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Commentary

On the adequacy of scope test results: Comments on Desvousges, Mathews, and Train

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ABSTRACT

Desrvousges et al. (2012) investigate criteria for judging the adequacy of scope test differences in contingent valuation studies. They focus particular attention on our study (Chapman et al. 2009), arguing that, while it demonstrated a statistically significant scope effect, the effect is too small. Unfortunately, DMT misinterpreted Chapman et al., an error that makes DMT's criticisms of our study invalid.

1. Introduction

In a 2012 article, Desvousges, Mathews, and Train (hereafter DMT) quote the NOAA Panel on Contingent Valuation as stating, "…if a CV survey suffered from any of the following maladies, we would judge its findings 'unreliable'." One of the maladies on their list was "*Inadequate* responsiveness to the scope of the environmental insult" (Arrow et al., 1993, p. 4609, emphasis added). DMT propose criteria for judging whether scope differences (i.e., differences in values from scope tests) are adequate. They show that nearly all past CV studies do not provide sufficient data to apply their criteria but argue that Chapman et al. (2009) is an exception. They apply their criteria to argue that our study did not demonstrate adequate responsiveness to scope and should therefore be judged to be "unreliable."

After presenting relevant background about our study, we recap DMT's arguments and show how misinterpretations of our scenarios led them to incorrect conclusions. The bottom line is that our study should be included among the vast majority of studies to which their criteria for adequacy cannot be applied.

2. Background for Chapman et al. (2009)

Chapman et al. focused on Oklahoma's Illinois River (hereafter, "the river") and a major reservoir on the river, Tenkiller Lake ("the lake"). Manure and associated material from the floors of poultry houses, referred to as "poultry litter," were spread on lands in the basin. Resulting runoff contains large amounts of phosphorus. The study focused on eutrophication in the river and lake that has occurred as a consequence. [2]

Chapman et al. developed and administered a CV survey to estimate the future damages in dollars to Oklahoma residents from this pollution. The study assumed that a ban on spreading poultry litter would be put in place in the near future.[3]

The CV survey stressed that while the ban would stop the spreading of poultry litter in the future, phosphorus from past spreading of litter would continue to pollute the river and lake for many years to come.

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[2] For additional details about the study site, see Chapman et al. (2009, Chapter 3).
[3] At the time the study was done, Oklahoma had brought suit in federal court to institute such a ban.

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Hence, full recovery of the river and lake would be slow. Gradually, there would be less and less algae as phosphorus is flushed out of the watershed or covered by sediment. The water would become progressively clearer. As algae growth declines, species of fish, insects, small animals, and small plants that were common before 1960 would slowly increase in numbers, replacing those that live in water that contains a great deal of algae.

Respondents were randomly assigned to hear one of two scenarios (called Scenario 1 and Scenario 2) describing the pollution and natural recovery. The scenarios described a way to speed up recovery of the lake and river using alum treatments.[4] Each scenario was built around what might be termed a "baseline for valuation," the status quo ante without alum treatments. The baseline described how recovery of environmental services would proceed if there were no alum treatments. This was compared to a second time path for recovery if alum were to be applied.[5]

Fig. 1(a) illustrates lake recovery in Scenario 1, with environmental services from the lake represented on the vertical axis and time on the horizontal axis. Scenario 1 stated that, with the ban in place but no alum treatments, full lake recovery would require 60 years. The baseline for valuation of lake recovery without alum treatments is illustrated by the lower diagonal line in Fig. 1(a), labeled L_{60}. Lake recovery with alum treats would be much faster along a time path illustrated by L_{20}, with full recovery in 20 years. Of course, different environmental services might actually follow different paths and such time paths might not be linear. Hence, Fig. 1(a) is a simplified version of the story, used here to illustrate the scenario.[6] The exact shape of the recovery path is not relevant to our argument.

In a similar fashion, Fig. 1(b) illustrates the time paths of recovery for the river in Scenario 1. With no alum treatments, river environmental services would slowly recover, with full lake recovery in 50 years. This baseline for valuation is time path R_{50}. Alum treatments would speed up recovery, with full recovery in 10 years. This time path is represented by R_{10}.

The purpose of Scenario 1 was to describe future injuries from eutrophication in the lake and river. Hence, Scenario 1's baselines for valuation were worked out with the help of scientists studying the phosphorus problem in the lake and river. These scientists suggested alum treatments as a scientifically plausible way to speed recovery.

