Modeling of Income Effects on Biodiversity for Proper Global Policies

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Abstract

This paper attempts map changing pattern of impacts of export promotion for biodiversity and attractions of international tourists from biodiversity under globalization constructing theoretical models proved by analysis of empirical data sets. The results were compared with existing economic theories and highlight qualifications and disqualifications of existing theories in application for this case. The study discovered theories, facts and new analytical methods, which will nourish future research directions. For export promotion, Kuznet curve was reached and for recreation arrival rates, GDP-ppp per capita, Biodiversity, and other more variables were modeled. The correlation between arrival rate and per capita income violates absolute income theory of consumption. Finally this paper demonstrates that non-linear correlation exists between arrival rate and GDP-ppp per capita among countries, and also arrivals and Biodiversity are interdependently correlated. Moreover, this paper proves that conservation of more biodiversity by means of parks, sanctuaries and different kinds of reserves in developing countries is the better option than converting for export agriculture for maximizing global welfare.

Keywords: Economic modeling; Biodiversity; export promotion; Recreation

1. Introduction

Very important global ecosystems, particularly including tropical rain forests and biodiversity hotspots are located in developing tropical countries. Except for California floristic province all the other 24-biodiversity hotspots are located in Latin America, Africa, and Asian and Pacific countries. Only Mediterranean basin hotspot and Caucasus hotspot are situated between African and Asian countries and Europe respectively, which borders developed countries Spain and France **[1]**. The degradation of these globally important ecosystems continues worldwide. **Swanson [2]** says that loss of Biodiversity is currently one of the major problems facing the world.

Globalization has increased encroachment for export agriculture. Global forest cover is estimated to have decreased by around 40% since pre-agricultural times and currently tropical deforestation which exceeds 130,000 square kilometers a year is the most serious threat to the biodiversity as shown by **Sterner [3,p.406]**. Tisdell **[4]** argues that globalization is the dominant development strategy for achieving growth worldwide, and development under globalization requires conversion of natural capital to manmade capital degrading more biodiversity. Tisdell **[4]** further goes on that there exist global economic failures in biodiversity conservation such as low support from high-income countries for Biodiversity conservation, and limitations of eco-tourism etc. Even though Tisdel **[4]** argues that conversion of natural capital into manmade capital is essential for sustainable development under liberalization-globalization, there never exist adequate evidence for such, because question remains that there needs to compare the benefits or contributions to GDP by unit areas (land) of natural capital and manmade capital. Therefore in this paper we examine impacts of these two factors; export promotion and international recreation.

2. Theoretical Approach.

Biodiversity dimension of sustainable development is the management of maximum benefits generating stock of global biodiversity for infinite number of years (see Munasinghe **[5]**). Sri Lanka is a biodiversity hotspot among the 25-biodiversity hotspots in the world. The biodiversity recreation is a factor of decision-making by a tourist of a developed country to select a country to be visited. So we can obviously mention that mass tourism income of a developing country is a proportional to the biodiversity richness. This could be linear or non-linear.

$R_{b=kT}$ (Linear) (1)

Where R_b-biodiversity richness , T-mass tourism income and k- a constant

$R_b=\lambda T^{\alpha}$ (Non-linear) (2)

Where R_b-biodiversity richness, λ- a constant, T- mass tourism income and α-power of T. When there is no any biodiversity richness in a particular country, people still travel in that country to visit other things like archeological sites, monuments and cultural aspects etc.

Analysis of spillover effect

Looking at absolute income theory of consumption, $C_i=C_0+MPC*Y_d$ where C_i-consumption level, C_0- Consumption at zero income, MPC-Marginal Propensity to Consume and Y_d – Disposable income, we understand that disposable income is a function of consumption. Then we assume recreation level of the tourist depends on his income, as the recreation is also a kind of consumption. By this means, the demand (D) of a foreign country tourist for traveling in a local biodiversity rich developing country can be formulated as

D=f (Y, B, E, X, C, P, I, A, T…) (3)
(1)
Y-Per capita income of the tourist
B-Biodiversity richness of the developing country.
E-education level of tourist
X-tourist's value on cultural sites in the developing country.
C-cost of traveling
P-Previous specific knowledge and experience about biodiversity or fragile ecosystems in developing country to be visited. (according to Krutilla **[6]**)
I-informal knowledge acquired (after formal education)
A-awareness (promotion) from domestic (developing) country
T-level of technology in the world (cheapness, safety and security etc)
And more variables…

Above formula (3) can be abbreviated in with following arguments.

1. We can also write the following formula

Y=f(C, T) (4)

assuming changes in cost of traveling could be captured by real income (reducing return ticket over time) and advanced technology in a country may be increasing real per capita income.

2. Likewise we can construct the following formula too.

$$E= f (P, I, A) \quad (5)$$

assuming E can capture previous specific knowledge on biodiversity and related issues(P), level of informal knowledge acquired(I), and how much knowledge the prospective tourist achieve from awareness from developed country(A).

Likewise per capita income Y and education level E could capture more associated variables as in formula and therefore we can reconstruct the model (1) as following

$$D=f (Y, B, E, X) \quad (6)$$

Now we can leave the variable X to go with the error term or any constant in the model and then write the model as following

$$D=f (Y, B, E) \quad (7)$$

This model now with features of simple augmented production (D: $R^3_{+} \longrightarrow R_{+)}$ function could behave to give output or product of tourist arrivals (D) employing inputs of per capita income Y, richness of biodiversity B and education level of the tourist E. The other variables such as cultural value of domestic country etc could be captured by the error term.

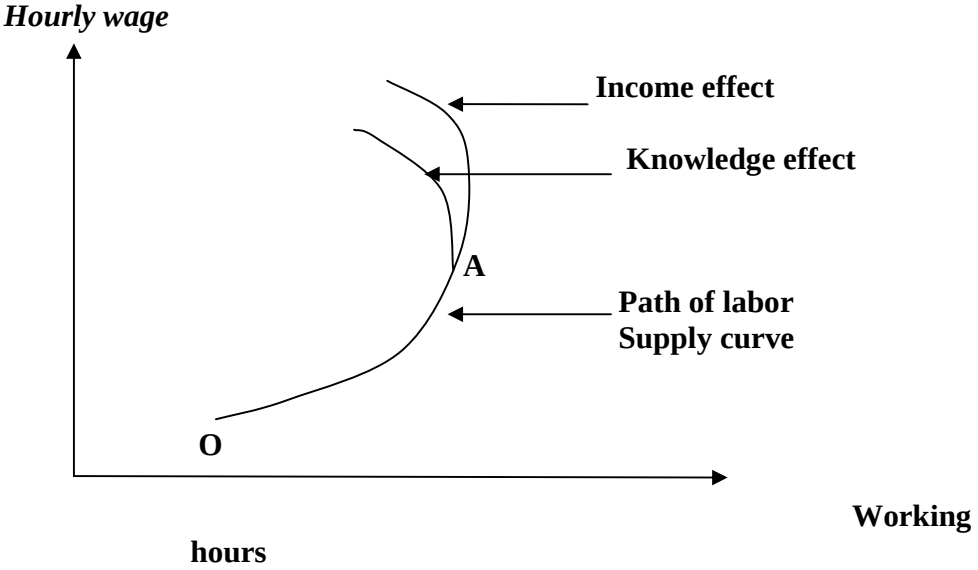
This model is convex and obviously shows following properties.

$D_y>0$, $D_b>0$ and $De>0$

Next problem comes on how to use the formula
(4), D=f (Y, B, E)

Here indicators for each variable have to be developed and discussed. Also if we know any series of value for D and at least for any other one variable(Y, B or E) we will be able to find the correlation. For D, we can consider number of tourists arriving, for Y per capita income of any foreign country. Assuming average expenditure in developing country by the tourist (this is the income of developing country), we can calculate income effect in tourism from increasing income in developed countries. Here we have to consider B and E in the model as constants.
D in the model could be let to be the proportion of income generating as a component of recreation values of biodiversity from tourism if we include biodiversity variable in the model. Therefore D is only a proportion of mass tourism income. But when tourists make decisions to travel in a country, they take in to consideration in which country they should travel in taking into account biodiversity richness too. Therefore ultimately number of arrivals could capture level of biodiversity in that country even the biodiversity richness in error term or in any constant.

