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Valuing water quality in China: purpose, approach and policy

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Abstract—The economic valuation of water quality in a rapidly developing country such as China should be undertaken to determine when the benefits from rapid growth begin to exceed the costs from the same. The best approach is to ascertain the total economic valuation of the environmental resource. This includes all of the various uses of the resource, and even those values that are unconnected to individual use (e.g. natural and aesthetic values). A method known as contingent valuation (CV) is used to ascertain these forms of value. This approach is demonstrated here in an application to river water quality in the Beijing area. A CV study is reported in which Beijing area citizens reported an average willingness to pay about 1.3% of annual income in order to prevent further deterioration of river water quality. Aggregation over the representative population indicates that the perceived cost of further river quality deterioration is in the neighbourhood of USD 60 million. Such a measure provides some indication of the socially desired "stopping point"—— in the pursuit of economic growth at the expense of environmental quality.

Keywords: water management policy, environmental valuation, environment, development.

1 Introduction: heavy growth and light regulation (the TVIE sector)

In China, as in many rapidly developing countries, there are rapid changes in the environment occurring. The case of water quality is an important one as China's water quality has deteriorated significantly since 1980 under the pressure of industrial development, population and urban growth (World Bank, 1997). According to China's environmental yearbook, the proportion of river water that is classified as suitable for no purposes other than irrigation and industrial use (Class III and IV water supplies) was 27.5%. In urban areas almost 40% of all rivers are classed below Class IV water quality, and hence are unsuitable for even these uses (NEPA, 1996).

The reason for this decline in water quality is clear: China is on the move. It has been one of the world's most rapidly developing countries over the past twenty years GNP quadrupled between 1980 and 1996—and it is expected to remain one of the leaders in growth (World Bank, 1997). The Ninth Five Year Plan calls for continued GNP growth at 8% per annum, and forecasts population growth of 1.08% per annum. By 2010 it is forecast that the Chinese GNP will be double that of current levels, with a total national population of 1.4 billion people (NEPA, 1998).

A large part of the change in China is occurring within the less formal sectors of the economy principally the township and village industrial enterprises (TVIE). In fact industrial discharges of pollutants into surface waters actually declined slightly in recent years, e.g. from 22.19 to 20.59 billion tones between 1995 and 1996 (NEPA, 1996). However, these slight declines have been overwhelmed by the growth at the TVIE level, which are not recorded in official statistics. TVIE production, as a proportion of GNP, has expanded from 24% in 1989 to 42% in 1995. A recent survey by NEPA indicated that perhaps as much as 42% of China's annual water discharges now emanate from the TVIE sector, and all of this centred in urban areas (NEPA, 1997).

The source of pollution is important because it is indicative of the complexity of the regulatory problem. The local environmental protection bureaus (EPBs) focus on the larger state-owned industrial enterprises, and NEPA focuses on collecting data from and regulating for these same enterprises. For example, in the Beijing area, the EPBs collected "over-standard water pollution fees" from 1128 State-owned enterprises in 1996, in the aggregate amount of 40 million RMB

Yuan (NEPA, 1996). No data is available on fees collected below the county level, i.e. from TVIEs, but it is generally the sector goes largely uncharged.

The Ninth Five Year Plan and 2010 Long Term Objectives for China are ambitious and specific. By the year 2000 the Plan calls for wastewater discharges to be limited to 48 billion tones, allocated between industrial wastes (30 billion tones) and domestic sewage (18 billion tones). The Plan further calls for pre-treatment of 74% of industrial discharges (about the same as current levels) and 25% of sewage discharges by this time. At the level of the TVIEs the plan is for industrial emissions to total no more than 8 billion tones (22.5% of the total industrial discharges) and for 50% of these to be treated. Clearly, the discharges allocated to the TVIE sector are out of proportion to its contribution to the national economy (only half the size of its relative contribution), and it is difficult to conceive how this level of control will be achieved. It is very likely to be the case that this sector of the Chinese economy will continue to enjoy relatively relaxed regulation, and that it will also continue to be the case that it will be this sector that will demonstrate disproportionate growth. To a large extent the rapid growth in output in this sector, and the rapid growth in wastewater discharges, are linked outcomes.