Lower case letters in Figs. 1(a) and (b) represent areas bounded by solid and broken lines. Such areas represent cumulative environmental services over time. Under Scenario 1, alum treatments generate Areas (a + b + c) in lake services and Areas (d + e) in river services.

The purpose of Scenario 2 was to provide data for a scope test. Fig. 2(a) shows the baseline for valuation of the lake as L_{60}, the same baseline for the lake as the first scenario. However, while alum treatments would still speed recovery of the lake somewhat, environmental services would recover more slowly than under Scenario 1, with full recovery requiring 50 years. Lake recovery with the alum treatments is represented by time path L_{50}. Without alum treatments, the river was assumed to recover rapidly as a result of the ban on spreading poultry litter alone. No alum treatments would be required. Time path R_{10} represents river recovery. In Scenario 2, R_{10} is part of the baseline for valuation. Scenario 2 generates only Areas (f + g) in environmental services, composed solely of lake services.

Comparing the time paths of lake recovery in Figs. 1(a) and 2(a) shows that the lake services in Areas (f + g) for Scenario 2 are a subset of the services in Areas (a + b + c) from Scenario 1, since both scenarios for the lake have the same baseline (L_{60}) and Scenario 2's time path (L_{50}) lies below Scenario 1's time path (L_{20}). Scenario 1 adds river services that are not part of the environmental services provided by Scenario 2, since these services are received automatically under Scenario 2 as a result of the ban on poultry litter alone, with no alum treatments required. Because Scenario 1 provides more services, the scope test evaluated the hypothesis that Scenario 1 would have a larger value.

Chapman et al. describe in detail the steps taken to design and execute the survey. By way of summary, CV exercises used to value both Scenario 1 and Scenario 2 employed single-bounded dichotomous-choice referenda with taxes as the payment vehicle. In addition to being randomly assigned to value either Scenario 1 or Scenario 2, each respondent was randomly assigned one of six levels of taxes, which ranged from \$10 to \$405. These tax amounts were lump sums, not annual amounts. Respondents from probability samples of Oklahoma households completed personal interviews. The weighted response rate to the survey was 51.9%. The percentages of respondents voting "for" increased taxes to fund alum treatments were higher for Scenario 1 than for Scenario 2 at all tax amounts ($p < 0.001$). Thus, the scope test was passed. A lower bound mean for willingness to pay for Scenario 1 was estimated to be \$184. The comparable lower bound estimate for mean willingness to pay for Scenario 2 was \$138.[7]

3. DMT criticisms and our responses

DMT argue that the scope difference of \$46 (\$184 minus \$138) is inadequate for three reasons. First, they claim that the results violate the logic of discounting. Second, they argue that the values arrived at by Chapman et al. are inconsistent with diminishing marginal utility and/or substitution. And, third, according to DMT, the results violate the scope criterion.

In order to arrive at these conclusions, DMT interpret what was done by Chapman et al. using a schematic, which is reproduced here as Fig. 3.

They explain their logic as follows (p. 125):

"The study's scope test involves three incremental parts, as illustrated in Fig. (3):

"A. Speed recovery of specified rivers by 40 years (starting in 10 years)

"B. Speed recovery of a specified lake by 10 years (starting in 50 years), conditional on A already being obtained

"C. Speed recovery of the same lake by another 30 years (starting in 20 years), conditional on A and B already being obtained."

In fact, their three increments involve misinterpretations of Scenarios 1 and 2. The problems are apparent from the parenthetical statements in this quotation. Throughout their critique, DMT assume that the public would benefit from restoration of the river and lake only after restoration is fully achieved. That is, their part A assumes that, under Scenario 1, only the river services from year 10 to 50 would benefit the public. This is only Area (e) in Fig. 1(b), whereas the public would also benefit from the services in Area (d). Their part B assumes that only the lake services in Area (g) of Fig. 2(a) are of benefit, whereas Scenario 2 would also yield the lake services in Area (f). Their part C only accounts for Area (b) in Fig. 1(a), while Scenario 1 also yields the lake services in Area (a).

To see how this misinterpretation leads to erroneous conclusions, consider first application of discounting. Their argument (found on p. 125 of their article) can be paraphrased as follows. Under DMT's interpretation, their part B only provides 10 years of services while parts B and C combined yield 40 years of services. Thus, if the discount rate were zero, they reason that the present value of benefits from their parts B and C combined would be four times the benefits under

4 Alum bonds with phosphorus and renders it unavailable to plants. It has been used in water treatment plants and several agencies have used it to combat eutrophication of lakes.

