

## FROM THE PRESIDENT...

I'd like to begin my report by welcoming our new EAERE members who applied for secondary membership in AERE this year. At present, that total is 40 individuals—all but a dozen are new to AERE.

- **Our annual luncheon and general meeting at the splendid Four Seasons Hotel in Boston this past January was well attended.** Results of the Fall elections for new officers and board of directors were announced: Charlie Kolstad, president-elect; John Loomis, vice president; Anna Alberini and Richard Carson, board members. Anna and Richard replace Terry Dinan and Steve Swallow who are sincerely thanked for their three years of service to AERE along with Ray Palmquist who served as vice president.

- **Awards for the 1999 *Publication of Enduring Quality* were presented at the annual meeting.** Recipients were Richard Bishop and Thomas Heberlein for "Measuring Values of Extramarket Goods: Are Indirect Measures Biased?" *American Journal of Agricultural Economics*, vol. 61, no. 5, December 1979 and W. Michael Hanemann for "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses," *American Journal of Agricultural Economics*, vol. 66, no. 3, August 1984.

- ***JEEM* subscribers will soon find the special 25<sup>th</sup> anniversary issue arriving in their mailboxes.** Yes, the Journal of Environmental Economics and Management (*JEEM*) is now 25 years old. The special, refereed issue includes seven articles outlining progress in environmental and resource economics over this quarter century.

Not only has the profession come a long way, but so has the journal itself. Last year marked the fourth consecutive year in which the number of new submissions hit new records. The editor currently handles about two and a half times as many manuscripts as he did ten years ago. No one doubts that *JEEM*'s reputation has been growing, but recent statistics on citations suggest that *JEEM* is as "influential" in this regard as many of the mainline economics journals.

## TABLE OF CONTENTS

From the President...	1
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### AERE Announcements

Nominations for Board Members	3
Publication of Enduring Quality	3
Home Page	3

### Calls for Papers, Posters, and Proposals

ASSA	4
Managing Editorship of <i>JEEM</i>	4
Valuing the Benefits of Food Safety Conference	5

### Meetings

AERE Workshop	5
AAEA	6
EAERE	7
The International Dimension of Environmental Policy	8
Second World Congress	8

### Essays

"Green Tax Reform and the 'Double Dividend'" by Lawrence H. Goulder and Ian Parry	9
"Evaluating Contingent Valuation of Environmental Health Risks: The Proportionality Test" by James K. Hammitt	14

### Bulletin Board

Publications	20
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• **This is all good news. Now for the bad news... Bob Deacon, who has done an outstanding job as managing editor for the past five years, is coming to the end of his term.** Given his many other obligations, Bob cannot consider another term as editor. As a consequence we are issuing, in this newsletter, a call for proposals for the managing editorship of *JEEM*. The AERE Board is in the process of appointing a committee to review these proposals. In the meantime, a smaller committee is working on developing a financial plan to help cover more of the out-of-pocket expenses involved in running the journal. There is no way to avoid the need for some institutional support, however. Individuals interested in submitting proposals will need to seek some credible commitment from their institutions in the form of release time, space, etc. Please see the announcement on page 4 for more details.

The environmental and resource economics profession owes Bob Deacon a great debt for taking on such a huge responsibility—with so little return to himself, and for discharging that responsibility so admirably over the

last five years. In keeping with his generosity, Bob has agreed to stay involved into 2001, making the transition a smooth one.

In closing, let me remind you of AERE's upcoming "intellectual" agenda. Announcements about all of these meetings can be found elsewhere in this newsletter. Look for a report on the upcoming AERE workshop in La Jolla in June. The European Association of Environmental and Resource Economists (EAERE) annual meeting in Crete is also at the end of June. And of course AERE sponsors sessions at the American Agricultural Economics Association (AAEA) meetings held this year in Tampa in August and the Allied Social Science Associations (ASSA) meetings in New Orleans in January, 2001. The AERE reunion at the AAEA meetings is always well attended and will be held this year on Monday evening. Last of all, please see the report about the Second Annual World Congress of Environmental and Resource Economists to be held in Monterey, California in June 2002.

We are extremely grateful to all the AERE members who have generously given of their time to our association to make these events happen. I invite any of you who are interested in serving in some capacity to contact me or one of the other officers or board members.

### **AERE Newsletter**

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## AERE ANNOUNCEMENTS

### NOMINATIONS FOR BOARD MEMBERS

This year AERE members will vote for two new members of the Board of Directors who will serve for three years beginning in January 2001. Nominations are being accepted by John Loomis, AERE Vice President. The elections will occur in the Fall of 2000.

If you have a candidate whom you would like to see nominated, contact John before the July 1<sup>st</sup> deadline. Nominations may also be made by the membership through petitions, each of which contains signatures of 5% of the association's members. Such petitions should be sent to arrive **no later than July 1, 2000 to:**

**Prof. John Loomis**  
**Dept. of Agricultural and Resource**  
**Economics**  
**Colorado State University**  
**Fort Collins, CO**  
**Telephone: 970-491-2485**  
**Facsimile: 970-491-2067**  
**E-mail: jloomis@ceres.agsci.colostate.edu**

### PUBLICATION OF ENDURING QUALITY AWARD

The AERE Board of Directors will present the annual award (to co-authors if appropriate) for a publication of enduring quality that appeared at least five years prior to the year of the award. The award will be announced at the annual winter meeting luncheon in January 2001. Nominated works are to be evaluated on their seminal nature and enduring value. Place and type of publication are unrestricted, but posthumous awards will not be given. Nominees may include individuals who are not members of AERE. Evaluation of nominated works and final selection for the 2000 award will be undertaken by a committee chaired by Chuck Howe, University of Colorado-Boulder.

Nomination packages should consist of four copies each of a cover letter, a document supporting the nomination, and the publication itself. The supporting document (not to exceed three pages) should include

quantitative as well as qualitative information (e.g., number of citations or copies printed). Nominations should be sent to arrive **no later than September 1st to:**

**Prof. Chuck Howe**  
**Department of Economics**  
**University of Colorado-Boulder**  
**Campus Box 468**  
**Boulder, CO 80309**  
**Telephone: 303-492-7245**  
**Fax: 303-492-1231**  
**E-mail: Charles.Howe@colorado.edu**

### HOME PAGE

AERE can be found on the world wide web at:

**<http://www.aere.org>**

(Note: There have been no changes to the AERE server. The AERE home page can also be found at <http://www.ecu.edu/econ/aere/>.)

The AERE Home Page is a valuable resource. It provides information about membership, the *Journal of Environmental Economics and Management (JEEM)*, a list of AERE members with web pages, the on-line edition of excerpts from the *AERE Newsletter*, graduate programs in environmental and resource economics, meetings and workshops, job opportunities, on-line discussion lists, and WWW links of interest. Send any and all comments to:

**John Whitehead**  
**Department of Economics**  
**East Carolina University**  
**[WhiteheadJ@mail.ecu.edu](mailto:WhiteheadJ@mail.ecu.edu)**

For AERE membership information, including application forms, see the AERE Home Page at: [www.aere.org](http://www.aere.org).

For inquiries about subscriptions to *JEEM* or other matters, please contact: Marilyn M. Voigt, AERE Executive Secretary, [voigt@rff.org](mailto:voigt@rff.org); Telephone: 202-328-5077.