2 Economic growth and environmental quality: regulating the TVIEs

China's urban water situation is probably best described as another instance in which economic growth is being purchased at the expense of environmental quality. The relatively relaxed regulatory atmosphere is conducive to rapid economic growth in the unregulated sector, but it necessarily comes at the expense of those resources that are unregulated. In part, the achieved growth and the lowered water quality are both caused by the light handedness in regulation and the low price of resources in this sector.

This is a not uncommon, and not necessarily sub-optimal, approach to the pursuit of the national welfare. Many, if not most, countries experience water quality deterioration in the initial stages of development, and then subsequently implement environmental management when higher levels of income have been attained. Grossman and Krueger (Grossman, 1995) estimated this "turning point" for river water quality improvements in three different countries as falling below USD 8000 per capita. This implies that in many countries the river water quality deteriorates initially (with initial stages of economic growth) but then (at the higher income levels) societies begin to demand higher water quality.

It is also not necessarily sub-optimal for a society to choose to traverse such a path. A largely unregulated industrial sector is an engine for economic growth that is able to initiate the development of an entire society. This will seem very important to a society with a deficit of subsistence and consumer goods. However, once the nation's economic growth is underway and the consumers' desire for a minimal level of goods satiated, then it makes sense to bring the informal sector under the control of society. When the sector is regulated, this allows it to serve a multiplicity of objectives (environment, growth, employment, etc.) not the single objective of maximum industrial growth.

Therefore, it is reasonable for the TVIE sector to remain relatively unmanaged throughout the period that unmitigated industrial growth is the primary objective of Chinese society. However, this implies that the crucial question is the manner in which Chinese people will themselves trade-off between further increases in consumer goods and their river quality. When the Chinese people reach the point that they would prefer river quality to increased product, then it is time for the sector to be much more strictly regulated.

3 Valuation of river quality: assessing the trade-off

The important question within this context is then: when do the Chinese people value the quality of their river waters more than they value increased industrial production? This question may be answered by means of the creation of an "artificial market" for river water quality, in which Chinese people are asked to state their preferences for more consumer goods (in the form of more RMB Yuan with which to purchase them) or more river quality.

Water quality improvements in surface waters generate a wide variety of market and non-market benefits. For the particular case of rivers in the Beijing region, benefits might include direct on-site uses and indirect use. The direct use comprise mainly in-stream and off-stream recreation (swimming, boating, beach sports, sun-bathing, sightseeing, hiking/walking, angling, amenity values from the surrounding environment). The indirect use values comprise such as increased employment because of tourism or pleasure from reading or seeing pictures of the rivers.

Water quality improvements may also produce a different type of benefits known as "non-use values" that correspond to a wide range of motivations for which individuals might value environmental improvements in rivers irrespective of their use of it: benefits from protecting river quality for future generations (bequest values), from knowing that other people may enjoy cleaner river (altruistic values) or simply from the knowledge that rivers are being preserved for their own sake, providing a natural habitat for fish, plants and wildlife (existence values). In addition, between use and non-use values are the so called "option values" that refer to benefits arising from guaranteeing the opportunity to use the rivers at a future date.

The economic evaluation of rivers and lakes has traditionally focused on the demand for on-site recreation use. However, non-use values may play as important a role in justifying expenditures in water protection as the more conventional use benefits. A study of the social welfare flowing from river quality improvement should estimate the total benefits from improving water quality levels.

