0372		-0.0880		0.3312	***
	(0.0851)		(0.0949)		(0.0961)		(0.1240)	
Number of generations	0.1149	*	0.1423	*	0.1236	*	0.0048	
	(0.0667)		(0.0729)		(0.0737)		(0.0931)	

Concluding Discussion

The relationship between fertility and poverty is complex. Whereas many low-income countries has experienced substantial decline in TFR, sub-Saharan fertility levels have remained high, together with consistently high poverty levels. The contributing factors are of course many, including poor employment prospects, primitive production technology in rural areas, lack of family planning, low education and poor education infra structure, and last but not least, strong social norms associated with women's role in society. Whereas much has been said about the associations between poverty and fertility, existing data sources have prevented analysis of a more causal nature. Using longitudinal data set from three comparable waves from rural and urban Ethiopia together with random effect models, our paper goes little further in terms of establishing causal mechanisms.

An important finding of our paper is the issue of state dependence in poverty. This is particularly strong in urban Ethiopia, and suggests that experiencing poverty tend to bring about further poverty in the future. There is also evidence of some state dependence in rural poverty, but there the estimates are somewhat sensitive to the equivalence scale. There is also state dependency in childbearing, in that past fertility events tend to influence further childbearing. However, state dependence in children has opposite signs in the rural and urban samples. Whereas recent childbearing events in urban areas tend to discourage further childbearing, it encourages more children in rural areas. However, we find very little evidence of any causal feedback mechanism from poverty onto fertility, independent of the sample used. Moreover, the feedback from childbearing onto poverty is also quite weak once state dependence is controlled for.

One of the most important findings of our study is the significance of child labour as a mechanism influencing both fertility and poverty. Whereas we do not find any significant effects in urban areas, possibly due to small sample size, we do find that child labour increases both fertility and poverty in rural areas. These differences have important policy implications, and suggest the need to abolish child labour, especially in rural areas, so that Ethiopian children are granted the chance to allocate their time for productive uses such as attending schools. The issue of child labour is likely to be an important contributor in perpetuating intergenerational poverty traps. Reducing child labour enhances children's chance of becoming non-poor adults in the future. Our results support therefore the policy recommendations in SPRPR, which highlights the importance of increasing enrolment rates in rural Ethiopia. Of course, rural Ethiopia are still facing endemic school drop out rates, and poor education infra

structure. Much more is needed. (elaborate on the issues lied out in SDRPR concerning education).

We also find that household composition matters. In particular we find that the more adults present in the household, the higher is poverty. This is consistent with our regressions using log of consumption expenditure. We also find that extended household where there are more than two generations living in the household (e.g. presence of grand parents) are not always more likely to be poor, but also have higher fertility. On one hand large families might simply reflect traditional coping mechanisms where friends and relatives pool resources to deal with economic hardship. However, our measure of extended family relations might also reflect more traditional attitudes and social norms, in which men are perceived successful if they have many children, and women are expected to specialise in household production and rearing of children. In so far this is the case, presence of social norms is potentially important in explaining both higher fertility and higher poverty.

Our analysis also shows that education have strong explanatory power in rural Ethiopia, both for fertility and poverty. As expected, higher levels of education either of the household head or other household members, reduced poverty incidence. The role of education is not equally strong in rural areas. This is perhaps not unexpected. First, the distribution of education in rural areas is highly skewed in that very few have any formal education. Illiteracy rates are still extremely high in rural areas. Another issue is related to the fact that rural Ethiopia is dominated by primitive agriculture, in which the return to schooling might not be particularly high. Consequently, our study suggest that there is a great need to increase enrolment rates partly to offset the high incidence of child labour, but also that investment in higher education might not yet be the most sensible policy. In other words, in terms of policy implication, it is important that the government ensure that not only more children attend school, but also that they reduce the drop out rate. Our analysis also shows that both improved labour market and educational opportunities and improvements in family planning – preferably both – should have a substantial impact on reducing poverty in Ethiopia. Problem is that we don't really show directly that lack of family planning is important – i.e. there are no variables measuring the level of family planning.

For the urban sample, a similar analysis can be conducted due to the presence of income data which can be complied from different disaggregated components (such as business income, wage income, pension income, remittance income, and income from female/children economic activity). As an extension, we would also like to conceptualise our joint estimation in a structured theoretical framework. From an econometric point of view, there are outstanding empirical issues such as sensitivity analysis of our results with respect to the equivalence scale. As a result we need to

estimate equivalence scales fitting Engel curves using data from the surveys themselves. To demonstrate the robustness of our analysis, we will also use several measures of household wellbeing by using different adult equivalence scales. Hence we explore the data further more carefully to discuss the implications of our study in much more detail.

References

Admassie, A. (2002). Explaining the High Incidence of Child Labour in Sub-Saharan Africa, *African Development Review*, **14**(2), 251 – 275.

Baulch, B. and Hoddinott, J. (Eds.) (2000). Economic mobility and poverty dynamics in developing countries, *Journal of Development Studies*, Vol 36(6).

Becker, G. and Lewis H. G. (1973). On the Interaction between the Quantity and Quality of Children, *Journal of Political Economy*, **81**(2), Part 2, S279-S288.

Bigsten, A., Kebede, B. and Shimeles, A. (2003). Growth and Poverty Reduction in Ethiopia: Evidence from household Panel Surveys, *World Development*, **31**(1), 87 – 106.

Birdsall, N. M. and Griffin, C. C. (1988). Fertility and Poverty in Developing Countries, *Journal of Policy Modeling*, **10**(1), 29-55.

Birdsall, N., Kelley, A. C. and Sinding, S. W. (2001). *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World*, Oxford University Press, Oxford,

Dercon, S. (2004). Growth and Shocks: evidence from Rural Ethiopia, *Journal of Development Economics*, **74**(2), 309-29.

Dercon, S. and Krishnan, P. (2000). Vulnerability, Seasonality and Poverty in Ethiopia, *Journal of Development Studies*, **36**(6).

Easterlin, R. A., and Crimmins, E. M. (1985). *The Fertility Revolution*, University of Chicago Press.

Eastwood, R. and M. Lipton. (1998). *Impact of Changes in Human Fertility on Poverty*, mimeo, Department of Economics, University of Sussex.

Foster, J., Greer, J. and Thorbecke, E. (1984). A Class of Decomposable Poverty Measures, *Econometrica*, **52**(3), 761-766.

Hazan, M. and B. Berdugo (2002). Child Labour, Fertility and Economic Growth, *Economic Journal*, Vol. 112, No. 482, P. 810-828.

Hotz, V.J., Klerman, J. and Willis, R. (1997). The Economics of Fertility in Developed Countries, in *Handbook of Population and Family Economics*, M. Rosenzweig and O. Stark (eds.), Elsevier Science, 275-348.

Jalan, J. and Ravallion, M. (2000). Is transient poverty different? Evidence for rural China, *Journal of Development Studies*, Vol.: **36**(6)

Kedir, A. and McKay, A. (2004). Chronic Poverty in Urban Ethiopia: Panel Data Evidence, mimeo, University of Leicester, UK.

Kinfu, Y. (2000). Below-Replacement Fertility in Tropical Africa? Some Evidence from Addis Ababa, *Journal of Population Research*, 17(1): 63-82.

Lanjouw, P. and Ravallion, M. (1995). Poverty and Household Size, *The Economic Journal*, **105**(433): 1415 – 1434.

Lindstrom, D. and Berhanu, B. (1999). The impact of war, famine, and economic decline on marital fertility in Ethiopia, Demography, **36**(2), 247 – 261.

Lipton, M. (1998). *Successes in Anti Poverty*, International Labor Organization, Geneva.

Livi-Bacci, M. and de Santis, G. (1998). Population and Poverty in the Developing World, Clarendon Press, Oxford.

Mcculloch, N. and Baulch, B. (2000). Stimulating the impact of policy upon chronic and transitory poverty in rural Pakistan, *Journal of Development Studies*, **36**(6)

Moav, O. (2005). Cheap Children and the Persistence of Poverty, *The Economic Journal*, **115**, 88-110.

Ravallion M. (1996), Issues in measuring and modelling poverty, *The Economic Journal,* **106**, n. 438, 1328-1343.

Ravallion, M. and Bidani, B. (1994). How Robust Is a Poverty Profile?, *World Bank Economic Review*, Oxford University Press, **8**(1), 75-102.

Rosenzweig M. R. and Schultz P. T. (1985). The demand for and supply of births: Fertility and its lifecycle consequences, *American Economic Review*, **75**(2):992 – 1015.

Schoumaker, B. and Tabutin, D. (1999). Relationship between poverty and fertility in Southern countries: Knowledge, methodology and cases, Working Paper no 2, Department of Science of Population and Development, Université Catholique de Louvain.

Schoumaker, B. (2004). Poverty and Fertility in Sub-Saharan Africa: Evidence from 25 Countries, paper presented at the Population Association of America Meeting, Boston.

Shultz, T. P. (2005). Fertility and Income, Centre Discussion paper No. 925, Economic Growth Centre, Yale University.

_____ (1997). Demand for children in low income countries, *Handbook of Population and Family Economics*, Volume 1A, M. Rosenzweig and Stark (eds.), Elsevier, North-Holland: Amsterdam, 349-430.

_____ (1981). Economics of Population (Addison-Wesley, Reading, MA).

Sibanda, A., Woubalem, Z., Hogan, D. P. and Lindstrom, D. P. (2003). The proximate determinants of the decline to below-replacement fertility in Addis Ababa, Ethiopia, *Studies in Family Planning*, **34**(1):1 – 7.

UNDP (2003). Human Development Report 2003 Millennium Development Goals: A compact among nations to end human poverty, Oxford University Press.

Willis, R. J. (1973). A New Approach to the Economic Theory of Fertility Behavior, *Journal of Political Economy*, **81**(2), part 2, S14-S64.

