Tropical Agricultural Research Vol. 12: 236-248 (2000)

An Assessment of the Individual Rate of Time Preference of Local Communities in Peripheral Areas of the Sinharaja Forest

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ABSTRACT. *The discount rate derived for one purpose may not be appropriate for another purpose. Despite the possibility of existence of different time preference in an imperfect market situation, project evaluators use arbitrarily selected discount rates. This practice may have serious consequences on the natural resource base and may act as an obstacle to achieve sustainable development. This study conducted an experimental survey in the Sinharaja area to estimate the individual rate of time preference (IRTP). Results show coherent evidence of allocating low values of future consumption by rural people. The average IRTP is estimated to be 0.21. IRTPs show a large variation and they decline as delaying time of consumption increases. This provides supportive evidence for using different discount rates for benefits/costs occurring in different time scales. The analyses on the determinants of IRTP show that it is negatively influenced by income and base value while positively influenced by risk perception.*

INTRODUCTION

There has been a revival of interest in discounting and its impact on the natural environment. Environmentalists and ecologists argue that benefits, which occur in the distant future (some benefits relevant to future generations), are given less weight due to discounting and hence the process disfavours the long-term environmental benefits. Further, they point out that this practice in project evaluation has contributed to the current environmental crisis by promoting development activities that generate short-term economic benefits and long term environmental costs. In fact, some environmentalists consider assigning lower values for future benefits and cost as a major obstacle in achieving sustainable development. Along with these arguments, many have suggested to use lower discount rate in evaluating projects with long term environmental benefits. However, it has been shown that lower discount rates may not necessarily favour the environment because such rates may promote many projects exerting extra pressure on the natural resource base (Markandya and Pearce, 1994; Dixon and Hufschmidt, 1990). Another suggestion is to use different discount rates to give higher weights (through lower discount rate) for environmental benefits/costs which occur in the distant future. Although this seems a feasible solution to assure intergenerational equity, theoretical guidelines and empirical evidence to select appropriate different discount rates are lacking. While the debate on discounting is continuing in the academic circles, most of the project evaluations are carried out with arbitrarily selected discount rates.

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The theoretical foundation of discounting arises from the individual rate of time preference (IRTP) (Boardmar *et al.*, 1996; Markandya and Pearce, 1994). According to the theory of the individual rate of time preference, economic agents place a greater value on a good or a service which is received at present than in the future (Dixon and Hufschimidt, 1990; Fisher and Krutilla, 1995). Rate of time preference is defined as the marginal rate of substitution between current and future consumption (Becker and Mulligan, 1997). The market interest rate, the rate of return on investments and the opportunity cost of capital are other concepts which are considered similar to the IRTP in perfectly competitive markets. The literature in finance and economics shows that the concept of discount rate has been theoretically investigated intensively (Benzion *et al.*, 1989). However, when market imperfections are present, individuals may have different time preferences. According to Benzion *et al.* (1989), the knowledge of valuing future gains and losses by individuals and the empirical evidence on conformity of their behaviour to theories of time preference is scarce.

The appropriate discount rate for evaluating and appraising public investments, policies and programs is the individual rate of time preference. But the divergence of interest rates and time preferences, which is a consequence of market imperfections, has led to difficulties in selecting discount rates in developing countries (Poulos and Wittington, 1999). Empirical research on individual rate of time preference in developing countries for goods and services, particularly for non market goods and natural resources, are scarce (Poulos and Wittington, 1999; Godoy *et al.*, 1998). The use of a discount rate which is derived for one purpose is not relevant for other purposes, because, the marginal rate of time preference can be different for different goods (Fisher and Krutilla, 1995; Baumol, 1968; Boardman *et al.*, 1996). In appraising policies or projects, use of a discount rate that is derived for another purpose may have significant impacts on rate of use of natural resources and environmental degradation.

