Estimating Recreational Benefits of the Glacier-Based Highland Ecosystem: A Case Study of Mt. Yulong, China

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ABSTRACT

This paper examines the tourism demand and assesses the consumer surplus of visiting a unique tourist attraction site: glaciers in Mt. Yulong, Yunnan, China by using the zonal travel cost method (henceforth, TCM). We aim to uncover the use value of this particular site in tourism development. We divide domestic travelers into 20 groups based on the demographical and geographical characteristics of their place of residence. The empirical results show that the economic value of the glaciers in the tourism industry is more than three billion Chinese Yuan, roughly equivalent to 500 million dollars, which is approximately ten percent of the local GDP. The high estimated value of the glaciers suggests that some conservation policy interventions are necessary.

Keywords: Highland Ecosystem, Glaciers, Economic Valuation, Travel Cost Method, Consumer Surplus

บทคัดย่อ

งานวิจัยฉบับนี้ศึกษาอุปสงค์ของการท่องเที่ยวและประเมินมูลค่าส่วนเกินผู้บริโภค ของการเยี่ยมชมสถานที่ท่องเที่ยวธารน้ำแข็งที่เทือกเขา-หิมะหยู่หลง มณฑลยูนนาน ประเทศสาธารณรัฐประชาชนจีน โดยใช้วิธีการคำนวณค่าเดินทางระหว่างภาค (TCM) เราตั้งใจจะหามูลค่าการใช้ของสถานที่นี้ในการพัฒนาการท่องเที่ยว เราแบ่งนักท่องเที่ยวท้องถิ่นออกเป็น 20 กลุ่ม ตามลักษณะทางประชากรศาสตร์และทางภูมิศาสตร์ของถิ่นที่อยู่ ผลลัพธ์เชิงประจักษ์แสดงให้เห็นว่ามูลค่าทางเศรษฐศาสตร์ของธารน้ำแข็งในอุตสาหกรรมการท่องเที่ยวมีมากกว่า 3 พันล้านหยวน หรือประมาณ 500 ล้านดอลลาร์สหรัฐอเมริกา (ประมาณ 10 เปอร์เซนต์ของผลิตภัณฑ์มวลรวมในประเทศของท้องถิ่น) ค่าประเมินที่สูงของธารน้ำแข็งบ่งชี้ว่าจำเป็นต้องมีนโยบายแทรกแซงในการอนุรักษ์ธารน้ำแข็งนี้

คำสำคัญ: ระบบนิเวศน์ของที่ราบสูง, ธารน้ำแข็ง, การประเมินค่าทางเศรษฐศาสตร์, วิธีการคำนวณค่าเดินทาง, ส่วนเกินผู้บริโภค

INTRODUCTION

Tourism has recently grown to become a star sector in China. It generates millions of dollars for locals without consuming much of the resources. In Yunnan Province, tourism is one of the most profitable sectors, and it has helped an array of poor regions raise their living standards. Nonetheless, the tourism sector has recently started to draw concerns from policymakers, scholars and concerned citizens, as the associated activities carried out at the tourist attraction sites raise many environmental issues, such as air and water pollution, and deforestation. The degradation of the main environmental asset is possible and such a development can result in a drastic decrease in tourist visitation, and thereby tourism revenue.

The general public has since started to call for more sustainable development and, more importantly, implementation of feasible conservation plans, especially in tourist

* *AU Journal of Management*, Vol. 13, No. 2 (2015). ISSN: 1686-0039.

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attraction sites with highly sensitive environmental assets. However, a central issue often raised by skeptics regarding the conservation of such environmental assets is: whether it is worth the money and effort, and whether the implemented rules and policies to conserve the environment will pay off in the long run.