Appendix I:

World Health Organization equivalence scales

```
gen eq1 = 0.33 if age<=1
replace eq1 = 0.46 if age>1&age<=2
replace eq1 = 0.54 if age>2&age<=3

replace eq1 = 0.62 if age>3&age<=5

replace eq1 = 0.74 if age>5&age<=7&sex==1
replace eq1 = 0.70 if age>5&age<=7&sex==2

replace eq1 = 0.84 if age>7&age<=10&sex==1
replace eq1 = 0.72 if age>7&age<=10&sex==2

replace eq1 = 0.88 if age>10&age<=12&sex==1
replace eq1 = 0.78 if age>10&age<=12&sex==2

replace eq1 = 0.96 if age>12&age<=14&sex==1
replace eq1 = 0.84 if age>12&age<=14&sex==2

replace eq1 = 1.06 if age>14&age<=16&sex==1
replace eq1 = 0.86 if age>14&age<=16&sex==2

replace eq1 = 1.14 if age>16&age<=18&sex==1
replace eq1 = 0.86 if age>16&age<=18&sex==2

replace eq1 = 1.04 if age>18&age<=30&sex==1
replace eq1 = 0.80 if age>18&age<=30&sex==2

replace eq1 = 1.00 if age>30&age<=60&sex==1
replace eq1 = 0.82 if age>30&age<=60&sex==2

replace eq1 = 0.84 if age>60&sex==1
replace eq1 = 0.74 if age>60&sex==2
```

Endnotes

[1]All figures quoted in this section come from the *World Development Indicators* database (see http://www.worldbank.org/data/wdi2004/)

[2] The urban population in Ethiopia is about 15 percent of the total.

[3] The poverty line for Ethiopia controls for regional prices, including controls for urban and rural areas.

EXPLORING THE LINK BETWEEN EXCHANGE MARKET PRESSURE AND MONETARY POLICY IN ETHIOPIA[1]

Abebe Deressa[2]

Abstract

Entrusted with the responsibilities of maintaining exchange rate stability, the central bank Ethiopia, namely, the National Bank of Ethiopia (NBE) has paid more attention to the maintenance of exchange rate stability in the formulation and implementation of monetary policy during the past years. These considerations often prompted the NBE to intervene in the foreign exchange market so as to influence exchange rate developments.

A recent study that estimated an index of the Exchange Market Pressure(EMP) for Ethiopia over the period November, 2001 to December, 2005, on the other hand, reveals that in majority of the cases (in 42 months out of 49 months considered) the Ethiopian foreign exchange market was characterized by depreciation pressures (Abebe, 2006). According to a monetary model of exchange market pressure, an increase in domestic credit (expansionary monetary policy) will increase the EMP by decreasing foreign reserves, or by causing a depreciation of the exchange rate, or some combination of the two (Kim, 1985).

The objective of this study is, therefore, to examine empirically the existence of such link between EMP and monetary policy in Ethiopia using the Girton-Roper monetary model of exchange market pressure and VAR technique. The result of the single equation model reveals that measure of the stance of monetary policy, i.e domestic credit growth, has a significant and positive impact on EMP. The VAR test provides further evidence supporting the claim that domestic credit has a positive impact on exchange market pressure. The estimated impulse response function (IRF) as well indicates a positive response of EMP due to a shock in domestic credit, implying that an expansionary monetary policy increases EMP in line with the traditional theory.

---

[1] This paper was originally prepared for the In-house presentation forum at the National Bank of Ethiopia.

[2] National Bank of Ethiopia, Economic Research and Monetary Policy Directorate, e-mail: abebederessa@yahoo.com

1. Introduction

The level and movements in the exchange rate have been a matter of policy concern for central banks of most countries, including that of Ethiopia, as erratic changes in the exchange rate not only undermine the goal of price stability but also reduce real output, trade, capital flows and investment (IMF, 1984). These considerations often prompt central banks to intervene in the foreign exchange market so as to influence exchange rate developments.

In a free floating exchange rate regime, the total pressure in the foreign exchange market is reflected in observed changes in exchange rate. At the other extreme, in a fixed exchange rate regime, foreign exchange market conditions are completely captured by changes in reserves. But, in mixed exchange rate regimes such as in a managed floating, a part of the pressure is absorbed by a change in exchange rate and a part by changes in reserves. Under such circumstances, neither the reserve changes nor the exchange rate movements capture the extent or nature of the exchange market disequilibrium. This calls for the precise measurement of pressures in the foreign exchange market. The pressure in the foreign exchange market is measured by an exchange market pressure (EMP). It is simply the sum of the percentage changes of international reserves and nominal exchange rate depreciation.

As the exchange rate regime of Ethiopia is characterized as managed floating (the simultaneous adjustment of both exchange rates and reserves), EMP is the appropriate concept for analysis. A recent study that estimated an index of the EMP for Ethiopia over the period November, 2001 to December, 2005 reveals that in majority of the cases (in 42 months out of 49 months considered) the Ethiopian foreign exchange market was characterized by depreciation pressures (Abebe, 2006). A critical issue under such circumstances is the identification of the sources of exchange market pressure in Ethiopia.

A simple monetary model of exchange market pressure states that for a given rate of growth of world prices, real income and the money multiplier, an increase in domestic credit (expansionary monetary policy) will result in an equi-proportionate loss in foreign reserves, or an equi-proportionate depreciation of the exchange rate, or some combination of the two (Kim, 1985). Another study also indicated that a pressure in the foreign exchange market pressure can be contained by tight monetary policy, via controlling domestic credit (Kamaly and Erbil, 2000, Tanner, 2001).

To the best of my knowledge, however, there has been no study conducted so far investigating the impact of monetary policy on EMP in Ethiopia. Previous studies mainly investigated the relationship between exchange rate and monetary policy or the relationship between reserves and monetary policy alone, instead of the relationship between exchange market pressure and monetary policy.

The objective of this study is, therefore, to examine empirically the impact of monetary policy on exchange market pressure (EMP) in Ethiopia. More specifically, this study examine whether expansionary monetary policy contributed to EMP or not. The study also tests empirically how the monetary authority absorbs the pressures in the foreign exchange market. The hypothesis of the study is that domestic credit growth would have a positive and significant effect on EMP. In this study, EMP is measured as the sum of the percentage change of international reserves scaled by the monetary base and the percentage change of nominal exchange rate depreciation. Domestic credit, the domestic component of monetary base, which is considered the variable directly controlled by policy makers, is used as measure of monetary policy.

The remainder of this paper is organized as follows. The next chapter provides a brief overview of the conduct of exchange and monetary policy in Ethiopia. Chapter 3 briefly describes a theoretical model of EMP and reviews an empirical work on exchange market pressure and monetary policy focusing in particular on the Griton-Roper's model of exchange market pressure. Chapter 4 specifies an empirical EMP model for Ethiopia and presents main results. Chapter 5 presents conclusions and policy implications.

2. An overview of the conduct of exchange and monetary policy in Ethiopia

As the central bank of the country, the National Bank of Ethiopia (NBE) is obviously entrusted with the responsibility of maintaining the stability of the exchange rate of the Birr, the country's legal tender currency against other currencies.

Accordingly, during 1970s and 1980s, when the Ethiopian Birr was pegged to the US dollar at a fixed rate, the NBE used to maintain exchange rate stability of the Birr by making available foreign currency to the market at the fixed rate.

Following the introduction of the auction system on May 1, 1993 and the subsequent replacement of the auction system by the daily inter-bank foreign exchange market in October, 2001, demand and supply factors were given more latitude in the

determination of the exchange rate. As a result, the NBE acts as a buffer between forces of demand and supply through intervention. Indeed, the NBE has attempted to stabilize the exchange rate through official interventions mainly by varying the amount of foreign exchange it supplied to the market. In effect, pressures in the foreign exchange market are reflected by changes in both exchange rate and reserve holdings of the NBE.

The objectives of monetary policy in Ethiopia are, among others, maintenance of price and exchange rate stability and ensuring the safety and soundness of the financial system, within the broader macroeconomic policy of attaining high level of economic growth. The responsibility of formulation and implementation of Monetary Policy in Ethiopia is vested in the National Bank of Ethiopia (NBE).

A monetary control mechanism in Ethiopia mainly resembles the financial programming approach applied by IMF. This involves establishing a ceiling for the growth rate of money supply on the basis of projected growth rate of GDP and targeted inflation, establishing a floor for international reserves and ceilings for net domestic assets of the National Bank of Ethiopia and net domestic government financing.

With regard to instruments of monetary policy, prior to the commencement of economic reform program in 1992, the National Bank of Ethiopia uses direct monetary policy instruments. The direct control mechanisms include aggregate and individual bank credit ceilings, direct controls on interest rates, including preferential rates for socialized sectors.

Since 1992, the NBE starts to shift its policy orientation towards use of indirect monetary policy instruments. The NBE started to rationalize the structure and interest rates in October 1992, by eliminating discriminatory deposit and lending interest rates. By January 1, 1998, the NBE has totally liberalized the lending interest rates while continued to determine the minimum deposit rate.

In short, the National Bank of Ethiopia controls the supply of and demand for money largely by using the mix of both direct and indirect monetary policy instruments. These include setting a floor rate for saving and time deposits, reserve requirements and open market operations mainly sale of Treasury-bills.

3. Literature review

3.1 The relationship between exchange rate and monetary policy

An exchange rate policy implies a systematic effort on the part of the monetary authorities to influence the level or rate of change of the exchange rate. A variety of policy instruments are potentially available to influence the exchange rate, including foreign exchange market intervention, domestic monetary policy, various forms of controls on international trade and capital flows, and official announcements of future policies (Glick and Hutchison, 1989).

Most attention has focused on either foreign exchange market intervention or domestic monetary policy as the primary instruments available to the central bank in its pursuit of systematic exchange rate policy. In many respects, it is possible to accomplish the same objectives with either domestic monetary policy or foreign exchange intervention policy (Glick and Hutchison, 1989). Domestic monetary policy typically involves a change in domestic monetary base (that is, reserves held by the banking sector plus currency held by the public) brought about by the central bank through the open market purchase or sale of domestic government securities. Un-sterilized foreign exchange market intervention - purchase or sale of foreign currency in the foreign exchange market have also a direct effect on the domestic monetary base. In case of un-sterilized intervention, the central bank changes its net foreign asset holdings through purchases and sales of foreign exchange and allows a corresponding change in its monetary liabilities, that is, the monetary base. Un-sterilized intervention, thus, amounts to using the foreign exchange market to conduct monetary policy in lieu of the domestic financial market.

The exchange rate is often a signal of the stance of monetary policy. For example, in the absence of any other changes in economic circumstances, a weakening of the exchange rate (or upward pressure) may suggest that monetary policy is too loose, relative to policy in the country of the reference foreign currency. On the other hand, a strengthening of the exchange rate, or downward pressure, may suggest that monetary policy is tight.

3.2 Monetary model of EMP

The exchange market pressure model draws on the combination of the monetary approach to the balance of payments and the monetary approach to the exchange rate determination (Younus, 2005).

