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Poverty, market imperfections and time preferences: of relevance for environmental policy?*

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ABSTRACT. Rates of time preference (RTPs) of rural households in Indonesia, Zambia and Ethiopia have been measured using hypothetical questions about preferences for current versus future consumption. In general, the rates were found to be very high. Factors influencing or correlated with the personal rates of time preference were investigated through regression methods. OLS was the technique used in the estimation. Market imperfections, particularly in credit and insurance markets lead to variation in RTPs. Poverty in assets, or cash liquidity constraints, was leading to or correlated with higher rates of time preference. The poor are, therefore, less likely to invest in environmental conservation. In Zambia, independent estimates of risk preferences were made. More risk-averse people tended to have lower RTPs. The results support the hypothesis that poverty and/or liquidity scarcity lead to high RTPs. Poverty reduction may thus reduce the RTPs of the poor and reduce the 'intertemporal externality' due to high RTPs. The high average RTPs indicate, however, that complementary policies may be needed to ensure sufficient levels of investment in conservation. Another logical implication is that institutionalization of private property rights may not be a sufficient tool to initiate sustainable resource management.

1. Introduction

Problems of poverty and environmental degradation in developing countries are closely linked (WCED, 1987; Mellor, 1988). The majority of the poor live in rural areas and derive most of their income from soil and forest resources (World Bank, 1990; Dasgupta, 1993). In Africa, more than 80 per cent of the poor live in rural areas. Most live in and derive most of their income from ecologically fragile environments (Pearce and Warford, 1993). Even in Latin America, where the level of urbanization is high, the worst poverty is found in rural areas that are ecologically fragile. These

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areas are typically isolated and with few non-farm employment opportunities (World Bank, 1990). In Africa and Latin America, most of the poor are self-employed peasant households. This group also numerically dominates the poor in Asia, where the farm wage workers constitute a larger share of the poor. As a result of economic stagnation and rapid population growth, the poverty problem has become worse in sub-Saharan Africa.

It has been claimed that poverty may lead to short planning horizons, which may prevent poor farm households from investing in conservation to protect their natural resource base (Mink, 1993). Yet there have been very few empirical studies of the planning horizons or rates of time preference (RTPs) among rural poor. It is also frequently stated that insecurity of land tenure is a major reason for environmental degradation. Peasants are not likely to invest in land conservation if they are uncertain that they will derive benefits from their investments. Thus, provision of secure property rights to land is commonly proposed as the instrument to induce peasant farmers to invest in land conservation (Cruz and Gibbs, 1990; Feder and Feeny, 1993).

The causal relationship between poverty and RTP can be questioned. Is the causality in the opposite direction? Is it high RTPs that lead to low investment and poverty? In this case, trickle-down effects from economic growth would not reduce the market failure ('intertemporal externality') effect of high private RTP. On the other hand, if there is a causal relationship between poverty and RTP, poverty reduction itself would reduce this externality. Pender (1996) has tested for this in a study of RTPs of Indian peasants and could not reject the causal relationship (wealth being exogenous). Pender and Walker (1990) found in their study in India, using experimental games with real payoffs and hypothetical questions, that the RTP was inversely related to the level of wealth of peasants. Mean rates ranged from 30 to 60 per cent, considerably higher than interest rates on debt outstanding. One third of the sample had RTPs above 100 per cent. A proportional 10 per cent rise in net wealth was accompanied by a 3–7 per cent fall in the estimated rate of time preference (Pender and Walker, 1990).

This study is a by-product of research on the causes of environmental degradation in three countries. The main objective is to provide additional evidence on the importance of high RTPs among rural poor. High RTPs can be a potential disincentive to investment (Deaton, 1991), thus also to investment in conservation, even when property rights are adequately secure. In our case study areas, rapid environmental degradation was found taking place even though the farm households appeared to have secure rights to their land. In Ethiopia, Shiferaw and Holden (1996) found a negative correlation between RTPs and adoption of conservation technologies. Shiferaw and Holden (1997) use an applied farm household model for the Ethiopian highlands which illustrates clearly how sensitive benefit–cost ratios for conservation investments are to the RTP. Variation in land tenure security was not apparent in the study areas and could therefore only be included as a precondition. Furthermore, we investigated the factors influencing or correlated with the RTPs. These included the level of poverty/wealth in different asset categories in economies where markets are highly imperfect (Reardon and Vosti, 1995), and different household

characteristics including risk preferences as production and consumption decisions are not separable under such imperfect market conditions. The question of direction of causality was also tested carefully in one of the case-study areas (Indonesia).

In Section 2, we discuss relevant theories on market imperfections, particularly in credit markets. A simple theoretical model is presented and the importance of credit constraints discussed. In Section 3, the methodological approach for the empirical estimations and detailed hypotheses are presented. Section 4 gives empirical results and discusses the case studies in Indonesia, Zambia, and Ethiopia. In Section 5, we conclude.

2. Rural economies, market imperfections and time preferences

In a theoretical economy, with perfectly functioning markets and perfect information, the market mechanism should also ensure optimal investment levels in conservation. Environmental degradation will only exist if it is economically optimal to let it happen. In such a theoretical economy, there are no externalities because they are automatically internalized through the perfect markets. The market rate of interest would equal the intertemporal rate of substitution (RTP). In the real world, however, and in particular in rural areas of developing countries, markets are far from perfect. Market imperfections exist due to high transactions costs and imperfect information. Markets may be missing entirely, seasonally (partly missing), selectively (rationing) or may be very thin (imperfect competition). These market imperfections are particularly common in relation to land resources, labour, credit, risk/insurance and some basic food commodities (Hoff *et al*., 1993; de Janvry *et al*., 1991; de Janvry and Sadoulet, 1992). Imperfect information and high transaction costs may also lead to interlinkage of markets, as in sharetenancy (Cheung, 1969; Stiglitz, 1974). Asymmetric information leads to problems with adverse selection, e.g., in credit, insurance and commodity markets (Akerlof, 1970; Rotchild and Stiglitz, 1976), and moral hazard, e.g., in land, credit and insurance markets (Arrow, 1963; Hoff *et al*., 1993).

Of particular interest in this paper is the widespread empirical evidence that small farmers in most third world countries face credit constraints. Their freedom of choice may also be severely limited by subsistence requirements. Credit rationing in formal credit markets may be explained by adverse selection and moral hazard (Stiglitz and Weiss, 1981). Informal credit markets in rural areas of developing countries are characterized by very high interest rates, which may be explained by the lender's risk hypothesis (Tun Wai, 1958; Bottomley, 1975) or her/his monopoly power (Bottomley, 1964). Binswanger and Sillers (1983) used the lender's risk hypothesis and small farmers' lack of collateral as an explanation of why small farmers face credit constraints. There have been many interventions in credit markets, e.g. through setting ceilings on interest rates and by channelling funds to rural financial markets. Most of these attempts have failed. This is clearly shown by the fact that only 5 per cent of farms in Africa and 15 per cent of farms in Asia and Latin America have had access to formal credit (Hoff *et al*., 1993). The distribution of formal credit is also severely skewed as 5 per cent of the borrowers have received 80 per cent

of the credit (Hoff *et al*., 1993). High interest rates found in informal credit markets are also evidence of high rates of time preference.