The question is how to estimate this total value. Many of the benefits described above are not traded in market and hence cannot be valued by looking at market prices. To resolve this problem, economists have developed special techniques for placing monetary values on "non-market" goods and services. In recent years, one such technique, the contingent valuation method (CVM), has gained widespread acceptance among both academics and policy makers as a versatile and complete methodology for benefit estimation. CVM is a survey-based methodology. The basic underlying idea is that, by means of an appropriately designed questionnaire, a hypothetical market is described where the good in question can be traded. People are then directly asked to express their maximum willingness to pay (WTP) for a hypothetical change in the level of provision of the good.

In line with standard economic analysis, willingness to pay is considered to be the appropriate measure of the value which a person derives from a particular good, corresponding to the correct monetary welfare measures, namely Hicksian compensating and equivalent variations (Varian, 1996). This is because it forces people to take into account the fact that they are being asked to sacrifice some of their limited income to secure the good, and must thus weigh-up the value of what is being offered to them against alternative uses of that income. In this sense, willingness to pay is a much more powerful measure of value than a more general attitudinal question. While people may say, in response to an attitudinal question, that they "care about" many things, in practice they will only be able to pay for a much smaller subset of these things. This is the way in which the local preferences about the trade-off between economic product and water quality may be assessed.

4 Other valuation studies: the appropriate measure

In recent years, CVM has been extensively applied in both developed and developing countries to the valuation of a wide range of environmental goods and services. Existing water related valuation exercises in developing countries have concentrated primarily in two areas: water supply and sanitation. Moreover, in many cases, WTP studies of sanitation demand in developing countries estimate values that are so low that cost recovery is not feasible. The reason for this low demand lies, not only on a low ability to pay, but also on an incomplete perception of the benefits arising from installation of improved sanitation systems. One such benefit is improving surface water quality. In many cases, citizens of developing countries are concerned with pollution levels of rivers and lakes; had they been aware of the link between lack of domestic wastewater treatment and increased river pollution, their WTP for sanitation might have been different (higher).

But uncovering the true value of wastewater treatment is not the only or even the more important reason why it is important to estimate the value of surface water quality improvements in developing countries. In many cases, surface waters are very polluted, directly affecting all those who use it for recreation or subsistence. The potential for tourism is undermined and all the range of indirect, option and non-use values described above are negatively affected. The trade-off between economic growth and environmental quality involves all of these values, and they should be incorporated into the assessment of individual preferences regarding this trade-off.

An overview of selected contingent valuation studies estimating benefits from water quality improvements in surface waters in both developing countries and transitional economies is discussed. In both cases, given the distinguishing features of these economies, the success of CVM techniques depends crucially on careful design and implementation.

It is interesting to note that, in at least four of the above studies, WTP for water quality improvements amounts to less than 1% of household income. Of particular interest is the Chinese case-study, a very basic willingness and ability to pay survey of water supply and sanitation in Kunming City, province of Yunnan. In fact, this is not really a contingent valuation study but a series of WTP questions. As a secondary output, the survey also included a question about WTP to help cleaning up Lake Dianchi (neither the payment vehicle nor the mechanism through which the clean-up would be achieved were specified). Some additional results are reported below as they may allow an interesting comparison with the estimates from the present study.

· 87% of respondents were concerned with the condition of Lake Dianchi and 75% would be prepared to pay 8.5 RMB Yuan per month (102 RMB Yuan per year) to clean it. Overall, this corresponds to a WTP of 6.4 RMB Yuan per month or 77 RMB Yuan per year. Estimated mean gross household income is 15516 RMB Yuan per year. Hence the WTP is about 0.5% of household income.

· 72% of respondents with piped water (84% of the total) were willing to pay an additional 11.9 RMB Yuan per month for better water quality. Only 10% of those not connected were willing to pay 5.2 RMB Yuan. Overall, the average WTP is 7.3 RMB Yuan per month or 87.6 RMB Yuan per year (0.6% of household income).

· 57.3% of respondents with indoor WC's (43% of the sample) were prepared to pay 6.8 RMB Yuan per month for an improved sewerage system. Only 9% of those without indoor WCs wanted to connect at a mean monthly charge of 9.1 RMB Yuan. Overall, the average WTP is 2.1 RMB Yuan per month or 26 RMB Yuan per year (0.17% of household income).