Barbier **[7]** also shows that awareness is growing in industrialized nations that tropical forests are unique ecosystems as a major source of biological diversity for important climatic functions. Therefore, tropical forests are drawing attention towards complete protection, with the exception of traditional use by indigenous communities who have used these resources over centuries in sustainable manner. Krutilla **[6]** proves that when the existence of a unique and fragile ecosystem is involved, its preservation and continued availability are a significant part of the real income of many individuals. Freeman **[8]** argues that this is due to bequeathing these resources to future generations and existence values for future options and future research as still much is to be learned. Krutilla **[6]** further goes on that funds are employed for conservation of fragile ecosystems in developing countries. Recreational value depends on previous experience in that regard and personal knowledge on those ecosystems.



Graph 1-effects of knowledge on labor supply curve

To elaborate the effect of increasing knowledge of tourists as Krutilla **[6]** and others point out, we shall consider any country with above labor supply curve. Labor curve starts from point O and moves until point A with time passage under constant knowledge of tourists. After point A, knowledge of some portion or all population is supposed to be increased due to any reason. Then labor curve will be bent backward due to effect of increased knowledge on fragile ecosystems in developing countries.

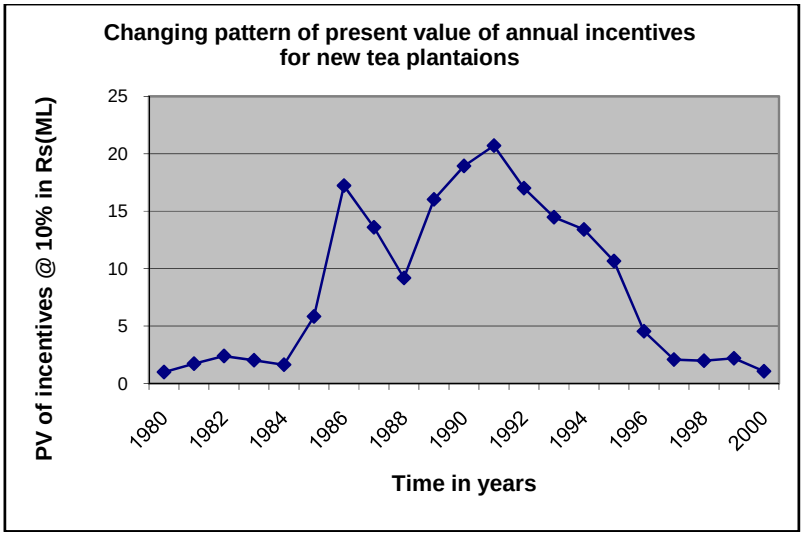
3. Data Sources

Total tea land areas (in hectares) in 1982 and 1992 according to administrative districts and annual total amounts of incentives from 1980 to 2000 (Sri Lankan Rupees millions) were taken from Plantation Sector Statistical Pocket Book **[9].** Time series nominal values (in Rs millions) and real values (calculated using nominal values and Consumer Price Indexes) of Gross Domestic Production of Sri Lanka were taken from Sri Lanka Central Bank Annual Report **[10]**. Time series data of the total numbers of foreign tourists arrived in Sri Lanka, visited each site (cultural triangle, zoo, and museum etc), gate fee incomes, total tourism income etc was taken from Sri Lanka Tourists Board Annual Statistical Report 0f 2005 **[11].** The number of

biodiversity parks, relevant declared years as parks and gate fee income from foreign tourists from some of them were obtained from Sri Lanka Forest Department Administrative Reports **[12]**. Sri Lanka Central Bank Research division provided the time series data of contributions of tea and forestry. The populations and GDP-ppp values of most tourists arriving countries in were obtained for 2002 from **[13]**. The contributions of tea and forestry sectors to the GDP (nominal values in million of Sri Lankan Rupees) from 1972 to 2003 were taken from Sri Lanka Central Bank Research Division data base as unpublished data **[14]**.

4. Results and Discussion

Per capita income of Sri Lanka increased to US $ 850 in 2004 moving the country to lower middle-income category of countries from low-income category. The Sinharaja tropical rain forest, an international biosphere reserve has been declared as a National Wilderness Area, which is Sri Lanka's only one World Heritage Site **[15,p.48]**. It is also a strict reserve in the country. Four administrative districts surround this strict reserve - namely Galle, Rathnapura, Kalutara and Matara. In these districts Tea plantations have increased from 57799 ha in 1982 to 74856 ha in 1992. This increase is 29.51% of initial extent (57799 ha). Again a huge amount of this 29.51% increase would absolutely be encroachments of government reserves including Sinharaja reserve itself. The Sri Lankan government has established Tea Small Holding Authority (TSHA), which has been granting incentives for tea cultivators since 1980 to date. It has been granting incentives for new tea plantations establishments, which actually are new encroachments of government forests to a certain extent. As the extent of government forests has been decreasing with every annum new encroachments and increasing pressure from conservation oriented government agencies, TSHA has happened to reduce the amount of annual incentives, which could be understood from the following graph (**Graph 2**). Present Value (PV) of total amount of incentives granted by TSHA for establishing new tea plantations has increased until 1992 since 1980 and decreased from 1992 to 2000. PV was calculated taking 10% as average annual interest rate in Sri Lanka. PV is, in fact, proportional to extent of new encroachments, which therefore can be considered as the rate of forest degradation. In fact, per capita income in Sri Lanka has increased until 2000 since 1980 with some fluctuations due to civil struggles and international conditions. Therefore, however, regardless of per capita income in Sri Lanka this encroachment behavior is close to Environmental Kuznet Curve (EKC) behavior-hypothetical inverted "U" shape curve representing environmental degradation rate with respect to per capita income increase in a country. In 1987, 88, and 1989 civil struggles culminated and therefore relevant PV values are out of this Kuznet curve behavior, which could be observed with the graph 2.



Graph-2- changing pattern of PV of total amounts of incentives granted by THSA. From 1980 to 2000.

Now if we correlate these PV values of incentives with relevant per capita incomes in each year (time series), we can get the following chart(chart 1) which is, in deed, the Kuznet curve for deforestation in Sri Lanka for establishment of tea plantations. (per capita income is in the real values neglecting impacts of inflation and interest rates)

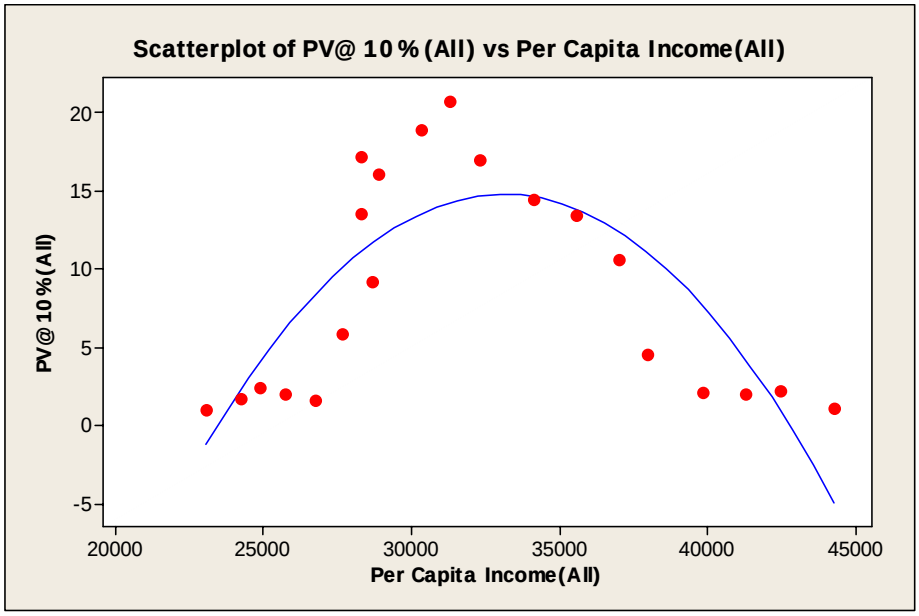


Chart-1

We can get the correlation (regression) as following

$$R_{df} = -0.00000016\ Y^2 + 0.0105\ Y - 159 \qquad (8)$$

where R_{df}- rate of deforestation for tea (PV of incentives) and Y-real value of per capita income(without inflation and interest rate impacts). As R-Sq(adj) is 60.7%(a very high value) , this model is more accurate.