Credit market failures have important policy implications.

- Liquidity constraints lead to a non-separable relationship between household production and consumption decisions. A shadow mark-up value will be placed on relaxing this constraint. Poor peasant households may thus appear more risk-averse than they really are as the credit constraint may reduce investments in risky, cash-demanding activities (Masson, 1972; Eswaran and Kotwal, 1990).
- The market imperfections in credit markets cause the relationship between interest rates and time preferences to be tenuous or disconnected (Binswanger and Rosenzweig, 1986; Pender and Walker, 1990).

In conventional neo-classical economics the trade-offs between outcomes occurring at different points in time have been explained by the discounted utility model. We define the rate of time preference (RTP) as the consumption rate of interest (CRI) or the intertemporal marginal rate of substitution. A high rate implies that consumption now is given high value relative to consumption in the future. In this case returns on investments must be at least as high as the RTP for this myopic person to be willing to invest. The RTP is also found to be equal to the pure rate of time preference (δ) plus the elasticity of marginal utility of consumption (μ) times the expected rate of consumption growth (g) (RTP = CRI = $\delta + \mu g$) (Markandya and Pearce, 1988). The pure rate of time preference (δ) is the rate at which individuals discount future utility ('positive time preference' or impatience (Olson and Bailey, 1981)). We have chosen to estimate the RTP because of difficulties in finding empirically the expected rate of consumption growth and the marginal utility of income. Furthermore, the average expected consumption growth is likely to be close to zero in the types of stagnant economies we have been studying. We think, however, that the variation in the RTP may be due to consumption smoothing problems because of liquidity constraints. We first develop a model ignoring the consumption smoothing problem. We assume an individual household with an intertemporal utility function:

$$U = \int_0^T \nu(C_t) e^{-\delta t} dt \tag{1}$$

where $\nu(.)$ is the utility function in a specific period, C_t is consumption in period t, and δ is the pure rate of time preference. If we consider a household choosing among alternative combinations (C_0, C_1) of consumption at $t = 0$ and $t = 1$, keeping consumption in other periods fixed, we may write:

$$dU = \nu'(C_0) dC_0 + \nu'(C_1) dC_1 e^{-\delta} = 0 \tag{2}$$

at their point of indifference between marginal changes in periods 0 and 1.

At the point of indifference between dC_0 today and dC_1 one year into the future ($t = 1$):

$$\left(\frac{dC_1}{dC_0}\right)_{U=\text{Const}} = -\frac{\nu'(C_0)}{\nu'(C_1)} e^{\delta}. \tag{3}$$

If we assume that the preferences are stable over time (curvature of the utility function does not change from period to period), assume no (or minimal) changes in expected income level in the types of stagnant economies we were studying:

$$C_1 = C_0,\ v(C_1) = (C_0),\ v'(C_1) = v'(C_0) \tag{4}$$

which enables us to simplify expression (3) above:

$$dC_0 + dC_1 e^{-\delta} = 0. \tag{5}$$

In this special case the RTP will be equal to the pure rate of time preference.

The severity of the consumption smoothing problem of the decision making is likely to affect her/his personal RTP. Dasgupta (1993) has shown how shadow values on credit constraints or investment constraints may affect intertemporal decisions and thus the trade-off between current and future consumption:

$$v'(C_0) = Ev'(C_1)e^{-(\delta - r)} + \lambda. \tag{6}$$

By combining equations (3) and (6) we get an explicit expression for the relationship between the RTP and the credit constraint:

$$-\frac{dC_1}{dC_0} \mid U = e^r + \frac{\lambda e^{\delta}}{Ev'(C_1)}. \tag{7}$$

We see that the pure rate of time preference and the shape of the utility function are irrelevant to the rate of intertemporal substitution unless the credit constraint is binding. A positive shadow value on the credit constraint (λ) will increase the intertemporal rate of substitution (RTP). The unevenness and riskiness of income sources, risk preferences that are related to the elasticity of marginal utility, the amount of buffer stocks or other insurance systems, access to credit, etc., may then be variables influencing the personal RTP. To what degree is the RTP determined by the shadow prices related to the constraints the individual is facing at any point in time? Individual characteristics which stabilize or represent more long-term and 'pure' rates of time preference may exist. These pure rates would have to be estimated using time-series data.

Wealthier individuals are likely to have better access to, and face lower interest rates in credit markets, than poorer individuals. Therefore, we expect that wealthier people would tend to have lower rates of time preference. We also expect people facing severe liquidity constraints to have higher RTPs than people facing less severe liquidity constraints. Moreover, RTPs are likely to influence people's investment decisions. And households with better investment opportunities (higher interest rates) are also likely to have higher RTPs.

A large gap between private and social rates of time preference may call for concern and policy intervention. Pearce and Warford (1993) have argued that values of the pure rate of time preference should not be assumed to be relevant for the calculation of the social rate of time preference when environmental degradation is taking place and incomes are stagnant or falling. We argue that a large discrepancy between social and

private rates of time preference may represent market failures of relevance for environmental policy.

Unconditional provision of credit may in some cases result in more rapid environmental degradation, as there is no guarantee that the credit will be used for investment in environmental conservation. However, more rapid resource degradation could be optimal unless it is due to high private RTPs relative to the social RTP ('intertemporal externality'). This points in the direction of careful targeting if credit is used as an environmental policy instrument.

3. Methodology

3.1 Survey methodology

Surveys were carried out in rural villages in Indonesia, Zambia, and Ethiopia. Average incomes were low in all locations and natural resource degradation was prominent (Holden *et al*., 1994; Holden *et al*., 1995; Shiferaw and Holden, 1997). The subjects interviewed were heads of households or other adult household members. Hypothetical questions were used to estimate the RTPs. The methodology was similar in the three cases, facilitating comparison. The use of hypothetical questions has been shown to have methodological weaknesses. Distinct framing effects that depart from the neo-classical discounted utility model have been identified. These include (Pender and Walker, 1990):

- The RTP is a decreasing function of the time delay over which it is estimated (Thaler, 1981; Benzion *et al*., 1989; Horowitz, 1988). The RTP does not change much when the interval increases beyond one year (Pender, 1996).
- The RTP decreases when large magnitudes of gains and losses are involved (Thaler, 1981; Benzion *et al*., 1989; Loewenstein, 1988b).
- Individuals have a lower RTP for losses than for gains (Thaler, 1981; Loewenstein, 1988b).
- RTPs are higher when individuals are asked to delay consumption than when they are asked to expedite it (Loewenstein, 1988a).
- Timing and magnitude effects may serve as a weighting mechanism for the RTPs (Loewenstein, 1988b; Tversky *et al*., 1988).
- Adjusting a present value equivalent to a fixed future value may yield higher RTP than when respondents are asked to adjust a future value equivalent to a fixed present value (Pender, 1996).