Overall, these studies suggest that WTP for water quality improvements in developing

countries is positive, although typically amounting to far less than 1% of household income.

5 The value of Beijing river quality: a case study

A recent study of the river quality in the Beijing area attempted to correct for these deficiencies by asking questions related to the total benefits to be derived from river water quality improvements in the region. This CV study provides a case study in how the willingness to pay for river quality is dependent upon so many other facets other than sanitation and drinking water quality (Day, 1998).

The purpose of this survey was to obtain an estimate of the value of water quality changes in Beijing rivers. Specifically, respondents were asked their WTP to prevent the deterioration of river water quality in (1) the Chaobai He; (2) the Nan Sha He; and (3) in all rivers in the Beijing region. In the first three scenarios each respondent was asked two valuation questions, one about a particular river and one about all rivers. This design permits an investigation of sensitivity to scale in the case of Chinese rivers, i.e. whether the value of one river is significantly different from the value of all rivers.

The survey initially requested information on the individual's perspectives on river quality, and their usage of the river. These questions reveal in a qualitative manner the distribution of preferences concerning the environment-economic growth trade-off. Most respondents believed that the purpose of river quality was to serve human goals and objectives (Table 1(a)). However, most respondents believed that there were important non-use values involved, including future generations and future own-use (Table 1 (d, e)). The questions eliciting information on the economy /environment trade-off generated a mixed response; most refused to support a pollution-generating factory but many felt that river pollution was not an important concern (Table 1(i, j)).

Table 1 Attitudes on economy-environment trade-off, %

Attitude	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a	1	7	5	54	32
b	2	6	9	58	25
c	15	56	21	6	2
d	17	64	12	5	2
e	23	65	5	5	2
f	21	60	11	6	2
g	18	45	20	14	3
h	2	19	11	49	19
i	2	11	10	52	25
j	10	38	17	29	6

Notes: a. If no one uses a river, the fact that it is polluted is not important; b. if a river becomes polluted, the fact that other people will not be able to use it for recreation does not bother me if I, myself, don't use it; c. it is worth spending more money on water quality in rivers because clean rivers attract new business to the area; d. even if I don't use rivers at the moment I would still like to preserve them in case I want to use them in the future, even if that costs me money now; e. we have a responsibility to protect rivers for future generations, even if that costs us money; f. the fact that some animals and plants may die due to pollution in rivers is a serious problem; g. if the animals and plants that live in a river are unique than the river should be protected at all costs; h. rivers should only be kept clean if the costs are not very high, otherwise we will just have to learn to live with polluted rivers; i. if a factory pollutes a river but provides many jobs then it is worth having the factory; j. we have more important things to worry about than some dead fish in a polluted river

The survey also asked the respondents about the frequency and nature of their usage of the Beijing area rivers. These questions uncovered a wide range of existing uses in already polluted waters. Most people used them for relaxation and transport (50%) but many still used them for

swimming (20%), fishing (18%), boating (17%), and washing clothes (6%). Only a small minority of the people (8%) stated that they never made any use of the area rivers.

The valuation part of the survey (of 999 individuals in the Beijing area) asked these individuals to report their willingness to pay for river water improvements. It was based on showing each respondent a photograph of a "clean Chinese river" and another photograph of a "deteriorated Chinese river", and then requesting their WTP to maintain existing river water quality against further deterioration.

The results of the valuation section of the survey are as follows (Table 2):

· Average WTP per household per year for the prevention of water quality deterioration was found to be 123 RMB Yuan (US$ 15) for the Chaobai He and 101 RMB Yuan (US$ 12) for the Nan Sha He. As expected, these two values are not statistically different from one another although the two rivers are perceived to be very different. The implication is that transferability of values between rivers may be possible even though the rivers may be different.