Determining appropriate discount rates is very controversial and a debatable subject among economists in the world. Thus; it is said that no exact discount rate can be used for different situations. It could be the rate of time preference, rate of return on private investment or opportunity cost of capital. Therefore, discount rates which are selected are different for different projects, depending on the economic characteristics of the projects and the economy (Lind, 1990). The rate of time preference can be suitable as the discount rate for the situation addressing allocation problems. This is because time preference make sense for use in allocation within the consumer lifetime (Lind, 1990). Natural resource conservation is concerned with allocation of resources for later time periods. According to Randall (1987), natural resource conservation is a transfer of consumption from immediate to later time periods. Therefore, for the natural resource conservation projects, the suitable discount rate should be the rate of time preference of the people using a particular resource. Hence, in appraising or evaluating any project oriented to conservation of the natural forest, the suitable discount rate is the rate of time preference of the people using the forest resource.

Further, the rate of time preference can be used as a discount rate for projects, which are financed by foreign funds. When individuals are investing at the margin, the rate of return should be equal to interest rate on which foreign funds are taken. According to the life cycle theory of consumption and savings, this rate should be the rate of time

preference (Lind, 1990). Most development projects related to forest conservation in Sinharaja area are also foreign funded. According to the above facts, individual rate of time preference is the suitable discount rate that should be used in evaluation of forest projects.

This study estimates the individual time preference of the local communities living around the Sinharaja forest. There are various development projects implemented in the Sinharaja area in relation to its protection. Such projects have been evaluated with arbitrarily selected discount rates. Failure of such projects may be due to inappropriate discount rates. Therefore, a discount rate determined on forest products is necessary for analysing and evaluating projects and programs related to forest protection. Following the above discussion, the objective of this study is to assess the individual rate of time preference of people extracting non-timber forest products (NTFP) in the Sinharaja forest. The study also attempts to examine variation in time preference with the period of delayed consumption and socio-economic determinants of the individual rate of time preference.

THEORETICAL FOUNDATION

The general theory of time preference is well known. Therefore, no attempt is made here to review it. However, those who have not had an exposure to this theory can refer Boardman *et al.* (1996) for a recent review. This section presents some theoretical details in relation to eliciting individual time preferences. The discounted utility model by Samuelson asserts that a sequence of consumption ($c_0 \ldots c_T$) is preferred to ($c'_0 \ldots c'_T$) if and only if:

$$\sum_t \delta^t u(c_t) > \sum_t \delta^t u(c'_t)$$

where u(c) is a utility function and δ is a discount factor. In eliciting the IRTP, a question on delaying or speeding up of consumption is asked from the respondent and based on his response δ is calculated. As described by Loewenstein and Prelec (1992), in elicitation of the individual time preference through field surveys, the researcher has to be aware of four types of possible anomalies, namely, common difference effect, absolute magnitude effect, gain loss asymmetry, and speedup-delay asymmetry.

One assumption in the basic discounted utility model is that consumption adjustments depend only on the absolute time interval (stationarity property). That means if a person prefers Rs. 1 today to Rs. 2 tomorrow he should prefer Rs. 1 on 50th day to Rs. 2 on 51st day. Thus, displacing the time should have no affect on time preference. However, in practice, many studies have shown that Rs. 2 on 51st day is preferred to Rs. 1 on 50th day while preferring Rs. 1 today to Rs. 2 tomorrow. This is referred as the common difference effect. As Stortz (1955), Ainslie (1975, 1985), have theorized and Horowitz (1988) and Benzion *et al.* (1989) have reported, the IRTP is decreasing as a function of time delay over which it is estimated.

Empirical studies on time preference have also shown that large base values are subjected to less proportional discounting compared to small base values. This is referred

to as the absolute magnitude effect (Loewenstein and Prelec, 1992). A similar anomaly is that losses are discounted at a lower rate than the gains. This effect is known as the gain-loss asymmetry. Adding to these anomalies, Loewenstein (1988) showed a delay-speedup asymmetry, that is the asymmetric preferences between speeding-up and delaying consumption.