A standardized methodology was used to reduce these problems. In all questions, we used the same time frame of one year. In Indonesia and Ethiopia we used a cash value indicating that there may be a need to correct for inflation. In Zambia both cash and food (maize) were used as measures. The question asked was:

> If you were told you have the choice between an amount of money today (PV) and the amount FV in one year, how large would the amount PV have to be for you to prefer it instead of FV in one year?

The cut-off point was then identified and interpreted as the point of indifference. No specific procedure was prescribed to arrive at the point of indifference. If FV = 100, the respondent was asked whether she preferred PV = 100 to FV = 100. If yes, she was asked about the preference between PV = 90 and FV = 100, etc., until the point of indifference was identified. Alternatively, with FV = 100, she was asked whether she preferred PV = 5 to FV = 100. If no, she was asked about the preference between PV = 10 and FV = 100, etc., until the point of indifference was identified. Starting-point bias or range bias are possible. In some cases a rapid narrowing down of the interval was attempted as these questions only formed part of a large questionnaire. In other cases the point of indifference was approached from both sides to check for consistency in the answers. This variation in approach may have increased the measurement error compared to using a standardized approach but has probably not biased the regression results.

Some respondents found it hard to respond to the questions, particularly if they had a low level of education. Six out of 41 households had to be discarded for that reason in Indonesia, while 14 out of 100 were discarded in Zambia. None were excluded in Ethiopia.

More information on the methodology and sample areas is presented in Table 1. Besides the hypothetical questions, data were collected on household characteristics, production, consumption, income, expenditure, savings, etc.

3.2 Sampling procedure

Indonesia

The survey was carried out in two transmigration settlements in Seberida, Riau Province, Sumatra. The transmigrants had been provided secure rights to their individual two hectares of land by the state. The level of poverty (64 per cent of the population was estimated to be below the poverty line) and seriousness of environmental degradation (severe soil erosion, rapidly declining yields) has been documented by Holden *et al.* (1995). Both settlements were inhabited by Javanese transmigrants 5–10 years before our survey. We would therefore expect no cultural differences between the two areas. A difference in average RTPs between the two areas would consequently be an indication that these rates respond to differences in local conditions and would, therefore, be an indication of the direction of causality. This is particularly the case if the difference between the two areas can be explained by specific variables that vary systematically among individuals in the two areas. One of the settlements had relatively good market access while the other had very poor market access. The two settlements were both characterized by having poor land quality, although the land was somewhat better in the area with poor market access. Poverty was most severe in the area with poor market access. The level of food self-sufficiency was low in both areas but higher in the area with poor market access. The survey was carried out in 1991/92, and the sample size was 41 households (stratified random sampling).

The credit market was not well developed. Some received cows on credit

Table 1. *Basic survey and methodological data*

Variable	*Indonesia*	*Zambia*	*Ethiopia*
Inflation rate, %	9	25–100[a]	10
Total income per capita (US$)	107	108	196
Cash income per capita (US$)	100	72	72
Subsistence production value per capita (US$)[b]	7	36	73
Food purchase value per capita (US$)	64	16	27
Food self-sufficiency ratio[c]	0.1	0.7	0.73
Environmental problems	Deforestation/ soil erosion	Deforestation	Soil erosion
Preference study			
Unit of consideration	Money	Grain/money	Money
Time frame	1 year	1 year	1 year
Value magnitude, percentage of average hh. annual income	4	1–10	4
Average present value equivalents (US$)	20	6, 42, 50	23

[a] The inflation rate was sharply falling during 1993–94 in Zambia owing to a severe monetary restraint put in effect in 1993 after a period of hyperinflation.
[b] The market value of subsistence food production.
[c] The ratio between the value of subsistence food production and value of total food consumption

(about 10 per cent of the households in the area with poor market access and none in the area with good market access). One cow should be paid back in the form of two calves within five years. Otherwise, there was only some informal credit because those who could afford to lend out money were reluctant to do so because of the low creditworthiness of people under the prevailing economic conditions (lenders' risk explanation for credit rationing). Use of land as collateral had not yet developed as land titles had only been issued quite recently. There was some sale of land holdings, although it was illegal before land titles had been received.

Zambia

The survey was carried out in six rural villages in northern Zambia. Three of the villages were located in a fairly densely populated area (26–82 persons/km^2) near the provincial capital, Kasama. The situation in these villages has been thoroughly documented by Holden (1988, 1991). Deforestation, due to shifting cultivation, was taking place at a rapid rate, whilst shortening of fallow periods and use of acidifying fertilisers caused a decline in yields or total crop failure for some crops (finger millet and groundnuts). The remaining three villages were located in an area with low population density (<6 persons/km^2) and poor market access. Deforestation had also started in this area. Traditional rules regulated land use although all land officially was state property. Village land, including

fallow land, was in general controlled by individual households and inherited in a matrilineal system (Richards, 1939; Schultz, 1976; Holden, 1991). Sale of land was prohibited. Land disputes were resolved by village committees, the chief or local courts. Security of tenure appeared to be good as individual households could exclude other households from their fallow land.

The formal credit market was rationed and commodity specific (fertilizer and maize seeds) (Holden *et al*., 1994, Tviland, 1996[1]). Informal credit markets were very limited (lenders' risk) although informal borrowing was more common in the densely populated area, but on a very small scale and usually only within the family (Holden, 1991). The survey was carried out in 1994. Fifty households were sampled from each area, giving a total of 100 households, of which only 86 could be used for the analysis.

Ethiopia

The survey was carried out in a location with relatively high agricultural potential and good market access (Ada district some 20 km from Debre Zeit, a town situated about 45 km southeast of Addis Ababa). Commodity-specific (fertilizer) formal credit was available at 10–12 per cent interest. Relatives may provide some credit without interest. The village money lenders charged up to 70 per cent (continuous time rate). Someone's guarantee or asset ownership (especially oxen) was needed to qualify for informal credit. Crops were also sometimes used for borrowing and payback at the same rate of interest as credit in cash. The state is officially the owner of all land but individual user rights appeared to be considered secure and were inherited within the family. Redistribution of land rights had stopped and was not considered to threaten the land security at the time we carried out the survey. The farmers were concerned with the falling productivity of their land due to soil erosion but conservation technologies were not adopted on erodible lands.