# CALLS FOR PAPERS, POSTERS, AND PROPOSALS

## ALLIED SOCIAL SCIENCE ASSOCIATIONS (ASSA)

### 2000 Winter Meeting

New Orleans, Louisiana

January 5-7, 2001

AERE will sponsor six contributed papers sessions of three to four papers each at the ASSA Annual Meeting. Those wishing to have a paper considered for AERE's sessions should send six copies of a 1-3 page abstract. Submissions must be postmarked or sent via facsimile by **May 19, 2000** to:

**Prof. Anna Alberini**  
**Department of Agricultural and Resource**  
**Economics**  
**2200 Symons Hall**  
**University of Maryland**  
**College Park, MD 20742**  
**Telephone: 301-405-1267**  
**Facsimile: 301-314-9091**  
**E-mail [alberini@arec.umd.edu](mailto:alberini@arec.umd.edu)**

Proposals for complete sessions are also invited. Organizers of proposed sessions should submit abstracts of papers following the above instructions. Papers may be accepted or rejected on an individual basis unless the organizer specifically requests the session be considered only in its entirety. Due to limited resources, those wishing to have receipt of their submissions must also submit a self-addressed, stamped postcard.

## *JOURNAL OF ENVIRONMENTAL ECONOMICS AND MANAGEMENT (JEEM)*

### Managing Editorship of *JEEM*

After completing his five-year term as managing editor of *JEEM*, Bob Deacon is stepping down from this position. The AERE Board is beginning the search for a new managing editor. It is hoped that this new editor could begin taking over near the start of 2001, although Bob will stay through the transition phase.

This announcement seeks proposals from individuals interested in assuming the responsibility of managing editor. Although *JEEM* has historically been edited by a single person with help from many associate editors,

this search will not rule out, *a priori*, proposals from individuals who may wish to serve as an editorial team. In such cases, the coordinating arrangement must be spelled out carefully in the proposal. It is also possible that the AERE Board will require one individual in the team to be designated as lead editor.

Proposals should include:

- Curriculum vita(s) of proposed editor(s), including evidence of substantive participation in and contributions to the discipline of environmental and resource economics;
- Detailed information on how the editorial tasks will be organized and accomplished;
- Information on the other commitments of the individual(s) and the time that the individual(s) can commit to the editorial task;
- Evidence that the institution(s) of the proposed editor(s) will support, at the minimum, release time and space requirements needed for the editorship. Information on any additional resources that can be provided by the institution would be useful but not required;
- Any future plans that may bear on the usual five year term that is currently expected.

Proposals should be sent by **September 15, 2000** to:

**V. Kerry Smith**  
**CENREP**  
**Department of Agricultural and Resource**  
**Economics**  
**North Carolina State University**  
**Box 8109**  
**Raleigh, NC 27695**

In the interim, we invite requests for further information about the position. Please direct those requests to AERE president, Nancy Bockstael, by e-mail: [nancyb@arec.umd.edu](mailto:nancyb@arec.umd.edu). Information will be obtained from Bob Deacon that can be forwarded.

## CONFERENCE ON VALUING THE BENEFITS OF FOOD SAFETY

University of Maryland, College Park  
September 14-15, 2000

### Call for Posters

The Food and Drug Administration (FDA), the Department of Agriculture (USDA), the Centers for Disease Control and Prevention (CDC), and the Environmental Protection Agency (EPA) seek submissions for posters for a conference on "Valuing the Benefits of Food Safety." Other organizers and conference sponsors include: The NE-165 Regional Research Project, The Joint Institute for Food Safety and Applied Nutrition (University of Maryland and FDA), and The Office of the Assistant Secretary for Planning and Evaluation, Department of Health and Human Services.

The conference will discuss economic issues related to valuing food safety risk reduction. The conference is intended to be a first step in developing a common approach to valuing risk reduction that will facilitate comparing programs across agencies. Specifically, four sessions dealing with the following topics are planned:

- estimating the value of a statistical life;
- reconciling or comparing stated willingness-to-pay (contingent valuation), revealed willingness-

to-pay (hedonic measures), and cost-of-illness estimates of the value of reducing foodborne illness;

- measuring (including comparative measures) the value of reducing bacterial hazards and the value of reducing chemical hazards; and
- measuring the pain and suffering and indirect productivity losses associated with foodborne illness.

Submissions for poster sessions planned for the conference are now being accepted. Posters should summarize original research falling into one of the session topics listed above. Posters and accompanying information will become part of the conference record which will be used to formulate recommendations on the four topics. Submissions should, **in three pages or less**, summarize the information to be conveyed and describe how the poster format will be used to facilitate information-exchange. Plan for a 4' high by 8' wide (less approximately one inch for board frame) poster board. Summaries must be received **by June 1, 2000**. Selections will be finalized and authors will be notified by July 15, 2000.

Submissions should be directed to Nicole Owens by e-mail: [owens.nicole@epa.gov](mailto:owens.nicole@epa.gov) (with attachments in Word Perfect 8.0 or Word97) or by postal mail: **Nicole Owens, U.S. EPA, 401 M Street (Mailcode 2172), Washington, DC 20460**

## MEETINGS AND WORKSHOPS

### AERE WORKSHOP

#### Effectiveness of Resource and Environmental Regulation

June 11-13, 2000

Hubbs Conference Center  
Scripps Institution of Oceanography  
La Jolla, California

### Papers

- Anna Alberini, "Environmental Policy Based on Polluter Financial Responsibility: The Case of the Underground Storage Tanks"
- Clive Chapple, "The 1990 Oil Pollution Act: Consequences for the Environment"
- J.R. DeShazo and Andres V. Lerner, "Toward an Even More General Theory of Regulation"
- Nancy E. Bockstael and Jacqueline Geoghegan, "Smart' Growth and the Supply of Sprawl"
- Wayne B. Gray and Ronald J. Shadbegian "When is Enforcement Effective—Or Even Necessary?"
- John K. Horowitz, "Overcompliance in Point-Source Water Pollution"

**AMERICAN AGRICULTURAL ECONOMICS  
ASSOCIATION (AAEA) ANNUAL MEETING**

**July 30<sup>th</sup> - August 2<sup>nd</sup>, 2000  
Tampa, Florida**

**Agricultural Technology and Policy  
Retrospect and Prospect**

The theme of this year's AAEA annual meeting centers around the economic history and the economic future of agriculture. Registration materials will be mailed to all current AERE members. Additional copies may be obtained by contacting Nancy Herselius by e-mail at: [nancy@aaea.org](mailto:nancy@aaea.org). Information about the meetings is also available on the AAEA home page at: [www.aaea.org](http://www.aaea.org).

All AERE members are cordially invited to attend a reception **on Monday, July 31<sup>st</sup>** in Florida Ballroom Salon VI of the Tampa Marriott Waterside Hotel from 5:30 to 7:00 p.m.