This paper attempts to gauge the economic value of a well-known tourist attraction site: the Jade Dragon Mountain (Mt. Yulong) in Yunnan, China. This site is celebrated for its unique and precious environmental asset: glacier. We employ the widely adopted travel cost method (TCM) and the economic value derived from such a method shall serve as a benchmark that allows us to examine whether or not this tourist attraction is crucial for the vigor of the local tourism sector and economy. This study hopefully can provide some first-hand evidence that signifies the economic importance of the site and its glaciers. It is, thus, necessary for the local authority and policymakers to implement some urgent measures to conserve this sensitive but precious environmental asset.

BACKGROUND

Mt. Yulong, also known as the Jade Dragon Mountains, is located in the northern part of Yunnan, China (latitude 27° 10' N to 27° 40' N, longitude 100° 9' E to 100° 20' E), and it is one of China's southernmost mountain ranges. Mt. Yulong has glaciers, that are the closest to the Equator in the entire northern atmosphere. It is the most remote mountain range reaching out from the Tibetan Plateau (Himalaya) and covered with maritime glaciers. The climatic snowline of the Jade Dragon Mountain is at approximately altitude 5,000 meters, with a terrain snow line as low as 4,000 meters. Its main peak has a developing hanging glacier, while cirque glaciers cover most of other peaks above altitude 4,500 to 5,000 meters. There are currently 19 glaciers blanketing a total area of more than 11.61 square kilometers. Most of the glaciers possess similar characteristics of a mountain ecosystem such as those typically found in the Alps:[1]

> "…lands provide a scattered but diverse array of habitats in which a large range of plants and animals can be found. At higher altitudes harsh environmental conditions generally prevail, and a selection of treeless alpine vegetation, upon which the present account is focused, is supported. The montane forests commonly cover the lower slopes. At even lower levels mountain lands grade into other types of landform and vegetation - e.g., tropical or temperate forest, savanna, scrubland, desert, or tundra…" (Smith, n.d.).

Combining the sub-tropical location and rapid altitude change, Mt. Yulong has a fairly diverse range of ecosystems: (1) sub-tropical rain forests in the river valley, (2) temperate broad-leaves forests between altitude 2400 to 3200 meters, (3) the boreal coniferous at altitude 3,200 to 4,200 meters, (4) alpine scree with sparse vegetation covered between altitude 4,300 to 5,000 meters, and (5) permafrost and glaciers dominating the higher levels.

For thousand years, Mt. Yulong was residence of a small number of tribal people living in tiny basins over the river valley, enjoying the fertile soil, mild climate and rich natural diversification. Outsiders travelled to the region only occasionally and were often marveled by the mountain's natural beauty.

The uniqueness of the ecosystem and spectacular scenery have given Mt. Yulong a new life in the late 20th century. Local residents and the provincial authority started to

[1] See He and Zhang (2004) for more details.

explore the huge tourism value of the glaciers and the mountain. Various tourism projects including airports, hotels, and roads were proposed and subsequently developed and completed. For example, the new cable tram, allowing travelers to reach the glaciers, was built in 1998.

With the completion of these tourism projects, the surrounding area and local town have since enjoyed a substantial economic expansion. As shown in Table 1, there were merely about 200,000 visitors in 1994. That figure soon exploded to roughly 1.7 million in 2004 and 3.6 million in 2013. The importance of this sector on the local economy had also grown substantially.

Unfortunately, perhaps due to the economic activities carried out at and around the mountain, ominous signs of environmental deterioration have emerged and started to draw concerns. He et al. (2006) predicted that there will be only six glaciers left in 2050, compared to a total of 19 in 1994. Table 2 reveals his other predictions about the fate of the mountain and its glaciers. It is apparent that the development of tourism brought about a huge amount of tourism revenue and speeded up the social and economic development. However, these tourism projects and activities have negative effects on the very most important environmental resource – the glaciers. Almost 30 percent of the glaciers (six out of 19) have disappeared since 1994. The remaining 13 glaciers have also retreated by more than 200 meters on average. The total area covered by glaciers and permafrost has also shrunk by around 30 percent in size. At this speed, by year 2050, all the glaciers are expected to recede to above 5,000 meters and half of the area currently covered by glaciers would have nothing but bare rocks. The glaciers would likely appear only at altitudes where it is inaccessible for human within 20 years, if nothing were done to conserve them.

