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Biodiversity and the tourism value of Changbai Mountain Biosphere Reserve, China: a Travel Cost approach

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The recreational value of an outdoor site is reflected in a visitor's willingness to pay for the visit. This can sometimes be estimated using the Travel Cost Methodology (TCM) as the consumer surplus under the site demand curve. Based on a case study of Changbai Mountain Biosphere Reserve (CMBR) located in Northeast China, this paper focuses on the recreational values of tourism using the TCM and speculates on the extent to which this value depends on the biodiversity present in CMBR.

Application of the Travel Cost Methodology (TCM) to value protected areas and outdoor recreational sites has now become relatively common in Western countries. But, apart from initial research undertaken by Xue[1] for Changbai Mountain Biosphere Reserve (CMBR) located in Northeast China, there have been no such studies for China. The purpose of this paper is to use Xue's data to estimate the recreational tourism value of CMBR using the TCM and to speculate on the extent to which this value depends on the biodiversity present in CMBR.

Considerable gaps exist in our knowledge about the value of biodiversity as a magnet for tourism, even though biodiversity valuation has been designed as a key part of studies of countries by the United Nations Environment Programme (UNEP).[2] Generally, biodiversity in a nature reserve has four categories of values: the direct value of extractive goods, the direct value of non-extractive services, the indirect value of ecological functions, and non-use values including existence value, bequest value and option value.[3] A nature reserve is an important facility for conserving biodiversity as well as a resort location for tourism. Recreational value is one of the non-extractive services of biodiversity, and is an important characteristic for a nature reserve.

Helpful comments by Jackie Robinson on an earlier version of this paper are thankfully acknowledged. The usual *caveat* applies.

Using the TCM, this article highlights the substantial economic value of CBMR for tourism, a value believed to depend largely but not exclusively on its conservation of biodiversity. This biodiversity is characterized by the extent of the variety and the number of relatively unique species and ecosystems there. As yet no satisfactory means have been devised or applied to value these various characteristics or attributes as variables. Instead, particular protected areas, species or ecosystems have been valued. A characteristics-type approach, as, for example, that pioneered by Lancaster,[4] may have potential for determining the importance of various attributes of biodiversity as generators of tourism demand. This is not used here, but it is noted as a gap in current tourism analyses of the value of nature conservation. Site valuation using the TCM is undertaken and information is reported which suggests that most of the tourism value of CMBR is attributable to the biodiversity characteristics present.

The TCM has been applied in many US governmental institutions and it revealed that the average outdoor recreational value for one person-day in the country was US$34 in 1987.[5] A study funded by the UK National Forestry Commission evaluated the recreational values of 900,000 ha of six forests under the Commission by the TCM and the result indicated that the total recreational values in 1988 were up to £53 million.[6] Another study reveals that the wildlife attributes of each forest are estimated to contribute about 38% of the total recreational value.[7] The TCM is usually used to value a given site, such as in the study on Achray Forest in the middle of Scotland.[8] The method can also be used to value a group of sites. Examples are the study of lakes in eastern Texas,[9] and studies on recreational lakes in the USA.[10] Tobias and Mendelsohn[11] used the TCM to measure the value of ecotourism at Monteverde Cloud Forest Reserve in Costa Rica. They found domestic recreational visits alone represented an annual value of between US$97,500 and $116,200, and foreign visitation represented an additional US$400,000 to $500,000 annually.

Description of study site

The Changbai Mountains are situated in the northeast of China, straddling the border with North Korea. Their location is shown in Figure 1.

The CMBR is a typical example of an intact primary natural forest ecosystem. It is a rare natural protected area and includes the highest mountain in northeast China, Bai Yun. This is a volcano, 2,691 metres high with a large and deep crater lake at the summit that is actually half in North Korea and half in China. CMBR is an attractive recreational site covered by ancestral forests and thousands of hot springs, and displays typical altitude vegetation zones in a temperate climate, as well as alpine tundra in the far east. CMBR is important for science and evolution, not only because of the variety of forest types, but also because of its rare fauna and flora and special volcanic relics. There are over 300 species of vertebrate animals as well as more than a thousand species of plants for medicinal use, many of which are valuable Chinese herbal ingredients.[12]

Since the reserve opened the north slope of Baitou Peak for tourism in 1982, visitation has increased. There are now around 200,000 people visiting per year and the total visitor numbers up to 1996 amounted to 1.6 million, of which many were from abroad. CMBR was established in 1960 and was incorporated

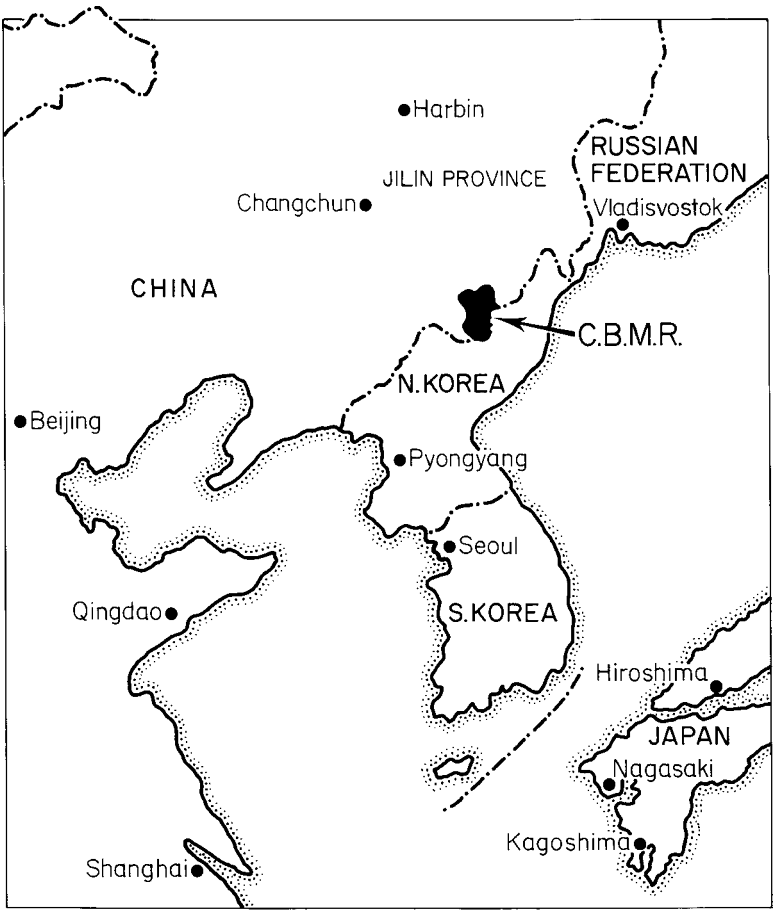

Figure 1. The Changbai Mountain Biosphere Reserve in northeast China, on the border with North Korea.

in the World Biosphere Reserve Network in 1980. Each Biosphere Reserve in the Network fulfils three basic functions, which are complementary and mutually reinforcing:

- a conservation function – to contribute to the conservation of landscapes, ecosystems, species and genetic variation;
- a development function – to foster economic and human development which is socio-culturally and ecologically sustainable;
- a logistic function – to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development.[13]

The CMBR therefore has as one of its aims the conservation of the biodiversity of the forest ecosystems. This biodiversity has an important direct non-extractive service value for science, culture and recreation, as well as remarkable indirect values in ecological functions and non-use values such as existence, bequest and option values. This paper aims to reveal the non-extractive value of domestic tourism through a case study in CMBR and attempts to evaluate what portion of this value can be attributed to the biodiversity qualities of the reserve. Although international tourism has value, it is not easy to measure using this methodology, so we concentrate on domestic tourism here.