The survey was carried out in 1994. The households were stratified according to their number of oxen, a vital asset used for cultivation. Random samples were taken from each stratum (0, 1, 2 and >2 oxen). The total sample size was 120 households, 30 from each group.

3.3 Validity and reliability

The results were in general consistent with economic theory. We cannot exclude the possibility of bias in the estimated average RTPs or parameter estimates in the regression analyses. The fact that we asked the households to adjust a present value equivalent to a fixed future value may point in direction of an upward bias (Pender, 1996).

Several of the variables in the regression model are of an endogenous

[1] Tviland (1996) found that credit rationing became more serious during the period 1993 to 1995 as the percentage of households which received credit out of those which applied was reduced from 56 per cent in 1993 to 14 per cent in 1995. Approximately 60 per cent of the farmers had applied for credit in both years. The default rate for those who received credit increased from 15 to 35 per cent from 1994 to 1995.

character and their parameters should therefore ideally have been estimated using a simultaneous equation system. Because we only had cross-section data, we were unable to identify sufficient instruments or lagged variables for a system estimation. A time-series study may reveal more evidence on the determinants and variability of RTP.

3.4 Regression models and data analysis

The rate of time preference was estimated for individual *i* as

$$\mathrm{RTP}_i = \ln(\mathrm{FV}/\mathrm{PV}_i) \tag{8}$$

where PV is the present value equivalent to FV (future value) received one year into the future. With a credit constraint, the shadow value on the credit constraint would be confounded in the PV equivalent and the estimated RTP. We found credit markets to be highly imperfect, particularly in the Indonesian and Zambian case study areas. We would therefore expect a non-linear relationship between the RTP and income. When income falls below the subsistence minimum, we expect the RTP to approach infinity. With random variation in income and consumption smoothing problems, the shadow value on the credit constraint is likely to vary randomly and to be a function of the shape of the utility function (risk preferences or elasticity of marginal utility), wealth and other socio-economic characteristics of the household. With a constant FV, we may then make the PV a function of these variables, as we think that the PV may give a better fit than the RTP when people are very poor and have very high RTPs. By using the PV the parameters will be of opposite sign than when using the RTP:

$$\mathrm{PV}_i = F(\delta_i(W_{-1i}), \mu_i, g_i, \lambda_i(X_{0i}, E(X_{1i})) + \epsilon_i. \tag{9}$$

The PV for individual *i* is a function of the pure rate of time preference (δ_i) of individual *i*, her elasticity of marginal utility (μ_i), the shadow value of her credit constraint (λ_i), which again is a function of current (X_{i0}) and expected figure ($E(X_{i1})$ wealth and other socio-economic characteristics, and the expected rate of consumption growth (g_i) for individual *i*. We also argue that the pure rate of time preference may be a function of the past wealth of households:

$$\mathrm{PV}_i = F(W_{-1i}, \mu_i, X_{0i}) + \zeta_i. \tag{10}$$

This is based on the assumption that when income falls below the subsistence minimum, the pure rate of time preference (δ_i) approaches infinity and otherwise is a decreasing function of past wealth (W_{-1i}). Alternatively, it must be a high shadow value on the credit constraint (λ_i) that pulls up the RTP. The two explanations are not mutually exclusive. We would argue that in a stagnant economy ($g \approx 0$), if we look at a year which is not particularly good or bad ($X_0 = E(X_1)$), that the average PV may provide a good estimate of average RTPs, making it only dependent on the pure rate and the average shadow value on the credit constraint. The case studies we carried out did not hit years that were particularly good or bad in any of the areas. In a particularly bad year, high RTPs may be explained by high expected growth (g_I) and a high shadow value on the credit constraint. We

Table 2. *Variables included in the regression models for the three countries*

Variables		*Hyp. sign*[a]	*Indonesia*	*Zambia*	*Ethiopia*
Household characteristics	Age	?	41.0 (1.97)	47.7 (1.6)	46.6 (1.50)
	Sex	?	D[b]	D	D
	Education	+	3.85 (0.80)	4.75 (.032)	1.20 (0.18)
	Ethnic group	?	n.r.[c]	n.r.	D
	Risk aversion	?	n.d.a.[d]	2.29 (0.14)	n.d.a.
	Household size	+	4.57 (0.29)	4.75 (0.31)	5.25 (0.24)
	C/W-ratio	−	1.36 (0.049)	1.42 (0.042)	1.52 (0.037)
	Children	+	2.03 (0.24)	2.50 (0.20)	2.47 (0.16)
Wealth/ scarcity variables	Total income	+	927 (165)	70.3 (5.6)	6489 (446)
	Low income	?	D	D	D
	Cash liquidity	+	−27.3 (113.5)	6.86 (1.77)	402 (192)
	Savings	+	13.3 (9.05)	n.d.a.	n.d.a.
	Labour force	+	2.82 (0.175)	2.9 (0.18)	2.8 (0.135)
	Male lab. force	+	n.r.	1.48 (0.13)	1.62 (0.095)
	Female lab. force	+	n.r.	1.54 (0.092)	1.18 (0.068)
	Former land	+	0.518 (0.092)	n.r.	n.r.
	Oxpower	+	n.r.	n.r.	2.23 (0.105)
Other variables	Location[e]	?	D	D	n.r.
	Interviewer	?	n.r.	D	n.r.
Observations			35	100	120

[a] Hypothesised sign of variable with respect to PV.
[b] D = dummy variable.
[c] n.r. = not relevant for this case study.
[d] n.d.a. = no data available.
[e] Location dummy: 1 = good market access, poor soil, land scarcity (Zambia); 0 = poor market access, better soil, abundant land (Zambia).
Standard errors in parenthesis.

do not think this explanation holds in explaining high average rates in our case-study areas, but perhaps it may hold to explain high RTPs for some households, but rather as a result of high pure rates of time preference and constraints on access to credit, etc.

Regression models for each of the three country case studies were developed to identify whether wealth indicators and other household variables had an influence on or were correlated with the personal RTPs.

In all models the present value equivalent (PV) was chosen as the dependent variable as we expected the RTP to be non-linearly related to, for example, the income or wealth as income/wealth approaches the minimum subsistence requirement. Many households in our case-study areas were living close to their minimum subsistence level. In Table 2, we find an overview of the right-hand-side variables used in the models for each of the three country case-study areas. As many asset variables were included, serious multicollinearity became a problem, necessitating careful elimination of some variables.