Following the work of Girton-Roper (1977), different authors (for instance, Kim (1985), Thornton (1995), and Younus (2005)) have developed a simple monetary model of exchange market pressure as follows:-

$$M^d = kPY \quad (1)$$

$$M^s = A(R+D) \quad (2)$$

$$P = EP^* \quad (3)$$

$$M^d = M^s \quad (4)$$

Equation (1) represents the demand for money where P stands for the domestic price level and Y is real income, k is a fraction of nominal income that people want to hold as cash. Equation (2) is a nominal money supply equation. The money supply is the sum of the net foreign assets (R), the foreign component of the monetary base and the domestic assets (D), the domestic component of the monetary base multiplied by the money multiplier, A, where as A=M2/Monetary Base. Equation (3) represents a purchasing power parity condition where E is the nominal exchange rate, which is defined as the domestic currency per unit of foreign currency and P* is the foreign price level. Equation (4) represents a money market equilibrium identity where money demand equals money supply.

Substituting (1) and (2) into (4) we get

$$kPY = A(R+D) \quad (5)$$

Replacing P by EP*, we get

$$k(EP^*)Y = A(R+D) \quad (6)$$

In terms of percentage change and rearranging terms, equation (6) can be rewritten as:

$$r-e = -d+ p^* + y-a \quad (7)$$

Where, r=the percentage change in international reserves;
e= the percentage change in the nominal exchange rate depreciation;
d=the percentage change in domestic credit;
p*=the percentage change in the foreign price level;
y=the percentage change in domestic real income; and

a=the percentage change in the money multiplier; money multiplier is calculated as the ratio of broad money to the monetary base

Kim (1985) and Thornton (1995) citing the works of Connolly and Silveira (1979), and Shiva and Bahmani-Oskooee (1998) included a variable Q= (e-1/r-1) on the right hand side of the equation to see whether the monetary authority respond to absorb exchange market pressure either by the exchange rate depreciation or reserve depletion. The variable Q is a measure of the way a central bank absorbs exchange market pressure. A significant and positive coefficient of Q implies that the monetary authority absorb more pressure by the exchange rate depreciation, while a significant and negative Q implies that more pressure is absorbed by reserve losses (Younus, 2005). An insignificant coefficient implies that the monetary authority is not sensitive to components of EMP.

3.3 Review of empirical literature

Empirical studies on the interrelations between exchange market pressure and monetary policy can be broadly divided into two categories: single-equation econometric methods and vector autoregressive (VAR) models. Earlier studies mostly used single-equation econometric methods, while a number of recent studies have applied VAR models.

Most of the empirical studies that applied Girton-Roper model of exchange market pressure (Kim 1985, Hallwood and Marsh, 2003, Thornton, 1995) found that there is a strong evidence of a negative relationship between the rate of domestic credit creation and the rates of changes in the exchange market pressure.

Kim (1985) applied a Girton-Roper model of exchange market pressure to the Korean data from March 1980 to July 1983. The regression analysis using the OLS estimation technique shows that there is a strong evidence of a negative relation ship between the rate of domestic credit creation and the rates of changes in the exchange market pressure. The coefficient of domestic credit was -0.699 indicating the fact that as the domestic credit increases by 10 percent, foreign reserve decreases by 6.7 percent or exchange rate depreciates by the same amount. The result also shows that coefficients of foreign prices and domestic real income are positive (0.952 and 0.057 respectively) implying that an increase in foreign prices or real income increases the foreign reserves or appreciates the domestic currency. On the other hand, an increase in money multiplier is found to reduce reserves or depreciate the domestic currency in line with theoretical expectations. The study also indicated that the measure of exchange market pressure does not depend on its

composition between foreign exchange and foreign reserves as the variable Q is statistically insignificant. Moreover, the Korean experience indicates that most exchange market pressure is absorbed by adjustments in foreign reserves (as use of r as the sole dependent variable results in overall good fit while use of e alone as the dependent variable results in exceedingly poor fit), reflecting the government's wariness of inflation and of the debt burden effects of exchange rate devaluation.

Thornton (1995) applied the Girton-Roper monetary model of exchange market pressure to the experience of Costa Rica in the period 1986-92. The OLS estimation of the exchange market pressure provide a strong evidence of a negative relationship between domestic credit creation and exchange market pressure (measuring EMP as the sum of r and e, where e is the percentage appreciation (if positive) of the exchange rate). The coefficient for domestic credit, d, is close to its hypothesized value of minus one. The study also indicated that over the sample period, the Central Bank of Costa Rica absorbed most of the exchange market pressure by adjustments in foreign reserves.

Many current works prefer to apply a VAR technique in order to account for the many possible interactions between the variables in monetary models. Tanner (2001) uses a VAR technique to unravel the interrelations between EMP and monetary policy (observable in changes in domestic credit and the interest rate differential) for the cases of Brazil, Chile, Mexico, Indonesia, Korea, and Thailand in 1990-98. He found that monetary policy affects EMP as generally expected: contractionary monetary policy helps to reduce EMP.

Kamaly and Erbil (2000) applied a VAR technique to Turkey, Egypt and Tunisia. There results are somewhat more mixed. They found a strong link between domestic credit and EMP for Turkey. Egypt and Tunisia have used domestic credit and interest rate changes, respectively, as a policy tool in response to EMP shock, but the direction of the response is not clear from the results.

Younus (2005) examined empirically the impact of monetary policy on exchange market pressure (EMP) in Bangladesh using quarterly data from 1976:2 to 2003:1. He applied Engle and Granger's (1987) two-step single-equation error correction model (ECM) and Impulse response functions (IRFs) and variance decompositions (VDCs) derived from a vector error correction model (VECM), to examine the Girton and Roper's (1977) monetary model of the EMP. The estimated coefficient of domestic credit derived from the ECM shows that domestic credit has a significant and negative impact on EMP. The IRFs and VDCs derived from the VECM also indicate that monetary policy, measured by domestic credit, has a significant and negative impact on EMP. Younus (2005) found insignificant coefficient of Qi , indicating the

fact that the monetary authority in Bangladesh responds to EMP by depreciating currency and losing international reserves.

Empirical literatures on Ethiopia mainly focused on the determinants of the real exchange rate (Andualem, 1996, Teferi, 2005, Melesse, 2001). The real exchange rate is hypothesized to be determined by terms of trade, fiscal and monetary policy variables and trade variables. The rate of growth of domestic credit less the lagged rate of growth of real GDP, a proxy for excess supply of credits, was among the monetary variables frequently used in empirical analysis.

An excess supply of credits is found to have a depreciating impact on the real exchange rate (Andualem, 1996, Teferi, 2005) contrary to the expectations of appreciating the real exchange rate. On the contrary, Melesse (2001) found that high level of excess credit would result in the appreciation of the real exchange rate.

4. An application of the EMP model to Ethiopia

4.1 Sources and description of the data

The main sources of the data for this study are NBE's Quarterly Bulletin (various issues) and International Financial Statistics (IFS) data base. The data used in empirical analysis are monthly data spanning from August 1993/94 to December 2005/06.

4.2 Econometric methodology

In order to gauge the impact of monetary policy on the exchange rate, this study estimates two sets of econometric models-single equation regressions and Vector auto regressions (VARs)

4.2.1 Single equation model.

Following the works of Kim (1985), Thornton (1995), and Younus (2005), the empirical formulation of the model is given by the following form:-

$$\ln EMP_t = \beta 0 + \beta 1 \ln DC_t + \beta 2 \ln FP_t + \beta 3 \ln mm_t + \beta 4 \ln SP_t + \beta 5 \ln Q_t$$

Where EMP is exchange market pressure, DC is the percentage change in domestic credit, FP is US inflation (a proxy for foreign inflation), mm is the change in money multiplier, SP is the spread and Q is Q= (e-1/r-1). The variable Q is added to the

model to see whether the monetary authority in Ethiopia, namely, NBE respond to absorb exchange market pressure either by the exchange rate depreciation or reserve draw down or both. In other words, it shows the sensitivity of the NBE to the components of the EMP. A significant and positive coefficient of Q implies that the NBE absorbs more pressure by the exchange rate depreciation, while a significant and negative Q implies that more pressure is absorbed by reserves losses. An insignificant coefficient implies that the monetary authority is not sensitive to components of EMP.

The expected sign of β1 is positive as an increase in domestic credit creation is assumed to increase the exchange market pressure through depreciating the domestic currency or reserve losses. For similar reason, the expected signs of β3 and β4 are also positive. On the other hand, the expected sign of β2 is negative, implying that an increase in foreign prices increases the foreign reserves or appreciates the domestic currency, thereby reducing EMP.

4.2.2 Vector Auto Regression (VAR)

Despite its simple appearance, single equation estimation embodies a number of interdependent relations between variables. For instance, when faced with a surge in EMP, the authority may choose to fend such pressures by reducing domestic credit. According to this policy option, the line of causality runs from EMP to domestic credit. Similarly, in case of a bulge in capital flows monetary authority may decide to sterilize these flows by lessening the amount of domestic credit. Here, a fall in EMP following the accumulation of international reserves induces a reduction in domestic credit**.** Single estimation equation, on the other hand, depicts the opposite direction of causality from domestic credit to EMP. This relation simply states that a lax monetary policy would likely result in a loss in reserves or a depreciation in domestic currency or both spurring a rise in EMP. The interdependence between the variables renders the process of empirically delineating the factors affecting EMP a bit challenging. In order to sift out the reactions of the monetary authority to a rise in EMP, we need to portend the response of domestic credit to a shock in EMP. This, however, can not be accomplished under OLS framework (Kamaly and Erbil, 2000). There are mainly two reasons that justify the use of VAR. First, VAR would enable a researcher to circumvent the endogeinty problems that exist in a single equation. Second, VAR is a very effective tool in portending how this system reacts to a shock in one of its components through impulse response functions (Tanner, 2001).

Following Tanner (2001), this study uses a VAR methodology and focuses on EMP. A key feature of this framework is how monetary policy is modeled. In most recent

research works, a monetary aggregate and the interest differential are considered as the policy variable. However, in this study, the domestic credit is considered as the stance of monetary policy.

The VAR system applied in this study takes the following form:-

$$Xt = a0 + a1Xt\text{-}1 + a2Xt\text{-}2 + ... + vt \quad (1)$$

where X = (δ , EMP,) is a matrix of variables, ai is a vector of coefficients, and vt = (v δ , vE,) is a vector of error terms. A system like (1) permits testing for effects of past values of X on current values. Assumptions regarding the exogeneity of certain variables (like a policy variable) are easily incorporated into a system like (1). To do so, first assume that each element of the error vector vt is, in turn, composed of "own" error terms wt = (w δ , wE,) and contemporaneous correlations with "other" errors. That is:

$$vt = Bwt \quad (2)$$

where B is a 2 x 2 matrix whose diagonal elements (own correlations) equal one and whose nonzero off-diagonal elements reflect contemporaneous correlations among the error terms.