Description of the economic valuation methodology

The transaction price for most goods can be considered to be an expression of willingness to pay for the right to consume the good, or the utility received from it.

A financial analysis focuses on such market prices and cash flows. However, an economic analysis is concerned with the total value to the whole community or country including, for example, the existence value of a park or forest that provides enjoyment and pleasure to those who visit. It is important in economics to acknowledge that utility and welfare can be obtained from goods and services even if they are provided free or at minimum charge. The difference between the amount paid and the total utility enjoyed is sometimes measured by the 'consumer surplus', or CS.

Travel Cost methodology

In this study, the 'Zonal Travel Cost Method' is used to measure the recreational value in terms of the economic welfare measure, the consumer surplus. This is a measure of visitors' willingness to pay for the recreation above the price currently charged. This is a minimum valuation of the site, as it does not include the non-use values or the extractive use values.

In order to estimate a value for the recreational use of Changbai Mountain Biosphere Reserve, a demand curve is needed. It is not possible to estimate a demand curve directly for the site since there is no variation in the price of admission. Only one point on the demand curve can be obtained corresponding to the present entry fee. The TCM enables a demand curve to be derived for different entry fees, based on the actual costs involved for travel to the site. This is achieved in a two-step procedure. Once the site demand curve (stage II) has been estimated then the calculation of consumer surplus can be obtained.

The TCM relies on the assumption that the value people place on the site is represented by the amount they are willing to pay to travel to it. Thus linking visitation rates with travel costs and other socio-economic variables enables its recreation value to be estimated. This constitutes stage I of the procedure. Then, assuming that visitors would respond to an increase in entrance fees in the same way they respond to an increase in travel costs, the second-stage demand curve for the actual site can be estimated.

Following the methodology initially described by Clawson and Knetsch,[14] the whole country was divided into 37 residential zones by administrative areas, including 28 provincial areas, and 9 municipal areas within Jilin Province, where the reserve is located. The average income for each zone is known, as well as the distance to the reserve. The statistical data for all residential zones are shown in Table 1. The average travel cost and time taken from each zone can be calculated. Using this aggregate data the first-stage demand estimation can be made, which provides an indication of how demand for the reserve varies as the characteristics of the zones vary. Clawson and Knetsch[15] call this 'the demand curve for the whole recreation experience'. The second stage of the demand estimation derives a demand curve for the recreation site (CMBR) itself. The number of visitors at the present entry fee is one point on the demand curve for the site. In order to derive other points, the travel cost was incremented by various amounts and the number of visitors calculated. This was carried out for each individual zone until visitation from the zone was depressed to zero. The total visitation was then calculated by summing across all the zones for each increment. Since the zones at different distances do not exhibit a uniform change in demand for each incremental cost, the resulting relationship between the incremental amounts and total visitation is usually a decreasing non-linear function which is called the demand curve for the actual site (or site demand function). This is the second stage of the TCM and assumes that visitors would react to higher entrance fees in the same way they do to higher travel costs. Using the estimated site demand function the consumer surplus can be calculated as the area under the curve above the current costs. This is illustrated in Figure 2, in which *DD* represents the demand curve and P_1 the current price paid.

It is expected that zones closer to the site, which have lower travel costs and hence usually higher rates of visitation, will exhibit a more rapid decrease in demand as the cost is incremented. This is because the amount of the increment constitutes a larger proportion of travel costs than for those visitors from a more distant zone.

Calculation of the dependent variable, visitation rate

On-site questioning of 3,131 visitors identified their zonal origin, from which the dependent variable in the regression was calculated. The period used was the full year 1996. Table A1 in the Appendix indicates that total domestic visitation for the year amounted to 176,000 people. Assuming the same proportion as in the sample, the total number of visitors per residential zone (V_i) for 1996 can be calculated. This can be used as the dependent variable, or alternatively can be divided by the population for each zone to obtain the visit rate from each zone. Here the zonal visit rate (VR_i) has been calculated by dividing by the population in tens of thousands, resulting in a rate per ten thousand population.

total number of visitors per residential zone = sample proportion × total visitation

$$V_i = \frac{n_i}{3{,}131} \times 176{,}000$$

$$\text{visit rate from each residential zone} = \frac{\text{total visitors per zone}}{100 \times \text{zonal population}}$$

$$VR_i = \frac{V_i}{100 \times n_i}$$

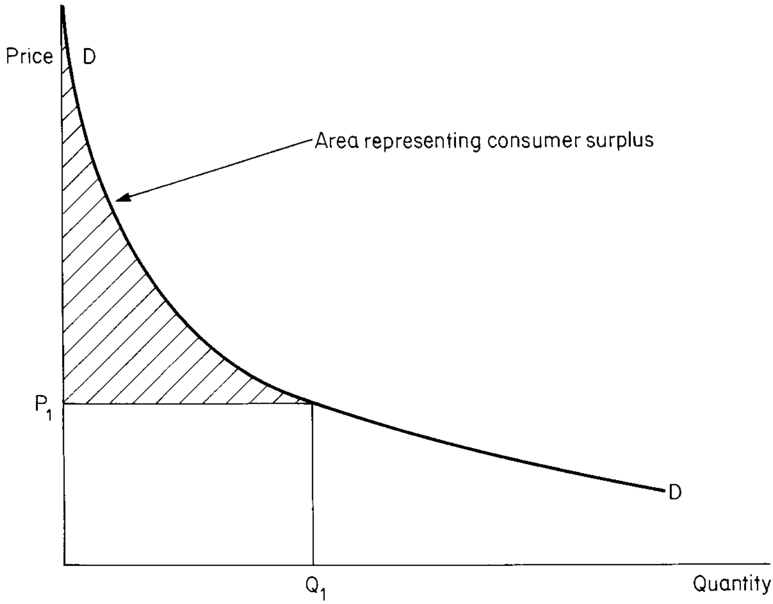

Figure 2. Consumer surplus.

Description of independent variables

The most important independent variable is the total travel cost. Travel time was also considered, as was the average zonal income.