Household characteristics

In all of the models, we included certain variables concerning household characteristics: *inter alia* age, sex, years of education, household size, number of children and/or consumer–worker ratio. Intuitively, we would expect older people to have higher RTPs than younger people. This is because they have higher probability of not surviving (Eckstein, 1961; Kula, 1984). From a life-cycle perspective, older people are likely to be less interested in investing and therefore demand less credit. This may imply a less severe credit constraint, which may in turn suggest lower RTPs. Older people, may also have better access to credit (if they are credit worthy) because of better established reputations. The net effect of age is thus ambiguous. Age may also be correlated with wealth (accumulation).

Educated people may be more forward looking (lower RTPs) than the illiterate. On the other hand, they may have access to better investment opportunities and thus have higher RTPs. They may also have more wealth and therefore have lower RTPs. We have not tested for this as we have corrected for wealth, but it may potentially create an endogenous variable/multicollinearity problem.

We had no expectation of how gender differences could influence the RTP. For Ethiopia we included ethnic group as a household characteristic variable, without expecting this variable to have a certain sign. In the models for Zambia, we included risk preference as a variable as we had an independent estimate of this. For the other countries we did not have available risk preference data. Household heads' risk preferences were estimated using games with real payoffs, similar to what was done by Binswanger (1981) in his well known study in India. A discrete variable from zero (extreme risk aversion) to five (neutral to negative risk aversion) was defined. With perfect markets, risk preferences should not influence RTPs, as shown by Pender (1996), because the RTP should equal the market rate of interest. A significant response of RTPs to risk preferences therefore also indicates an imperfect insurance system. Risk aversion is not sufficient to predict precautionary savings (Kimball, 1990), but highly risk-averse households (living close to the subsistence level in a risky environment) will keep a buffer stock of savings to insure against income shortfalls (Carroll, 1992). More risk-averse people may thus make more precautionary savings, but this should be controlled for through the wealth and income variables in our analysis. One can postulate that risk-averse households will have a higher RTP if they expect a positive growth rate, while a negative g indicates lower RTP, as has also been discussed by

Munasinghe (1993). If risk aversion is also correlated or confounded with expectations about the future, e.g. such that more risk-averse people have more pessimistic expectations about the future outcomes (lower *g*), more risk-averse people will have lower RTPs independent of the current wealth and income situation.

Economies of scale in consumption, poverty and RTP

It was furthermore hypothesized that there may be economies of scale in consumption in the household. This may be derived from a hypothesis that there exists an optimal household size. Below a certain size there are economies of scale due to indivisibilities but at a certain level this may turn into diseconomies of scale (organizational problems leading to splitting of large households into smaller ones). A doubling of the household size may require less than a doubling of wealth, liquidity and other resources to attain the same level of welfare or security. This would imply an inverse relationship between the RTP and household size if poverty leads to a higher RTP. Based on the household-size optimality theory, there may also be decreasing marginal economies of scale as household size increases, turning to diseconomies of scale at some point. Household-size and household-size-squared variables were therefore included. If these variables are significant with the signs we have hypothesised, it also indicates the causal direction from wealth (poverty) to RTP. The reverse causality that high RTP leads to small household size seems less likely unless high RTP cause households to split more easily. Another hypothesis may be that households with children (large households) are more forward looking and thus have lower RTPs. To test for this we included the number of children, a dummy for whether households had children below 15 years or, alternatively, the consumer–worker ratio.

Wealth variables

When credit is rationed we would expect wealthier individuals to face fewer constraints and lower interest rates in credit markets. Thus, we would expect that wealthier people would tend to have lower rates of time preference. This is supported by the case study in India by Pender (1996) where the informal credit market was more developed than in our case-study areas. The discount rates he found, through similar experimental questions to those we used, gave RTPs that were significantly higher than the credit market rates. He also found that borrowing increases with wealth for low levels of wealth, which is consistent with the credit rationing hypothesis. Morduch (1990, 1995) also found that landless labourers and small farmers face substantial constraints in borrowing in the same Indian villages.

We included several different wealth variables in the models. Asset market imperfections constraining substitution between different categories of wealth were typical in the study areas and are consistent with what Reardon and Vosti (1995) have argued. Some of the asset categories, such as land, were not fully or easily marketable. Under such conditions each asset category may have an independent, direct effect on the RTP. If they have only indirect (and no independent) effects through the income and

liquidity variables, this may cause multicollinearity problems, making it necessary to eliminate some variables.

To test whether present wealth is influencing or being correlated with RTP, we included total income (including value of subsistence crops except minor crops per capita (Indonesia and Zambia) or per consumer unit (Ethiopia)) and labour force (per capita or consumer unit) as indicators of current wealth in all the three case studies. In Zambia and Ethiopia, male and female labour are not easily interchangeable, and these were included as separate variables. We also included a cash liquidity variable (total income minus total expenditures per capita (Indonesia and Zambia) or per consumer unit (Ethiopia)) for all countries. In Indonesia, we used per capita savings in the previous year as a wealth variable. These savings tended to be less liquid as they may have been put in the bank. Data on savings were not available for Zambia and Ethiopia. In Zambia the inflation rate was high and the real interest rate negative. We hypothesize that a low level of savings and liquidity would be a sign of cash shortage (and possibly an effective credit constraint) and would imply a high RTP.

In Ethiopia, oxen for ploughing are very much a key resource and thus number of oxen was included as a wealth variable. Asset variables were expected to have a negative effect on the RTP (positive effect on the present value equivalent). Present access to land was not included in any of the models. Land reforms in Ethiopia and resettlement programs in Sumatra ensured an egalitarian distribution of land in these two countries. In Indonesia all households had received 2 ha of land with secure tenure rights. There was some difference in the land quality between the two settlements in Indonesia, however. In Zambia, there was abundance of land and access to land was not considered to be a binding constraint, although land of good quality and with large trees was scarce in the densely populated area. Differences in land quality may therefore explain differences in economic conditions between the sites in each of the case-studies in Indonesia and Zambia. These differences are confounded with differences in market access, however.

Past wealth and current RTPs

We have argued that the current pure rate of time preference may be inversely related to past wealth. We believe this is because poor people are likely to be more in a survival and current-consumption mode. We are able to test for this by controlling for current wealth and income. However, there are alternative theories that could explain a significant relationship between past wealth and current RTPs. People with lower past wealth but with the same current wealth as people with higher past wealth may have lower pure rates of time preference and have been more prone to save and invest (Deaton, 1991). Another plausible explanation is that past wealth matters for current investment opportunities. This may imply that people with lower past wealth have higher RTPs because they currently have better investment opportunities.

To test whether former wealth had an independent effect on RTPs, we included a variable called former land ownership (area in Java) in the

Indonesian case study. This variable showed how much land respondents used to own in Java before they were transferred to Sumatra.