Income effect I, for deforestation could be calculated as following by differentiating R_{df} with respect to Y.

$$I=d(R_{df})/dY= -0.00000032\ Y+0.0105 \quad (9)$$

At the maximum, as slope should be zero, we can find the most accurate Y value.

$$-0.00000032\ Y+0.0105 = 0 \quad (10)$$

Therefore Y= -0.0105/-0.00000032=Rs.32812. (annual real value). Therefore, according to our real value per capita table, encroachments of rainforests deforestation began to happen in a decreasing rate since 1993 but until then it was increasing with increasing rate.

Currently under the Forestry Resources Management Project (FRMP) funded by Asian Development Bank, these encroached lands are being considered to be regularized-to offer the freehold ownership. Because as shown by **Barbier [7]**, developing countries think that tropical forests should be exploited for economic development such as roads, electric power generation, and agriculture lands uses and shifting cultivations etc. In the other words, they believe net benefits of conservation are lower than the net benefits of above mentioned development activities. Krutilla **[6]** also argues that there is no significant local interest for the preservation of the grand scenic wonders, threatened species, which involves comparatively large land tracts. Swanson **[2]** explains that though almost 5% of remaining tropical forests in the world received legal protection, it was only limited success, because they do not address the forces, which exacerbate the losses of biological diversity.

3.2 Empirical evidence

Many researchers have argued that unique ecosystems and biodiversity in developing world should be protected for the sake and benefits of all people living in the world- to preserve global public goods such as climate, temperature and nutrient cycling etc. But, I argue that if unique ecosystems and biodiversity are managed properly in developing countries, it will be important to developing countries itself for achieving growth and stability in the own country.

Increasing global values

Kramer and Mercer **[16:p.96]** point out that the increasing concern of developed countries over the global values played by tropical forests in carbon cycle, climate regulation, and genetic resources conservation has produced another set of beneficiaries to those living in thousands of miles away where protection takes place. According to their study, an average American household is willing to contribute US $21-31 for increasing 5% of tropical rain forests in 1997. This amount would obviously be an annual value. The total population in America is 288 millions and assuming 5 members in a family, we can calculate the potential annual contribution (288/5*26) as US $ 1487.6 million per annum. It is most likely that other high-income economies in Europe such as France, Germany, UK, Luxemburg etc would have higher

willingness to pay for preserving rain forests. Therefore, it is absolute that if developing countries could improve the knowledge of citizens of industrialized developed countries, they will be able to develop and improve efficient financial inflow (by means of higher willingness to pay for conservation and tourism) so that tropical rain forest cover will be increased. The high income could be used to compensate agriculture families living in periphery of reserves for removing them to other parts of the country. Any international organization can buy 1 ha of tea land in the periphery of Sinharaja tropical rain forests at around US $ 14000 (in 2005) from a private owner and donate to government for developing tropical rain forests.

National Benefits of Biodiversity from recreation.

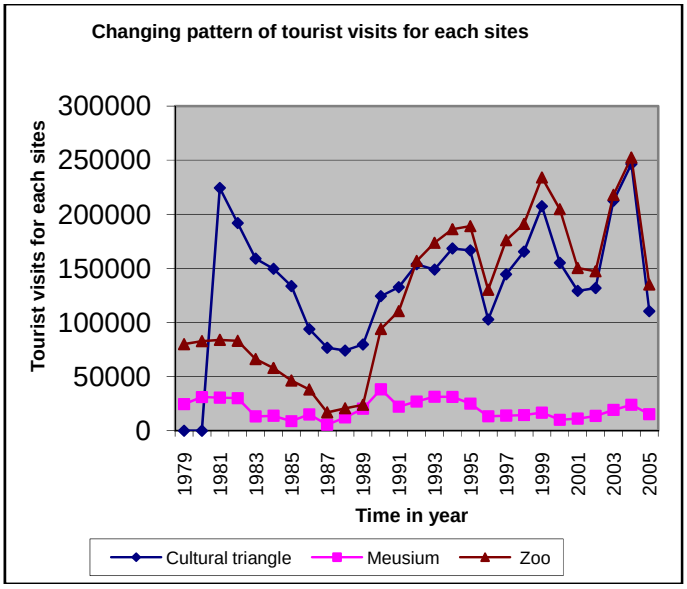
Tourism is one of the fastest growing and a major source of foreign exchange earnings for many developing countries. Earnings of international tourism grew at an average rate of 9% from 1988 to 1997 reaching US $443 billion in 1997. Tourism receipts accounted a little over 8% of total world exports of goods and almost 35% of total world exports of services in 1997. Tourism contributes around 1.5% of world GNP and is the major source of employment, hotel accommodation sector alone employing around 11.3 million people worldwide. The environment-based tourism is vital and growing segment of tourism industry for US $260 million in 1995 **[17.p.639]**, which violates Tisdell's **[4]** argument that eco-tourism in developing countries has limitations and constraints.

The relationship between tourism and bio-diversity is very complex. Biodiversity is only a one component of tourism demand function. Advisor to the UN secretary general **Sachs [18]** has shown that tourism is the major way for economic development in Sri Lanka.

Following graph 2 shows the changing the pattern of foreign tourists visits to main three kinds of sites in Sri Lanka, national zoo, cultural triangle and the museum. Comparison of numbers of tourists visited for each site is absolutely a comparison of real values they keep for visiting these sites while comparison of total gate fee income could be a comparison of nominal values. Therefore to analyze and understand this tourists' behavior let's make the following assumptions.

1. Incomes of all the tourists are equally changing over the time and it does not effect the different gate fee amounts for three sites, zoo, cultural triangle and the museum for any tourist to visit-usually most of tourists arrive in Sri Lanka from Europe and in fact their incomes could be close.
2. There is no any influence from Sri Lankan people to visit any particular site from above three.
3. Traveling expenses associated with visiting each of three sites are equal.
4. Tourists' formal education levels are equal.

Therefore, according to above assumptions we can come to a conclusion that willingness of many tourists has increased to visit zoo over cultural triangle. As theoretically proved above, at average tourists' recreational values on seeing animals have increased over the time which could be the knowledge effect as shown in above labor supply curve (**graph 1**)



Graph 3-Changing pattern of tourists visits for Zoo, Museum and Cultural Triangle.

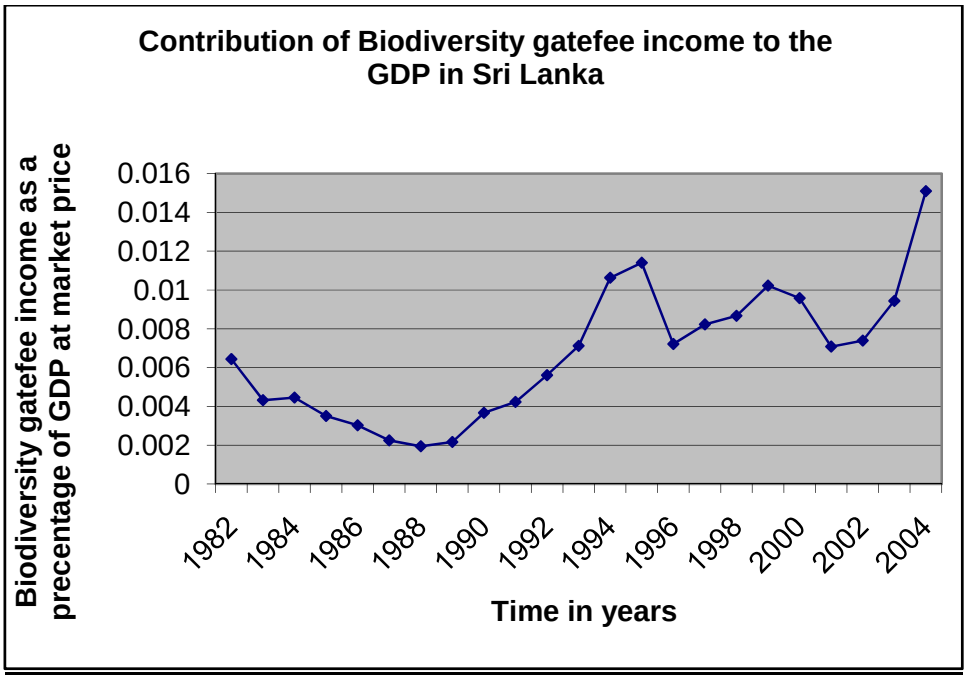
In the analysis of Sri Lankan data we can understand that the contribution of Biodiversity by means international recreation is very significant. In Sri Lanka in 2002 National parks (50.86%), botanical gardens (22.89%) and zoological gardens (26.24%) contributed 115 million Rupees only as gate fees to the national income. This amounts to $8.34*10^{-3}$ % of GNP (current factor cost price). There is a trend towards Biodiversity recreational tourism, which may be due to increasing knowledge in the world regarding biodiversity and fragile ecosystems in Sri Lanka. The following (table 1) table shows changing pattern of gate fee income from major three components of foreign tourist visits in the country showing huge trends towards visiting zoological gardens. This situation indicates that government should allocate more money for conservation**.**