Calculation of total travel costs. The zonal total travel costs include the following three items:

- transportation costs based on the actual ticket prices in the summer of 1996 for a round-trip by train and bus;
- accommodation costs calculated by trip days multiplied by average standard accommodation hotel costs plus food; and
- entrance costs – the actual fees (50 yuan per person) charged by the reserve administration.

The details of these costs are shown in Appendix Table A1.

Zonal average income. The average annual per capita wages for formal employees from the cities and provinces[16] are shown in Table 1. It is noted that these statistics are official wages and do not necessarily represent the full income.

It can be seen from Table 1 that the travel costs from some of the zones constitute a large proportion of the annual average wage rate for the region. In two-thirds of the zones the travel costs are over 25% of the annual salary and in one-quarter of the zones they are more than 40% of the annual salary. It is unreasonable to assume that people earning only the average wage would spend this much on a short holiday. The visitors to this special Biosphere Reserve are likely to earn well above the zonal average, and so have far more discretionary income than the common worker. Many visitors also are entitled to reimbursement for their visitation expenditures. Hence, the assumption that the visitors' incomes are representative of the zonal population average incomes may not be applicable.

Consideration of travel time. Incorporating travel time into a travel cost analysis has received wide attention. Visitors from distant zones visit the site less frequently than those who live closer, because of the combined effect of transportation costs and travel time. The opportunity cost of scarce time acts as a separate deterrent at the margin to visiting more distant sites.[17] Failure to include travel time will bias the results. In 1987 the UK Department of Transport, in a re-appraisal of the value of non-working time, advocated a standard average appraisal value of 43% of earnings, with slightly higher values for adults and people of working age, but a lower value for retired people and children. This amount is used by Willis and Benson[18] to value non-working or leisure time forgone to visit the forest sites. Chavas *et al*[19] consider that the opportunity value of travel time is between 30% and 50% of actual wage. But Smith *et al*[20] assume that the opportunity cost of time is equal to the wage rate, and they find that assuming a fraction of the opportunity cost is not superior to using the full wage rate. In this study, travel time has been arbitrarily valued at 40% of the average wage for each zone for the travel time involved.

Travel time and travel cost cannot both be included in a regression analysis, as discussed. Estimation has been carried out in this study in two ways: (a) using only travel costs (TC) and (b) using travel costs plus travel time (TT) (but not on-site time) valued at 40% of the wage rate. On-site time has been considered to be a benefit rather than a cost, since CMBR is taken as a single destination trip.

The travel time opportunity cost has been calculated as follows:

$$\begin{aligned}\text{total work hours per year} &= \text{No of working days} \times \text{average workday hours}\\ &= 254 \times 8\\ &= 2{,}032 \text{ hours}\end{aligned}$$

$$\text{average zonal hourly wage per person} = \frac{\text{average wage per year}}{2{,}032} \times 40\%$$

total travel hours = hours by train or bus + hours for transit + on-site time (as shown in Table 1, column 3)

value of travel time per person = (total travel hours − 36) × average hourly wage

Since on-site time has not been included in the travel cost analysis and visitors, on average, spend one night and two days at the Reserve, 36 hours have been deducted from the total travel hours.

Table 1. Sampling data statistics and visiting rates of residential zones.

Residential zones	Population in 1995 (million)	1995 avge wage (yuan/per capita)	Total travel time (hours)	Total cost (yuan/ trip)	Sampling number (persons)	1996 visiting quantity to CMBR (trips)	Visiting rate to CMBR in 1996 (o/000)
Changcun, Jilin Prov.	6.78	5,119	79	573	494	27,773	40.96
Jilin, Jilin Prov.	4.34	4,635	74	514	301	16,914	38.97
Siping, Jilin Prov.	3.15	3,562	71	551	66	3,714	11.79
Liaoyuan, Jilin Prov	1.25	3,649	68	498	60	3,379	27.03
Tonghua, Jilin Prov.	2.28	4,026	48	385	161	9,046	39.68
Baishan, Jilin Prov.	1.32	3,781	45	357	286	16,069	121.73
Songyuan,Jilin Prov	2.59	4,338	103	722	37	2,077	8.02
Baicheng, Jilin Prov	1.99	3,303	110	808	19	1,074	5.40
Yanbian, Jilin Prov.	2.22	4,030	48	330	595	33,446	150.66
Heilongjiang Prov.	37.01	4,145	99	752	272	15,294	4.13
Liaoning Prov.	40.92	4,911	87	617	297	16,695	4.08
Beijing Munic.	12.51	8,144	124	1,158	275	15,458	12.36
Tianjin Munic.	9.42	6,501	120	1,094	39	2,200	2.34
Hebei Prov.	63.47	4,839	144	1,352	17	950	0.15
Shanxi Prov.	30.77	4,721	151	1,457	6	334	0.11
Inner-Mongolia Reg.	22.84	4,134	156	1,526	7	387	0.17
Shandong Prov.	87.05	5,145	131	1,257	50	2,811	0.32
Shanghai Munic.	14.15	9,279	158	1,688	14	787	0.56
Jiangsu Prov.	70.66	5,943	150	1,554	27	1,518	0.21
Zhejiang Prov.	43.17	6,619	188	1,862	7	387	0.09
Anhui Prov.	60.13	4,609	172	1,620	3	176	0.03
Fujian Prov.	32.37	5,857	216	2,299	3	176	0.05
Jiangxi Prov.	40.63	4,211	206	2,145	1	53	0.01
Henan Prov.	91.00	4,344	168	1,557	31	1,742	0.19
Hubei Prov.	57.72	4,685	183	1,795	5	282	0.05
Hunan Prov.	63.92	4,797	194	1,958	3	176	0.03
Guangdong Prov.	68.68	8,250	215	2,284	28	1,566	0.23
Guangxi Reg.	45.43	5,105	222	2,397	5	282	0.06
Hainan Prov.	7.24	5,340	248	2,627	1	53	0.07
Sichuan Prov.	113.25	4,645	207	2,162	8	458	0.04
Guizhou Prov.	35.08	4,475	221	2,383	4	229	0.07
Yunnan Prov.	39.90	5,149	239	2,671	1	53	0.01
Shaanxi Prov.	35.14	4,396	182	1,769	2	106	0.03
Gansu Prov.	24.38	5,493	200	2,116	4	229	0.09
Qinghai Prov.	4.81	5,753	208	2,186	1	53	0.11
Xinjiang Reg.	16.61	5,348	256	2,937	1	53	0.03
Tibet Reg.	2.40	7,382	328	3,444	0	0	0

Analysis of recreational value

Travel cost stage I regression

The first-stage regression relates visitation rates to travel cost and other variables. The data for the CMBR include total population, travel cost, and travel time. It can be seen from the correlation matrix in Table 2 that there is almost

Table 2. Correlation matrix of variables.