TABLE 1

Lijiang's Tourism and Economic Statistics, 1994-2013

Year	1994	2004	2013
Total Number of Tourists (million)	0.2	1.7	3.6
Nominal GDP (million USD)	50	250	4,490
Percent of Tourist Revenue (to Nominal GDP)	28.40	48.30	61.40
Percent of Tourist Visiting Glacier	7.60	41.20	77.40

Note: The GDP figures are converted based on the USD-CNY exchange rate on October 30, 2015. The total number of tourists in 1994 and 2004 were estimated.

Source: Lijiang Tourism Authority and Yunnan Economics Statistic Year Book, 2004 and 2013.

TABLE 2

Mt. Yulong's Environmental Statistics, 1994-2050

Year	1994	2012	2050
Average Annual Local Temperature	12.6	14.2	3.6
Number of Existing Glaciers	19	14	6
Area Covered by the Glaciers (square kilometer)	11.5	8.5	4.4
Underground Water Line (meter)	65	105	n.a.
Five-year Average Glacier Retreat (meter)	10.13	24.7	n.a.
Glacier Lower Edge Altitude (meter)	4,550	4,771	4,911

Note: The 2050 figures were estimated by Dr. Qingyuan He, a member of the Chinese Academy of Sciences.

Source: A newspaper interview of Dr. Qingyuan He by Li (2014).

METHODOLOGY

Theoretical Framework

To assess the monetary value of the mountain, we employ the well-developed TCM. Such an approach was firstly introduced by Hoteling (1947) and extended by Clawson and Knetsch (1966) in order to estimate the non-market value of assets, especially environmental resources, which, in most of cases, are public goods and therefore the traditional asset valuation approaches (for example, the market value approach or the acquisition cost approach) are normally not applicable. TCM attempts to extract the value of the public good from the revealed preference of the consumers (Brown & Mendelsohn, 1984). There have since been extensive discussions and debates regarding the functional forms and econometric approaches of estimating travelling demand under the framework of TCM (Bowes & Loomis, 1980; Strong, 1983). Yet it remains to be one of the most adopted methods to assess the value of an environmental asset. In addition, TCM employs secondary data to observe the ex-post value of travelers (Offenbach & Goodwin, 1994). As a result, TCM provides not only a fair approximation of the value of a certain environmental asset but also a first glance at whether the protection of such an asset is economically sound.

The entrance fee (price) to an environmental asset or a tourist attraction site normally does not vary much across different travelers and across time. It is not feasible to estimate the “actual” demand curve. Alternatively, TCM assumes that the time and money visitors have to spend so as to gain access to the tourist site affect their utility. (Freeman, 1979; Kealy & Bishop, 1986). In other words, the time and money spent on travelling constitute a great proportion of the “price” travelers pay to visit the site. The utility one receives from visiting a site can, thus, be theorized to depend on the total cost of traveling (C), number of visitation to the site (V) and his or her income (W):

$$MAX\ \{U = (C, V, W)\}$$

The utility maximization solution would yield the Marshallian demand function:

$$\mathrm{V}^* = \mathrm{F}(\mathrm{C}, \mathrm{W}).$$

The demand curve or function is essential for an estimation of the consumer surplus. Various prior studies adopting TCM (Clawson & Knetsch, 1966; Bowes & Loomis, 1980) have assumed a linear form of the demand function, but it is now generally agreed that the linear demand model overestimates the consumer surplus (Strong, 1983) comparing to other forms of the demand curve.