**AERE Contributed Papers Sessions**

**Session I**

***Topics in Environmental Economics***

**Chair:** David Austin  
Resources for the Future (RFF)

**Discussant:** Allen Blackman, RFF

**Papers:**

1. H. Spencer Banzhaf, Duke University, "Environmental Price Indexes: An Application to Air Quality;"
2. Allen Blackman, Steven Newbold, and Jhin-Shyang Shih, RFF, "The Benefits and Costs of Informal Sector Pollution Control: Traditional Brick Kilns in Ciudad Juarez, Mexico;"
3. Sarah Stafford, College of William and Mary, "The Effect of Punishment on Firm Compliance with Hazardous Waste Regulations;"
4. Michael Taylor, Brent Sohngen, and Alan Randall, The Ohio State University (OSU), "Improving the Prospects for Technology-Based Point-Nonpoint Source Pollution Trading: The Optimal Trading Ratio in a Dynamic Setting."

Madhu Khanna, Murat Isik, and David Zilberman, "Cost-Effectiveness of Green Payment Policies for Conservation Technology Adoption and Nonpoint Pollution Control"

Dean Lueck and Jeffrey Michael, "Preemptive Habitat Destruction Under the Endangered Species Act"

Katrin Millock and François Salanié, "Are Collective Environmental Agreements Ever Effective? The Impact of Free Riding"

Ian Parry and Antonio Bento, "Assessing the Welfare Impacts of Congestion Taxes: The Critical Significance of Other Distortions Within the Transport System"

R. Quentin Grafton and Dale Squires, "Regulating the Commons: Effects of Input Controls on Technical Change and Efficiency"

David Finoff and John Tschirhart, "A Computable General Equilibrium Model of an Economy and Ecosystem"

Larry Karp and Jiangfeng Zhang, "Stock Externality Regulation with Endogenous Technical Change and Learning"

We gratefully acknowledge the Scripps Institution of Oceanography for the use of the Hubbs Conference Center as well as the National Oceanic and Atmospheric Administration; the Economic Research Service, U.S. Department of Agriculture; the Center for the Study and Improvement of Regulation at Carnegie Mellon University and the University of Washington; and the Fish and Wildlife Service, U.S. Department of the Interior for sponsorship of this workshop.

We look forward to seeing you in La Jolla.

**Peter Berck  
Chair**

**Program Committee**

John Beghin, Iowa State University  
Peter Berck, University of California at Berkeley  
Joseph Charbonneau, U.S. Fish and Wildlife Service  
Carol Adaire Jones, Economic Research Service  
Norman Meade, NOAA  
Laura Taylor, Georgia State University

**Arrangements Committee**

Peter Berck  
Norman Meade  
Dale Squires, NMFS

**Session II**  
***Data Collection and Modeling in  
Non-Market Valuation***

**Chair:** Patricia Champ  
U.S. Forest Service (USFS), Fort Collins

**Discussant:** Frank Lupi  
Michigan State University (MSU)

**Papers:**

1. Kathleen Bell, University of Washington and Ivar Strand, University of Maryland, College Park (UMCP), "Minimizing the Cost of Travel;"
2. Patricia Champ, USFS, Anna Alberini, UMCP, and Ignacio Correias, University of Colorado, "Using Contingent Valuation to Value a Noxious Weeds Program: The Effects of Including a 'Not Sure' Response Category;"
3. Doug MacNair, Triangle Economic Research (TER), John Whitehead, East Carolina University, and Karen Palm, TER, "Alternative Methods for Comparing RP and SP Data;"
4. Karin Steffens, Northern Michigan University, Frank Lupi, MSU, Barbara Kanninen, University of Minnesota, and John Hoehn, MSU, "Optimal Experimental Designs for Binary Choice Experiments: An Application to Bird Watching."

**Session III**

***Land Use and Land Use Policies***

**Chair:** J.R. DeShazo  
University of California (UC), Los Angeles

**Discussant:** Kathleen Bell, University of Washington

**Papers:**

1. Diane Hite, Mississippi State University, Brent Sohngen, OSU, and Josh Templeton, OSU, "Competing Risks in the Suburbanization of Agricultural Land;"
2. Jyotsna Puri, UMCP, and Maureen Cropper, The World Bank and UMCP, "Agricultural Expansion in Forest Villages in Chiang Mai, Thailand;"
3. Tomislav Vukina, Armando Levy, and Michelle Marra, North Carolina State University (NCSU), "Auctions with Environmental Criteria: Evidence from the Conservation Reserve Program."

**Principal Papers Session**  
***Spatial Models and Fisheries Economics***

**Chair:** Nancy E. Bockstael  
University of Maryland, College Park

**Discussant:** James Wilen, UC Davis

**Papers:**

1. Rob Hicks and Rita Curtis, National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service, "Spatial Models and Fisheries Economics;"
2. Martin Smith, UC Davis, "Spatial Search and Diving Location Choice in the California Sea Urchin Fishery;"
3. Johan Mistiaen and Ivar Strand, UMCP, "Locational Choice of the Longline Fishing Fleet in the Gulf of Mexico and Atlantic Ocean."

**EAERE-2000 ANNUAL CONFERENCE**

**Rethymnon, Crete, Greece**  
**June 30 - July 2, 2000**

The three-day program at the tenth annual EAERE conference will consist of plenary sessions with keynote speakers and parallel sessions with contributed papers in areas of interest to the EAERE. The conference program will also include social events in the evenings.

Crete stands at the crossroads of Europe, Asia and Africa, rich in history, mythology, and culture. Rethymnon, on the northern coast of Crete, is a modern city which has maintained its historical role as the Cretan city of arts, culture and education.

**Information**

Further information see the web site at:

<http://www.soc.uoc.gr/calendar/2000EAERE/index.htm>

**Conference Executives:**

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Emmanuel Petrakis  
Vasilis Pasmazoglou  
Joan Stefan  
Periklis Drakos  
Nektaria Liodaki  
Fax: +30 831 77406, +30 831 77860  
E-mail: [eaere2000@econ.soc.uoc.gr](mailto:eaere2000@econ.soc.uoc.gr)

**THE INTERNATIONAL DIMENSION  
OF ENVIRONMENTAL POLICY**

**Euroconference on Environmental Policy,  
International Competitiveness and the Location  
Behavior of Firms**

**October 7<sup>th</sup>-12th, 2000  
Kerkrade, The Netherlands**

The conference series "The International Dimension of Environmental Policy" will contribute to our understanding of firms' reactions to environmental policies and of governments' incentives to implement those policies. Some of the latest theoretical and empirical research findings that integrate capital flight, ecological dumping, the Porter hypothesis, trade and environment, political-economy and distributional issues of international environmental policy will be presented. The main objective of the conference series is to bring together the leading researchers in the field as well as young researchers, policymakers, industrialists and nongovernment organizations, in order to discuss the new scientific developments and provide political recommendations.

The conference is open to researchers world-wide, whether from industry or academia. Participation will be limited to 100. The emphasis will be on discussion about new developments. The conference fee covers registration, full board and lodging. Grants will be available, in particular for nations from EU or Associated States under 35.

Chairperson: Laura Marsiliani  
Tilburg University, NL  
Vice-Chairperson: Michael Rauscher  
Rostock University, D  
Co-Chairperson: Cees Withagen  
Tilburg University and  
Vrije Universiteit Amsterdam, NL

**Deadline for applications: May 22, 2000.** For information and application forms, see the website at:

<http://www.esf.org/euresco>.