	Visit rate VR	Number of visitors V	Average wage Y	Travel cost TC	Travel time t
Visit rate	1				
Visiting quantity	0.767296	1			
Average wage	–0.28102	–0.14223	1		
Travel cost	–0.54871	–0.64931	0.419691	1	
Travel time	–0.58715	–0.66107	0.405316	0.993555	1

perfect correlation between the travel cost and travel time. Hence, both variables cannot be included in the regression as the estimation would have almost perfect multicollinearity.

There is a low correlation between each of the possible dependent variables (V, VR) and the average zonal wage, which again suggests that the visitors to CMBR are not the 'average' for the zone in terms of wages.

Since only zonal averages for income and travel distance and time are available, it is necessary to build an aggregate travel cost model. This can provide an indication of how demand for the reserve varies as the characteristics of the zones vary. However, there are limitations to using aggregate data. Hellerstein[21] points out that, if only averages and sums are available, then only linear models can be estimated consistently. If additional information on the distribution of the aggregate data is available, then the set of models can be expanded to include non-linear functional forms. These data are not available in this case.

Linear initial regressions. When linear regressions were estimated (taking into account Hellerstein's warning) none were particularly satisfactory. Average income was not a significant variable when included in a multiple regression with either travel costs or travel costs plus time, as shown in Table 3 in which t values are shown in parentheses.

Non-linear initial regressions. Non-linear estimation produced a much better fit to the data, as shown in Table 4. In both the linear and non-linear estimations, it can be seen that the inclusion of the value of travel time does not improve the estimation, with the first equation in each of the above tables giving the best fit. Durbin–Watson values of 1.7 indicate no autocorrelation problem for $n = 37$ and two independent variables.

Travel cost stage II demand curve derivation

The first regression equation from Table 3, relating visit rates to total travel cost only, and the first equation from Table 4 have been used to derive separate demand curves for the CMBR (the demand curve for the recreation resource). Various entry fee levels can be represented by incrementing the travel cost values for each zone until visitation drops to zero.[22] For each increment the visitation rate for the zone can be calculated and all the zones summed to obtain the total visitation rate at that increment. These values are shown in Appendix Tables A2 and A3. Table A2 shows the estimated visitation rates at various increments

Table 3. Linear regressions estimated.

Regression equation	F	p-value	R^2	$\bar{R}^2$	D–W
$VR = 46.39 - 0.0217TC$ (4.75) (–3.88)	15.078	0.00044	0.301	0.281	2.22
$VR = 45.6 - 0.0197TT$ (4.74) (–3.87)	14.96	0.0001	0.300	0.279	2.22
$VR = 52.38 - 0.00147Y - 0.0207TC$ (2.87) (–0.39*) (–3.32)	7.43	0.00210	0.304	0.263	2.27
$VR = 50.06 - 0.001106Y - 0.0190TT$ (2.74) (–0.289*) (–3.29)	7.33	0.00226	0.301	0.260	2.26

TT = travel cost plus value of travel time but not including on-site time
* = not significant at 5% level
D–W = Durbin–Watson statistic

Table 4. Non-linear regressions estimated.

Equation	F	R^2	$\bar{R}^2$	D–W
$\ln VR = 8.054 + 2.889\ln Y - 4.66\ln TC$ (1.652*) (4.54) (–20.36)	223	0.93109	0.92691	1.675
$\ln VR = 5.060 + 3.196\ln Y - 4.563\ln TT$ (1.027*) (4.94) (–20.26)	221	0.93044	0.92623	1.704
$VR = 214.5 + 6.26\ln Y - 35.58\ln TC$ (1.47*) (0.325*) (–5.099)	16.4	0.490	0.460	2.27
$\ln VR = 3.046 + 0.000328Y - 0.00357TC$ (3.68) (1.97*) (–12.4)	80.2	0.82939	0.81905	1.149

TT = travel cost plus value of travel time but not including on-site time
* = not significant at 5% level
D–W = Durbin–Watson statistic
p-values for the F statistic are not quoted since they are all close to zero

Table 5. Estimated stage II regressions from initial first-stage linear regressions.

Regression equation	F	R^2	$\bar{R}^2$	D–W
$P = 2940.57 - 194.407\ln V$ (9.38) (–7.41)	55.0	0.833	0.818	0.612
$P = 1370.6 - 0.001302V$ (370.62) (–9.36)	87.5	0.888	0.878	0.314
$\ln P = 7.424 - 3.402\times10^{-6}V$ (54.1) (–16.16)	261	0.963	0.959	0.636
$P = 1526.16 - 0.00321V + 1.703\times10^{-9}V^2$ (22.17) (–7.35) (4.45)	128.59	0.963	0.955	0.670

p-values for the F statistic are not quoted since they are all close to zero above the present entry fee starting from a first-stage linear estimation, whereas Table A3 shows the estimated visitation rate calculated from the initial non-linear first-stage equation.

Stage II estimations and consumer surplus from initial linear regressions. The estimated functions connecting the increments (P) with the estimated total number of visitors (V) (for linear initial estimation) are shown in Table 5. From the table it can be seen that the log-linear form and the quadratic form of the demand curve give similar statistics and appear to fit the data better than the first two equations estimated. However, they both have a problem of autocorrelation, but since the procedure simply requires integration to find the area under the curve, the presence of autocorrelation does not present difficulty.

It was decided to use the log-linear form for the site demand curve originating from a linear first-stage estimation. The relationship between price (P = increment) and quantity (V = number of visitors) is therefore:

$$P = e^{7.424}\ e^{-0.000003402\,V} = 1674.93\ e^{-0.000003402\,V}.$$

This estimated demand curve and the total demand (from Appendix Table A2) are plotted in Figure 3.

The consumer surplus is calculated as the area under this curve in the first quadrant. Since the increments are plotted against the estimated total visitation, this is the area above the present entry price.

The consumer surplus, or area under the function, is:

$$\int_0^{1.2\text{m}} 1674.93e^{-0.000003402\,V}dV = 1674.93\left[\frac{e^{-00.000003402\times 1.2\text{m}} - 1}{-0.000003402}\right]$$

$$= 492336860.7[e^{-4.0824} - 1]$$

$$= 48.4 \text{ m yuan}$$

Stage II estimations and consumer surplus from initial non-linear regressions. The estimated functions connecting the increments (P) with the total visitors (V) (for non-linear initial estimation) are shown in Table 6.

Table 6. Stage II estimation from initial non-linear equation.