Loewenstein and Prelec (1992) developed a model that accounts for the above mentioned anomalies. In this model, a value function has been introduced in place of the utility function of the discounted utility model. This model is comprised of two functions; value function and discount function. The model is based on the assumption that inter-temporal choice is made considering the divergence of the choice from the anticipated status quo consumption plan. In formulating this model, it is assumed that outcomes are separated in a temporal prospects and prevailed in an additive utility function - $\Sigma_i u(x_i,t_i)$.

where: x_i = outcome (i = 1,2,3,...n)
t_i = time period during which each outcome occurs (i = 1,2,3,.....n)

For a single outcome; $u(x,t) = F(v(x)\phi(t))$

where, $v(x)$ = value function, $\phi(t)$ = discount function

Considering the distributivity condition F can be eliminated, and the final model is of the form:

$$U(x_1,t_1; \ldots x_n,t_n) = \Sigma_{i=1} v(x_i)\, \phi(t_i)$$

Discount function, $\phi(t)$ is a function of time and the discount rate. Two discount functions are assumed to be existing; the constant exponential function and the generalized hyperbola (a non-exponential function). The constant exponential function is of the form:

$$\phi_t = 1/(1+r)^t = e^{-rt}$$

where, ϕ_t = discount factor, r = discount rate, t = time period

The generalized hyperbola is of the form:

$$\phi_t = (1 + (\alpha t)^{-r/\alpha})$$

where, α, r are non negative parameters

Though the generalized hyperbola function is more consistent with the individual time preference, work done on the values of the parameters of the function are little (Poulos and Wittington, 1999). According to Becker and Mulligan (1997), individual's discount function is compatible with a constant exponential function. As more evidence and suggestions are in favour of the constant exponential function this study uses the constant exponential discount function.

When this model was developed, utility function of the discounted utility model has been replaced by the value function. This function has two segments, which are for

losses and gains, joining at a reference point. The segment, which represents losses, is negative whereas the segment for gain is positive. The reference point represents the current expenditure level or status quo. The segment representing loss is steeper than the segment for gain. This property reflects that the losses are more valued than the gains. Thus, this function is more elastic for losses than gains and more elastic for outcomes in larger absolute magnitude (Loewestien and Prelec, 1992).

Assume two outcomes x and q, then the equivalence between them suggest that:

$$v(q) = \phi(t)\, v(x)$$

where, q = equivalent present value of x,
x = amount consumed within t time period.

Inversion of the function gives: $q = v^{-1}(\phi(t)\, v(x))$

By division of x and inserting $\delta = 1/(1 + r)^t$ we get: $q/x = 1/(1 + r)^t$

Solving for r results: $r = (x/q)^{1/t} - 1$

The above equation can be used to derive IRTP in an experimental survey.

Hypotheses of the study

This section presents the hypotheses tested in this study about the discount rate. Similar hypotheses have been previously tested by Becker and Mulligan (1997).

Base Value

H_0: Individual rate of time preference is directly proportional to the base value
H_1: Individual rate of time preference is inversely proportional to the base value

As mentioned in the theory section, the base value is the average value which has a negative impact on the estimated discount rate. This is due to the tendency of people to discount less when the sums involved are large.

Income

H_0: Individual rate of time preference is directly proportional to the income.
H_1: Individual rate of time preference is inversely proportional to the income.

It is claimed that the people who have the higher income level or wealth possess lower rate of time preference than those with lower income level (Becker and Mulligan, 1997). Income level of an individual reflects degree of poverty. It is said that poverty

causes the impatience of the people resulting in higher rate of time preference. Therefore, it is hypothesized that income is inversely related with the rate of time preference.

Education

H_0: Individual rate of time preference is directly proportional to the educational level of the individual.

H_1: Individual rate of time preference is inversely proportional to the educational level of the individual.

Level of education is assumed to increase income and to reduce poverty. Therefore, education reduces impatience leading to lower the rate of time preference (Becker and Mulligan, 1997).

Age

H_0: Individual rate of time preference is directly proportional to the age of the individual.

H_1: Individual rate of time preference is inversely proportional to age of the individual.

The effect of age on the rate of time preference is not clearly understood. It is argued that the older people have the lower rate of time preference than the younger people. This is assumed due to impatient quality of the younger. However, counter arguments suggest that older people tend to consume more at present than future due to uncertainty of living. Then the older people have higher IRTP than younger people. However, the need to leave bequests prevents the aged from possessing extremely higher IRTP (Boardmar *et al.*, 1996). According to Becker and Mulligan (1997), the younger and the older have shown similar rates of time preference.