(Note: there may be some flexibility in late applications on a space available basis.) E-mail address is:

[euresco@esf.org](mailto:euresco@esf.org).

**SECOND WORLD CONGRESS OF  
ENVIRONMENTAL AND RESOURCE  
ECONOMISTS**

**Monterey, California  
June 23-26, 2002  
Monterey Marriott Hotel**

About 700 people attended the first World Congress in Venice in 1998, and we are hoping for a similar attendance at Monterey in 2002. Monterey is located on the Monterey Peninsula, 105 miles south of San Francisco International Airport (SFO), accessible via a two-hour drive or by a connecting flight to Monterey Airport.

The city lies beside Monterey Bay, the largest marine sanctuary in the U.S. It served as the capital of Alta California under Spanish and Mexican rule, and was the first capital of California as a U.S. territory. The area is famous for its scenic beauty and natural attractions, including Pebble Beach, Pacific Grove, Carmel, and Big Sur. Four nearby state parks offer abundant hiking and camping opportunities as well as many recreational opportunities associated with the Bay itself, including kayaking, boating, scuba diving, and whale watching. Areas of local historical interest include the Monterey State Historic Park, centered around the main public buildings of the original Spanish and Mexican capital, Cannery Row, the Maritime Museum, and the breathtaking Monterey Bay Aquarium, which the Congress will take over for a reception and dinner. The timing of the conference should coincide with the annual Carmel Art and Wine Festival, the Monterey Bay Blues Festival, and shortly before the Carmel Bach Festival.

In addition to the usual array of conference sessions, symposia and invited keynote speeches, the Congress organizers are considering adding some special events such as short courses covering particular areas of interest or perhaps mini-conferences on more specialized topics. These would be held just before or after the Congress either in Monterey or at some other scenic location in northern California such as Yosemite, Tahoe or the Napa Valley. Suggestions for special activities that could enrich the intellectual fare at the Congress are welcome.

**Michael Hanemann  
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## Green Tax Reform and the “Double Dividend”

by Lawrence H. Goulder\* and Ian W.H. Parry\*\*

There has been a great deal of interest in recent years in “green tax reform”—the reorienting of the tax system so that it focuses more on “bads” like pollution and less on “goods” like labor effort or capital formation (saving and investment). *Revenue-neutral* green tax reform, in particular, involves introducing an environmentally oriented tax (e.g., a tax on CO<sub>2</sub> emissions or gasoline) and using the revenues from this tax to finance reductions in the rates of pre-existing distortionary taxes like income or sales taxes.

Policy analysts and politicians have been keenly interested in the possibility that a revenue-neutral green tax reform might offer a “double dividend:” not only (1) improve environmental quality but also (2) reduce the overall cost of the tax system, apart from consideration of the benefits from environmental improvement. If the second dividend is realized, then the reform’s gross costs (that is, the costs apart from the benefits from improved environmental quality) are zero or negative. This would enhance the political prospects for revenue-neutral green tax reforms: policies with “win-win” outcomes are always an easier sell. In addition, since the values of environmental benefits from many policies (such as actions to mitigate global climate change) are highly uncertain, showing that the reform’s gross costs are zero would make it easier to convince people that the policy’s overall net benefits—environmental benefits minus gross costs—are positive.

At first glance, the prospects for a double dividend might seem quite good. It seems reasonable to expect that, if environmental tax revenues were used to reduce the rates of taxes on labor or capital income, a revenue-neutral green tax reform would reduce the costs of the tax system. Yet analytical studies and investigations with detailed numerical simulation models often reject the double dividend under fairly neutral assumptions. In what follows, we articulate some of the main insights

that have emerged from the research on this issue that has been carried out over the past 6-7 years. This research calls attention to general-equilibrium interactions that are important not only for evaluations of green tax reforms but for assessments of other environmental policy initiatives as well.

Before proceeding further we would emphasize that a double dividend is not necessary to make the *efficiency* argument for green tax reforms. Even without the double dividend, such reforms can produce substantial efficiency gains by correcting externalities when environmental tax rates are set at appropriate levels. Further, as discussed below, (revenue-neutral) green tax policies can have significant cost advantages over other policy alternatives, including the free allocation of emission permits.

### Does the Double Dividend Arise? A First Look

Clearly, using revenues from green taxes to finance cuts in the rates of pre-existing taxes avoids some of the distortions that those taxes would otherwise generate. This beneficial efficiency impact from reducing the rates of pre-existing taxes has been termed the *revenue-recycling effect*. Because of the revenue-recycling effect, the costs of a green tax reform will be lower when the environmental tax revenues are used to finance cuts in prior distortionary taxes than when the revenues are returned to the economy in a lump-sum fashion—for example, through lump-sum transfers to households. However, this simply means that the former policy’s costs are lower than the latter’s: it does not mean that the former policy’s costs are negative—which is the requirement for the second dividend.

Are the former policy’s costs negative? The simplest analytical models suggest the answer is no.<sup>1</sup> These models point out that green taxes usually are a relatively inefficient way to raise revenue: the economic cost of raising a dollar through green taxes tends to be greater than that of raising a dollar through ordinary income taxes. The intuitive reason is that green taxes have a much narrower tax base than that of the income tax. They focus on individual commodities (such as fossil fuels) or on emissions from particular industries. As a result, they tend to imply larger “distortions” in markets

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<sup>1</sup>For a survey of analytical and numerical studies of this issue, see Bossello, Carraro, and Galeotti (1998), and Bovenberg and Goulder (2000).

for intermediate inputs, for consumer goods, and for labor and capital.<sup>2</sup> Hence, swapping a green tax for part of the income tax augments the (nonenvironmental) distortions of the tax system, so that the economic cost of the revenue-neutral tax reform is positive.

A seminal paper on this subject is Bovenberg and de Mooij (1994). In the Bovenberg - de Mooij model, households gain utility from a “clean” good (involving no pollution), a “dirty” good (involving pollution), and leisure. The functional form of the utility function implies that both goods are equal substitutes for leisure, and that environmental damages are weakly separable from both leisure and consumption. Goods are produced under constant returns to scale, and labor is the only input. In addition, there is a fixed level of public expenditure that initially is financed through a proportional tax on labor income. In this simple model it is straightforward to show that the net impact of a tax on the polluting good, with the revenues used to cut the labor tax, is to reduce labor supply and hence exacerbate the efficiency cost of the labor tax. This result generalizes to the case when firms can reduce pollution per unit of output through input substitution or end-of-pipe abatement. Similar results have been obtained in other papers employing fairly simple models.<sup>3</sup>

### A Closer Look

The requirements for obtaining the second dividend can be understood more fully by distinguishing three components of the overall cost of a green tax reform. The first component is the *primary cost* of the environmental tax: this is the direct cost to the regulated sector associated with that sector’s need to reduce pollution through changes in production methods or installation of pollution-abatement equipment. The second component, which requires a general equilibrium analysis, is the revenue-recycling effect. As mentioned, this component serves to lower the reform’s costs. The third component is an additional general equilibrium element called the *tax-interaction effect*, which counters the revenue-recycling effect. To the extent that environmental taxes raise producers’ costs, they imply higher prices of commodities. This effectively reduces the real returns to factors—a

given nominal wage payment or given nominal distribution of profits has less purchasing power. When there are pre-existing taxes on these factors, the environmental tax functions like an increase in factor taxes, compounding the distortions in factor markets from prior taxes. This adverse factor-market impact is the tax-interaction effect.