	Cultural Triangle	Museums	Zoos
1981	Rs.224354	Rs.30560	Rs.83912
2002	Decreased by 41.25%	Decreased by 55.47%	Increased by 75.57%

Table 1

Now we have proved that number of tourists visiting zoo as an indicator of biodiversity values increasing over the time since 1979 to 2005 as shown in above graph 2. Then second question is how much of money Sri Lanka could get from tourists for biodiversity as gate fees. Here we assume responsible government institutions have changed the gate fees for each of sites frequently taking into account demand side factors. We have calculated total gate fees income from i. Dehiwala zoo and Pinnawala elephant orphanage, ii.Yala national park, Wilpattu, Kumana, Udawalawa, Bundala, Horton plains and Wasgamuwa sanctuaries and parks, iii. Peradeniya, Huggala, and Gampaha gardens and iv.Udawattakele, Sinharaja and Deenstone reserves. Some sites (Kumana and Wilpattu) could not be visited by tourists continuously due to fluctuations in ethnic war status in north and east areas. In such cases last gate fee income is assumed for all next years. Also government has established each of these sites at different times.

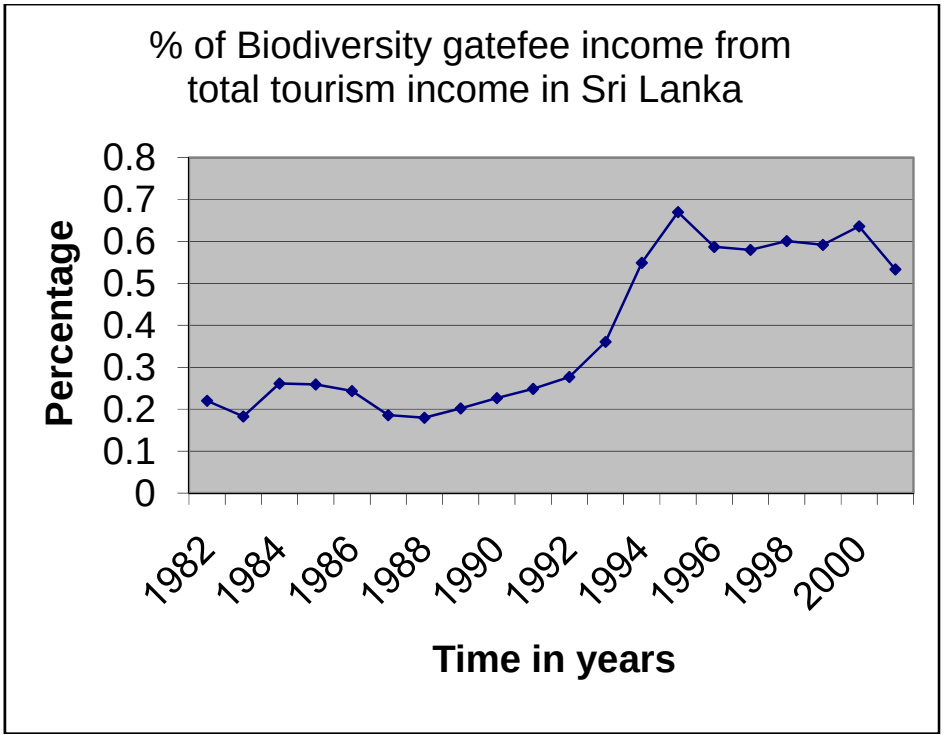
Then gate fee income starts from that relevant year, then the proportion of total of biodiversity site gate fee income to the GPD was taken, as this proportion can be a real value. Then the following graph (graph 4) could be drawn.



Graph 4-

According to this graph, contribution of biodiversity gate fee income to the GDP has been increasing as a common trend. In around 1987 it has reduced due to government forces' civil struggle with anti-government teams. It also reduced in 2002 due to September 11 attacks in USA.

Even the contribution of biodiversity gate fee income to the total tourism collections has been increasing over time as a general trend (see following graph 5). By all these means we can understand that Biodiversity in developing countries could be potentially used for more tourist attractions in future to augment the contributions to the national income to achieve sustainable development.



Graph 5.-

The most important next issue, according to above analyzed literature is that many developing countries believe converting forest lands into agriculture lands such as tea would bring more benefits to achieve growth. The Central Bank of Sri Lanka in calculating GDP only calculates annual timber value of State Timber Cooperation as contribution from forestry. This value could increase due to value additions. Therefore, to compare with these values of contribution of forestry, we take the values of just harvested tealeaves as that value could increase under value additions (following chart).

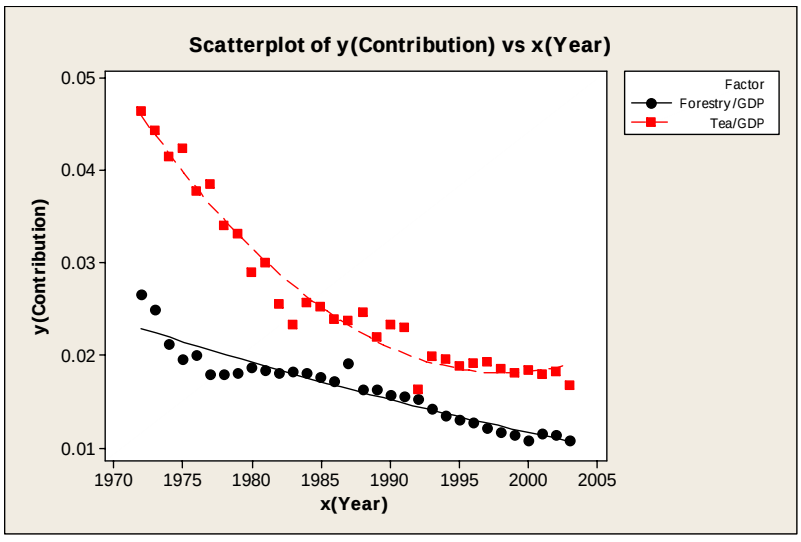


chart –Changing pattern of contributions of tea and forestry (base year 1982) to the GDP- from 1972 to 2003.

Contribution of tea has fast fallen down compared with forestry. Both tea and timber there are substitutes while there is never any substitute for recreation of biodiversity. In addition tea has to face many factors such as competitiveness etc in the market to determine the price. As both contributions of tea and forestry are decreasing while contribution of biodiversity parks (gate fee income which is coming under tourism in calculating GDP) is increasing, the best option for Sri Lanka is establishing more parks for recreation. When contribution of tea is calculated, the negative externalities such as soil erosion, increasing flood damages in the country, poisoning of tea pesticides, committing suicide by tea farmers drinking this pesticides and injuries to the farmers are not calculated. In the other hand, when contribution of forestry to GDP is calculated only annual value of timber harvest is taken from Sri Lanka State Timber Co-operation. But total values of timber use in the country, non-wood forest products, fuel-wood use and global values are assessed in deed; contribution of forestry in Sri Lanka would obviously be several folds of that of tea.

Testing recreation modeling

In construction of theory above we have developed the final formula (7), D=f (Y, B, E) where D-number of arrivals, Y-per capita income (ppp) of the tourist, B-biodiversity richness in developing country and E-education level of tourist. Now this formula could be tested with available data.