The ordering of the variables imposes certain restrictions on the VAR model so that the domestic credit growth variable δ is assumed to be the exogenous policy variable. That is, in any period, innovations to δ (i.e., v δ)reflect only the tastes and preferences of the policymaker:

$$v\delta t = w\delta t \quad (3)$$

Next, shocks to exchange market pressure (vE) contain two elements: the "own" shock (wE) plus one related to innovations in domestic credit:

$$vEt = wEt + b21w\delta t \quad (4)$$

Thus, wE may be thought of as a shock to the demand for a country's currency, attributable perhaps to changes in investor confidence and sentiment. Thus, b21w δ t represents the portion of shocks to EMP that is contemporaneously correlated with domestic credit growth.

In addition to the contemporaneous relationships shown in equations (3) and (4), impulse response functions (IRFs) summarize the effect of past innovations (i.e., lagged elements of w) to current values of X. Thus, IRFs provide additional ways to evaluate the effect of monetary policy on EMP. IRFs show effects on EMP of both current and past innovations to domestic credit (w δ). The IRFs also provide a policy reaction function: they show effects on current δ of past (but not current) innovations to EMP (wE) .For example, when faced by positive innovations to EMP (for example, a decrease in investor confidence) policymakers may respond "prudently" with contractionary policy (reducing δ).

In brief, the IRFs show the dynamic response of each variable in the system to shocks from each variable in the system. Ordinarily we expect the response of the exchange market pressure to be significant and positive due to shocks to domestic credit. An IRF is significant if its t-statistic exceeds/2/

4.3 Unit root tests of the variables

As this study employs time series data, an analysis of the statistical properties of each variables are essential before proceeding to the estimation of the model. This procedure helps as to identify the problem of spurious regression. A series of Dickey-Fuller unit root tests are conducted to test for the presence of unit root using log level data.

The augmented Dickey-Fuller (ADF) unit root tests suggest that the logs of all the variables are stationary. Consequently, tests for co integration among the variables were not conducted.

4.4 Interpretation of results

4.4.1 Single equation results

The coefficients of the growth rate of the domestic credit and foreign prices appear to be statistically significant with the expected positive and negative signs, respectively. A significant and negative coefficient of foreign inflation implies that an increase in foreign prices decreases foreign exchange market pressure in Ethiopia, either through increase in reserves or appreciating the currency, or both.

The coefficient of money multiplier is with the expected positive sign but not statistically significant, presumably reflecting the offsetting impacts of increases in net foreign assets and domestic credit on exchange market pressure. In other words,

increases in net foreign assets would decrease the pressure on EMP while an increase in domestic credit increases EMP. The coefficient of the spread between the parallel and official exchange rate is with a negative sign, contrary to the expectation and is also statistically insignificant. The negative coefficient may indicate the fact that unsatisfied demand in the official foreign exchange market will shift to the parallel market and cause the spread between the parallel and the official market to rise, while an increase in the spread will not immediately result in depreciation of the official exchange rate or in official reserve drawdown. The inclusion of an additional variable, Q, which captures the sensitivity of the NBE to exchange rate depreciation or reserve drawdown, improves the overall fits of the model. The coefficient of Q is negative and statistically significant implying that the NBE absorbs a lion's share of the exchange market pressure by drawdown of reserves rather than exchange rate depreciations.

Table 1: OLS Estimation Results:- Final Output

Independent Variables	Dependent Variables		Q	R^2	Ad.R^2	D-W
	LNDC	LNFP				
	0.93	-0.84		0.13	0.13	1.99
LNEMP	(5.83)	(-2.66)				
	2.564		-1.658	0.31	0.30	2.1
	(8.49)		(-6.81)			

Note: T-statistics in parentheses

4.4.2 VAR estimation results

Table 2 presents the summary results of the VAR test. The Table depicts that 24 percent of the variations in EMP are explained by the VAR system, together with its exogenous variables. The estimated coefficients of DC and MM are with the expected positive sign indicating that increases in both domestic credit and money multiplier raises the exchange market pressure. The coefficient of FP is with the correct sign reflecting the fact that increase in foreign prices would decrease the exchange market pressure largely by increasing foreign reserves. On the other hand, the coefficient of SP was with the wrong sign presumably reflecting the ex-post result of the shift in foreign exchange demand from the official market to the parallel market.

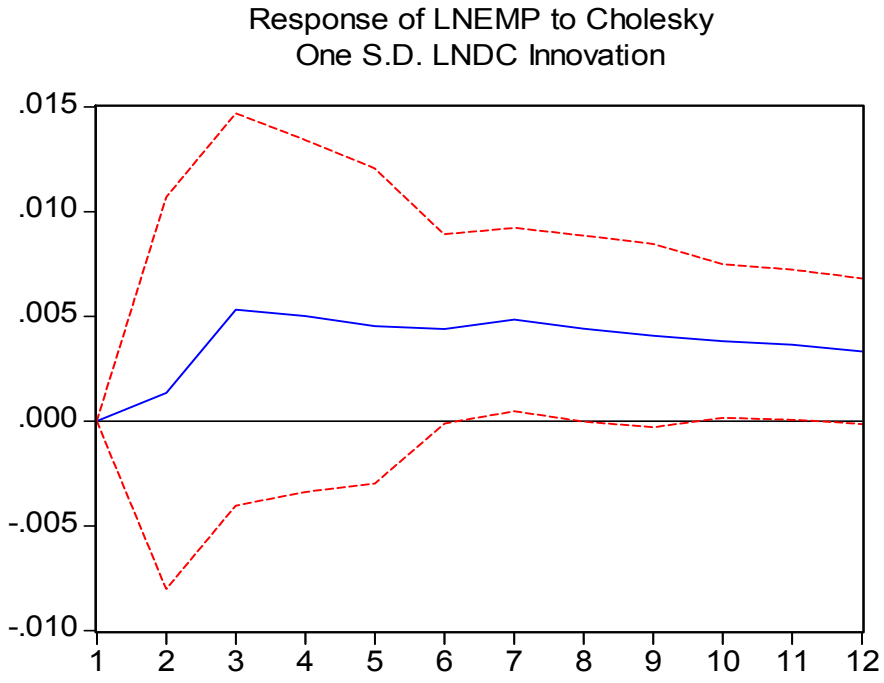
Table 2. VAR Estimation Results

Dependent Variable	EMP	DC
R-squared	0.24	0.01
Adj.R-squared	0.18	-0.06
F-Statistics	4.15	0.16
FP Coefficient	-0.03	0.09
t-statistics	-0.15	1.19
MM Coefficient	0.01	0.02
t-statistics	0.76	2.01
SP Coefficient	-0.06	0.09
t-statistics	-0.43	1.63

Source: Appendix 1.

Domestic credit shocks affect EMP positively as depicted in Fig 1. The positive response of EMP to domestic credit shocks is supportive of the conventional wisdom, where an expansionary shock to domestic credit builds up pressure on EMP, either by reducing reserves, depreciating the currency or some combination thereof.

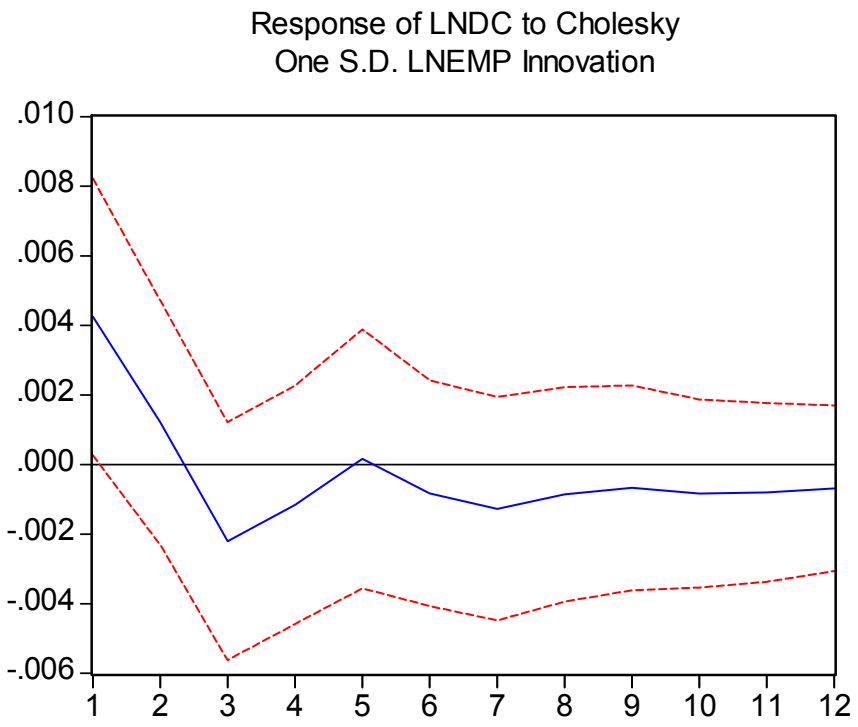
Figure 1: Response of Exchange Market Pressure to Domestic Credit



On the other hand, the domestic credit equation suffers from a low level of overall significance, with F-statistics of 0.15, R-squared of 0.01 and Adj. R-squared of -0.06. This presumably was due to the exclusion of major explanatory variables, such as economic growth and budget deficit.

As a policy reaction function, except in the initial cases, EMP shocks affect domestic credit negatively (though the coefficients are insignificant)(see Appendix 2 and Fig 2). This result suggests that the NBE responds to increased EMP by withdrawing liquidity from the banking system (i.e by contracting money supply). This finding seems plausible given the un-sterilized nature of NBE's intervention in the foreign exchange market.

Figure .2 Responses of Domestic Credit to Exchange Market Pressure



5. Conclusion and policy implications

With the introduction of the auction system on May 1, 1993 and the subsequent replacement of the auction system by the daily inter-bank foreign exchange market in

October, 2001, the exchange rate regime of Ethiopia is officially classified as managed floating. Under this regime, the NBE allows some exchange rate flexibility but often intervenes in the foreign exchange market(mainly through sale of foreign exchange) to influence the path of the exchange rate. In such circumstances, neither the reserve changes nor the exchange rate movements capture the extent or nature of the exchange market pressure. Indeed, monetary authorities should focus on the exchange market pressure, rather than on changes in exchange rates or foreign exchange reserves alone (Tanner, 2001).