Location dummy variable: market access and population pressure
In Indonesia and Zambia, we included a location dummy where 1 = good market access/poor land quality (and high population density in Zambia) and 0 = poor market access/good land quality (and low population density in Zambia). In Ethiopia, there were no differences in market access among the survey households. The sign of the location dummy therefore depends on the relative sizes of the following residual effects:

- Boserup (1965) effects:
  —Good market access may have a positive effect on household income (due to better access and more favourable prices) and cause lower RTPs if this causal direction can be established.
  —Good market access may also imply better investment opportunities, higher interest rates and thus higher RTPs.
  —Good market access may imply better access to credit, lower probability of an efficient credit constraint and thus a lower RTP.
  The serious economic decline, high inflation rates, negative real interest rates and still low investment levels may make the second argument less relevant in the Zambian case, however.
- Geertz (1963) (agricultural involution) or Malthusian effect:
  —Population pressure (land asset poverty) leads to poverty and high RTPs. Land wealth was not included directly. In the poor-market-access areas soils were better and land more abundant. Land was relatively more abundant in the Zambian area with poor market access than in the Indonesian area with poor market access. This may imply a more significant negative effect on the location dummy variable in Zambia.
- Social capital effects:
  —Differences in RTPs may be explained by cultural differences between the areas, the strength of traditions, influence by western culture, religion, community vigour ('social capital'), which again may depend on political and social stability and security, health standards, etc.

In Indonesia there were no cultural differences between the two settlements because they were both inhabited by Javanese transmigrants 5–10 years before our study was carried out. We can therefore test the hypothesis that RTP is a more permanent characteristic of individuals, depending on past wealth, against the hypothesis that RTP is adjusting to the current liquidity and wealth situation or is independent of these. If there is no significant difference between the two settlement areas in terms of average RTP, we cannot reject the permanence hypothesis. On the other hand, if a significant difference can be found between the two settlements, and this difference can be explained by variables illustrating the differences between the two areas, we can reject the permanence hypothesis. Furthermore, we test whether RTP is a function of wealth in the past or is independent of wealth in the past (5–10 years earlier). A significant test

result indicates that RTP has at least some degree of permanence related to past wealth levels.

In Zambia there may be cultural differences between the two areas, although they are populated by the same ethnic group (Bemba). The densely populated area is more influenced by western culture, traditional norms have lost ground and this has had a significant negative effect on the level of organization (social capital) in these villages. Alcoholism, AIDS and theft of crops represent severe problems in this area (Holden *et al*., 1994; Holtskog, 1996). This social poverty may also drive the RTP up (PV down) and strengthen the likelihood of a negative sign for the location dummy. Intensification according to the theories of Boserup (1965) and Ruthenberg (1980) has taken place as a response to population growth and population concentration in this area (Holden, 1991, 1993). The intensification may in this case represent an agricultural involution as the government policy of stimulating food production (maize) for the market has largely failed (Holden *et al*., 1994; Holden, 1996; Wik and Holden, 1996; Tviland, 1996). The equity pricing system, as well as the state sponsored credit and input supply programmes, favoured remote areas since transportation costs were covered by the state (Holden, 1997).

To summarize, the Boserup effects are likely to be stronger in Indonesia than in Zambia because the Indonesian economy shows strong economic growth while economic decline and social disintegration may point more in the direction of a Malthusian scenario in Zambia. If RTP responds to economic conditions, the location dummy may be significant, but not necessarily so. We think the location dummy is more likely to be significant with a negative sign (Malthusian scenario) in Zambia owing to the economic decline there.

In Zambia we used two interviewers. We included a dummy variable for the interviewers to check for interviewer bias.

4. Results

4.1 Indonesia

Table 1 shows that the surveyed households on average were very poor with an annual income per capita of only US$107. Table 3 shows the present value equivalent amounts to an FV of Rp.100,000 in one year for each of the two settlements, the standard deviations for the means in each settlement and the equivalent average rates of time preference for the two areas. Table 3 shows that the estimated rates of time preference were very high and higher in the remote settlement with more severe poverty problems. The difference between the areas was highly significant (t-value = 2.9, $P = 0.01$). The hypothesis that RTP is a stable preference parameter unaffected by local conditions may be rejected.

Results from two regression models are presented in Table 4. Variables with t-values less than one have been excluded. Total income per capita was included in the first model, however, and was not significant. We expected some multicollinearity between this variable and the net-cash-liquidity variable. This was proved when we removed the total-income variable in the second model. The cash-liquidity variable then changed

Table 3. *Average present value equivalents, standard deviations and equivalent rates of time preference in the three country case studies*

Country/ Area/ Household group	*FV*	*Present value equivalent*	*Standard error of mean (Rp.)*	*Rate of Time preference (%)*
Indonesia	Rp.	Rp.		
All $n = 36$	100,000	39,583	5,536	0.93
Poor market access, $n = 18$	100,000	26,667	5,224	1.32
Rel. good market access, n = 18	100,000	52,500	8,904	0.64
Zambia				
All households $n = 86$	Maize, 15 bags	5.33	0.57	1.04
	Kw.10,000	3,504	361	1.05
	Kw.100,000	31,269	3,659	1.16
Poor market access/ low pop density, $n = 38$[a]	Maize, 15 bags	7.24	0.85	0.73
	Kw.10,000	4,455	575	0.81
	Kw.100,000	41,763	5,825	0.87
Good market access/ high population density, $n = 48$	Maize, 15 bags	3.82	0.7	1.37
	Kw.10,000	2,752	435	1.29
	Kw.100,000	22,961	4,348	1.47
Ethiopia	Birr	Birr		
All households, $n = 120$	100	58.6	1.89	0.53
No oxen, $n = 30$	100	45.5	3.49	0.79
One ox $n = 30$	100	54.3	2.95	0.61
Two oxen, $n = 30$	100	59.2	3.34	0.52
> Two oxen, n = 30	100	75.5	3.35	0.28

[a] More observations had to be deleted in the low population density area in Zambia. Illiteracy and inumeracy were more prevalent problems there.

from being insignificant in the first model to being significant at 5 per cent level in the second model. The R^2 was 0.57 in both models. The current liquidity situation seemed to be more important than the total income in explaining current RTPs. The labour force was only weakly significant (10 per cent level). The location dummy was also significant with a negative sign indicating a higher rate of time preference in the area with good market access. This result is the opposite of what we see in Table 3. This may be explained by the differences in the savings and cash-liquidity situation of households in the two areas as these were the only significant variables with a systematic difference between the two settlements.[2] It may therefore be concluded that the RTP is influenced by the current income/liquidity

[2] Estimated average savings and cash liquidity (total income − total expenditure) were Rp.66,000 and Rp.380,000 in the settlement with good market vs Rp.20,900 and Rp.−37,000 in the area with poor market access.