To get the double dividend, the (cost-reducing) revenue-recycling effect would have to outweigh both the primary cost and the (costly) tax-interaction effect. Under neutral conditions<sup>4</sup> (but not in every possible situation, as we discuss below), theoretical models indicate that the revenue-recycling effect is not strong enough to do this: the double dividend does not arise. Indeed, under these conditions the revenue-recycling effect is weaker than the tax-interaction effect alone. *Thus, in these cases the gross costs not only fail to be negative but turn out to be higher than they would be in a world without prior distortionary taxes, where the revenue-recycling and tax-interaction effects are absent.*<sup>5</sup> This attests to the fact that environmental taxes are implicit factor taxes that compound existing factor-market distortions.<sup>6</sup>

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<sup>4</sup> The key assumption is that the environmental tax falls on a good or activity that is “average” in terms of its substitutability with leisure. For details, see, for example, Parry (1995).

<sup>5</sup> These findings have implications for the optimal environmental tax rate in a second-best setting. In the absence of distortionary taxes, the optimal environmental tax rate corresponds to the marginal environmental damages. But to the extent that pre-existing distortionary taxes raise the costs of a given environmental tax, the optimal environmental tax rate will be below the marginal environmental damages. This issue is examined in Bovenberg and Goulder (1996).

<sup>6</sup> We have focused here on the most widely discussed definition of the second dividend – a reduction in overall costs of the tax system. This is sometimes called the “strong” second dividend. There are other definitions. The “weak” second dividend claim is that a given environmental tax reform is less costly when revenues are recycled via marginal income tax cuts than when they are returned lump-sum. This second dividend is easy to obtain and amounts to a situation where the revenue-recycling effect is beneficial. Parry and Bento (2000) define an intermediate notion of the second dividend: a situation where the revenue-recycling effect more than offsets the tax-interaction effect, so that a given environmental tax reform is less costly in a second-best setting than in a first-best setting.

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<sup>2</sup>“Distortions” is in quotes to acknowledge the fact that, in keeping with the focus on the second dividend, the present discussion ignores the policy’s impacts on environmental quality and associated implications for overall efficiency -- environment-related benefits net of the economic costs.

<sup>3</sup> See, for example, Parry (1995), Bovenberg and Goulder (1997), and Christiansen (1996).

Still, there are circumstances under which the double dividend can arise after all. Although the simplest analytical models tend to reject the doubled dividend, more complex analytical models, as well as larger numerical models, offer more scope for the phenomenon by acknowledging additional potential channels for beneficial efficiency impacts. The additional channels include the following:<sup>7</sup>

1. *The polluting good is a relatively weak substitute for leisure.* In the 1994 Bovenberg and de Mooij paper and in many other analyses, the taxed (polluting) good is assumed to be an average substitute for leisure. If, in contrast, the polluting good exhibits a weaker degree of substitution with leisure than the clean good does, the efficiency loss from the tax-interaction effect will be smaller and the prospects for a double dividend will improve. In fact the tax-interaction effect enhances efficiency when the polluting good and leisure are complements. Goods that are relatively weak leisure substitutes include cigarettes and (perhaps) recreational vehicles, suggesting that taxes on these goods could produce a double dividend.

But it should be noted that taxing goods that are relatively *strong* substitutes for leisure would enlarge the tax-interaction effect, making the costs of revenue-neutral green taxes even higher. Moreover, pollutants associated with energy production (e.g. carbon, sulfur, or nitrogen oxides) are effectively inputs into a wide range of consumption goods. The broader the range of final output produced with the pollutant, the more likely this aggregate polluting good will approximate an average substitute for leisure. In our view, in the absence of clear evidence to the contrary, a logical starting point is to treat output from polluting industries as average leisure substitutes.

2. *Inefficient relative taxation of multiple factors of production.* Extending the models to consider more than one factor of production adds a new twist. In models with both capital and labor, for example, the double dividend can occur if one factor initially is overtaxed (in efficiency terms) relative to the other, and the environmental reform serves to improve the relative taxation of the factors. Several studies indicate that in

the U.S., capital is overtaxed relative to labor in efficiency terms. To the extent that a green tax reform shifts the tax burden from capital to labor at the economy-wide level, the double dividend can occur. For this to happen, this “tax-shifting effect” must be strong enough to outweigh the primary cost plus the net cost from the tax-interaction and revenue-recycling effects. This is more likely when environmental tax revenues are used to cut taxes on capital rather than labor, and when the environmental tax is levied on a relatively labor-intensive industry. However, most highly polluting industries are relatively capital intensive. Numerical simulations by Bovenberg and Goulder (1997) find that, under plausible parameter values, the “tax shifting effect” is not strong enough to yield the double dividend, even when all revenues are devoted to cuts in capital taxes.<sup>8</sup> The fact that most pollution-intensive industries are also highly capital intensive tends to subdue the tax-shifting effect and work against the double dividend.

There are other primary factors of production besides labor and capital. Natural resource stocks represent another primary factor. Such stocks are used in the production of petroleum, coal, timber, and metals. To the extent that these stocks are inelastically supplied relative to capital and labor, there is an efficiency argument for taxing them. But partly because of measurement problems, natural resource stocks seldom are taxed directly. Still, introducing taxes on the *output* of a resource-based industry (e.g., introducing a tax on extracted coal) could generate an efficiency gain (via the tax-shifting effect) if much of the burden of this tax falls on the resource owners (rather than on labor and capital) and the resource is inelastically supplied. However, to the extent that resource stocks are inelastically supplied, and the burden of green taxes falls on owners these stocks, such taxes will lead to reductions in supply prices rather than increases in prices to demanders (i.e., consumers). Hence the second dividend might be obtained at the expense of the first.

3. *Environmental feedbacks.* The environmental improvements from green tax reforms can feed back on the functioning of labor and capital markets. They may lead to improved human health and productivity, for example.<sup>9</sup> This environmental feedback can help expand labor

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<sup>7</sup> These and other channels are examined in Bovenberg and Goulder (2000). Non-competitive labor markets provide another potential channel for the double dividend. This may be especially important abroad. For some European countries, for example, it would be important to consider various non-tax factors that affect the operation of the labor market, such as the role of trade unions in wage determination.

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<sup>8</sup> However, Jorgenson and Wilcoxon (1996) obtain the double dividend when revenues are devoted entirely to cutting taxes on capital.

<sup>9</sup> Whether this impact should be classified as a cost-reduction (relevant to the second dividend) or as an environmental benefit (relevant to the first) is fairly arbitrary.

supply and improve the efficiency of the labor market. Williams (2000) has recently explored the productivity issue. He finds that the feedback on labor productivity can attenuate the tax-interaction effect, but in general this effect is not large enough to resurrect the double dividend. One reason why this effect may be weak empirically is that about 90 percent of the health benefits from pollution reduction accrue to seniors who are not in the labor force.

Another example is peak-period charges imposed on freeways trips that are primarily work-related. A study by Parry and Antonio Bento (2000) finds that revenue-neutral congestion taxes can encourage labor force participation at the margin by raising the household wage, net of taxes and commuting costs. In fact the resulting efficiency gain in the labor market is about as large as the efficiency gain from internalizing the congestion externality.

