Study on Meteorological Service Model Optimization

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- Ⅰ. Improvement of efficiency evaluation model
- Ⅱ. Contingent valuation method

- Meteorological service is a kind of service offered by meteorologists to the society.

- World meteorological organization convened a special technology seminar themed meteorological and hydrological socio-economic benefit in Geneva in March 1990.125 scholars from 67 countries discussed four themes, one of which is assessment method of socio-economic benefit in meteorology and hydrology.

- In September 1994, a second meeting was convened in Geneva; it pointed out benefit evaluation was important and valuable, was also a difficult subject.
- Experts and scholars analyzed and evaluated socio-economic benefit from different perspectives, but because of the difficulty to define its ownership and various factors affecting its ultimate benefit, there have not been a commonly-recognized evaluation method or model.

- At present, there are two main methods:

measuring increased benefit and reduced loss by practical investigations and analyses

calculating benefits by theoretical analyses and using mathematical models

Ⅰ.Theoretical basis and method of public meteorological service benefit assessment

1.Theoretical basis-WTP

On the basis of “cost –benefit analysis” theory and utility theory in microeconomics (WTP) is adequate to be used to measure the values of goods (service)), and. Consumer’s degree of satisfaction depends on the number of consumed goods (service)

- so satisfaction (U) can be expressed:

$$U = f(q_1, q_2, \cdots, q_n)$$

- utility function must meet

$$L = \sum_{i=1}^{n} p_i \cdot q_i$$

- The main conditions for the existence of Lagrange extreme value are:

$$W = U + \lambda L$$

$$\frac{\partial W}{\partial q_i} = 0 \qquad \frac{\partial U}{\partial q_i} = -\lambda p_i$$

that rations of the marginal utility of all items to their prices are equal

$$\frac{\partial U / \partial q_1}{p_i} = \frac{\partial U / \partial q_2}{p_2} = \cdots = \frac{\partial U / \partial q_n}{p_n} = -\lambda$$

expressed as:

$$U_i = \int_{p_i}^{q} \cdot dq_i$$

2. Three main methods of quantitative assessment

- (1) **Paying voluntarily**

$$W = P \bullet \sum_{i=1}^{t} \frac{M_i}{N_i} \sum_{j=1}^{n} C_j \bullet B_{ij}$$

- W- is the benefits of meteorological services
- P- is correction coefficient, usually defined as national television coverage
- M_i- is the population over 15years old of ith investigation area
- N_i- is the population of ith valid questionnaires
- C_j- is median of jth payment grade
- B_{ij}- is the number of people who will pay the jth payment grade in ith area.

(2) Cost saving

$$W = P \bullet \sum_{i=1}^{t} \frac{M_i}{N_i} \sum_{j=1}^{n} C_j \cdot B_{ij}$$

- (3) **Shadow price**

$$W = P \bullet C \bullet T \sum_{i=1}^{t} \left(M_{\mathrm{i}} \bullet \frac{G_{\mathrm{i}}}{N_{\mathrm{i}}} \right)$$

Ⅱ. Amendment of public meteorological service benefit evaluation model

1.**Amendment of correction coefficient P**

$P=0.9658$

2.**Adjustment of shadow price   C**

3.**Redefinition of G_i**

Table1. The number of public listening to (watching) weather forecast

Options	Once per week	Once every three days	Once per day	Twice per day	Three times per day	Others
Number	7515	13999	98352	38503	14003	2069
Proportion	4.31%	8.03%	56.38%	22.07%	8.03%	1.19%

From table1, we know that 88% of the public listen to (watch) weather forecast over one time per day.

$$\frac{7515\times\frac{1}{7}+13999\times\frac{1}{3}+98352\times1+38503\times2+14003\times3+2069\times4}{7515+13999+98352+38503+14003+2069}\approx1.33$$

So the new frequency is 1.33, multiplying the population of ith area, we will get a new value of Gi.

Ⅲ. Empirical analysis-calculation of paying voluntarily

- According to data from China statistics Yearbook 2008, we know P=0.9658, M=1328.02 million, N=44828. With data from questionnaires, formula can be expressed as:

$$\mathrm{W} = P \bullet \sum_{\mathrm{i}=1}^{t} \frac{M_{\mathrm{i}}}{N_i} \sum_{j=1}^{n} C_j \bullet B_{ij} = 68.15\text{亿元}/\text{年}$$

Ⅳ. Contingent valuation method

- There are four design patterns which are bidding game (BG), open-ended (OE), payment card (PC) and dichotomous choice (DC), in this paper, we use DC to infer average WTP.