Equations	F	R^2	$\bar{R}^2$	D–W
$P = 1277.2 - 0.023745V + 9.175\times10^{-8}\ V^2$	10.8	0.682	0.619	0.378
(7.96) (–3.49) (2.46)	(0.0032)			
$\ln P = 7.023 - 2.64\times10^{-5}\ V$	85.5	0.895	0.885	0.281
(49.7) (–9.25)				
$\ln P = 11.96 - 0.631\ln V$	172	0.945	0.939	0.459
(27.1) (–13.12)				
$P = 3918.9 - 339.7\ \ln V$	187	0.944	0.939	0.258
(16.7) (–13.7)				

p-values for the F statistic are close to zero. The highest value is shown in parentheses and the others are of the order of 10^{-6} or less.

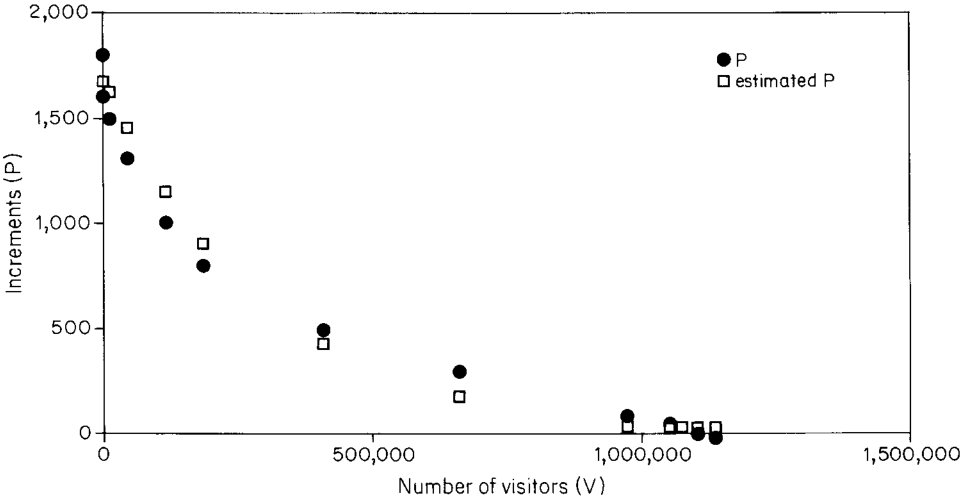

Figure 3. Demand and estimated demand.

Using the final equation, the consumer surplus may be calculated as follows:

$$\int_0^{102370} 3918.9 - 339.7 \ln V \, dV = [3918.9 - 339.7V(\ln V - 1)]_0^{102370}$$

$$= 34.78 \text{ m yuan}$$

This value of consumer surplus is much less than the one estimated from an initial linear regression which was not a particularly good fit to the data even though it may have had the property of consistency. This latter, lower value is therefore taken as the minimum measure of the recreation value of CMBR and is used later in the paper.

The estimated demand function $P = 3918.9 - 339.7 \ln V$ and the total demand from Appendix Table A3 are plotted in Figure 4.

Summary of results

Results of valuation

Total travel expenses. By calculation, the total travel costs of all domestic visitors to CMBR in 1996 was 114.75 million yuan as shown in Appendix Table A1.

Total consumer surplus. The consumer surplus value was found (above) to be 34.78 million yuan.

Total travel time costs. The total value of travel time was calculated to be 8.61 million yuan using (travel hours – 36) × average hourly wage × 40% × zonal visitation numbers to CMBR. The average hourly wage is described earlier and other data are presented in Table 1.

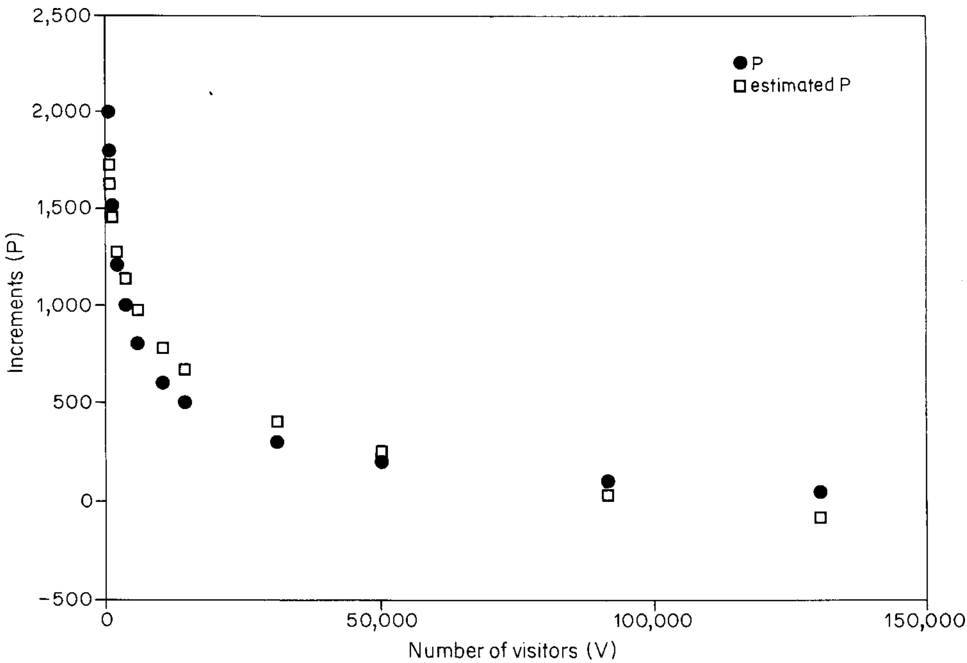

Figure 4. Demand curve and total estimated demand from an initial non-linear estimation.

Other expenses. There are other expenses for visitors, mainly photography, shopping for souvenirs, local art and crafts, native products, cultural T-shirts and other items, which reflect the characteristics of the site. A survey showed that each visitor spent 80 yuan on average for these purchases:

total other expenses = total domestic visitors to CMBR in 1996 × average expenses

$$= 176{,}000 \times 80$$

$$= 14.08 \text{ million yuan}$$

Total recreational value for domestic tourism:

$$\text{total recreational value} = \text{travel cost} + \text{consumer surplus} + \text{travel time value} + \text{other expenses}$$

$$= 114.75 + 34.78 + 8.61 + 14.08$$

$$= 172.22 \text{ (million yuan/year)}$$

Recreational value of biodiversity for CMBR

CMBR is characterized by its rich biodiversity, especially the primary forest ecosystem. However, the total recreational value noted above cannot all be attributed to this biodiversity because there are other famous geological and geomorphological features in the reserve, such as waterfalls, hot springs and the volcanic crater lake called 'Sky Lake'. To identify the value of biodiversity, some of the questions in the questionnaire were designed to investigate visitors' main preferences for the alternative recreational resources. Questions aimed to find out the motivation for visiting the CMBR from a choice of four: 416 respondents indicated their main preferences as follows:

- the intact forest ecosystem and typical zonal vegetation at various altitudes – 39%;
- the wild animals (eg possibly tigers and other endangered animals) – 28%;
- the wild plants, especially ginseng and other rare plants – 20%; and
- the geological sites, such as Sky Lake, waterfalls, hot springs – 13%.