4. *Tax-deductible consumption expenditure.* Most of the recent models neglect the fact that certain expenditures—for example, mortgage interest for owner-occupiers and employer-provided medical insurance—are deductible from income taxes. This means that the tax system distorts the choice between tax-favored spending and ordinary (non-tax-favored) spending, in addition to distorting factor markets. This implies that recycling environmental tax revenues through income tax cuts can yield an especially large revenue-recycling effect, since cutting the income tax rate lowers the effective subsidy for tax-favored spending. Parry and Bento (2000) find that, in the presence of tax deductible spending, environmental tax swaps may yield a revenue-recycling effect that outweighs the tax-interaction effect, so that the general equilibrium costs of the policy are less than half of the primary costs.

These cases illustrate a general principle. The double dividend arises if three conditions hold: (1) the initial tax system is inefficient along some nonenvironmental dimension<sup>10</sup>, (2) the revenue-neutral environmental tax reduces this inefficiency, and (3) the efficiency-improvement along this dimension more than compensates for the environmental tax's inherent efficiency disadvantage (attributable to its narrow base). This principle makes clear that the presence or absence of the

double dividend depends on the nature of the prior tax system and how revenues are recycled. This does not mean, however, that the double dividend is as likely to occur as not. The narrow base of green taxes constitutes an inherent efficiency handicap. The green tax reform's impact on pre-existing inefficiencies in the tax system could offset this handicap, but could also add to it. Numerical general equilibrium models aim to incorporate realistically the pre-existing inefficiencies of the tax system, and to gauge how green taxes alter these inefficiencies. Although results vary, the bulk of existing numerical research indicates that even when revenues are recycled in ways conducive to a double dividend, the beneficial efficiency impact is not large enough to overcome the inherent handicap, and the double dividend does not arise.<sup>11</sup>

### **The Broader Relevance of Tax-Interactions to Environmental Regulation**

The general equilibrium tax-interactions we have discussed are relevant not only to the costs of green tax reforms, but also to the costs of a wide range of non-tax environmental policy instruments, including tradeable emissions permits, technology mandates, and pollution performance standards. In joint papers with Dallas Burtraw and Roberton Williams, we have shown that for each of these instruments, the cost of achieving given amounts of pollution abatement is higher in the presence of distortionary taxes than the cost in an economy with no such taxes.<sup>12</sup> The extra cost reflects the tax-interaction effect, which is an increasing function of the magnitude of pre-existing tax rates.

Pre-existing taxes differentially affect policy costs, however, altering the rankings of policies. The cost-impact can be especially large for (non-auctioned) emissions permits. If these permits are auctioned, and the revenues are used to finance cuts in prior distortionary taxes, the tax-interaction effect will be partly offset by the revenue-recycling effect. On the other hand, if the permits are given out free, there can be no such offset. Goulder, Parry, and Burtraw (1997) show that the cost of reducing sulfur emissions by 20 percent or 50 percent are increased by 200 percent or 70 percent, respectively, when we account for the tax-interaction effect. In some cases, whether the overall efficiency impact (environment-related benefits minus nonenvironment-related

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<sup>10</sup> More precisely, the initial tax system must fail to be second-best optimal abstracting from the benefits from environmental improvement.

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<sup>11</sup> For a recent review of results from numerical studies, see Bossello, Carraro, and Galeotti (1998).

<sup>12</sup> The costs of a wide range of instruments are compared in Goulder, Parry, Williams, and Burtraw (1999).

costs) is positive or negative depends on the decision whether to freely allocate or auction the permits. In this connection, Parry, Williams, and Goulder (1999) find that while reducing carbon emissions through auctioned permits is efficiency-improving (provided that the revenues are recycled), reducing such emissions through freely provided carbon permits *reduces* efficiency under plausible assumptions for marginal environmental benefits.

### Concluding Remarks

In assessing the costs of revenue-neutral green tax reforms and of various non-tax environmental policies, it is important to consider interactions between the new policies and pre-existing taxes. These interactions—as expressed through revenue-recycling and tax-interaction effects—crucially influence the cost-assessment. Partial equilibrium analyses, which ignore such interactions, can yield highly misleading results regarding the magnitude, and even the sign, of the efficiency effect of green tax reforms and other environmental policy initiatives.

The general equilibrium interactions we have described are relevant as well to the impacts of a wide range of government policies outside of the environmental arena. Indeed, they are relevant to *any* public policy measure that affects product prices, and hence the real factor returns. Minimum wage laws and product safety standards, for example, raise production costs and produce a costly tax-interaction effect. At the same time, subsidies for agricultural production, mass transit fares, or child-care can generate a *beneficial* tax-interaction effect that may offset much of the cost of financing the subsidy through distortionary taxes. These impacts deserve attention in evaluations of regulatory costs.

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## Evaluating Contingent Valuation of Environmental Health Risks: The Proportionality Test

James K. Hammitt\*

The rate at which people are willing to substitute money for mortality risk can be estimated using revealed- or stated-preference methods. Revealed-preference methods are generally considered more credible since it is reasonably assumed that people's choices about real risks are more thoughtful and better informed than their responses to survey questions about hypothetical risks. However, revealed-preference estimates of the value of mortality risk can only be obtained in settings where the alternatives that an individual passes up can be identified and the differences in risk, cost, and other important dimensions can be estimated. Unobserved differences between individual risks and actuarial risk estimates can produce misleading results.

Most revealed-preference estimates of the monetary value of mortality risk have been obtained by comparing workers' pay and on-the-job fatality risk (Viscusi, 1993). After controlling for education and other factors that influence employment opportunities, these studies find that workers in high-risk jobs receive higher wages than those in safer jobs. For example, workers facing an annual occupational-fatality risk of 3 in 10,000 may receive \$500 more in annual wages than workers with otherwise similar jobs in which the risk is only 2 in 10,000.

The rate of compensation for risk is commonly expressed as a "value per statistical life" (VSL). In this example, the VSL is \$5 million ( $= \$500 \div 1/10,000$ ). Since workers who prefer the safer, lower-risk job are willing to give up \$500 per year for the risk reduction, 10,000 such workers would together be willing to give up \$5 million per year to prevent one expected death among them.

Are the estimates of VSL obtained from occupational-risk studies appropriate for evaluating the benefits of environmental and public-health regulations? A number of factors suggest they may not be.

First, the target populations may include different types of people. Wage-risk studies by necessity reflect the preferences of workers in high-risk jobs, who are

generally healthy, male, and young adults. In contrast, environmental and public-health regulations may primarily benefit children or the elderly, or people who are unusually susceptible to pollution due to chronic lung disease, HIV-impaired immune systems, or other factors.

Second, wage-risk studies are based on the preferences of people who accept high-risk jobs, who implicitly reveal a greater willingness to accept risk for money than otherwise similar people who do not accept these jobs.

Third, the types of mortality risks differ. Wage-risk studies are largely based on fatal-accident risks. The mortality benefits of environmental regulations more often come in the form of lower risk of cancer or other fatal disease, which people may value differently.