A recent study that estimated an index of the EMP for Ethiopia over the period November, 2001 to December, 2005 found that in majority of the cases (in 42 months out of 49 months considered), the Ethiopian foreign exchange market was characterized by depreciation pressures (Abebe, 2006). A critical issue under such circumstances is the identification of the sources of exchange market pressure in Ethiopia.

The objective of this study is, therefore, to examine empirically the impact of monetary policy on exchange market pressure (EMP) in Ethiopia using monthly data from August 1993 to December 2005 by applying the Griton-Roper(1977) model of exchange market pressure.

The results of the study should be interpreted with caution as the data used in the analysis are monthly data. The single equation model result reveal that measure of the stance of monetary policy, i.e domestic credit growth, has powerful impact on EMP. Domestic credit has a significant and positive impact on EMP. The coefficient of domestic credit was 0.93 implying that as the domestic credit increases by 10 percent, foreign reserve decreases by 9.3 percent or exchange rate depreciates by the same amount, or a combination thereof. The result also shows that the coefficient of foreign prices is negative (0.83) and significant indicating that an increase in foreign prices increases the foreign reserves or appreciates the domestic currency. On the other hand, the coefficient of money multiplier was positive in line with theoretical expectations (though insignificant). The study also indicated that the monetary authority tend to absorb more of the exchange market pressure by drawing down of reserves as the sensitivity variable Q is statistically significant with a negative sign.

The VAR test provides further evidence supporting the claim that domestic credit has a positive impact on exchange market pressure. The estimated IRF as well indicate a positive response of EMP due to a shock in domestic credit, implying that an expansionary monetary policy increases EMP in line with the traditional theory.

The paper also provides evidences of the fact that the NBE responds to increases of EMP by contracting domestic credit. This finding largely reflects the un-sterilized nature of NBE's intervention in the foreign exchange market.

The main policy implication of the findings of this study is that the NBE can reduce EMP by containing the pace of domestic credit expansion.

References

Abebe, Deressa. 2006. Measuring exchange market pressure and the degree of NBE's intervention in the foreign exchange market. A paper presented to the 9th in-house presentation forum of the Economic Research and Monetary Policy Directorate, National Bank of Ethiopia, January 2006.

Andualem, Berhanu. 1996. The behavior and dynamics of the real exchange rates of the Birr (1960-1991). Unpublished Masters Thesis, Addis Ababa

Girton, Lance, and Don Roper. 1977. A monetary model of exchange market pressure applied to the postwar Canadian experience, *American Economic Review*, 67(4): 537-48

Glick, Reuven and Michael Hutchison, 1989. Exchange rates and monetary policy. *Federal Reserve Bank of San Francisco Economic Review*, No.2

Haile Kibret, 2001. Monetary policy and the monetary approach to the balance of payments: The case of Ethiopia (1968/69-1999/00). Unpublished Masters Thesis, Addis Ababa.

Hallwood, C.Paul and Ian W. Marsh. 2003. Exchange market pressure on the pound-dollar exchange rate: 1925-1931.

IMF. 1984. Exchange rate volatility and world trade, Occasional Paper No. 28, Washington, D.C.

Kamaly, Ahmed and Nese Erbil. 2000. A VAR analysis of exchange market pressure: A case study for the MENA region, Working Paper 2025. Economic Research Forum.

Kim, Inchul. 1985. Exchange market pressure in Korea: An application of the Girton-Roper Monetary Model. *Journal of Money, Credit, and Banking*, Vol. 17, No.2 (May 1985)

Mcnown, Robert and Myles S. Wallace. 1994. Cointegration tests of the monetary exchange rate model for three high inflation economies. *Journal of Money, Credit and Banking*, Vol.26. No.3, PP 396-410.

Melesse, Minale. 2001. Determinants of equilibrium real exchange rate in Ethiopia, NBE Staff Working Paper, ERD/SWP/002/2001.

Neely, Christopher J. and Lucio Sarno. 2002. How well do monetary fundamentals forecast exchange rates? *The Federal Reserve Bank of St. Louis Review*, September/October, 2002.

Tanner, Evan. 2001. Exchange market pressure and monetary policy: Asia and Latin America in the 1990s. *IMF Staff Papers,* Vol. 47, No. 3, International Monetary Fund.

Teferi, Mequaninte. 2005. Estimating the equilibrium exchange rate of Ethiopia: dynamic OLS approach, A Paper presented to the 9th In-House Presentation

Forum of the Economic Research and Monetary Policy Directorate, National Bank of Ethiopia, January 2006.

Thornton, John. 1995. Exchange market pressure in Costa Rica, 1986-92: An application of the Girton-Roper Model." *International Economic Journal,* Volume 9, Number 1, Spring 1995.

Younus , Sayera. 2005. Exchange market pressure and monetary policy. Working Paper Series: WP 0603, Policy Analysis Unit (PAU), Research Department, Bangladesh Bank

Appendix 1: VAR Estimation Results

Sample (adjusted): 1993M12 2005M12
Included observations: 145 after adjustments
Standard errors & t-statistics in parentheses

	LNEMP	LNDC
LNEMP (-1)	0.287629	0.006741
	(0.07282)	(0.03078)
	(3.94961)	(0.21900)
LNEMP(-2)	-0.105854	-0.066769
	(0.05643)	(0.02385)
	(-1.87573)	(-2.79925)
LNEMP(-3)	0.159937	-0.010263
	(0.05249)	(0.02218)
	(3.04712)	(-0.46262)
LNEMP(-4)	0.023393	-0.000429
	(0.05338)	(0.02256)
	(0.43827)	(-0.01904)
LNDC(-1)	0.056533	0.194770
	(0.19695)	(0.08324)
	(0.28704)	(2.33976)
LNDC(-2)	0.196590	0.296919
	(0.19755)	(0.08350)
	(0.99514)	(3.55604)
LNDC(-3)	0.095469	0.143978
	(0.19594)	(0.08282)
	(0.48724)	(1.73853)
LNDC(-4)	0.045422	0.232570
	(0.19740)	(0.08343)
	(0.23010)	(2.78749)
LNFP	-0.026453	0.087178
	(0.17340)	(0.07329)
	(-0.15255)	(1.18950)
LNMM	0.014633	0.016491
	(0.01938)	(0.00819)
	(0.75518)	(2.01367)
LNSP	-0.060342	0.096017
	(0.13910)	(0.05879)
	(-0.43379)	(1.63313)
R-squared	0.236572	0.011933
Adj. R-squared	0.179599	-0.061804
F-statistic	4.152400	0.161827

Appendix 2: IRF of Domestic Credit Shock (DC) on EMP

Period	EMP
1	0.000000
	(0.00000)
2	0.001342
	(0.00468)
3	0.005316
	(0.00468)
4	0.005013
	(0.00420)
5	0.004535
	(0.00376)
6	0.004396
	(0.00226)
7	0.004844
	(0.00219)
8	0.004410
	(0.00222)
9	0.004072
	(0.00219)
10	0.003815
	(0.00183)
11	0.003643
	(0.00179)
12	0.003331
	(0.00174)

Appendix 3: IRF of Exchange Market Pressure (EMP) on Domestic Credit (DC)

Period	DC
1	0.004245
	(0.00199)
2	0.001212
	(0.00175)
3	-0.002202
	(0.00171)
4	-0.001158
	(0.00171)
5	0.000163
	(0.00186)
6	-0.000830
	(0.00162)
7	-0.001272
	(0.00161)
8	-0.000861
	(0.00154)
9	-0.000674
	(0.00147)
10	-0.000834
	(0.00135)
11	-0.000803
	(0.00128)
12	-0.000684
	(0.00119)

DEMAND FOR IMPROVED SOLID WASTE SERVICES IN JIMMA TOWN, ETHIOPIA: EVIDENCE FROM HOUSEHOLD SURVEY DATA

Degnet Abebaw[1] and Maru Ayenew[2]

Abstract

The main purpose of this study has been to measure the influence of socioeconomic, demographic and location characteristics on households' willingness to pay for improvement of solid waste services. The data for the study was obtained from a random sample of 200 households in Jimma town. Descriptive analysis of the data reveals that while some households are not willing to pay, others are interested to contribute either in labour, in cash or both for improvements in solid waste management services in Jimma town. Estimation results of a multinomial logit model indicate that these choices are influenced by a certain combination of family size, education and age of the household, years of schooling of children or family member, wealth, life-style and location of the dwelling unit. The study concludes with some policy implications for improved solid waste management services in Jimma town.

Keywords: Solid waste management, households' willingness to pay, multinomial logit, Jimma, Ethiopia

[1] Address of Corresponding Author:
Ethiopian Economic Association/Ethiopian Economic Policy Research Institute, P. O. Box 34282, Tel.: 251-114-162121, Fax: 251-114-160967, E-mail: degnet2003@yahoo.com
[2] [2] maryayenew@yahoo.com

Acknowledgement

We acknowledge the financial support given by the Jimma University College of Agriculture to conduct the study.

1. Introduction

Public access to reliable solid waste services is an essential ingredient for improved human health, safe environment and sustainable development (Ahmed and Ali, 2004; Doan, 1998; Altaf and Deshazo, 1996). Solid waste and sanitation services in many developing countries, however, remain unsatisfactory and erratic (Lall *et al*. 2004; Temesgen and Legesse, 2005; Altaf and Deshazo, 1996). According to Cointreau-Levine (1994), around 30-50% of residents in most cities in developing countries do not get proper solid waste management services and most of the time their disposal practices are unsafe. In the literature on solid waste issues, supply side constraints are among the main reasons for the insufficient supply of solid waste management services such as collection, transportation and disposal. In fact, many municipal governments of developing countries, including that of Ethiopia, lack adequate physical and financial resources to generate optimal amount of public services for their inhabitants (Thapa, 1998; Altaf and Deshazo, 1996; Lall *et al*., 2004).

Reviewing the literature on solid waste management services for Ethiopia one finds that these services are poor and inefficient. As a result, the majority of inhabitants in most towns in the country often use unsafe solid waste disposal practices, such as open dumping, burning, burying and so on. For instance, according to Birke's (1999) study of the municipal solid waste management practices of 15 regional cities of Ethiopia, a controlled solid waste disposal is practiced in only 2 of them. The study of Bonga town in southwestern Ethiopia by Temesgen and Legesse (2005) also shows the widespread lack of proper municipal solid waste services. Similarly, in Jimma town, where we carried out this study, solid waste service is still rudimentary and inefficient. During writing this paper, the town had only one dump truck for solid waste collection and disposal services for the entire population of over 138,070 people.