The first three are components of the biodiversity present in CMBR. These results suggest that the major portion of the tourism motivation for visiting CMBR can be attributed to these characteristics. If we assume that the main reasons given by the visitors surveyed for visiting CMBR indicate the prime source of their tourism or recreational value from the reserve, then

$$\begin{aligned}\text{total recreational value from biodiversity} &= \text{total tourism value} \times 87\% \\ &= 172.22 \times 87\% \\ &= 149.83 \text{ million yuan/year}\end{aligned}$$

However, this value should only be regarded as indicative. The numbers used are use values and do not include the option value of (say) visiting the park because of other attributes that might be experienced. As mentioned in the introduction, more definitive results require the development of more sophisticated analyses and techniques for the valuation of the tourism and the recreational economic value of biodiversity.

Discussion

In this study 'recreational value' includes two elements: total value to consumers from visiting CMBR as revealed by their expenses, including travel time cost; and consumer surplus, which is the difference between the amount paid and the additional amount consumers (in this case, visitors) are willing to pay to visit CMBR. Together these represent the complete economic use value for the recreation resource (CMBR). The total recreational value was found to be about 172.22 million yuan per year.

A proportion of this value was allocated to the biodiversity qualities of the reserve. The domestic recreational value for biodiversity in CMBR was found to be 149.83 million yuan per year.

Issue of multiple destination trips

Although many outdoor recreation trips have a single primary destination, multiple destination trips, where there is a choice about which site to visit, are common. Sorg *et al*[23] found that 20% of cold-water fishermen in Idaho were on multiple destination trips. The consumer surplus emanating from multiple destination trips is a large component of total site value.[24] Sorg *et al*[25] using the contingent valuation method, found that multiple destination visitors actually placed a higher marginal value on the measured recreation site than single destination users of that site.

In this study CMBR has no close substitutes, and a visit to the reserve may be considered as a single destination trip. The multiple destination issue is ignored and on-site time has not been included as a cost. Among the 3,131 survey respondents, there were 64.5% from Jilin Province in which the reserve is located, 18.2% from Liaoning and Heilongjiang, two neighbouring provinces of Jilin, and 8.8% from Beijing. So 91.5% of visitors can be regarded as having the CMBR as their sole destination because there is no other attractive recreational site near the reserve. The other 8.5% of visitors were from more than 20 other provinces or regions, and would possibly have other destinations for meetings or recreational visiting. Due to this small proportion, the multiple destination trip issue is not taken into account in this paper.

Recreational value of foreign visitors

CMBR is of international recreational significance, with many foreign visitors especially from South Korea. In 1996, the number of foreign visitors was 71,312, constituting 28.8% of total visitors. These visitors have higher travel costs and they generate producer surplus for providers of recreation-related products and services as well as contributing to consumer surplus. Recreational value for foreign visitors has not been dealt with in this paper. So, actually, the estimate for recreational value calculated on domestic visitors is not the whole recreational value of the reserve or of biodiversity within the reserve.

Conclusion and comment

This study has found the consumer surplus value for CMBR using the Zonal Travel Cost methodology to be 34.78 million yuan (US $4.2 million). This is considered to be a minimum estimate. The total biodiversity recreational value of the reserve has been found to be 149.83 million yuan (US $18.2 million). These valuations are for only one year (1996) and therefore are static estimates. In the longer term those values can be expected to increase.

The recreational value estimation in China is based mainly on visitors' travel costs involving bus and train travel. The availability of public transport is important for visitation in China since most people depend on public transportation. When suitable public transport is available to visit a recreation site, a higher consumer surplus value will be found for biodiversity recreation. But those sites that are not easy to access now, or are currently short of tourism facilities, will display a lower recreational value even if they possess a rich biodiversity. This paper has suggested a biodiversity recreation value for CMBR in 1996. With further development in ecotourism infrastructure, and improvements in transportation in the future, this value is likely to increase. With rising incomes in China and more leisure-time as China develops, Chinese demand for recreation in CMBR can be expected to grow and the tourism value of CMBR to rise. In addition, there is opportunity in the future to evaluate the recreational value of biodiversity in other more remote sites when ecotourism is better developed. It follows that current tourism economic values of protected areas in China are likely to understate considerably the long-term recreational values of these areas, or the discounted present sum of the future tourism economic values of such areas, which far exceeds their current annual recreational economic value.[26]

Endnotes

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22. It is important to keep incrementing until the visitation drops to zero, since otherwise the summations of the visitation quantity data will be truncated. This may simply result in an inaccurate estimation of the demand function and hence consumer surplus, or else in points

representing only a limited section of the demand curve, making the choice of functional form in the estimation difficult due to extrapolation. This difficulty of finding the correct functional form due to having only a narrow band of values for the independent variable has occurred in D.J. Beal 'A travel cost analysis of the value of Carnarvon Gorge National Park for recreational use', *Review of Marketing and Agricultural Economics,* Vol 63, No 2, 1995, pp 292–303. Beal limits her increments to a maximum of $20 instead of finding the increment value (or entry fee) for which visitation becomes zero.

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Appendix

(see overleaf)

Table A1. The travel expenses to CMBR for the domestic visitors.

Region	Distance to nearby city (km)	Transport cost (yuan/p)	Food cost (yuan/p)	Accomm. cost (yuan/p)	Entry fee + service (yuan/p)	Total travel costs (yuan/p)	Total visitor numbers in 1996 (people)	Total transport cost (million yuan)	Total travel cost in 1996 (million yuan)
Changcun, Jilin Prov.	477	291	132	100	50	573	27,773	8.08	15.91
Jilin, Jilin Prov.	349	240	124	100	50	514	16,914	4.06	8.69
Siping, Jilin Prov.	592	281	120	100	50	551	3,714	1.04	2.05
Liaoyuan, Jilin Prov.	480	236	112	100	50	498	3,379	0.80	1.68
Tonghua, Jilin Prov.	277	155	80	100	50	385	9,046	1.40	3.48
Baishan, Jilin Prov.	217	131	76	100	50	357	16,069	2.11	5.74
Songyuan, Jilin Prov.	626	350	172	150	50	722	2,077	0.73	1.50
Baicheng, Jilin Prov.	810	424	184	150	50	808	1,074	0.46	0.87
Yanbian, Jilin Prov.		100	80	100	50	330	33,446	3.34	11.04
Heilongjiang Prov.	719	388	164	150	50	752	15,294	5.93	11.50
Liaoning Prov.	635	298	144	125	50	617	16,695	4.98	10.30
Beijing Munic.	1,623	750	208	150	50	1,158	15,458	11.59	17.90
Tianjin Munic.	1,486	694	200	150	50	1,094	2,200	1.53	2.41
Hebei Prov.	1,906	862	240	200	50	1,352	950	0.82	1.28
Shanxi Prov.	2,137	955	252	200	50	1,457	334	0.32	0.49
Inner Mongolia Reg.	2,291	1,016	260	200	50	1,526	387	0.39	0.59
Shandong Prov.	1,843	837	220	150	50	1,257	2,811	2.35	3.53
Shanghai Munic.	2,811	1,224	264	150	50	1,688	787	0.96	1.33
Jiangsu Prov.	2,506	1,102	252	150	50	1,554	1,518	1.67	2.36
Zhejiang Prov.	3,000	1,300	312	200	50	1,862	387	0.50	0.72
Anhui Prov.	2,456	1,082	288	200	50	1,620	176	0.19	0.29
Fujian Prov.	3,972	1,689	360	200	50	2,299	176	0.30	0.40
Jiangxi Prov.	3,628	1,551	344	200	50	2,145	53	0.08	0.11
Henan Prov.	2,318	1,027	280	200	50	1,557	1,742	1.80	2.71
Hubei Prov.	2,852	1,241	304	200	50	1,795	282	0.35	0.51