If the results of wage-risk studies are of limited application to environmental risks, contingent valuation (CV) may be a valuable alternative. CV is an extremely flexible method. One can ask almost any sort of question about a hypothetical choice between alternative situations varying in risk and monetary consequences and experience suggests that most survey respondents will answer. Moreover, the questions can be targeted to the population most likely to benefit from a specific environmental regulation—the elderly, those with chronic disease, or others with relevant characteristics.

### Evaluating Contingent Valuation

Does contingent valuation yield valid estimates of WTP to reduce mortality risk? The fact that respondents will answer survey questions does not in itself imply that those answers are either thoughtful or informed. Other criteria are required to evaluate CV results.

One criterion is the extent to which the values estimated from CV studies agree with estimates from revealed-preference approaches. Some comparisons have been made which show rough consistency between CV and revealed-preference estimates. Yet the value of those comparisons is limited by the fact that revealed-preference estimates can only be obtained for goods with which consumers have experience. These comparisons do not provide direct evidence about the validity of CV estimates in cases where CV is most needed—for novel or unfamiliar goods.

A second criterion is the consistency between CV estimates and theoretical predictions about which factors should, and should not, affect willingness to pay (WTP). For mortality-risk reduction and many other goods one would expect that WTP for a benefit would be larger for people with higher incomes, all else being equal. By

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contrast, WTP should not depend on logically inessential aspects of the question such as whether the risk reduction is described as a change in probability (from 0.0003 to 0.0002), frequency (from 3 in 10,000 to 2 in 10,000), or odds (from 1 in 3,333 to 1 in 5,000).

### Proportionality of WTP to the Risk Reduction

One theoretical prediction that has received much attention is “sensitivity to scope,” that is, the extent to which estimated WTP depends on the size of the risk reduction or other good. CV has been criticized on the grounds that estimates of WTP are inadequately sensitive to differences between the items that are valued.

In some applications to environmental quality, respondents may indicate virtually the same WTP for protection of substantially different wilderness areas or numbers of wildlife (Diamond and Hausman, 1994). When respondents indicate they are willing to pay the same amount for improvements of widely differing magnitude, it raises a concern that they are simply expressing general support for environmental protection rather than valuing the specified improvement.

For environmental quality, while it is reasonable to expect that WTP should be larger for a greater improvement there seems to be no clear answer to the question of how much larger is enough. For small reductions in mortality risk, however, there are good reasons to assert that WTP should be nearly proportional to the reduction in risk. Indeed, near proportionality between WTP and change in mortality risk appears to be a necessary (but not sufficient) condition for CV-based estimates to be considered valid measures of VSL. If estimated WTP is not proportional to the magnitude of the risk reduction, the estimated VSL will be strongly sensitive to the arbitrary choice of how large a risk reduction is presented in the CV instrument.

The individual’s VSL describes the rate at which he would pay for infinitesimal reductions in risk. It is not constant but depends on income and baseline risk. As the individual buys successive increments his VSL will fall as both his remaining income and his risk decline. But under standard models of decision making, both effects should be small.

The standard model of WTP for reductions in current mortality risk is based on the assumption that individuals seek to maximize their expected state-dependent utility of income

$$U(p, w) = (1 - p) u_a(w) + p u_d(w) \quad (1)$$

where  $p$  is the probability of dying in the current period and  $u_a(w)$  and  $u_d(w)$  are the utility of income  $w$  condi-

tional on surviving and not surviving the period, respectively (Drèze, 1962; Jones-Lee, 1974; Weinstein et al., 1980). Holding expected utility constant yields

$$VSL = \frac{dw}{dp} = \frac{u_a(w) - u_d(w)}{(1 - p)u'_a(w) + pu'_d(w)}. \quad (2)$$

The numerator is the difference in utility between surviving and dying and the denominator is the expected marginal utility of income. Under the conventional and reasonable assumptions that  $u_a(w) > u_d(w)$  and  $u'_a(w) > u'_d(w) \geq 0$ , VSL increases in income and risk.

The effect of risk on VSL—the “dead-anyway effect” (Pratt and Zeckhauser, 1996)—reflects the difference in the marginal utility of income depending on whether or not the individual survives the period. The effect is largest when the marginal utilities are as different as possible, that is, for  $u'_d(w) = 0$ . In this case, decreasing the mortality risk  $p$  by  $\Delta p$  decreases VSL by the proportional change in survival probability  $(1 - p)/(1 - p + \Delta p)$ . For the usual case where the baseline risk  $p$  is a few percent or less, the proportional decrease in VSL is approximately equal to  $1 - \Delta p$ .

While theory implies the dead-anyway effect is small, it places no obvious constraints on the income effect. Thus, we must turn to empirical estimates. These suggest the income elasticity of VSL is no greater than one.

The primary sources of information on VSL—studies of compensating wage differentials—typically do not provide information about the income elasticity because income (or wage) is the dependent variable and cannot also be used as an explanatory variable. One approach to estimating the income elasticity is to conduct a meta-analysis of compensating-wage-differential studies where the populations differ in income, risk, and other factors. Liu et al. (1997) used this approach to evaluate the relationship between estimated VSL, average income, and fatality risk for the 17 compensating-wage-differential studies listed in Viscusi’s (1993) review article for which these variables were available. They estimated an income elasticity of 0.5.

Income elasticity can be estimated from revealed-preference studies for goods other than employment and from CV studies. For example, Blomquist (1979) estimated an elasticity with respect to the present value of future earnings of 0.3 in his study of seat-belt use. CV studies do not always find a statistically significant relationship with income or report sufficient information to calculate an elasticity. Jones-Lee et al. (1985) estimated

a value of 0.3 in a study of transportation risk. Evans and Viscusi (1990) estimated an income elasticity of 1.0 for nonfatal injury risk.

The available evidence suggests that the income elasticity of VSL is no greater than one, and may be substantially smaller. If so, the effect of changing income on the proportionality of WTP to risk reduction is small whenever WTP is a small share of income.

How large a departure from proportionality is consistent with the standard model? Consider an individual with annual income of \$40,000 (the approximate average for US households) facing a 28 in 10,000 chance of dying in the next year (the approximate average for US residents aged 25-54). Assume the individual's VSL is \$5 million (a standard estimate). How much more would he pay to reduce his risk by 2 in 10,000 than by 1 in 10,000?

For this individual,  $WTP_1$  to reduce mortality risk this year from 28/10,000 to 27/10,000 is equal to the risk increment  $\Delta p_1 = 1/10,000$  times some VSL intermediate to its initial value  $VSL_0$  (= \$5 million) and its value  $VSL_1$  at the final position where his risk is 27/10,000 and his income is ( $\$40,000 - WTP_1$ ). Since  $WTP_1$  is less than  $\Delta p_1 \cdot VSL_0 = \$500$ , his final income will be greater than \$39,500. If his income elasticity is no greater than one, the income effect alone yields  $VSL_1 > 39,500/40,000 \cdot VSL_0 = \$4.9375$  million. The dead-anyway effect decreases this value by a factor no smaller than 0.9999, to \$4.9374 million. Thus  $WTP_1$  is between \$500 and \$493.74.