5 No alum treatments have actually been proposed. Alum treatments provided a realistic counterfactual for the CV exercises that respondents could understand. Alum treatments and resulting recovery time paths were used to capture most of the dollar value of lost environmental services due to eutrophication of the lake and river.

6 Neither survey version used such graphs. Rather, they depended on verbal descriptions of recovery.

7 These are lower bound estimate of mean WTP because they were arrived at using a nonparametric estimator.

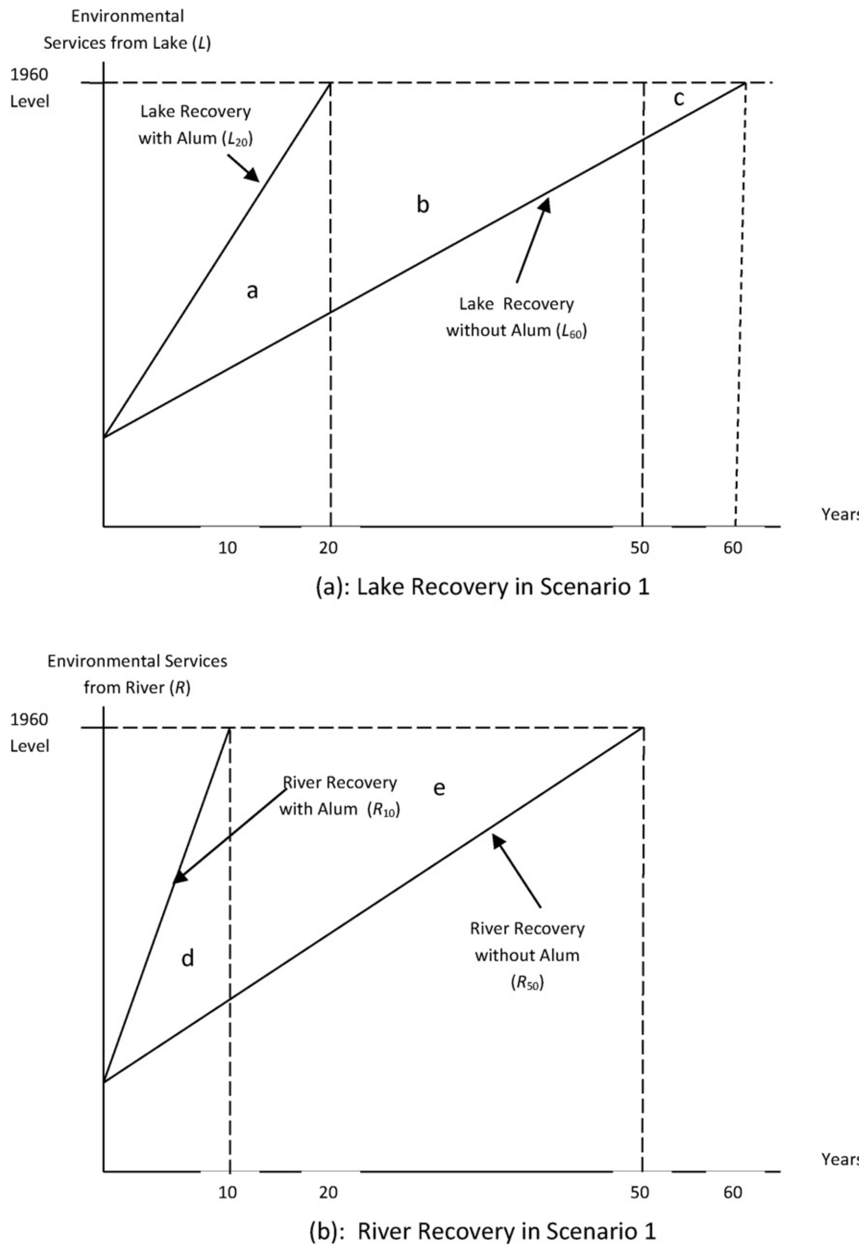

Fig. 1. (a): Lake recovery in Scenario 1. (b): River recovery in Scenario 1.

their part B alone. Given that the environmental services under their part B, according to their reasoning, occur later than many of the environmental benefits under part C, a positive discount rate would mean that the present value of environmental benefits under B and C combined should be more than four times the benefits under B alone. Instead, under their interpretation, B has a value of $138, which far exceeds the value of B and C combined, since the value of parts A, B, and C total $184, so that part C must be worth less than the difference, $46.