continued

Table A1 continued.

Region	Distance to nearby city (km)	Transport cost (yuan/p)	Food cost (yuan/p)	Accomm. cost (yuan/p)	Entry fee + service (yuan/p)	Total travel costs (yuan/p)	Total visitor numbers in 1996 (people)	Total transport cost (million yuan)	Total travel cost in 1996 (million yuan)
Hunan Prov.	3,210	1,384	324	200	50	1,958	176	0.24	0.34
Guangdong Prov.	3,936	1,674	360	200	50	2,284	1,566	2.62	3.58
Guangxi Reg.	4,188	1,775	372	200	50	2,397	282	0.50	0.68
Hainan Prov.	4,537	1,915	412	250	50	2,627	53	0.10	0.14
Sichuan Prov.	3,671	1,568	344	200	50	2,162	458	0.72	0.99
Guizhou Prov.	4,163	1,765	368	200	50	2,383	229	0.40	0.55
Yunnan Prov.	4,802	2,021	400	200	50	2,671	53	0.11	0.14
Shanxi Prov.	2,788	1,215	304	200	50	1,769	106	0.13	0.19
Gansu Prov.	3,436	1,474	392	200	50	2,116	229	0.34	0.48
Qinghai Prov.	3,721	1,588	348	200	50	2,186	53	0.08	0.12
Xinjiang Reg.	5,297	2,259	428	200	50	2,937	53	0.12	0.16
Tibet Reg.	5,711	2,384	560	450	50	3,444	0	0	0
Total							176,000	61.14	114.75

Table A2. Estimated visitation numbers using $VR = 46.39049 - 0.02172TC$; $V = 100N_i VR$.

	Increments P												
	0	20	35	50	100	300	500	800	1,000	1,300	1,500	1,600	1,800
Changcun, Jilin Prov.	23,015	22,720	22,499	22,278	21,542	18,597	15,652	11.234	8,289	3,871	925	0	0
Jilin, Jilin Prov.	15,288	15,100	14,958	14,817	14,346	12,460	10,575	7,747	5,862	3,034	1,149	206	0
Siping, Jilin Prov.	10,843	10,706	10,604	10,501	10,159	8,791	7,422	5,370	4,001	1,949	580	0	0
Liaoyuan, Jilin Prov.	4,447	4,392	4,352	4,311	4,175	3,632	3,089	2,275	1,732	917	374	103	0
Tonghua, Jilin Prov.	8,670	8,571	8,497	8,423	8,175	7,185	6,194	4,709	3,718	2,233	1,242	747	0
Baishan, Jilin Prov.	5,100	5,043	5,000	4,957	4,813	4,240	3,666	2,806	2,233	1,373	799	513	0
Songyuan, Jilin Prov.	7,954	7,841	7,757	7,672	7,391	6,266	5,141	3,453	2,328	640	0	0	0
Baicheng, Jilin Prov.	5,739	5,653	5,588	5,523	5,307	4,443	3,578	2,281	1,417	120	0	0	0
Yanbian, Jilin Prov.	8,707	8,611	8,539	8,466	8,225	7,261	6,297	4,850	3,886	2,439	1,475	993	28
Heilongjiang Prov.	111,241	109,633	108,428	107,222	103,203	87,125	71,048	46,933	30,855	6,740	0	0	0
Liaoning Prov.	134,992	133,214	131,881	130,548	126,104	108,329	90,553	63,889	46,114	19,450	1,675	0	0
Beijing Munic.	26,570	26,026	25,619	25,211	23,852	18,418	12,984	4,832	0	0	0	0	0
Tianjin Munic.	21,316	20,907	20,600	20,293	19,270	15,178	11,086	4,948	856	0	0	0	0
Hebei Prov.	108,058	105,301	103,233	101,165	94,272	66,701	39,130	0	0	0	0	0	0
Shanxi Prov.	45,369	44,032	43,030	42,027	38,685	25,319	11,952	0	0	0	0	0	0
Inner Mongolia Reg.	30,253	29,261	28,517	27,773	25,292	15,371	5,449	0	0	0	0	0	0
Shandong Prov.	166,165	162,384	159,547	156,711	147,258	109,443	71,629	14,907	0	0	0	0	0
Shanghai Munic.	13,764	13,149	12,688	12,227	10,691	4,544	0	0	0	0	0	0	0
Jiangsu Prov.	89,297	86,228	83,926	81,624	73,950	43,255	12,561	0	0	0	0	0	0
Zhejiang Prov.	25,677	23,802	22,395	20,989	16,300	0	0	0	0	0	0	0	0
Anhui Prov.	67,370	64,758	62,799	60,840	54,310	28,189	2,069	0	0	0	0	0	0
Fujian Prov.	0	0	0	0	0	0	0	0	0	0	0	0	0
Jiangxi Prov.	0	0	0	0	0	0	0	0	0	0	0	0	0
Henan Prov.	114,409	110,456	107,491	104,527	94,644	55,114	15,583	0	0	0	0	0	0
Hubei Prov.	42,731	40,223	38,343	36,462	30,194	5,120	0	0	0	0	0	0	0
Hunan Prov.	24,691	21,914	19,831	17,749	10,807	0	0	0	0	0	0	0	0
Guangdong Prov.	0	0	0	0	0	0	0	0	0	0	0	0	0

continued

Table A2 continued.