Assuming a linear relationship

$$D=\propto Y+\beta B+\theta E+e \qquad (10)$$

where $\propto$, β, and θ denote coefficients while e does the error term. In setting indicators D could be easily measured in number of arrivals and Y as individual tourist income. So we can take per capita income of each country of tourist. Here we take per capita income (purchasing power parity), which is GDP (purchasing power parity divided by population) because we have to compare per capita income among countries. As population is different in different countries, arrivals of each country were taken as percentages respectively by dividing population of the country. But as this value is very small, we calculate arrivals for every 10000 of the population to get a ratio. The data of tourist arrivals in Sri Lanka from 31 different countries and per capita income (ppp) of these counties (in 2002) were used as panel data.

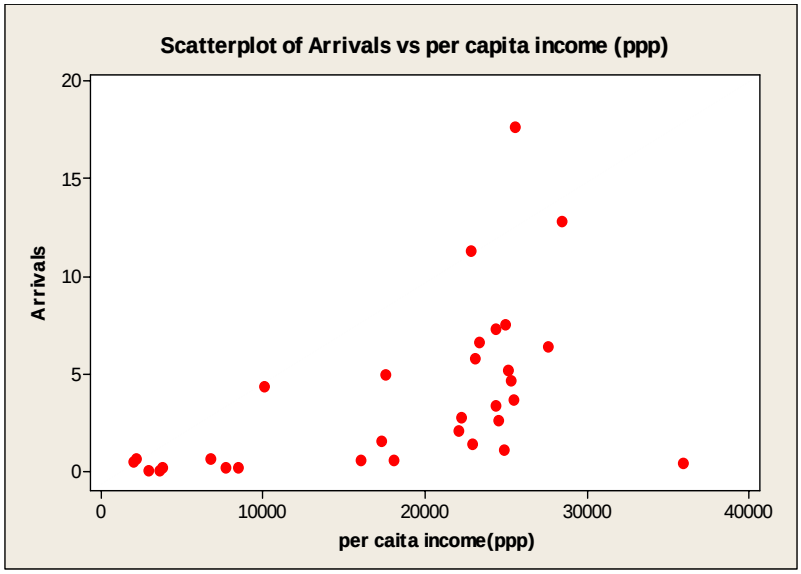


Figure 1

MINITAB package was employed to analyze these data (appendix 6). The scatterplot diagram was drawn for arrivals (arrivals from every 10000 from each country) and per capita income (ppp). At glance, the conclusion that there exists a correlation could be reached in. Therefore, correlation was also tested for and following model and results were obtained. Pearson correlation of arrivals and per capita income (ppp) was 0.517 and P-value was 0.003. Always a correlation exists between 0 and 1, where 0 (zero) means that there is no any correlation while 1 (one) means that there is 100% correlation. Here as the **Pearson** correlation value is 0.517, there is over 51.7% correlation between arrivals and amount of per capita income (ppp), which is rather strong correlation. `This` P-value (0.003) concludes that under 10 % level of significance (90 % confidence) that there exists a linear relation between arrivals vs per capita income (ppp). Then let's fit the model with trend line as shown in the following figure 2.

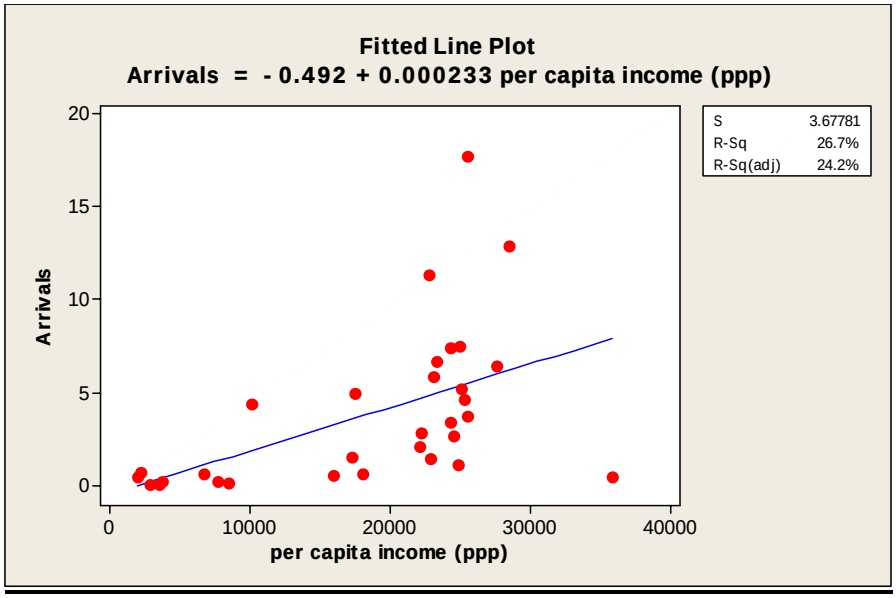
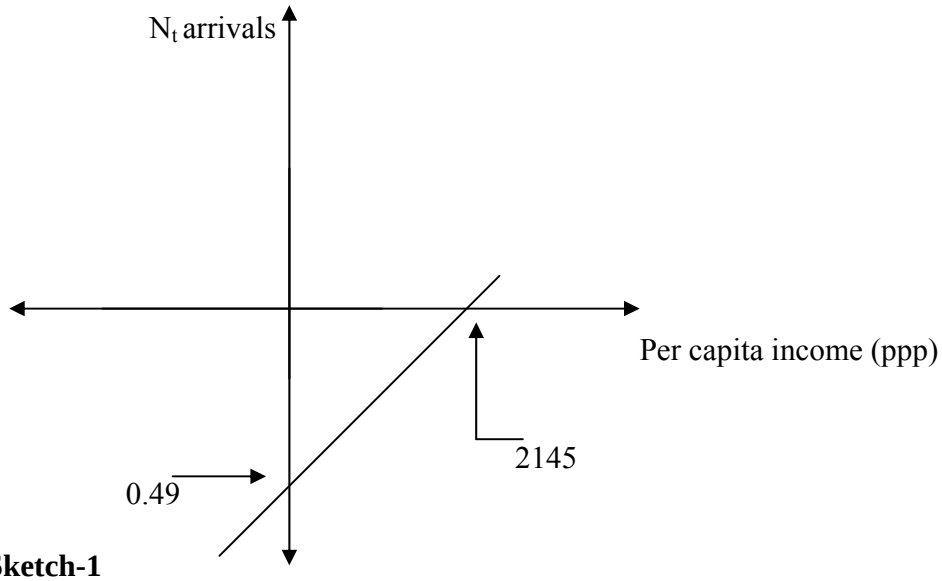


Figure 2



Sketch-1

The regression equation is following,

arrivals rate **Nt = - 0.49 + 0.000233GDP- ppp** (11)

This means when GDP-ppp in any of these countries at an average increases from 10000, 2.33 people will travel in Sri Lanka as tourists. Also any country should have at least US $ 2145 of per capita income (ppp) for starting tourists to arrive in Sri Lanka from that country. In this model R-sq value means the fitness of the model and as this value is 26.7%, it means the variation of arrivals is described only by 26.7% of the per capita income (ppp) value. For rest

73.3 % of variation is described by the other factors, which for this case could be culture of tourists and biodiversity etc.
When per capita income (ppp) is less or equal to 0 (when per capita income (ppp) < 0 **or** per capita income (ppp)=0), at least one tourist can not arrive in Sri Lanka. To arrive at least one tourist from 10000 population of any country per capita income (ppp) should be over than US $ 2145.00. This is in deed very important result with referring to absolute income hypothesis($C_i=C_0+MPC*Y_d$ where C_i-consumption level, C_0- Consumption at zero income, MPC-Marginal Propensity to Consume)) under which people have some consumption even with zero income. But referring to consumption international leisure from tourism, minimum income should be more than US$ 2145.00.

Following figure(figure 3) is showing relationship between estimates of errors and residuals. Checking errors could test the model. If model is fitting well, errors should be located within a band. Right side bottom dot is relevant to USA and due to September 11, 2001 attack to USA, in fact, tourists' arrivals from USA to Sri Lanka fell down. Therefore, if we remove or neglect that dot, we get other dots roughly in a band, which means our model is a good linear model.