However, this logic cannot be applied once their misinterpretation of the scenarios is corrected. Scenario 2 provides lake restoration benefits over 60 years as does Scenario 1. Calculating present values of environmental benefits, as they propose to do, would require detailed knowledge of how the environmental services and their values change as restoration proceeds over that 60-year period. This is not possible to do with Chapman et al.'s results.

Now consider the second criticism, that Chapman et al.'s results are inconsistent with diminishing marginal utility and/or substitution. DMT correctly recognize that many attempts to evaluate the adequacy of scope test results would be inconclusive because of possible diminishing marginal utility and/or substitution[8] but argue that Chapman et al. is an exception because of the structure of our scope test.

Quoting from DMT (p. 125),

"The scope program provides 10 years of faster lake recovery as an increment to the river recovery (i.e., part B). Diminishing marginal utility might cause B to be worth less than A, since B is incremental to A. But, instead, the study finds that B is worth more than A (and even more than A and C combined). Similarly, substitution between lakes and rivers might cause the lake recovery to be less valuable after the rivers have already recovered. But the study found the opposite: the lake recovery is more valuable than river recovery for which it is a possible substitute and was already provided."

[8] This point can be traced back at least to Carson and Mitchell (1995).

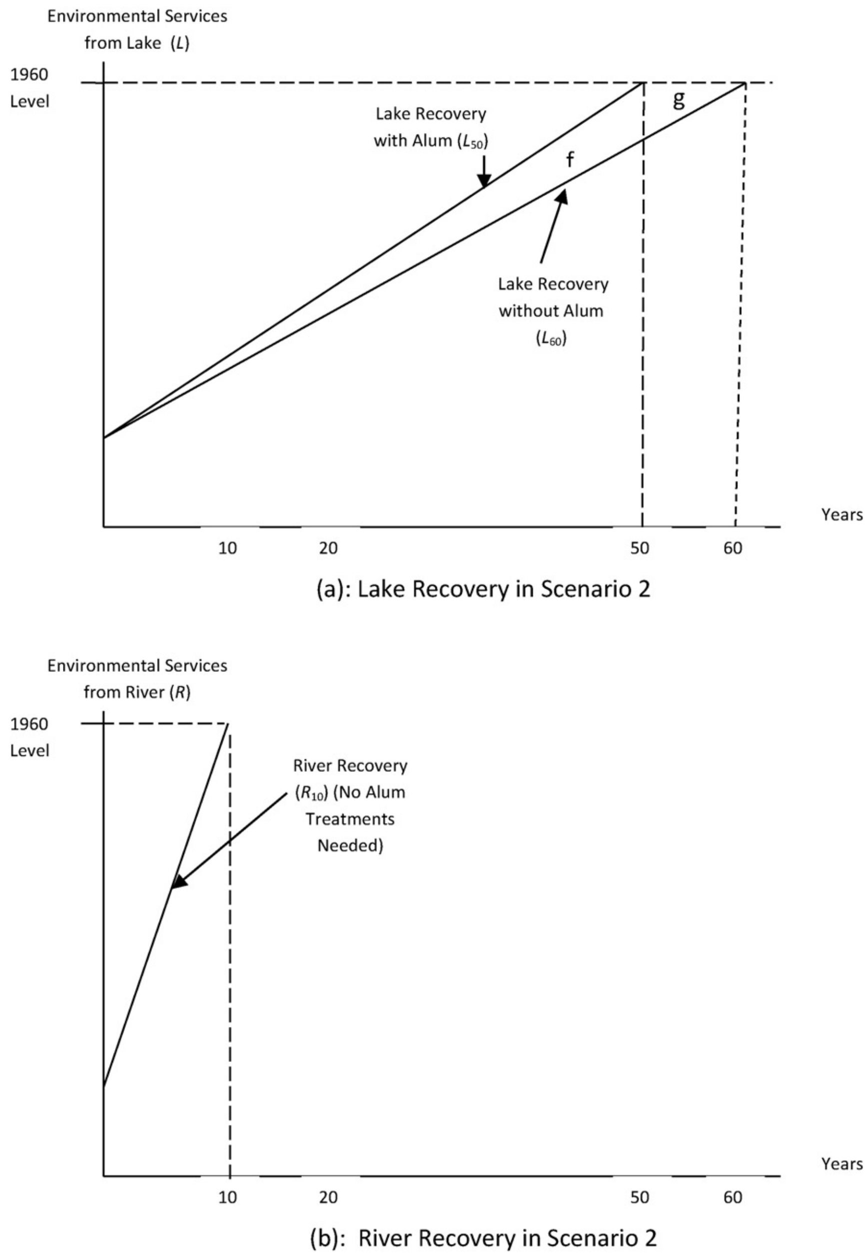

Fig. 2. (a): Lake recovery in Scenario 2. (b): River recovery in Scenario 2.

This inference is incorrect. For one thing, no a priori comparisons of marginal utility are possible between river services and lake services. As DMT state elsewhere in their critique (e.g., see the next quotation from DMT below), the river and lake are different "types of resources." If lake recovery and river recovery are indeed substitutes, then the value of Scenario 2's lake restoration would be less when it is conditional on river restoration than when it is not, but nothing can be said a priori about the absolute magnitude of this difference. When Scenario 1 adds on more lake services to those under Scenario 2, then diminishing marginal utility is plausible. Hence, the relative values of Scenarios 1 and 2 are consistent with both substitution and diminishing marginal utility.

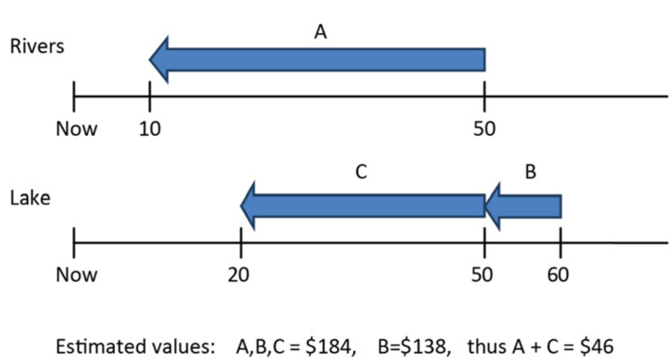

Fig. 3. Diagram from Desvousges et al., 2012, p. 125.