Consequently, in this study, we apply the zonal TCM and estimate both the linear and quadratic forms of the demand equation. The consumer surplus calculated from each specification is then evaluated and compared for more valid conclusions. Below are the econometric specifications we employ:

$$\frac{V_{it}}{N_{it}} = \alpha_i + \beta_1 \cdot C_{it} + \beta_2 \cdot I_{it} + \varepsilon_{it} \tag{1}$$

$$\frac{V_{it}}{N_{it}} = \alpha_i + \beta_1 \cdot C_{it} + \beta_2 \cdot I_{it} + \beta_3 \cdot I_{it}^2 + \varepsilon_{it} \tag{2}$$

$$\frac{V_{it}}{N_{it}} = \alpha_i + \beta_1 \cdot C_{it} + \beta_2 \cdot C_{it}^2 + \beta_3 \cdot I_{it} + \varepsilon_{it} \tag{3}$$

$$\frac{V_{it}}{N_{it}} = \alpha_i + \beta_1 \cdot C_{it} + \beta_2 \cdot C_{it}^2 + \beta_3 \cdot I_{it} + \beta_4 \cdot I_{it}^2 + \varepsilon_{it} \tag{4}$$

where V_{it} is the number of visitations from zone i in year t, N_{it} is the population (in millions); C_{it} the cost of travelling from the zone, and I_{it} the average monthly income. Under the zonal TCM approach, the demand was estimated by assuming each zone as an integrated entity that determines the visitation demand. Therefore, most of other commonly used socio-economic attributes such as education and gender become irrelevant since those are attributes at the individual level rather than zonal level. Unfortunately, the zonal attributes, such as consumption references or travelling destination choices, are essentially unobservable and hence treated as stochastic, which are represented by the random error ε_{it}.[2]

Both Equations (1) and (2) express a linear relationship between travel cost and visitation rate, with different ways to control for the effects of income. Equations (3) and (4) utilize the quadratic form of the demand function, while controlling for income. After obtaining the coefficient estimates, and hence the demand equation, we calculate the consumer surplus by plugging the demand equation into the following equation:

$$CS_{it} = \int_{C_{it}}^{C_k} \left(\frac{V_{it}}{N_{it}}\right) dC \tag{5}$$

where CS_{it} is the consumer surplus per one million population, and C_k is the choke price (at which visitation becomes zero).[3]

Data

We collected data from various sources. Annual data on travel cost and income from 2012 to 2014 were from the National Statistical Bureau of China. Information about the origin of more than two million travellers was provided through requests to the Tourism Statistical Office under the Tourism Authority of Yunnan.

Visitors, according to their origin, were classified into 20 different groups or zones. The zoning was generally based on the provinces of China. China has a total of 34 provincial-level government units. Several small provinces with similar geographical and demographical characteristics and in close proximity to each other were grouped together. On the other hand, some large and highly populated provinces were further divided into multiple zones. We also dropped a couple of provinces from the analysis because of data limitation. Table 3 reports the distance between the Jade Dragon Mountain and the airport of the provincial capital or the largest city of each zone, as well as the annual income and the cost of travelling to the Jade Dragon Mountain. The population figure is a three-year average.

Estimation

The econometric estimation of TCM typically does not include all relevant variables, as not all the characteristics of travellers that affect their demand can be observed and accounted for. Moreover, the unequal population from each zone may result in

[2] The rationality of such a practice was defined as the Random Utility Model by Hanemann (1984).

[3] "Choke price" is the price at which the visitation would become zero. Conventionally also known as the reservation price, but named as the choke price under TCM.

heteroscedasticity. Hence, Bowes and Loomis (1980) used zonal averages to tackle the heteroscedasticity problem. Nonetheless, Strong (1983) argued that by taking zonal averages, the Ordinary Least Square (OLS) estimator, even though unbiased, is likely inefficient, and he suggested the Weighted Least Square estimation as an alternative.