Risk perception

H_0: Individual rate of time preference is inversely proportional to risk.

H_1: Individual rate of time preference is directly proportional to risk.

When the people's existence and availability of benefits in future is uncertain, they perceive that they would not be able to consume in future. Then, they tend to consume more at present (Markandya *et al.*, 1994). Therefore, it could be assumed that individual perception of risk and time preference is inversely related. The time, during which an individual perceives to have benefits in future, is supposed to be reflecting both risk of living and availability of benefits. The greater the risk the shorter the time will be and vise versa.

METHODS AND DATA

The present analysis was carried out with the data collected from 80 households in the periphery of the Sinharaja forest. Eighty villagers were randomly picked up from 10 villages in four Gramasevaka divisions in Kalawana electorate of Rathnapura district. A list of all the households in the four Gramasevaka divisions were prepared and random number tables were used to select the households. A member of each household, who is mainly responsible for the household decisions, was interviewed. By this interview, socio-economic data, such as age, education level of the respondent, total household income, total household wealth, the respondent's personal perception of risk for extraction of resources from the natural forest, non-timber forest product extraction per year and the data important to calculate private time preference were obtained. The survey was conducted using a well-structured questionnaire. The questionnaire was pre tested with a few households before conducting the survey.

Individual rate of time preference was calculated using the data based on value of the NTFP extracted from the Sinharaja forest. First an account of all the NTFP collected from the forest was made. The respondents were informed of the value of their current NTFP extraction. Then they were told that the government is going to stop NTFP extraction but will pay compensation to the villagers equal to their income losses. They were further informed that if there are some administrative delays, they will be paid an additional amount for such delays. Then they were asked for their preferences for the compensation for various delays in the payments (see Appendix 1 for the question). The IRTP were calculated based on their responses using the last formula in the theory section.

Thus, the value of non-timber forest products extracted by the respondent was used as the base value in the estimation of IRTP. In valuing non timber forest products, the average quantity of extraction of each product per year is multiplied by the forest gate price of each product. When the market prices are not available price of the closest substitute of each product was used. Sometimes, when the substitutes are not available the material value- subtracting the incurred cost of production from the price of the value added product, was used. Thus, if any cost (time cost or any expenditure) was incurred in collecting forest products, that was also subtracted from the value of each forest product.

Age and income of each respondent was directly taken from the questionnaire. When the household income data was collected, the annual income of every family member (except separately living member) was included. This comprises both agricultural income (homestead, seasonal crops, perennial crops and livestock) and non-agricultural income (wage labour, kitul tapping *etc.*). Risk was measured according to the length of time period one perceives that he/she can extract NTFP in the future. If the individual feels that he/she can extract NTFP for a long period in the future, the risk perception was inferred to be low. Therefore, risk perception was ranked (1–6) according to the length of time period. The level of education of each household was also ranked according to the grades up to which one studied. The lowest rank given is one for not schooling and the highest is seven for tertiary education.

RESULTS AND DISCUSSION

Out of 80 questionnaires, only 76 were considered for analysis. The average IRTP across time for each individual and the average IRTP over the individuals for each year were calculated. The estimated IRTP values for different time periods are given in Table 1. The results clearly show that the IRTP declines with the years of delayed consumption. Also the ranges suggest that under each category of delayed consumption, there is a large variation.

Table 1. Estimated rate of time preference.

IRTP	Year					
	1	2	3	5	10	15
Average IRTP	0.34	0.30	0.26	0.19	0.14	0.11
Standard deviation	0.20	0.18	0.15	0.11	0.07	0.06
Maximum	0.90	0.92	0.69	0.47	0.33	0.25
Minimum	0.03	0.03	0.03	0.00	0.00	0.00

The results show that, on average, villagers discount future consumption at an average rate of 0.212. This is slightly above the market rate of interest for bank loans (0.185). This higher rate in discounting can be partly due to the existing poverty in the area. Recall that the discount rates were derived using the NTFP income as the basis. Economic theory suggests that if people are extracting natural resources under an open access situation, their discount rate should approach infinity. The situation in the Sinharaja is a mixed one in terms of property rights. Existing laws prohibit resource extraction except for Kithul products from Sinharaja. However, with the suggestion of the Forestry Master Plan to allow NTFP extraction, the Forest Department has taken a light attitude towards NTFP extraction. Moreover, with the increasing awareness on the biodiversity value of Sinharaja, social institutions, which change the resource extraction patterns, are emerging. Therefore, the property rights situation in Sinharaja, in terms of NTFP, is in-between private property and pure open access. In this light the estimated discount rates seem reasonable.