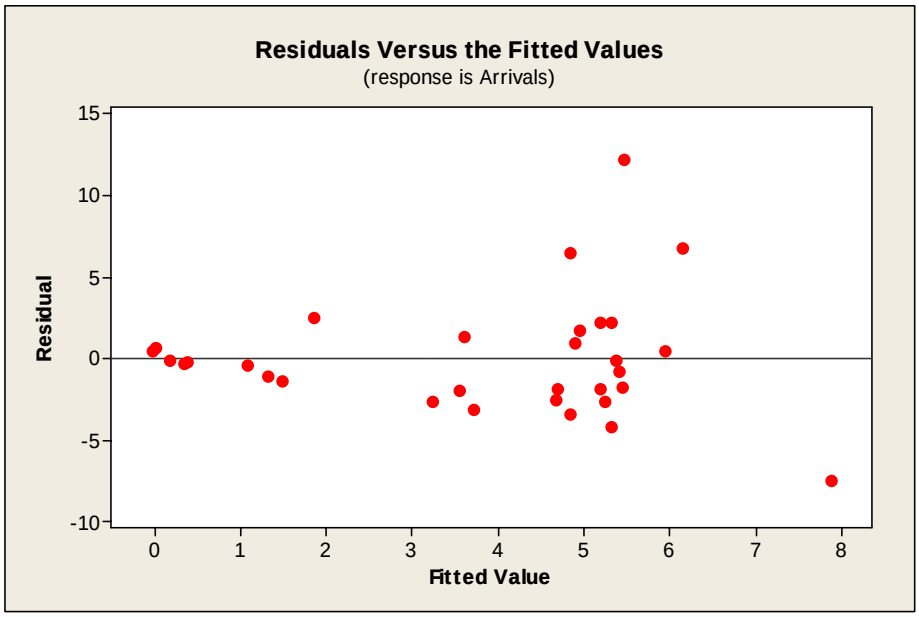
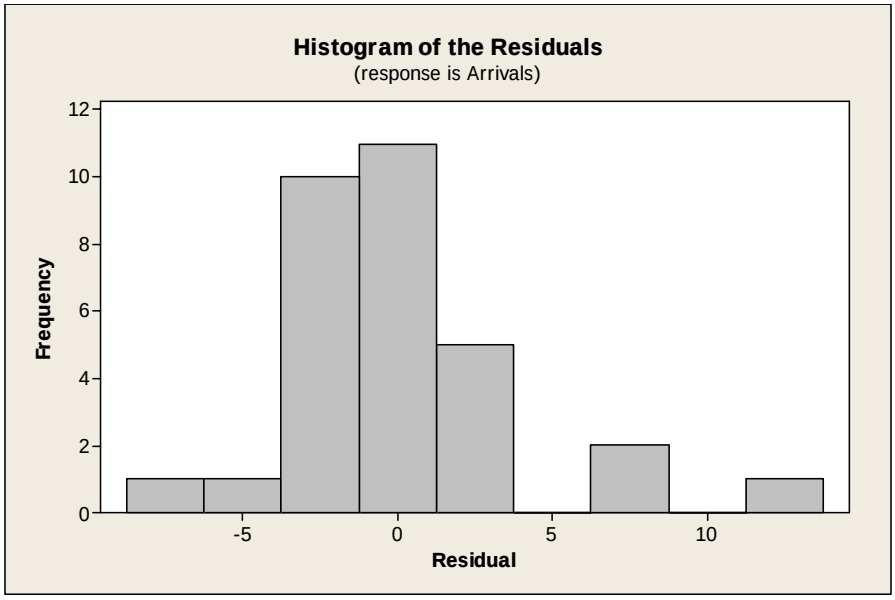


Figure 3-

The following graph (graph 7) explains the distribution of residuals under normal conditions. At glance it could be understood that distribution is approximately close to normal distribution, which admits the fitness of our linear model.



Graph-7-distribution of residuals under normal conditions

The normal distribution of residuals could also be tested by means of probability plot (following figure 4). For normal distribution observations should be located on the simple line. But as the observations are close to this simple line, this model could be considered as a good model. Here in probability plot of residuals, all the dots will be located on the line, if the model is a good linear one, But as these dots are closely located to the simple line, we can conclude that model is more accurate one.

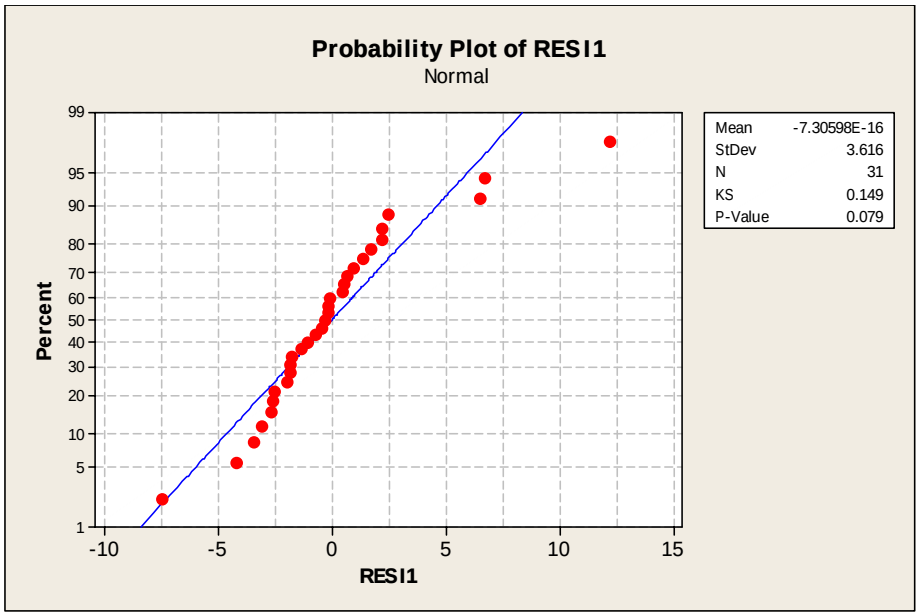


Figure 4-probability plot

Non-linearity correlation

Next let's check the existence of non-linear correlation between arrivals and per capita income (ppp) and robustness of such models (correlation natural log values of arrival rate and per capita income (ppp). Therefore, following scatterplot was obtained (**figure 6**). At glance, very strong correlation can be observed. This correlation looks more accurate than linear one according to appearance.

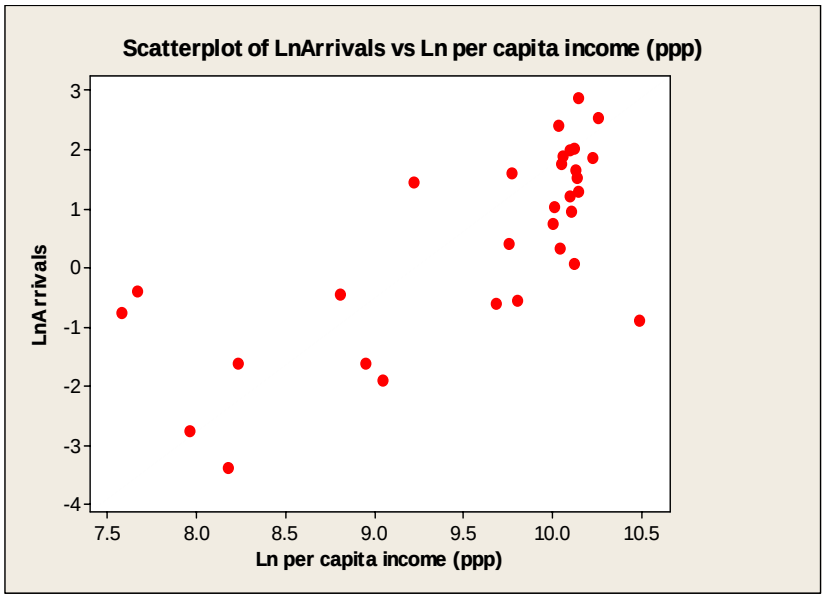


Figure 6.