In order to control for unobserved variables, we compiled a panel dataset. Crucial information from each of the zones was collected for three years (from 2012 to 2014). We employ the Random Effect model because the unobserved variables, such as the travelling preference of the travellers, are not time-invariant and are normally uncorrelated with the independent variables.[4]

TABLE 3

Zonal Statistics

Zone	Distance (kilometer)	Cost of Travelling (CNY)	Income (CNY)	Population (million)
1	1,510	2,784	3,557	37.62
2	1,640	3,886	2,017	25.82
3	1,857	3,215	6,239	45.19
4	1,868	3,135	3,029	5.77
5	1,890	2,415	3,561	66.81
6	1,892	3,298	2,642	79.37
7	2,030	2,843	3,256	6.53
8	2,040	3,264	2,870	36.27
9	2,250	2,963	5,683	54.93
10	2,360	2,971	3,196	73.26
11	2,400	2,842	2,632	60.25
12	2,430	4,033	7,544	24.05
13	2,506	4,305	5,617	24.96
14	2,574	4,153	7,739	21.06
15	2,650	2,702	4,825	37.67
16	2,890	3,315	8,168	14.60
17	2,942	3,712	5,097	43.92
18	3,463	4,492	3,910	27.51
19	4,100	3,962	3,120	38.38
20	5,200	4,713	3,087	22.59

Note: Distance is flight distance. Cost of Traveling and Income figures are the average values from 2012 to 2014.

Source: Tourism Authority of Yunnan; National Statistical Office in Yunnan; and Lijiang China Tourist Service.

RESULTS

Table 4 reports the empirical results. All specifications yield a negative coefficient on the cost of travelling. As expected, the higher cost, the lower visitation rate. In contrast, we would expect that income and visitation rate have a direct relationship. The positive estimate for income in all the four regressions confirms the theoretical conjecture.

The consumer surplus can be obtained by plugging the estimates derived from each of Equations (1) – (4) into Equation (5), and the mathematical computation results are reported in Table 5. The estimated consumer surplus using the estimated parameters from Equation (1) is fairly similar to that from Equation (2). Equations (3) and (4) also yield a similar pattern. Hence, only results from Equations (1) and (3) are reported.

[4] See Greene (2008, p. 183) for conditions where a random effect model is preferred to a fixed effect one.

TABLE 4

Random Effect Regressions of Visitation Rate

	(1)	(2)	(3)	(4)
Cost of Traveling	-0.157	-0.162	0.148	0.026
	(2.07)*	(2.14)*	(0.25)	(0.04)
Monthly Income	0.233	0.067	0.229	0.079
	(6.95)**	(0.38)	(6.79)**	(0.43)
Cost squared			-0.000043	-0.000026
			(0.51)	(0.31)
Income squared		0.000016		0.000015
		(0.94)		(0.83)
Constant	893.977	1,277.176	392.498	932.421
	(3.00)**	(2.58)**	(0.38)	(0.76)
N	60	60	60	60

Note: * significant at 5%, ** significant at 1%

TABLE 5

Computed Consumer Surplus

Zone	Distance (kilometer)	Linear Demand (million CNY)			Quadratic Demand (million CNY)		
		2012	2013	2014	2012	2013	2014
1	1,510	168.23	213.26	198.71	123.84	116.49	169.78
2	1,640	15.34	23.98	25.26	84.87	90.78	103.06
3	1,857	411.22	439.48	537.52	255.59	296.98	278.78
4	1,868	15.89	22.53	23.85	21.36	19.50	22.92
5	1,890	335.76	344.97	451.22	181.51	239.96	208.67
6	1,892	131.58	189.66	309.53	304.00	301.78	236.93
7	2,030	25.09	29.53	31.87	21.71	22.46	24.50
8	2,040	104.37	120.35	114.29	134.61	129.76	139.60
9	2,250	491.45	541.26	530.09	255.24	273.68	345.92
10	2,360	255.26	306.98	347.63	277.11	265.21	250.57
11	2,400	156.15	182.74	212.44	171.76	187.78	200.45
12	2,430	238.69	260.64	315.05	206.68	217.77	209.38
13	2,506	144.33	186.01	209.06	197.86	178.97	177.90
14	2,574	206.03	233.92	281.79	188.98	198.75	193.79
15	2,650	261.92	291.87	358.76	154.13	172.41	158.26
16	2,890	186.28	207.48	221.22	99.59	112.45	130.46
17	2,942	242.60	316.13	378.99	287.25	266.06	240.26
18	3,463	95.91	100.03	118.47	150.59	170.82	171.90
19	4,100	93.68	110.88	130.10	180.35	179.34	175.33
20	5,200	31.68	51.01	63.26	116.49	117.27	126.05
Total		3,611.46	4,172.72	4,859.10	3,413.54	3,558.22	3,564.52

Note: Computed using Equation (5).