Table 4. *Variables influencing the rate of time preference in the Seberida, Sumatra dependent variable: present value equivalent*

	Model 1		*Model 2*	
Independent variables	*Parameter estimate*	*t-value*	*Parameter estimate*	*t-value*
Intercept	−44197	−1.34	−45699	−1.45
Total income per capita	−0.67E–02	−0.19	—	—
Savings, last year per capita	1.34	2.44**	1.32	2.34**
Net cash liquidity per capita	0.065	1.57	0.058	2.60**
Household size	26018	2.87***	25979	2.85***
Household size, squared	−2563	−2.97***	−2535	−2.92***
Labour force per capita	40418	1.85*	40209	1.80*
Location	−18236	−2.01**	−18401	−2.08**
Area in Java	15677	2.12**	15111	2.55**
R^2	0.57		0.57	
R^2 adjusted	0.44		0.46	

Note. Pooled data for two areas. Location dummy: 1 = good market access, 0 = poor market access. Number of observations: 35 (17 + 18). Significance levels: * 10%, ** 5%, *** 1%.

situation of households. The household size variable was highly significant and non-linear (1 per cent level); RTP was inversely related to household size, which we think may indicate economies of scale in consumption at small household size but diminishing marginal economies of scale as household size increases and diseconomies of scale for large household sizes. This systematic correlation was not explained by the number of children or consumer–worker ratio effects on the RTP as these variables were insignificant. Reverse causality (high RTP leads to small family size) seems to be unlikely here. We think the result supports the hypothesis about the direction of the causality from the current liquidity situation to the RTP. A small cash-constrained household may perceive its cash constraint as more severe than a household of twice the size with double the amount of cash available. The past-wealth variable (area in Java) was also significant (5 per cent level), with the more wealth in the past, the lower the RTP today, showing that RTP is not totally determined by the current income situation but also by past wealth, another clear indication of the direction of causality.

We may conclude that current liquidity as well as past wealth of households influenced the stated RTPs. The significant difference in average RTPs between the sites (which could be explained by differences in savings and cash liquidity), the past-wealth and household size responses all support the hypothesis that there is a causal relationship from these variables to the RTP. The reverse causality may also be true for the wealth variables, but is not tested here.

4.2 Zambia

The average total income per capita among the sampled households was US$108 per annum, indicating their relatively severe level of poverty

Table 5. *Regression analysis: variables influencing time preferences of peasant households in Zambia (ordinary least squares); dependent variables: present value equivalents*

Variables	*Maize, 15 bags*	*Kw.10,000*	*Kw.100,000*
Constant	1.96	−4619**	−23309
	(0.46)	(−2.06)	(−0.94)
Sex	−0.28	1206	−254
	(−0.22)	(1.48)	(−0.03)
Male work force per capita	−0.53	3529**	27187
	(−0.19)	(2.28)	(1.62)
Total income per capita	0.55E–05	0.41E–02	−0.004
	(0.43)	(0.75)	(−0.09)
Low income dummy variable	−1.88	−1483*	−12313
	(−1.64)	(−1.97)	(−1.52)
Net cash liquidity per capita	0.53E–04*	0.040**	0.29**
	(1.83)	(2.30)	(2.10)
Risk choice	−0.53E–04***	−0.22*	−0.18
	(−2.82)	(−1.81)	(−1.58)
Location	−4.30***	−2412***	−21243***
	(3.57)	(3.31)	(2.78)
Household size	0.52	727***	3780
	(1.01)	(2.40)	(1.18)
Household size squared	−0.29	−29.0*	−157
	(−1.25)	(−1.96)	(−1.01)
Interviewer	−0.10	945	15045**
	(−0.10)	(1.59)	(2.41)
R^2	0.26	0.29	0.22
R^2 adjusted	0.19	0.19	0.12

Note. Figures in parentheses are *t*-values. Significance levels: * 10%, ** 5%, *** 1% Variables with *t*-values less than 1 in all three models were removed (except for total income per capita).

(Table 1). In Table 3 we give an overview of the average responses of households to the hypothetical questions. We can see that the average RTPs were above 100 per cent in all three cases. The inflation rate was high in Zambia (Table 1). This could affect the answers on the hypothetical questions using money. To counteract the inflation effect, the interviewers tried to get the respondents to assume there was no inflation. Maize was also used to check for money illusions. For the maize and the 10,000 Kwacha alternatives, we see no difference in RTPs. The highest monetary amount had a high RTP on average, but this difference was not significant, indicating that the high inflation rate has not inflated the RTPs.

Regression analyses were run for each of the three hypothetical questions. The results are presented in Table 5. The R^2s were fairly low, ranging from 0.22 to 0.29 for the three models. Most of the household characteristics variables had *t*-values less than one and have been removed in the models presented. The sex of household head variable had a *t*-value greater than one in one of the models and was thus retained. Its sign was not consistent in the three models. The total work force was split into male and female work forces as there is a relatively strict gender division of

labour. Male and female workforce could be considered as different categories of assets. The male workforce had *t*-values greater than one and had a significant positive parameter value in one of the models. The sign was as hypothesized (Table 2). The total income per capita variable was insignificant in all three models. It was retained because it was combined with a dummy variable for the third of the households with the lowest income, which became weakly significant. There is thus only a weak indication of a non-linear relationship between the PV and the income level. The wealth variables, total income and labour force per capita had no significant effect on or correlation with the RTP. The cash-liquidity variable (cash income minus cash expenditure per capita) was, however, significant in all three models, particularly in the models with monetary-dependent variables. The signs were also as hypothesized. Cash scarcity (liquidity constraints) seemed to drive up the RTPs. The reverse could also be true.

The risk preference variable was significant in two of the models, and highly significant (1 per cent level) in the model with maize. The signs indicate that more risk-averse households have higher PV (lower RTPs), which supports the hypotheses that either risk-averse households worry more about the future (are more pessimistic and have lower expectations about growth), and thus have lower RTPs, or they have lower RTPs because they have higher elasticities of marginal utility and negative expected growth.

The location dummy was highly significant in all three models. The signs were consistent and it appeared that the rates of time preference were lower in the low-population-density area. This is in line with our hypothesis that the Boserup effect (population pressure leading to economic development, wealth accumulation and thus lower RTPs) is weak in this stagnant or declining economy, where problems like loss of traditional norms, social disintegration, high unemployment, low investment levels, weakened social services and AIDS are signs of development in reverse.

The household-size and household-size-squared variables were significant in only one model, but the signs were consistent and all *t*-values were greater than one, indicating an inverse relationship between household size and RTP which supports the economies of scale in consumption hypothesis and the causality direction from wealth to RTP. The consumer–worker variable was insignificant. The interviewer dummy variable was significant in one of the models—the model with highest monetary values. This was also the model with lowest R^2 and the model with highest average RTP. This indicates that one should interpret the results with caution.