Previous studies elsewhere clearly pointed out that the participation of the local population in the formulation and implementation of urban infrastructure projects could help raise the supply of solid waste services in developing countries (Lall *et al*., 2004; Altaf and Deshazo; 1996). In this respect, a better understanding of residents' preferences and willingness to pay for improved delivery of non-market goods would pave way for entrepreneurs and small-enterprises to contract with residents to deliver the service at a lowest possible cost (Thapa, 1998). In fact, the involvement of the private sector in the delivery of waste management services would also ease government's budgetary pressure and enable local municipality to concentrate on other development activities (Ahmed and Ali, 2004; Obirih-Opareh and Post, 2002).

In this paper, we hypothesize and explain that a household's WTP for improved solid waste management practices is determined by his/her socioeconomic, demographic and location characteristics. In the estimations, we also focus on how the impacts of these factors vary between the types of payment required and discuss its implications for mobilizing local resources for household solid waste management in Jimma town.
This study was carried out in Jimma town using a random sample of 200 households. Several factors contributed to the choice of Jimma town for this study. First, Jimma town is the biggest town in population size in southwest Ethiopia. Second, available evidence (Kebede and Mirgissa, 1999) reveals that the supply of most public services such as water, sanitation, solid waste are inadequate and are major threats to human health and environmental conditions. For instance, about 59.49%, 54.45%, 29.5%, and 92.22% of the total household population of Jimma do not have access, respectively, to private house, to tap water, to private toilet and to a private telephone set (CSA, 1994). Third, as with most municipalities in Ethiopia, the municipality of Jimma town has limited fiscal, human and physical resources to expand and optimally provide its services to a rapidly growing number of inhabitants in the town. As one official of the municipality (Abay, 2000, personal communication) vividly reported to us, improvements in the delivery of solid waste services in Jimma town remains one of the top priorities of policy makers and local administrators. In view of these and similar other concerns, findings of this study would be useful to policy makers and public administrators who seek to know the potential of residents to participate in and benefit from improved provision of sanitation and solid waste services.

The paper is organized into five sections. Section 2 describes the study areas and the dataset. Section 3 defines the theoretical and empirical research methods of the study. The results and discussion of the paper are presented in Section 4 and the paper concludes in Section 5.

2. Study area and data

Jimma is the biggest town in the southwestern Ethiopia. It is located at 335 kilometers away from Addis Ababa with a geographic location of 7^0 40' N latitude and 36^0 60' E longitudes. The town occupies a total area of nearly 4623 hectares, of which about 26% is a residential area. Its mean annual rainfall varies between 450-1800 millimeters. Jimma has a warm and humid climate with daily average temperature of 20 ^{0}C and mean annual rainfall varying between 1450 and 1800 millimeters. During the field survey of this study, Jimma town had 20 administrative *Kebeles*.

Based on a sample frame of the total administrative units in the town, a total of four *Kebeles* were randomly chosen for the study. Next, a random sample of 200

households was selected from these *Kebeles* for detailed household interviews. The survey was carried out from August to September 2000. Semi-structured questionnaires were used for personal interviews by four trained enumerators. The questionnaires were pre-tested in the same site. The enumerators were trained both in the class and field conditions on how to administer the survey questionnaires to the respondents and how to collect the necessary data for the study. Data were collected on a wide range of topics such as personal and household characteristics, income, wealth, access to infrastructure and attitudes towards environment. A special section of the questionnaires elicited households' current solid waste management practices and also asked their willingness to pay for improved municipal provision of solid waste management services. Secondary data were collected from various publications and census reports. Furthermore, key informant discussions were carried out to get feedback about the status of various public services provided by the municipality.

3. Methods

Revealed preference, and stated preference methods are the two main approaches for assigning economic value for benefits of environmental goods and services (Young, 2005). Revealed preference methods are based on how individuals actually behave whereas stated preference methods use data on what individuals say they would behave contingent on a certain hypothetical market or program. However, at present it is very difficult to infer economic and environmental benefits of solid waste management services based on existing markets because these services are often under-priced or non/priced in most developing countries (Anaman and Jair, 2000 cited in Jin *et al*., in press). To overcome this difficulty, in this study, we applied a stated preference method to elicit consumers' preferences for solid waste services, *ex ante*, based on their willingness to pay for a hypothetical change.

3.1 Contingent valuation

Contingent valuation method (CVM) is a widely used stated preference method for estimating public values of environmental goods and services to society (Hanley and Spash, 1993). In other words, CVM is an important tool for researchers to inform policy makers about public values of environmental goods and services for which market prices do not exist or are not able to capture their social value. It enables them to put monitory values on products and services for which there is a market failure. A literature cited in Cameron *et al*. (2002) shows that contingent valuation (CV) estimates correspond in 75-90% of the cases to economic agents' actual or revealed preference values, indicating that CVM approximates reality fairly well. In

1993, the National Oceanic and Atmospheric Administration (NOAA) Blue Ribbon Panel reviewed the CV literature available at the time, and concluded that CV studies can yield estimates reliable enough to be a good starting point for natural resource policy making and damage assessment (Carlson, 1997; Portney, 1994).

CV is a direct information elicitation technique using a survey of individuals to estimate what they would be willingness to pay (WTP) for an improvement of the quality of services or products from a status quo, or the minimum amount of compensation they would be willing to accept (WTA) for a deterioration from a status quo (Echenssah *et al*., 1997). Stated in other words, WTP replies provide the Hicksian compensating variation as it leaves the respondent at the same utility level after realization of proposed welfare-improving programs and resulting expressed WTP. On the other hand, WTA replies give information about compensating variation for welfare-decreasing moves (Hanley and Spash, 1993). In the present case study, we applied WTP format since the hypothetical scenario would create a higher well-being to the target population of the study.

CVM has been used extensively in the USA, Europe and Australia (for comprehensive review of CVM applications, see Bateman *et al*., 1999). The first application of CVM was to determine the value to hunters and wilderness lovers of a particular recreational area (Davis, 1963 cited in Portney, 1994). Application of CV in developing countries has remained few and far apart for a long period. However, recent evidence shows that its applications are also expanding to developing countries (Whittington, 1998). Some notable examples are the study by Asrat *et al.* (2004) to elicit farmers' WTP for certain soil conservation practices in southeastern highlands of Ethiopia, Altaf and Deshazo (1996) to infer consumers' demand for solid waste management practices in Pakistan, Lura *et al.* (1999) to estimate households' willingness to pay for domestic water services in the Philippines, Echessah *et al.* (1997) to determine factors influencing households' WTP for tsetse control in Kenya.
A CV questionnaire is expected to be composed of the following key ingredients. Firstly, the survey questionnaire must contain and clearly describe a scenario or proposed (hypothetical or real) program to which respondents are asked to value or vote upon. The scenario is expected to provide the respondent a clear picture of the 'good' that they are being asked to value. Secondly, it must lay out the question format and specify the mechanism by which the respondents would be willing to pay for a welfare-improving program or be willing to accept compensation for a welfare decreasing program. To be useful a payment vehicle must be realistic and free of bias (Hanley and Spash, 1993). The CV question may follow an open-ended question, a bidding game and a referendum format. Finally, a CV survey should elicit information on respondents' socioeconomic and other characteristics.

In this study we used a referendum format to elicit if the respondents vote yes/no for a CV proposal that asks them to pay for a hypothetical policy scenario to improve solid waste management services in Jimma town. According to Hanemann (1984), the respondents' yes/no answers are interpreted as instances of utility maximization. In other words, an individual's 'yes' or 'no' response is assumed to depend on whether the difference in indirect utility between WTP and lack of WTP is positive (Cameron *et al*., 2002). Thus, consider the following indirect utility function for a representative individual household:

$$V(Y, P, \mathrm{Z}, \mathrm{Q}), \qquad \textbf{(1)}$$

where, Y is an individual's income; P is a vector of prices of all goods and services except solid waste; Z is an individual's socioeconomic, demographic, locational and institutional characteristics and Q is the current level of solid waste services received by the individual household. Suppose now a local policy that improves existing solid waste management services available to all inhabitants. From this it follows that the welfare measure involved is given as follows:

$$V(Y - WTP, P, Z, Q_1) = V(Y, P, Z, Q_0) \qquad \textbf{(2)}$$

where, WTP is a household's willingness to pay to secure a welfare gain from an improved change in solid waste service, that is the change from Q_0 to Q_1. The amount of this change corresponds to the Hicksian compensation variation for the proposed policy.

3.2 Empirical model and hypotheses

In this section we outline the econometric model that is proposed to estimate the impacts of hypothesized explanatory variables on households' WTP responses for a hypothetical CV program. More particularly, a multinomial logit (MNL) model has been used to estimate the probability of an individual's WTP for improvements in solid waste management services. As described above, respondents provided their answers to whether or not they would be willing to raise only cash, only labour, both cash and labour or remain unwilling to pay any contribution for implementing the CV program.[3] For econometric estimation these responses are coded as follows:

[3] The choice set for the econometric estimation of the MNL model should be mutually exclusive and exhaustive (Train, 2003). To assure this outcome, we pose a question to our respondents in such a way that it yields either of the following outcomes: WTP in only labour , only cash, both labour and cash or not WTP.

$$P = \begin{cases} 0 \text{ if a respondent is not WTP} \\ 1 \text{ if a respondent is WTP only labour} \\ 2 \text{ if a respondent is WTP only cash} \\ 3 \text{ if a respondent is WTP both cash and labour} \end{cases}$$

In choosing among these options, an individual is assumed to maximize his/her expected utility subject to time and budget constraints. An individual's utility function from using alternative payment vehicle by which he would be WTP for a proposed CV scenario is represented by a random utility model (RUM) (see MacFadden, 1978, 1981), where:

$$U(choice\ j\ \ for\ household\ i) = U_{ij} = V_{ij} + \varepsilon_{ij} \qquad \textbf{(3)}$$

where, U_{ij} is the overall utility, V_{ij} is an indirect utility function and ε_{ij} is a stochastic component, which is again assumed to be identically and independently distributed across alternatives.