As shown in Figure 1, the IRTP values show a clear trend of declining as time period of delayed consumption increases. Loewestien and Prelec (1992) assert that their model is capable of handling the four anomalies including the common difference effect. Our results show that the common difference effect has not been avoided. However, Loewestien and Prelec (1992) model is developed to estimate the IRTP for near future changes in consumption (only for a few years shifts in consumption). When the model is used for a long period of delayed consumption, the common difference effect may occur. Our finding thus confirms previous findings on common difference effect by Horowitz (1988) and Benzion *et al.* (1989).

The behaviour of the IRTP over different income groups is also depicted in Fig. 1. First three years, the higher IRTPs are shown by the income groups (Rs. 70000-100000) and the highest income group (Rs. 150000<) holds the lowest discount rates over the years. Generally, it seems that the IRTP is declining with income over the years. This behaviour is in line with the economic theory discussed earlier. Thus, every income group behaves almost similarly in valuing future benefits over time when consumption is delayed by different time periods.

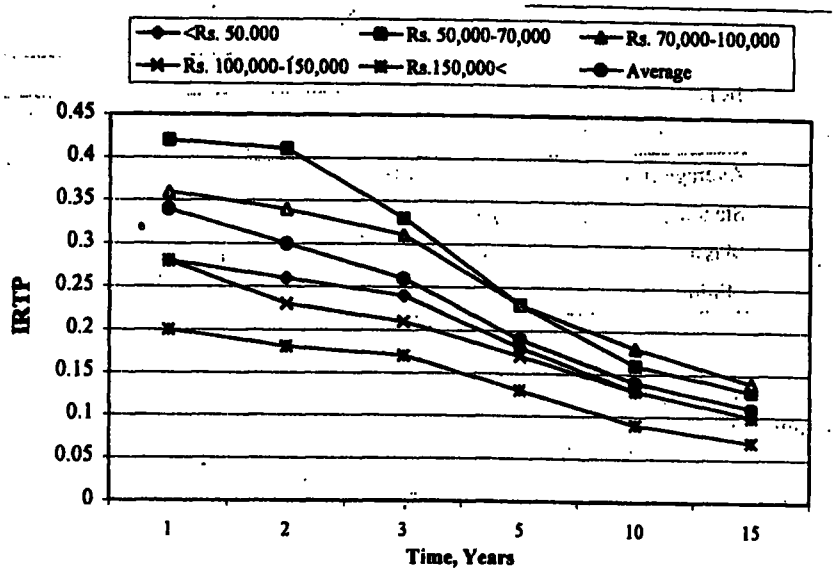

Fig. 1. Average IRTP for different income groups.

Factors influencing the IRTP

The results of the survey, as shown above, indicate a declining rate of time preference for all the individuals. Average of the time preference for different periods was used in estimating a regression equation to study the factors influencing the IRTP. The regression equation was specified based on the Becker and Mulligan (1997) work. The descriptive statistics of the variables used in the regression analysis is given in Table 2.

An initial run of the Ordinary Least Square regression provided R^2 of 0.24. Thus, only 24% of the variation in the individual rate of time preference is explained by the model. The low R^2 may be due to the averaging of varying rates of time preferences with planning horizons. The model was tested to diagnose heteroscedasticity. Results are given in Table 3. These results indicate that there is no heteroscedasticity in the data. Then, the data was checked for multicollinearity using the correlation matrix of the variables.

Table 2. Descriptive statistics of the variables used in regression analysis.

Variable	Mean	Standard deviation	Maximum	Minimum
IRTP	0.21	0.16	0.92	0
Age	46.29	11.94	87.00	18
Education	2.58	0.97	6.00	1
Income	98723.59	60948.85	294400.00	12150
Risk perception	3.57	1.47	6.00	1
Base value	28861.90	45336.59	240310.00	2020

Table 3. Results of the diagnostic tests for heteroscedasticity.