	Increments P												
	0	20	35	50	100	300	500	800	1,000	1,300	1,500	1,600	1,800
Guangxi Reg.	0	0	0	0	0	0	0	0	0	0	0	0	0
Hainan Prov.	0	0	0	0	0	0	0	0	0	0	0	0	0
Sichuan Prov.	0	0	0	0	0	0	0	0	0	0	0	0	0
Guizhou Prov.	0	0	0	0	0	0	0	0	0	0	0	0	0
Yunnan Prov.	0	0	0	0	0	0	0	0	0	0	0	0	0
Shaanxi Prov.	27,999	26,472	25,328	24,183	20,366	5,102	0	0	0	0	0	0	0
Gansu Prov.	1,051	0	0	0	0	0	0	0	0	0	0	0	0
Qinghai Prov.	0	0	0	0	0	0	0	0	0	0	0	0	0
Xinjiang Reg.	0	0	0	0	0	0	0	0	0	0	0	0	0
Tibet Reg.	0	0	0	0	0	0	0	0	0	0	0	0	0
Increments	0	20	35	50	100	300	500	800	1,000	1,300	1,500	1,600	1,800
Totals	1,140,716	1,106,399	1,081,449	1,056,500	973,334	660,083	405,658	180,234	111,291	42,766	8,220	2,561	28

Table A3. Estimated number of visitors V, using $\ln VR = 8.054454 + 2.889143 \ln Y - 4.656574 \ln TC$ and $V = 100N \exp(\ln VR)$.

	Increments										
	0	50	100	300	500	800	1,000	1,200	1,500	1,800	2,000
Changcun, Jilin Prov.	15,923.50	10,785.73	7,528.84	2,241.50	857.78	272.14	144.47	82.74	39.96	21.29	14.61
Jilin, Jilin Prov.	12,688.94	8,235.52	5,545.15	1,491.72	536.27	160.42	82.93	46.54	21.96	11.50	7.82
Siping, Jilin Prov.	3,113.73	2,077.89	1,432.22	411.36	153.94	47.81	25.14	14.29	6.84	3.62	2.48
Liaoyuan, Jilin Prov.	2,121.71	1,358.94	904.94	236.13	83.34	24.51	12.58	7.02	3.29	1.71	1.16
Tonghua, Jilin Prov.	17,042.59	9,651.71	5,815.27	1,164.99	353.40	90.77	43.91	23.43	10.45	5.25	3.49
Baishan, Jilin Prov.	11,697.61	6,353.54	3,704.15	683.26	198.22	48.99	23.32	12.29	5.41	2.69	1.78
Songyuan, Jilin Prov.	1,285.15	940.89	702.47	254.81	110.86	39.88	22.44	13.46	6.85	3.80	2.66
Baicheng, Jilin Prov.	266.01	201.13	154.50	61.14	28.23	10.79	6.25	3.84	2.01	1.14	0.80
Yanbian, Jilin Prov.	34,114.77	17,686.25	9,945.99	1,679.78	465.25	110.59	51.78	26.97	11.72	5.78	3.80
Heilongjiang Prov.	13,321.02	9,870.88	7,448.18	2,790.09	1,240.61	456.28	259.48	156.85	80.61	45.03	31.69
Liaoning Prov.	60,405.70	42,023.90	30,013.11	9,544.54	3,808.57	1,257.94	680.22	395.20	193.99	104.66	72.28
Beijing Munic.	4,244.58	3,486.16	2,886.21	1,451.94	797.97	367.83	233.86	154.78	88.62	53.86	39.71
Tianjin Munic.	2,172.10	1,764.01	1,445.41	702.74	376.41	168.63	105.66	69.09	38.98	23.42	17.16
Hebei Prov.	2,326.61	1,964.64	1,668.85	915.05	537.45	267.13	176.60	120.77	71.98	45.18	33.92
Shanxi Prov.	741.39	633.59	544.26	310.04	187.67	96.60	65.05	45.19	27.46	17.51	13.27
Inner Mongolia Reg.	302.30	260.16	224.95	131.06	80.78	42.47	28.92	20.28	12.47	8.03	6.12
Shandong Prov.	5,348.13	4,459.82	3,744.52	1,974.05	1,124.52	539.72	350.36	235.95	137.99	85.30	63.50
Shanghai Munic.	1,210.40	1,056.56	925.84	565.08	361.62	198.79	138.69	99.29	62.67	41.22	31.80
Jiangsu Prov.	2,452.35	2,116.11	1,834.26	1,077.99	669.02	354.60	242.57	170.75	105.50	68.20	52.08
Zhejiang Prov.	881.23	778.93	690.71	439.53	291.11	166.82	119.06	86.93	56.25	37.78	29.49
Anhui Prov.	824.94	716.06	624.15	373.97	235.74	127.29	87.94	62.44	38.99	25.43	19.52
Fujian Prov.	173.87	157.30	142.60	98.22	69.54	43.29	32.35	24.60	16.77	11.77	9.43
Jiangxi Prov.	116.19	104.37	93.98	63.16	43.80	26.56	19.56	14.68	9.84	6.81	5.41
Henan Prov.	1,265.58	1,092.37	947.12	557.13	346.02	183.56	125.62	88.46	54.69	35.36	27.01
Hubei Prov.	514.91	453.08	400.03	250.72	163.98	92.54	65.49	47.47	30.43	20.28	15.76
Hunan Prov.	407.30	362.17	322.98	209.71	141.25	82.62	59.64	43.98	28.82	19.56	15.37

continued

Table A3 continued.

	Increments										
	0	50	100	300	500	800	1,000	1,200	1,500	1,800	2,000
Guangdong Prov.	1,023.30	925.14	838.19	576.01	407.06	252.75	188.64	143.24	97.50	68.35	54.71
Guangxi Reg.	135.08	122.70	111.67	78.00	55.90	35.33	26.64	20.41	14.05	9.95	8.01
Hainan Prov.	16.00	14.66	13.45	9.67	7.11	4.64	3.56	2.78	1.95	1.41	1.15
Sichuan Prov.	414.45	372.60	335.76	226.31	157.31	95.67	70.57	53.04	35.63	24.69	19.63
Guizhou Prov.	73.26	66.51	60.50	42.18	30.18	19.03	14.33	10.97	7.54	5.33	4.29
Yunnan Prov.	73.47	67.39	61.91	44.75	33.04	21.69	16.71	13.05	9.22	6.67	5.44
Shanxi Prov.	279.14	245.16	216.08	134.59	87.58	49.12	34.65	25.04	15.99	10.63	8.24
Gansu Prov.	160.09	143.59	129.12	86.34	59.62	35.96	26.40	19.76	13.20	9.11	7.22
Qinghai Prov.	31.02	27.92	25.19	17.05	11.89	7.26	5.37	4.04	2.72	1.89	1.51
Xinjiang Reg.	21.93	20.27	18.77	13.94	10.55	7.14	5.60	4.45	3.21	2.37	1.95
Tibet Reg.	3.83	3.58	3.35	2.60	2.04	1.45	1.17	0.95	0.71	0.54	0.45
Total	**197,194.20**	**130,601.25**	**91,504.67**	**30,911.15**	**14,125.64**	**5,808.63**	**3,597.55**	**2,365.00**	**1,366.28**	**847.13**	**634.73**