· Average WTP per household per year to maintain the quality of all Beijing rivers was estimated to be 186 RMB Yuan (US$ 22). This value is significantly higher than the value of individual rivers like the Chaobai He or the Nan Sha He. This means that the proposed scenario passed the scale test, i.e. the preservation of a small subset of rivers has a significantly lower value than that attributed to preserving a larger set of rivers. Aggregating over the target population for which this survey was representative yields an estimate of 500 million RMB Yuan (US$ 60 million) for the preservation of all rivers in the area.

· As a proportion of income, the estimated values amount to 1.3% for all rivers and 0.8% for specific rivers. These results are reasonable and consistent to previous findings for both developed and developing countries.

Table 2 WTP as a percentage of income, total annual WTP for population, average WTP per household per year

Question	Scenario	Policy	WTP as % of annual income	Total WTP, mill RMB Yuan	Total WTP, mill US$	Average WTP, RMB Yuan	Average WTP, US$
1	All rivers deteriorate	Maintain water quality in all river	1.3	500.5	60.4	185.79 (±11.93)	22.44 (±1.44)
2	All rivers deteriorate	Maintain water quality in Nan Sha He	0.7	271.1	32.7	100.62 (±8.31)	12.15 (±1.00)
3	Only Nan Sha He deteriorate	Maintain water quality in Nan Sha He	0.8	298.0	36.0	110.57 (±12.28)	13.35 (±1.48)
4	All rivers deteriorate	Maintain water quality in Chaobai He	0.9	330.8	40.0	122.81 (±16.05)	14.83 (±1.94)

By and large, these results strike an optimistic note on the possibility of measuring the total economic value of surface water quality improvements in China. On average, WTP for preventing river water quality from deteriorating in the Beijing area is positive and amounts to around 1% of household income. This estimate is based upon a wide range of values (use and non-use), and its aggregate value is significantly greater than the earlier mentioned studies that were more narrowly focused.

6 Conclusion: valuing water quality in China

China is a rapidly developing country that faces some very difficult choices between continued

high rates of economic growth and continuing deterioration in its environmental quality. In many developing countries this same trade-off has been experienced. It is often the case that a lightly-regulated sector is also extremely dynamic, but also highly environment-intensive. This is probably the case with the TVIE sector in China, where much of the nation's growth is centred and also where much of the uncontrolled usage of its important environmental resources has occurred. China will-at some point in its development-rein in this sector and manage it and its use of resources more restrictively.

The point in time at which this management should occur will depend upon the Chinese society's valuation of the benefits and costs that flow from this high-growth sector. This points to the importance of undertaking valuation exercises for environmental quality in developing countries-they are means by which the societal "turning point" may be ascertained. The valuation exercise demonstrates to the government whether the society has reached the point in the economy-environment trade-off at which the people would prefer greater environmental quality at the expense of reduced economic growth.

The case study reported here demonstrates the nature of such a valuation exercise. It must be one that assesses the total economic value of the environmental resource, not just the value of one or two of its important uses. The issue of importance is the societal preference for "greater environmental quality", not just its willingness to pay for clean drinking water or indoor toilets. This valuation will contain many more facets of the environmental resource (recreation good, aesthetic good, bequest good, natural good), and it should yield a more substantial (and more valid) willingness to pay (in this case study the WTP as a proportion of income was about double that of the WTP in the other Chinese case study on water quality).

Finally this study also demonstrates that Chinese individuals in the Beijing area have a clear idea regarding the economic growth/environmental quality trade-off, and that they have a clear amount that they are willing to pay to prevent river quality deterioration in the Beijing area, i.e. about 1.3% of their income (aggregating to about USD 60 million for the representative population). It is the task of Chinese officials to weigh this benefit against the cost of heightened restrictions on the primary growth sectors in that society, but it is the role of valuation exercises such as this one to set the "stopping point" beyond which environmental deterioration should not continue.

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