Test	Test Statistics (Chi-square)	Critical Value	Remarks
B-P-G test	4.862	11.07	No heteroscedasticity
Arch test	0.721	3.84	No heteroscedasticity
Harvey test	7.444	11.07	No heteroscedasticity
Glejser test	6.068	11.07	No heteroscedasticity

The correlation matrix of variables (Appendix 2) depicts that correlation between variables is not severe. So the data is free from usual data problems, hence, the regression results are accurate.

The results of the regression analysis are given in Table 4. Among the variables that are related to the IRTP age shows positive relationship. But this is not statistically significant. As mentioned earlier, the impact of age on IRTP is not well-defined in theory.

Table 4. Regression results on rate of time preference.

Variable	Coefficient	Standard error	t-Statistics	P-value
Age	0.1707×10^{-03}	0.7894×10^{-03}	0.2163	0.829
Education	-0.1225×10^{-01}	0.1174×10^{-01}	-1.044	0.297
Income	-0.5847×10^{-06}	0.1235×10^{-06}	-4.733	0.000**
Risk perception	-0.2519×10^{-01}	0.8041×10^{-02}	-3.133	0.002**
Base value	-0.7719×10^{-03}	0.1436×10^{-03}	-5.377	0.000**
Constant	0.4066	0.5871×10^{-01}	6.927	0.000**

** significance at 0.05 level

Level of the education of the individual is negatively related as hypothesized. However, it is not statistically significant. The other three variables, income, risk and base value are statistically significant at $\alpha = 0.05$ level. All these variables show the expected signs. The overall regression results, despite the low R^2 value, are in line with the postulated theory. Therefore, one can use the estimated individual rate of time preference for practical use with confidence.

CONCLUSIONS

This study conducted an experimental survey to estimate individual rate of time preference among the peripheral villagers in the Sinharaja forest. The results show coherent evidence of placing lower value for future consumption by the respondents. The perception held by some that economists are imposing the discounting procedures in project evaluation is erroneous. This study provides clear evidence of the existence of discounting by rural villagers in a developing country, hence, provides justification for discounting in project evaluation.

Average rate of IRTP is estimated to be 0.212, which is slightly above the market rate of borrowing capital. However, the IRTP shows a very high variation. This poses a question on the appropriateness of using one rate of discount to value benefits and costs for individuals who have distinctly different time preferences. The results show that IRTP declines as the delaying time of consumption increases. This finding, on the one hand, contradicts the usual practice of using one rate of discount for the entire period of the project. On the other hand, if finds support for the view that environmental benefits/costs occurred in the distant future should be discounted at low rates. The analyses on the determinants of the IRTP show that income, base value and risk perception, negatively influence the IRTP. These findings are in line with the previous findings, hence, indicate the accuracy of the estimated IRTP values.

ACKNOWLEDGMENTS

The authors acknowledge the financial assistance received from the MacArthur Foundation to conduct this study.

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APPENDICES

Appendix 1. Question used to elicit IRTP.

"Under a forest conservation program, the government has decided to stop the forest resource (NTFP) extraction by an year. This year is supposed to be the first year from tomorrow. Then, you will lose a net income from the forest which is worth Rs.....

Instead of losing that amount, the government is willing to pay you the same amount in the first year itself. But, due to some administrative problems, paying may be delayed. If any delay happens, the government has decided to pay an additional amount to compensate for

delaying. Therefore, what would be the amount you are willing to accept for delaying the payment at different years as the following:

Year after first year	1	2	3	5	20	15
Amount (Rs.)						

Appendix 2. Correlation matrix of variables.

IRTP	1				
Age	-0.54859E-01	1.0000			
Education	-0.82105E-01	-0.45112	1.0000		
Income	-0.21703	0.80452E-01	0.46446E-01	1.0000	
Risk	-0.28495	0.47661	-0.31645	-0.67466E-01	1.0000
Base Value	-0.20954	-0.31015E-02	-0.12184	0.58263E-01	-0.11947