Ⅴ. Dichotomy logistic model

- Suppose that indirect utility function is

$$U = V(q, y, s) + \varepsilon$$

- their corresponding utility functions are

$$U_0 = V(q_0, y, s) + \varepsilon_0$$

$$U_1 = V(q_1, y, s) + \varepsilon_1$$

- So its probability is

$$P(\text{accept}) = P[V(q_1, y - BID, s) + \varepsilon_1 \geq V(q_0, y, s) + \varepsilon_0]$$

- Take the highest bidding as integral upper limitation, and lowest bidding as lower limit of integration, we can get

$$WTP_{mean} = \int_{BID_{\min}}^{BID_{\max}} \frac{e^{\alpha' + \beta' S + \lambda BID}}{1 + e^{\alpha' + \beta' S + \lambda BID}} dBID = \frac{1}{\lambda} \ln \frac{1 + e^{\alpha' + \beta' S + \lambda BID_{\max}}}{1 + e^{\alpha' + \beta' S + \lambda BID_{\min}}}$$

Ⅵ. Calculation of the value of public meteorological service

- In this paper, we uses dichotomy design pattern, and calculate the value of public meteorological service with WTP.
- Survey results show that public WTP has relation with socio-economic conditions and the status of meteorological service, such as: age, sex, family average monthly earnings, education level and degree of satisfaction of metrological service.

Table2. Descriptions and values of variables

Variables	Description and values
Y	Dependent variable, whether respondents will to pay 40Yuan to keep present meteorological service level, 1=accept, 0=refuse
Sex	1=male, 0=female
Age	1= respondents from 13 years old to 17years old 2= respondents from 18 years old to 23 years old 3= respondents from 24 years old to 29 years old 4= respondents from 30 years old to 39 years old 5= respondents from 40 years old to 49 years old 6= respondents from 50 years old to 59 years old
Education	The highest education level of respondents 1= respondents with a primary education 2= respondents with a high school education 3= respondents with a technical secondary school education 4= respondents with a junior college education 5= respondents with a undergraduate education 6= respondents with a postgraduate education 7= respondents with a doctoral education
Profession	The trade of respondents 1=worker 2=peasant 3=administrator in institutions 4=student 5=teacher 6=cadre 7=police/soldier 8=medical staff 9=businessman 10=individual household 11=civil servant 12=retired people 13=others
Income	Average monthly earnings 1=less than 1000 Yuan 2=1001-2000 Yuan 3=2001-5000 Yuan 4=5001-10000 Yuan 5=more than 10000 Yuan
Address	Residence of respondents 1=urban 2=rural
Bid1	Will to pay 40 Yuan More than 100 Yuan 80 Yuan 60 Yuan 50 Yuan 40 Yuan
Bid2	Refuse to pay 40 Yuan 0 Yuan 1-10 Yuan 11-20 Yuan 21-30 Yuan 31-39 Yuan

Table3. Results of backward regression

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1(a)	sex	-.077	.126	.373	1	.541	.926
	age	.469	.057	66.728	1	.000	1.598
	edu	.117	.053	4.844	1	.028	1.124
	address	.185	.134	1.917	1	.166	1.203
	income	.086	.068	1.581	1	.209	1.089
	profession	.027	.029	.918	1	.338	1.028
	Bid1	-.018	.004	24.295	1	.000	.983
	Bid2	-.057	.007	61.189	1	.000	.944
	Constant	-.958	.468	4.188	1	.041	.384

Table3. Results of backward regression

Step 2(a)	age	.470	.057	67.255	1	.000	1.600
	edu	.113	.053	4.595	1	.032	1.119
	address	.198	.132	2.262	1	.133	1.220
	income	.086	.068	1.595	1	.207	1.090
	profession	.027	.029	.871	1	.351	1.027
	Bid1	-.017	.004	23.973	1	.000	.983
	Bid2	-.057	.007	61.550	1	.000	.944
	Constant	-1.077	.426	6.390	1	.011	.341

Table3. Results of backward regression

	age	.474	.057	68.723	1	.000	1.607
	edu	.114	.053	4.732	1	.030	1.121
	address	.189	.131	2.068	1	.150	1.208
Step 3(a)	income	.087	.068	1.622	1	.203	1.090
	Bid1	-.017	.004	23.961	1	.000	.983
	Bid2	-.057	.007	61.657	1	.000	.944
	Constant	-.966	.409	5.577	1	.018	.380

$$WTP_{mean} = \frac{1}{\lambda} \ln \frac{1+e^{\alpha' + \beta' S + \lambda BID_{\max}}}{1+e^{\alpha' + \beta' S + \lambda BID_{\min}}}$$

$$= \frac{1}{-0.017} \ln \frac{1+e^{-0.966+0.474 age+0.114 egu+0.189 address+0.087 income-0.057 bid2-0.017 bid1_{\max}}}{1+e^{-0.966+0.474 age+0.114 egu+0.189 address 0.087 income-0.057 bid2-0.017 bid1_{\min}}}$$

Ⅶ. Conclusion

- The use of CVM to assess benefits of public meteorological services in china is still at the exploratory stage. There will be differences by using different CVM investigation models.
- We should choose and adjust investigation models by doing a large number of comparative studies while referring to the real situations of China.

- In my opinion, assessment models should be amended according to different questionnaire models. The revised model will have a more objective evaluation on the effectiveness of national meteorological service.

Thank you !