Then as we could get a correlation, we find non-linear model with trend line.(figure 7)

Regression Analysis: LnArrivals vs Ln per capita income (ppp)

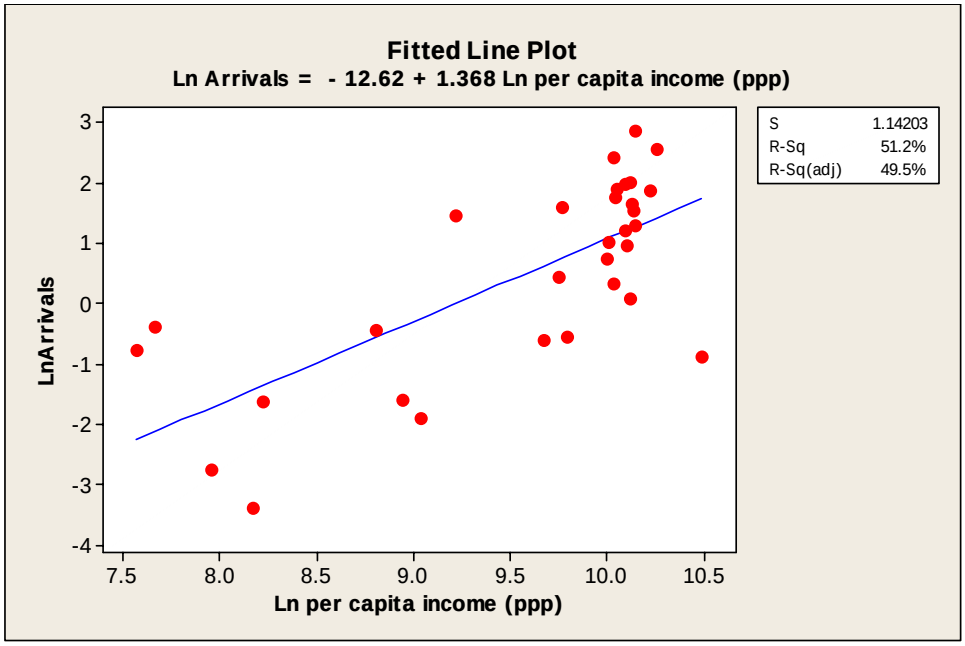


Figure 7.

Here the regression equation is
Ln Arrivals = - 12.6 + 1.37 Ln per capita income (ppp) (12)

If we take arrival rate as A and per capita income (ppp) as Y, then we can write non-linear relationship as following

$A=\lambda Y^{\alpha}$ (13)

where λ-a constant and α –co-efficient. Then let's write the non-linear function for it as following.

$\text{Ln } A=\text{Ln } \lambda+\alpha \text{ Ln } Y$ (14)

Now let's relate our formula with the model and get the results. Then we get
Ln λ= -12.62, $\lambda=3.313/10^{6}$, and α=1.37. Therefore our model now is

$A=3.313/10^{6} * Y^{1..37}$ (15)

.

Also we have got R-Sq(adj) = 24.2% and R-Sq(adj) = 49.5% for linear and non-linear regressions respectively. The non-linear value is over than the double of linear value and hence we can conclude that non-linear model is more accurate than the linear one.

Again the following figure (figure 8) shows relationship between estimates of errors and residuals of Ln values of arrivals and per capita income (ppp). As errors are closely located in a band, non-linear model could be fitting substantially.

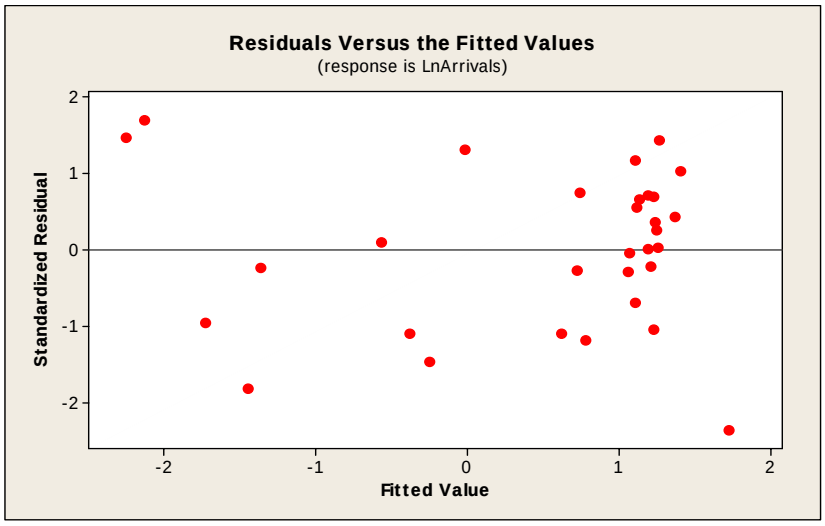
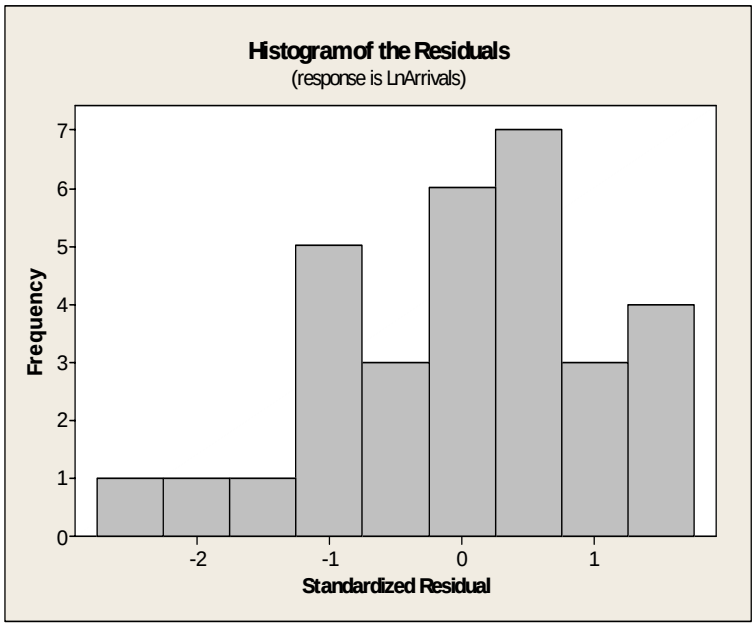


Figure 8

The distribution of residuals of the non-linear model is shown by the following graph (graph 8) . We can understand that distribution is approximately close to normal distribution, which admits the fitness of out non-linear model.



Graph 8

Again normal distribution of residuals was tested by means of probability plot. The normal distribution could be possible as all the observations are located on the simple line more accurately compared with probability plot of linear model. This means again non-linear model is more accurate than the linear one.