It is worth considering the possibility that river and lake services might be complements, since the river and lake are part of the same system. Many people may value lake restoration more if the river is to be restored as well, and vice versa. The fact that Scenario 2 makes lake restoration conditional on river restoration would enhance the value of lake restoration, but diminishing marginal utility could still affect the marginal value of the additional lake restoration from Scenario 1. Hence, Chapman et al.'s results are also consistent with complementarity, provided that lake recovery is subject to diminishing marginal utility.

Finally, applying the adding-up principle, DMT state (p. 125), "if the value of A, B, and C combined is $184, and the value of B is $138, then the combined value of A and C is $46." Yet,

"This result constitutes an actual violation of the scope criterion: Parts A and C provide more service than B in each dimension: more types of resources (the rivers and the lake versus just the lake), more years of service (40 years of additional service for the rivers and 30 years for the lake versus 10 years for the lake), and a closer time period (recovery occurring 10 years in the future for the rivers and 20 years in the future for the lake versus 50 years in the future for the lake). Yet these two parts are found by the study to be valued less than part B—a third as much." (p. 125)

DMT agree that Chapman et al. passed the scope test, but when they say that Chapman et al. violated the scope criterion, they are saying that the scope difference of $46 is too small.

Because both scenarios yield lake benefits for 60 years, Scenario 1 does not dominate in the time dimension. Furthermore, what matters is not how many services are provided, but what those services are worth. As we have already seen, a relatively small value for the extra lake services in Scenario 1 compared to those in Scenario 2 could be a reflection of diminishing marginal utility from lake services. Once DMT's misinterpretation of our scenarios is corrected, there is no basis for concluding that the $46 scope difference is too small.

4. Conclusion

In summary, DMT argue that Chapman et al.'s scope difference is inadequate because it fails to satisfy theoretical tests related to discounting and to diminishing marginal utility and substitution. Also, according to them, our scope difference is too small. Once the fundamental flaws in their interpretation of the scenarios are corrected, none of these arguments hold. The upshot is that Chapman et al. must be assigned to the long list of studies cited by DMT where their tests of adequacy cannot be applied.

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