Figures in Table 5 exhibit several crucial reflections. Firstly, the annual consumer surplus from the domestic travellers was estimated over three billion Chinese Yuan (approximately 500 million USD), indicating that the value of the glaciers for the tourism sector is substantial. The economic loss, if the glaciers were no longer accessible to tourists, could be as high as 3 billion Yuan per annual.

Secondly, the consumer surplus based on a linear functional form of the demand curve is noticeably higher than that based on a quadratic form. Such a finding corroborates those of Ziemer, Musser and Hill (1980), and Strong (1983). They explained that such a difference in consumer surplus between different functional forms of demand was due to "…the linear form of demand equation grossly misestimates the intercepts of the demand equation…" (Strong, 1983, p. 342). That is, a linear form of the demand curve leads to an imprecise estimation of the choke price and overstates the consumer surplus. From this perspective, Strong (1983) argued that the quadratic or other non-linear forms of the demand should provide better estimates of the consumer surplus than the linear model.

Another intriguing finding from Table 5 is that regardless of the form of the demand curve, the zones with a higher cost of traveling in general had a lower consumer surplus, which is as expected; but at the same time, income seemed to play an equally important role over the consumer surplus. Zones with a higher level of annual average income generated a higher consumer surplus than zones with lower income. Such a pattern is more pronounced under the linear demand models. As illustrated in Table 5, the consumer surplus computed from the linear demand curve was extremely high for zones with high income, and was extremely low for zones where the average income was low. However, under the quadratic demand model, the difference in consumer surplus estimates from zones with high income and those from zones with low income is much smaller. This finding illustrates the problem of aggregating the demand curve for each zone, as these zones had different income levels and consumer preferences. The choke (reservation) price, which represents the maximum willingness to pay, is expected to vary across zones. Unfortunately, the aggregation of the demand under a single equation results in a single choke price to be applied to all zones and is used as the upper bound in calculating the consumer surplus. This certainly leads to an inaccuracy of the consumer surplus estimation.

It is obvious in Table 5 that selection of the demand curve is important for the estimation of the consumer surplus, as suggested by Strong (1983), and different models might have their own limitations that may imprecisely estimate the consumer surplus. Nevertheless, it is fair to argue that the total consumer surplus in the tourism sector of the studied site is substantial and the consumer surplus is increasing over time. As income rises and the increase in the cost of travelling remains negligible, it is likely that the consumer surplus continues to grow in the future.

CONCLUSION

The objective of this study is to estimate the tourism demand and to assess the economic value of a unique environmental asset – the glaciers – in Mt. Yulong, Yunnan, China. The zonal TCM was employed and secondary data were exploited to estimate the demand curve. We selected two different functional forms of the demand curve and estimated them against the data.

Empirical findings suggest that even though the quadratic function and linear function did not yield similar accounts of the consumer surplus, the results arrived from both functional forms indicate a significantly high use value of the glaciers. The value of glaciers represented by the consumer surplus was more than three billion Chinese Yuan per annual. This value is approximately ten percent of the local GDP and it has been increasing over time. If the glooming picture painted by environmental scientists is correct, then this valuable asset to the locals is on the edge of disappearing and the economic loss to the locals might be catastrophic due to the high value of this asset in the tourism sector and the local GDP. Such findings inevitably imply that the local authorities should consider urgent policy interventions in order to conserve the glaciers. Suitable policy interventions, including instruments and process of implementations, remain to be explored in future studies.

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