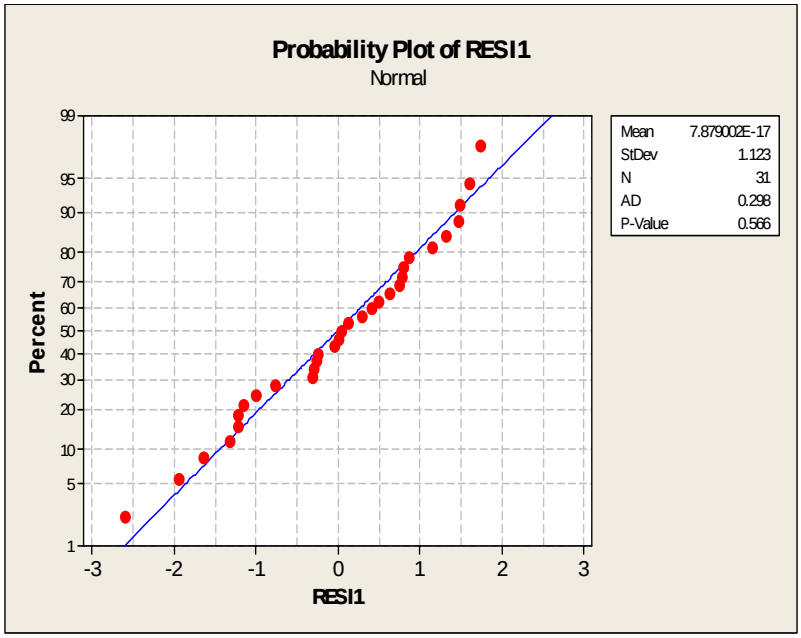


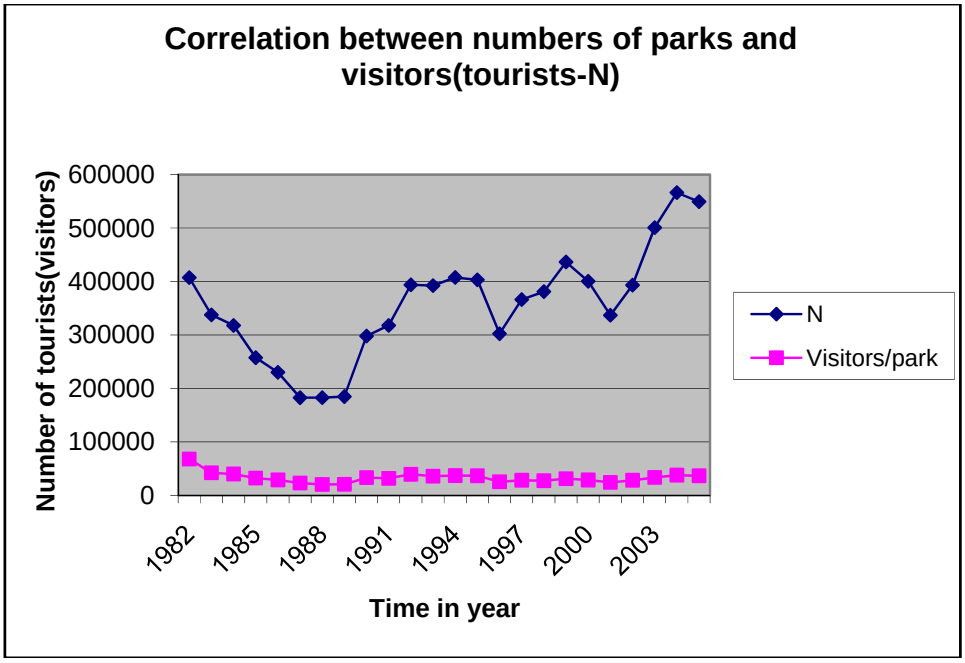
Figure 9

Biodiversity in Demand function

Let's attempt analyze the role of Biodiversity in international recreation referring to the formula above (8),

$$D=\propto Y+\beta B+\theta E+e \qquad (8)$$

For variable Biodiversity B in this tourism demand function, indicators have to be developed for the analysis. We found that number of tourists visiting sites in the country could be a robust indicator, which could be conceivably the supply of recreation by the government declaring parks and deciding gate fees for international tourists while total number of tourists being the demand for recreation. In fact these two variables, total number of tourists and number of biodiversity sites (zoos, sanctuaries, forest reserves and botanical gardens) are mutually inter-dependent. When number of tourists arriving is increasing government think to establish more sites and increase the gate fee income. In the other hand, when government increase number of sites and make aware international tourists by means of internet and tourists board, then number of tourists visiting the country would increase. There were only 6 sites in Sri Lanka in 1982 and by 2005 this number has increased to 15. Therefore, to analyze this demand and supply behavior, let's take the ratio between number of sites and number of tourists which was closely behaving as a constant expectedly (see **following graph 7**). In the same time both the number of tourists and number of sites have increased at a common trend.



Graph-7-Demand for Recreation

Mapping impact of Technology T

Technology is changing over time both in developing and developed countries at different rates, which will promote increasing tourists arrivals according to formula (3),D=f (Y,B, E, X, C, P, I, A, T…) . It affects all the variables in the formula (except B and E) in favor of increasing tourists' arrivals in developing Biodiversity rich countries. **Quareshi [19]** argues that globalization creates new opportunities for developing countries such as expansion of multi-nation corporations, wider markets for trade, expanding fast and low cost communication and transport, improved and cheap access to technology and inflow of private capital into the developing countries etc. As we explained before developing countries have been using some of these opportunities to promote international tourism such as cheap technology, low costs for communication and transport etc.

2.3 Policies and Strategies

Under these circumstances, developing countries should attempt follow new policies and strategies to maximize benefits from conservation for recreation. Because tourism receipts accounted a little over to 8% of total world exports of goods **[17,p.639]**. In Sri Lanka Biodiversity and fragile ecosystems have contributed 155 million rupees only as gate fees to national income in 2002 and it shows that tourists tend to visit more Biodiversity and ecosystems (parks, rain forests etc) than museum and historical sites. In turn clearing lands for tea obviously creates another set of grave negative environmental externalities. Promotion of industrial exports such as garments etc. can induce migration from export agriculture rural areas to industrial zones discouraging export agriculture because unskilled labor is used for both export agriculture and industrial export in developing Asian countries where biodiversity is in fact rich (see **Coxhead [20])**. The developed countries can discourage importing agriculture products (such as tea) from developing countries to protect the rain forests from encroachments.

Obviously tea has some substitutes as well as it is not an essential good for human existence on earth while Biodiversity recreation has no any substitute or alternatives and its services such as oxygen are essential for human existence.

We shall consider extent of forest cover as an indicator of holistic Biodiversity conservation in Sri Lanka because there are 3368 floral species and many fauna species living in these forests. This approach is obviously an ecosystem approach simply because natural vegetation consists many flora species and provides foods and niches for fauna species. In Sri Lanka currently 82% of land area belongs to government while rest is belonging to private sector. Forest cover in Sri Lanka as a percentage of total land area was 44% in 1956 and it is 27 % at present. But, forest cover percentage in wet zone of the country where endemism is the highest is 15%. The forest cover loss in past 45 years has been averaged to 30000 ha per year. Population in the country is 19 million and total land area is 6.5 million ha. This means that per capita land resource is 0.35 ha, which is the **lowest in Asia**, which is an indicator of the degree of population pressure on forestland for other uses. Latest Biodiversity assessment revealed that 560 plant species, 117 land snail species, 43 crustacean species, 70 dragon flies species, 76 butter fly species, 39 fish species, 33 amphibian species, 87 reptile species, 61 bird species, and 34 mammal species have become threatened or highly threatened in Sri Lanka. **[21].**

Coxhaed [20,p.22] argues that following of globalization as a development strategy in developing countries have exacerbated the deforestation of rain forests.. The extent of forest cover currently is 3% from primary original vegetation though Philippine has the highest density of endemic plants in the world (64.7 per 100 km^2). As an average 7.23% of tropical rain cover exists from primary original rain forests in these eight high priority hottest hotspots in the world. In Sri Lanka, promotion of tea cultivation has significant impact on encroachments of Sinharaja tropical rain forests. Governments in developing countries may attempt to acquire encroached lands and establish rain forests again. Current price of 1 hectare of tea land in this area is around US$ 14000.00. Within 30 years, substantial forests can be developed (under natural succession) in periphery of Sinharaja (personal interviews with Sri Lankan researchers and Forest Department officials).

5. Conclusion and Future Research

The lucid three objectives of this research were

1. To model, map and analyze this recreational behavior employing both economic and non-economic variables both from developed and developing countries and compare with existing economic theories.

2. To model export promotion behavior and test with empirical data sets and to compare expected results with existing economic theories.

3. To evaluate expected results with reference to development and conservation policies.

As a result of this research, final model D=f(Y,B,E) could be developed following a consequence of arguments and linking economic and non-economic variables. Though there exists both linear

and non-linear correlation between D (arrivals) and Y [per capita income (ppp)], non-linear correlation is stronger. However, empirical results conclude that relationship between D and Y violates absolute income theory of consumption. The correlation between D and B looks mutually interdependent. The labor supply curve could be edited to address the international tourists' recreational behavior with knowledge effect. The changing pattern of number of visitors to each site could be used to assess their values on each kind of sites with some reasonable assumptions. Also the contribution of gate fee income to the GDP in Sri Lanka shows very interesting increasing trend.

Meanwhile, the Present Value of total amount of annual incentives of the government for new tea plantations could be related as a indicator of environmental degradation, which behavior is really fitting with Environmental Kuznet Curve hypothesis. We could also carry out a really important policy discussion with this results, very important to developing countries, developed countries and many international research and donor agencies and academia.

However, in future international community could, without doubt, test the following model [above model (3)] for different countries for different time frames and panel data depending on data availability and nature of the decision-making requirements.

$$D=f(Y, B, E, X, C, P, I, A, T\ldots) \quad (3)$$

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