In the above specification (equation 3) it is assumed that given J bid vehicles for choice, an individual selects the one that brings the highest indirect (expected) utility, V_{ij}. In other words, an individual i will select bid vehicle j if $U_{ij} > U_{ik}, \forall k \neq j$. The measured component V_{ij} is linearly related to the individuals' personal, socio-demographic and economic characteristics, X_{ij}, which can be specified as follows:

$$V_{ij} = \beta_j X_{ij} \qquad \textbf{(4)}$$

where, β_j is a vector of regression coefficients, which measures the impact of, X_{ij}, on the probability of choosing bid vehicle j. Thus, the probability that an individual i choosing payment vehicle j out of J alternatives can be represented by the following equation:

$$P_{ij} = \frac{\exp(\beta_j X_{ij})}{\sum_{k=1}^{J} \exp(\beta_k X_{ik})} \qquad \textbf{(5)}$$

where, β_j and β_k measure impact of observable characteristics of the respondent on the probability of choosing payment vehicles j and k, respectively. In the MNL model, only $J-1$ of the parameters can be recovered (Haab and McConnel, 2002). For instance, with four categories of the dependent variable mentioned above for the present study, there will be three non-redundant logits. Hence, in the econometric specification of the MNL model it is a common practice to normalize equation (5) by one of the response categories and by constraining $\beta_j = 0$.[4] Accordingly, the MNL model can be re-specified as follows:

$$P_{ij} = \frac{\exp(\beta_j X_i)}{1+\sum_{k=0}^{J-1}\exp(\beta_k X_i)} \quad \textbf{(6)}$$

The coefficients of explanatory variables on the omitted or base category are assumed to be zero. With this assumption, the probability that a base category will be chosen can be obtained by using the following equation:

$$P_{ij} = \frac{1}{1+\sum_{k=0}^{J-1}\exp(\beta_j X_i)} \quad \textbf{(7)}$$

The log likelihood function of the MNL model can be calculated as follows (Greene, 2000):

$$\ln L = \sum_{i=1}^{n}\sum_{k=0}^{J} d_{ij} \ln \text{Prob}(Y_i = J)) \quad \textbf{(8)}$$

The sign and significance of an explanatory variable on the dependent variable should always be interpreted relative to the chosen base category. Another point to note here is that direct interpretation of the estimated coefficients of the MNL model is difficult because the MNL model is non-linear in nature (Aldrich and Nelson, 1984).

[4] In the econometric estimation of the MNL model, the most frequent response is usually taken to be the reference category (Long and Freese, 2001). However, the choice of which category is chosen as the reference category does not influence the estimation results, it only affects the way parameter estimates are to be interpreted.

One means of overcoming this problem is use the relative risk ratios[5] (RRR) of the explanatory variables.

The selection of explanatory variables X to be included in the MNL model has been guided by the literature on economics of solid waste and field-setting of the study area. Detailed description and summary statistics of the variables used in the study are presented in Table 1. Below we discuss the expected influence of various explanatory variables on households' willingness to pay for improvements in solid waste services.

Age of household head (HHAGE): according to Karppinen and Hanninen (2000), and Vanslembrouk *et al*. (2002), younger people are much more concerned about and are more interested to support the conservation of natural resources and environment than older ones. Likewise, a study by Altaf and Deshazo (1996) finds that willingness to pay for improved solid waste management services is strongly and negatively influenced by the age of the household head. In a similar vein, in this study age of household head is assumed to influence WTP for the proposed solid waste management program negatively. This variable was measured by number of years of the household head's age since birth.

Household size (HHSZ): it is expected that household size, measured by number of persons in the family, is directly associated with willingness to pay for improved solid waste management services.

Gender of household head (GEND): gender of head of household head is also one factor often considered in the study of household behavior with regard to conservation of natural resources and environmental quality. In this regard, existing studies show that females are more likely to reveal pro-environmental behavior than males (Steel *et al*., 1994). In the context of Ethiopia, mostly women and children carry out the majority of domestic chores including the disposal of solid waste. As such, in this study we anticipate that female-headed households are more likely to pay for improved solid waste management services than their male-headed counter-parts. This is a dummy variable with a value of 1 if male, and 0 otherwise.

Education of household head (EDUC1): education is a key instrument by which citizens gain knowledge of socioeconomic and environmental impacts of their daily

[5] RRR is defined as $\exp(\beta)$, which indicates the ratio of probability of occurrence of a current category to the probability of occurrence of a base category as a result of one unit change in the corresponding explanatory variable.

decisions. In so doing, economic theory postulates that education enables an economic agent to make a better decision(s). Steel *et al*. (1994) assert that education promotes pro-environmental attitudes and behavior. In the solid waste management literature, various empirical studies have pointed out that education contributes to investment on environmental quality. For instance, a study by Lall *et al*. (2004) found out that years of schooling of head of household increases willingness to pay for improved urban services provision in Bangalor, India. Furthermore, a study by Lauria *et al.* (1999) for the Philippines indicates that education of the household head increases willingness to pay for improved sanitation services. In this study, we also hypothesize that years of schooling of the household head has a direct relationship with WTP for improved solid waste management services.

Education of children (EDUC2): in the literature, no significant effort has been given to test the impact of child education on their parents' attitude towards nature and environmental resources. However, children have a direct exposure to physical neighborhood conditions and this allows them to understand the costs and benefits of keeping their environment clean. In this respect, child education is one means of increasing their awareness to and conservation of environmental amenities. As such, in this study we hypothesize that parents' willingness to pay for improved delivery of solid waste services is directly associated with years of schooling of their children.

Animal farming (TRAD): whether a household rears cattle is anticipated to influence his/her WTP. This variable takes on two values, 1 if the household is involved in animal husbandry and 0 otherwise.

Ownership of a refrigerator (WEALTH): it is expected that wealth is essential in determining to care for the environment. In this study we use ownership of a refrigerator as a proxy for wealth and expect that is has a positive influence on household WTP for improved solid waste services. Again, this variable is a dummy variable with a value of 1 if the household has a refrigerator and 0 otherwise.

Household income (INCOM): a study by Lauria *et al.* (1999) for the Philippines finds that income has a significant and positive influence on household willingness to pay for improved sanitation services. In another study (Altaf and Deshazo, 1996) in Pakistan, a significant and positive relationship between income and willingness to pay for improved solid waste management services was found out. Therefore, concurrent to these findings, we anticipate a direct effect of income on willingness to pay for solid waste management services in Jimma town. This variable is a continuous variable representing monthly household income in Ethiopian Birr.

Housing tenure (TENUR): according to Lall *et al.* (2004), households who own dwelling units are more likely to participate in community based urban service provision programmes than those without. House owners face reduced risk of eviction. As these authors note this enables them to capitalize appreciation in housing values, which results in improved cleanliness of the neighborhood. Drawing on this finding, we anticipate a direct relationship between house ownership and willingness to pay for improved solid waste management services. This variable has two values, namely, 1 for owner occupants and 0 for tenants.

Duration of stay in the house (SHOUS): in this study, number of years of stay in current dwelling unit is expected to have a positive influence on willingness to pay for improved solid waste management services.

Physical distance from road (ROAD): studies (see for e.g. Korfmacher, 1997) indicate that poor roads are one of the main reasons for the inadequacy or lack of solid waste collection systems in urban areas of developing areas. What this means is that the problem of solid waste increases with poor road quality. As such, in this study, it is anticipated that households located farther from a drivable road would be more willing to pay for improved solid waste management services than their colleagues who are found nearer to a drivable road. This variable is measured by walking distance in minutes to nearest main road.

4. Results and discussion

4.1 Descriptive statistics of the sample households

Descriptive analysis of socio-economic and demographic data of this study shows various contrasting differences and similarities among the survey household (see Table 1). Of the 200 sample households, 56% households do not own their own homes and 35.5% do not have a private toilet. Regarding human capital, about 14% are illiterate (cannot read and write in any language). Many of them also lack access to public information sources. For instance, around 33% and 63% of the survey households, respectively, do not possess a transistor radio and a television set. Access to electricity is also limited and around 16% of the sample uses crop residue for cooking their meals. The sample households also differ from one another in many ways. The age of household heads range between 18 years and 85 years (mean = 46 years). On average a household in the sample has 5 household members. Descriptive analysis of the data also suggests the majority of sample households is income-poor and lack access to essential assets. For instance, about 88% of the households in the sample do not have a refrigerator. Housing is an essential factor for poverty reduction as well as for a better quality of life. However, as the results of this

survey indicate, about 56% of the sample households do not have their own homes. Additionally, the average monthly income of the survey households is low and stands at about 613 Ethiopian Birr per household.

With respect to household access to municipal public utilities, it is estimated that about 74% of the sample households do not have a tap water source; and nearly 64% of them do not have a private telephone. In this study, it is also obtained that around 38% of the respondents do not get private toilet services. Respondents also mention the shortage of household solid waste management facilities. As a result of this, many households have used undesirable solid waste disposal practices. For instance, 72 (36%) of the survey respondents dispose their household solid waste indiscriminately to the surrounding environment. Our field observation and discussions with key informants also suggest that the existing waste bins are not emptied on a regular basis.

As shown in Table 1, four types of respondents were distinguished depending on their responses to our valuation question, which reads as follows: “Suppose the local municipality government is to devise a program to improve solid waste management services in Jimma Town, do you contribute any resource to achieve this goal?” Respondents who affirmatively answered our valuation question were asked to specify the form of resource by which they would be willing to pay for the service. As shown in Table 1, the vast majority of the respondents (42.5%) reported that they would like to contribute only labour. Of the total respondents, 14% declined to pay in any form for the proposed contingent valuation program.

4.2 Determinants of WTP

Estimation results of the MNL model are presented in Table 2. To obtain robust variances, we used the Huber and White Sandwich estimators. All explanatory variables were checked for multicollinearity and were found acceptable to be included into the regression model. Econometric analysis of the data was done with done using Stata 8.0 software. In Table 2, we report the relative risk ratios (RRR), rather than actual coefficients of the independent variables to make the interpretation of our findings easier. An RRR value greater/less than 1 implies that a one unit rise in the independent variable translates into greater/lesser probability of occurrence of that category relative to the reference category. On the other hand, a value of RRR at 1 indicates equal probability of occurrence of the particular category and the reference category.

In the estimation, willing to pay only in labour was taken as the base or reference category, since this is the most frequently reported response to our contingent valuation question. Wald-chi^2 statistic is significant at the 5% level suggesting the joint significance of the explanatory variables of the model.

As anticipated, variation in households' WTP is influenced by a combination of socioeconomic and demographic characteristics of respondents. As the estimates show, the coefficient of age of the household head is positive and statistically significant suggesting that as age increases households become more reluctant to pay in any form. More specifically, the variable "age of the head of household" decreases the probability of unwillingness by 4.16% in comparison to the base category of willingness to pay only in labour.

Contrary to the *a priori* expectation, education of the household head (EDUC1) increases unwillingness to contribute labour. The reason may be that education raises the opportunity cost of labour time. Additionally, the variable 'traditional life-style' is significant at the 5% level and increases the probability for households to be unwilling to pay in any form by about 214%. As expected, household size has a strong negative effect on WTP only in cash, suggesting that larger households are more likely to contribute only labour than small households. Education of children in the family (EDUC2) is significantly and positively associated with their parents' WTP for improved solid waste services in cash as well as in cash and labour.