4.3 Ethiopia

As can be seen from Table 1, the average level of income per capita was higher (US$196) for this sample than for the samples in Indonesia and Zambia. This may be surprising as overall GDP per capita is considerably lower in Ethiopia than in the two other countries. The relatively high level of total income in Ethiopia is because the survey was conducted in one of

Table 6. *Variables influencing the rate of time preference of rural households in Ada district, Ethiopia, dependent variable: present value equivalent*

Variables	*Parameter estimate*	*t-value*
Constant	12.97	2.62**
Ethnic group	7.38	1.77*
Ox power/cu[a]	36.78	3.76***
Ox power/cu squared	−9.99	−2.14**
Total income/cu	0.0046	2.80***
Low income, dummy variable	−6.58	−2.20**
Net cash/cu	−0.0047	−1.55
Household size	4.4	7.77***
R^2	0.44	
R^2 adjusted	0.41	

Note. Significance levels: * 10%, ** 5%, *** 1%.
[a] cu = consumer unit.

the best grain-producing areas in the country. The average PV equivalents, standard deviations of means and RTPs are presented in Table 3. We can see that the average rates were considerably lower than in Indonesia and Zambia and there were significant differences between the strata. The group without oxen (the poorest) had significantly higher average RTP than the groups with one or more oxen. Moreover, the group with more than two oxen had significantly lower average RTP than the groups with one or two oxen.

Results from the regression analysis are presented in Table 6. The R^2 was 0.44. None of the household characteristics variables were significant, except for the ethnic group variable which was significant at the 10 per cent level. This variable was a dummy variable with Oromo equal to zero and Amhara and others equal to one. The positive sign indicated that the second group had a lower RTP than the first group. Oxen wealth had a significant non-linear effect on, or correlation with, the stated PVs. As hypothesized, the RTP was declining with the increasing number of oxen. The total income per consumer unit was highly significant (1 per cent level). Likewise, when we combined total income per capita with a dummy variable (= 1) for the third of the households with lowest income per capita, we found this variable to be significant (5 per cent level). There was thus an inverse relationship between income per capita and RTP. The negative sign of the low-income dummy indicates that the PV is significantly lower for the low-income households and this comes in addition to the effect of the total-income variable. The net-liquidity variable was not significant and the sign was even opposite to what we would expect. We also found a significant inverse relationship between household size and RTP, indicating economies of scale in consumption and a causal direction from wealth to RTP. Large households had a lower RTP than small households with the same level of wealth per consumer unit. The squared variable was insignificant and its inclusion reduced the *t*-value of the linear effect of household size to 1.3 and that of the quadratic to 0.3, indicating a multicollinearity problem. Thus there was no significant

non-linear relationship between household size and the stated PV. The consumer–worker ratio or number of children in the household variables were insignificant. We can thus reject the competing hypothesis that the inverse relation between household size and RTP is because households with children (which tend to be large) are more forward looking and therefore have lower RTPs, because signs for the children variables even were in opposite directions and had very low *t*-values.

Oxen wealth and income were significantly correlated with the RTP in the Ethiopian case study. We think the significant effects of household size may be explained by the economies of scale in consumption hypothesis and this also supports the hypothesis that wealth affects RTPs. Cash scarcity was not significantly influencing (or correlated with) the stated RTPs, contrary to what we found in Indonesia and Zambia. This may be due to the relatively higher level of income and food security in the Ethiopian case. If we had carried out the survey after a drought or another calamity, the responses might have been different. The results support the hypotheses that poorer households on average have higher rates of time preference than wealthier households and that poverty may lead to higher RTPs.

5. Conclusion

This study used hypothetical questions to estimate RTPs of peasants in Indonesia, Zambia and Ethiopia. We have used a simple standardized method which we think facilitates comparisons of the rates across households and societies. The results were by and large consistent with economic theory. The estimated RTPs were very high in all three countries. The rates were higher in the case studies in Indonesia and Zambia, where the average levels of income were lower, than in the case study in Ethiopia. The rates varied systematically in each case-study area. Poorer households and/or households with severe immediate cash needs had higher RTPs. In Indonesia and Zambia immediate cash needs and consumption smoothing problems were correlated with the RTPs, while such a correlation was not found in Ethiopia. In the Ethiopian case study, where the households in the sample were relatively better off than in the case studies in the other two countries, total income and animal wealth seemed to play a more important role than immediate cash needs in explaining the RTPs. The direction of causality was tested in Indonesia; both past wealth (land ownership) and the current liquidity situation were found to affect current RTPs. The household-size variable was found to be inversely correlated with the RTPs in all case-study areas. The hypothesis that this was due to economies of scale in consumption, combined with a causal effect from wealth/liquidity situation to RTP, could not be rejected. The hypothesis that large households (with more children) have lower RTPs, because they care for their children, was rejected. This established causal direction from poverty to RTP has important policy implications as it follows that poverty reduction itself may contribute to lowering people's RTPs and thus reduce the 'intertemporal externality' and increase the probability of and/or size of investments. Lower rates of time preference make investments that offer long-term benefits with short-term costs, typical for, for example, soil

conservation, tree planting, etc., more profitable. This finding may give support to policies for poverty reduction on both efficiency and sustainability grounds.

In the Zambian case study we included an independent estimation of risk preferences. High risk aversion was found to be correlated with lower RTPs, indicating imperfect opportunities to hedge against future risk. Our results support the hypothesis that more risk-averse households have lower RTPs, either because they have more pessimistic expectations about income growth (negative growth) and/or because they have higher elasticities of marginal utility, which pulls in the same direction when growth rates are negative. In the Zambian case it appeared that the RTPs were higher in the densely populated area with good market access. This may be a sign of an agricultural and social involution with increasing population pressure. In the Indonesian case, RTPs were lower in the settlement with good market access. On the other hand, the location dummy in the regression analysis had the same sign as in the Zambian case. For both areas this might be due to the higher land quality (wealth) in the settlement with poor market access, making the residual Malthusian effects larger than the residual Boserup effects.

Our findings indicate that poverty and liquidity constraints or scarcity may have important consequences for behaviour. They may lead to high rates of time preference, which again may affect investments in environmental conservation. In poor rural economies, introduction of private property rights may, as a result of pervasive market imperfections, not be a sufficient policy instrument to achieve sustainable management of natural resources. Additional (second best) policy interventions, both to alleviate poverty and to enhance sustainable management of natural resources, are required.

Our results may imply that personal RTPs can be indicators of the level of poverty and immediate consumption smoothing problems of people living in rural areas in developing countries where credit and other markets are poorly developed. Further research should be conducted to test this hypothesis.

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