The estimation results also indicate that the wealth variable (WEALTH), as proxied by ownership of a refrigerator, is important in explaining what households would be willing to contribute for solid waste services. More specifically, ownership of a refrigerator is significant at the 10% level and increases the likelihood payment in cash as well as cash and labour, by 370% and 400%, respectively. Location of the dwelling unit in relation to road (ROAD) appears to be an important factor in influencing households' decision to pay for improved municipal services. More specifically, distance from road increases households' WTP in cash. Compared to cash, large households are more likely to contribute labour for CV program. From the estimated risk ratio, it can be calculated that household size (HHSZ) is significant at the 10% level and reduces the likelihood for cash payment by around 20%.

5. Conclusions and implications

Household solid waste management has remained a major challenge to the municipal government of Jimma town. One of the main constraints facing the local government in the provision of adequate solid waste collection and disposal services to its citizens

is the shortage of enough financial and physical resources. Furthermore, private sector investment in solid waste services has been very little (if any) or non-existent at all. Experiences elsewhere demonstrate that local people's participation in planning, financing and monitoring of solid waste management services is one of the main mechanisms to address this gap. However, adequate information has not been available on how to initiate and apply such practices by various municipality governments of Ethiopia including that of Jimma. Therefore, this study has been initiated to get empirical feedback on this issue using a case study from Jimma town, Ethiopia. The main purpose of the study was to identify the key factors influencing households' willingness to pay for improved solid waste services.

This study has provided several interesting outcomes. Firstly, descriptive analysis of the survey data clearly distinguishes four categories of household depending on their responses to the CV question, "Would you be willing to contribute resources for a program that strives to improve household solid waste service? If yes, which resources would you be willing to contribute?" Some households were not willing to pay any resource at all. However, others replied saying that they would like to contribute either only labour or only cash. And, still a group of other households report their willingness to contribute both cash and labour for the proposed program. Thus, policy makers and planners shall be informed that different households are willing to be involved in a program that strives to improve the supply of solid waste services by paying positive resources to the program. Secondly, our estimation results of the MNL regression model indicate that probability payment in any form for improved solid waste services is influenced by economic and non-economic characteristics of the household. Human capital formation and wealth are strongly related to demand for improved solid waste services. Willingness to contribute labour for solid waste is negatively associated with years of schooling and age of the household head. Households' involvement in cattle farming appears to suppress their propensity to raise labour for programs that improve solid waste services. However, it is interesting to note that education of children raises their parents' willingness to pay for improved solid waste services in cash as well as cash and labour. In a similar vein, ownership of a refrigerator increases willingness to pay for improved solid waste services. Additionally, the demand for improved solid waste services is directly correlated with distance from a drivable road. Thus, planners and policy makers shall give close attention to these evidences to initiate and enhance local people's participation in the provision of improved solid waste services either by the municipality, private sector or some kind of partnership between them. The presence of significant demand for improved solid waste services implies that micro-enterprises for solid waste collection as a low-cost alternative to self-disposal could be organized. Furthermore, the government has to provide assistance for local residents to initiate

and coordinate their efforts for self-organization of collection and disposal of solid wastes from their premises.

Last but not the least, further research is required to determine the magnitude of resources that could be generated from residents for implementation of improved solid waste services.

References

Ahmed, S. A. and Ali, M., 2004. Partnerships for solid waste management in developing countries: linking theories to realities. Habitat International, 28: 467-479.

Aldrich, J.H. and Nelson, F.E., 1984. *Linear Probability*, Logit and Probit Models. Sage Publications.

Altaf, M.A. and Deshazo, J.R., 1996. Household demand for improved solid waste management: a case study of Gujranwala, Pakistan. *World Development*, 24(5): 857-868.

Anaman, K. A., Jair, R. M., 2000. Contingent valuation of solid waste collection services for rural households in Brunei Darussalam. The Singapore Economic Review, 45(2): 223-240.

Asrat, P., Belay, K. and Hamito, D., 2004. Determinants of farmers' willingness to pay for soil conservation practices in the Southeastern Highlands of Ethiopia. Land Degradation and Development, 15: 423-438.

Birke, Y. 1999. Solid Waste Management in Ethiopia. 25th WEDC Conference, Addis Ababa, Ethiopia.

Cameron, T.A., Poe, G.L., Ethier, R.G. and Schulze, W.D., 2002. Alternative non-market value-elicitation methods: are the underlying preferences the same? Journal of Environmental Economics and Management, 44: 391-425.

Carson, R. T., 1997. Contingent valuation: theoretical advances and empirical tests since the NOAA Panel. *American Journal of Agricultural Economics,* 79(5): 1501-1507.

Central Statistical Authority (CSA), 1994. Population and Housing Census of Ethiopia, Addis Ababa.

Cointreau-Levine, S., 1994. Private sector participation in municipal solid waste services in developing countries. Urban Management Programme Discussion Paper. No. 13, Washington, DC. The World Bank.

Davis, R., 1963. The value of outdoor recreation: an economic study of the Maine Woods, doctoral dissertation in economics, Harvard University.

Echessah, P.N., Swallow, B.M, Kamara, D.W. and Curry, J.J., 1997. Willingness to contribute labour and money to Tsetse control: application of contingent valuation in Busia District, Kenya. *World Development*, 25: 239-253.

Greene, W.H., 2000. Econometric Analysis, 4th Edition. New Jersey. Prentice-Hall.

Karppinen, H. and Harri H., 2000. Forest conservation and environmental utilization: public attitudes in *Finland. Journal of Forest Economics*, 6(1): 55-80.

Haab, T.C. and McConnel, K.E., 2002. Valuing Environmental and Natural Resources. The Econometrics of Non-market Valuation. Edward Elgar Publishing Limited, Cheltenham, UK.

Hanemann, W.M., 1984. Welfare evaluations in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics*, 66(3): 332-341.

Hanley, N. and Spash, C.L., 1993. Cost-Benefit Analysis and the Environment. Edward Elgar Publishing, Inc. Cheltenham, UK.

Jin, J., Wang, Z. and Ran, S., In Press. Comparison of contingent valuation and choice experiment in solid waste management programs in Macao. *Ecological Economics*.

Kebede, F. and Mirgissa, K., 1999. Hygienic behaviour and environmental conditions in Jimma Town, South-western Ethiopia. *Ethiopian Journal of Health Development,* 13(2): 77-86.

Korfmacher, K.S., 1997. Solid waste collection systems in developing urban areas of South Africa: an overview and case study. Waste Management and Research, 15: 477-494.

Lall, S.V., Deichmann, U., Lundberg, M.K.A. and Chaudhury, N., 2004. Tenure, diversity and commitment: community participation for urban service provision. *The Journal of Development Studies*, 40(3): 1-26.

Lauria, D.T., Whittington, D., Choe, C.T. and Abiad, V., 1999. Household Demand for improved sanitation services: A Case Study of Calamba, The Phillippines. In Bateman, I. J. and Willis, K.G. (editors). Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU, and Developing Countries. Oxford University Press.

Obirih-Opareh, N. and Post, J., 2002. Quality assessment of public and private modes of solid waste collection in Accra, Ghana. Habitat International, 26: 95-112.

Portney, P. R., 1994. The contingent valuation debate: why economists should care? Journal of Economic Perspectives, 8(4): 3-17.

Long, J.S. and Freese, J., 2001. Regression Models for Categorical Dependent Variables Using STATA.

Steel, B.S., List P. and Shindler B., 1994. Conflicting values about Federal Forests: a comparison of national and Oregon Publics. Society and Natural Resources, 7: 137-153.

Temesgen, M. and Legesse, W., 2005. Analysis of the type and amount of solid waste generated and adopted disposal methods by the residents of Bonga Town. Ethiopian Journal of Health Sciences, 15(2): 157-166.

Thapa, G.B., 1998. Lessons learned from solid waste management in Kathmandu, Nepal. Habitat International, 22(2): 97-114.

Train, K. E., 2003. *Discrete Choice Methods with Simulation*. Cambridge University Press.

Young, R.A., 2005. Determining the Economic Value of Water: Concepts and Methods. Resources for the Future, Washington, DC, USA.

Table 1: Definition and summary statistics of the dependent and explanatory variables

Variables, and measurements	Mean or percent	Std. Dev.
The dependent variable categories (%)		
Not willing to pay in any form (0)	14.00%	
WTP labour-only (1)	42.50%	
WTP cash-only (2)	11.00%	
WTP both cash and labour (3)	32.50%	
Explanatory variables		
HHAGE	45.63	12.97
HHSZ	5.06	2.193
GEND	65%	
EDUC1	7.62	4.786
EDUC2	12.46	4.38
INCOM	127.80	133.55
TRAD	17%	
WEALTH	12%	
TENUR	44%	
SHOUS	19.04	11.54
ROAD	3.56	3.37

Source: Own survey, 2000.

Table 2: Multinomial logit estimates of households' WTP for improved solid waste management[+]

Explanatory variables	not willing		only cash		Cash and labour	
	Estimates	std. errors	Estimates	std. errors	Estimates	std. errors
HHAGE	1.0416*	1.75	0.9924	-0.30	1.0007	0.04
HHSZ	0.9251	-0.65	0.7906*	-1.59	0.9702	-0.32
GEND	0.5512	-1.01	1.5875	0.74	1.6105	1.02
EDUC1	1.1448	1.97	0.9636	-0.52	1.0621	1.18
EDUC2	1.0851	1.39	1.1132**	1.68	1.1273**	2.48
INCOM	0.9996	-0.63	1.0004	0.97	1.0002	0.51
TRAD	3.1388**	2.13	0.8173	-0.27	0.5992	-0.91
WEALTH	2.7077	1.06	4.7044*	1.75	5.0131*	2.23
TENUR	1.2236	0.40	1.2921	0.46	0.6107	-1.21
SHOUS	0.9698	-1.20	0.9924	-0.29	1.0014	0.07
ROAD	0.9411	-0.84	1.1249*	1.86	0.9702	-0.52
Intercept						
Number of observations	200;	Log-likelihood = -223.218				
Wald Chi^2 (33)	53.07**	Pseudo R^2 = 0.11				

Notes: ** and * show statistical significance respectively at the 5% and 10% probability levels.

Figures in the parentheses are robust z statistics. + Estimates are for RRR. WTP labour-only is the base category.

Source: Authors.