Similarly, the individual's  $WTP_2$  to reduce his risk from 28/10,000 to 26/10,000 is equal to  $\Delta p_2 = 2/10,000$  times some VSL between  $VSL_0$  and its value  $VSL_2$  once he has paid for the larger risk reduction. In this case, his final income will be greater than \$39,000, the dead-anyway effect reduces VSL by a factor of no less than 0.9998, and so  $VSL_2 > 39,000/40,000 \cdot 0.9998 \cdot VSL_0 = \$4.874$  million.  $WTP_2$  is between \$1,000 and \$974.80. Dividing the lower bound on  $WTP_2$  by the upper bound on  $WTP_1$  implies that the individual will pay at least 1.95 times as much to reduce his risk by 2/10,000 as he will pay to reduce it by 1/10,000.

The near-proportionality of WTP to change in mortality risk depends on several factors. First, the effect of reduced income cannot be too large, which implies that it is unreasonable to expect near-linearity if the payments are a substantial fraction of income (or if the income elasticity of VSL is much larger than current estimates suggest).

The dead-anyway effect is always small unless the risk change is a substantial fraction of the individual's total survival probability. Note that the effect depends on the individual's total mortality risk rather than the level of risk from any specific cause. Whether the risk reduction to be valued involves a small or large fractional change in a particular risk (for example, road accidents) is irrelevant, except perhaps if the marginal utility of income if one dies depends strongly on the cause of death.

Near-proportionality does not depend on the assumption that the individual maximizes his expected utility. Most alternative theories of decision making under uncertainty are locally linear in the probabilities (Machina, 1987) which is all that is required. Under rank-dependent expected utility, for example, the individual would evaluate his position using

$$V(p, w) = [1 - \pi(p)] u_a(w) + \pi(p) u_d(w) \quad (3)$$

where  $\pi(p)$  is a smooth, monotonically increasing function with  $\pi(0) = 0$  and  $\pi(1) = 1$  (Quiggin, 1993). Holding  $V$  constant yields

$$VSL = \frac{dw}{dp} = \frac{\pi'(p)[u_a(w) - u_d(w)]}{[1 - \pi(p)]u'_a(w) + \pi(p)u'_d(w)}. \quad (4)$$

Compared with the standard expected-utility result shown in equation (2), the numerator is multiplied by  $\pi'(p)$  and the expected marginal utility in the denominator is calculated using the transformed probabilities. This formula will yield qualitatively similar results to the standard model so long as  $\pi'(p)$  does not change sharply between the initial and final risks.

In contrast, near proportionality need not hold under theories of decision making such as prospect theory (Kahneman and Tversky, 1979) that allow for thresholds in the way people evaluate probabilities. For example, if an individual perceives an annual mortality risk of 27/10,000 as equivalent to zero but a risk of 28/10,000 as different from zero, then he would pay something to reduce his risk from 28/10,000 to 27/10,000 but nothing for the further reduction to 26/10,000. Thus, his WTP for the larger and smaller risk reductions would be equal.

Although such a result is possible, probability thresholds seem to be an *ad hoc* and context-specific rationalization. Depending on how the question is framed, the existence of probability thresholds could also yield a much greater than proportional relationship between WTP and risk change. If an individual views a reduction of 1/10,000 as negligible but a reduction of 2/10,000 as meaningful, WTP for the smaller reduction

might be zero while WTP for the larger one would be positive.

Another possible reason for non-proportionality in CV studies is that respondents may not report their values for the numerical risk change specified in the question. As suggested by Viscusi (1985, 1989), they may instead combine the stated risk reduction with their own prior estimates of how effective the hypothetical program might be to form a revised, posterior estimate of the risk reduction. Even if the respondents' reported values are proportional to their posterior risk estimates, they may not be proportional to the risk reductions specified in the survey. In this case, it is impossible to estimate the respondents' marginal rate of substitution for money and risk unless the posterior risks they value can be ascertained.

The argument for near proportionality of WTP to change in risk does not require that the individual be willing to pay the same amount to reduce different risks, since it concerns WTP to reduce the same type of fatality risk by different amounts. An individual might be willing to pay different amounts to reduce his risk of dying in a traffic accident and from cancer by 1 in 10,000. Nevertheless, he should be willing to pay nearly twice those amounts to reduce each risk by 2 in 10,000.

### **The State of the Field**

Hammitt and Graham (1999) reviewed the results of every CV study we could find that was published since 1980 and estimated WTP for reductions in numerically specified health risks. We sought to determine whether estimates of WTP were proportional to the risk reduction.

Of the 25 studies we identified, only 14 provided information on how estimated WTP varied with the magnitude of risk reduction. Eight studies involved fatality risks. Of these, WTP was statistically significantly related to the magnitude of risk reduction in six cases and not significantly related in two. In every case, WTP varied much less than proportionately to the risk reduction. Some of these studies asked the same respondents to value larger and smaller risk reductions and found that many reported they would pay the same amount for both reductions.

For example, Jones-Lee et al. (1985) elicited British respondents' WTP to reduce fatality risk on a foreign bus trip by 4/100,000 and 7/100,000 (from an initial level of 8/100,000). Mean WTP are £137 and £155, respectively. Because estimated WTP is not proportionate to the risk reduction, dividing WTP by the risk change yields different estimates of VSL—£3.4 million

and £2.2 million, respectively. Moreover, median WTP for the two risk reductions are equal (£50) and 42% of the respondents indicated the same WTP for both risk reductions. (Eight percent indicated greater WTP for the smaller risk reduction.)

Six of the 14 studies evaluated nonfatal risks and revealed a similar lack of sensitivity to the magnitude of benefit. WTP was significantly related to the risk change in five studies but was always much less than proportional to the magnitude of the change.

One reason that CV studies usually yield estimates of WTP that are inadequately sensitive to the risk reduction may be the difficulty of accurately communicating small risk changes to survey respondents. Except for the studies by Loomis and duVair (1993) and Hammitt and Graham (1999), there has been little formal testing of the effect of risk-communication methods in CV.

In recent work, Corso et al. (1999) found evidence that difficulties in communicating small changes in risk may be a major contributor to the generally inadequate sensitivity of CV-estimated WTP to the magnitude of risk reduction. These authors elicited WTP to reduce respondents' annual automobile-accident fatality risk by 5/100,000 and 10/100,000 from randomly chosen subsamples of respondents. Respondents were further randomized to one of three groups presented with a visual risk-communication aid (a chart with 25,000 dots, logarithmic or linear risk ladder) or to a control group that received no visual aid.

Table 1 presents regression models estimated separately for each of the four groups. The models assume WTP is lognormally distributed and include only an intercept and a dummy variable "Large risk reduction" which is equal to one if the respondent was offered the larger risk reduction and zero otherwise.

As shown in the table, sensitivity to scope varied markedly with the visual aid used. In the control group, median WTP for the larger risk reduction is 1.10 times larger than for the smaller reduction. The estimates are not significantly different (the coefficient on the dummy variable "Large risk reduction" is not significantly different from zero) and so the hypothesis that WTP is insensitive to risk reduction cannot be rejected. As a result, the estimates of VSL obtained by dividing estimated WTP by the risk reduction differ by a factor approaching two. In contrast, for the group presented with the dots, median WTP is nearly proportionate to the risk reduction (the coefficient on the dummy variable is not significantly different from  $\log(2) = 0.693$ ) and the hypothesis that WTP is proportionate to the risk reduction cannot be rejected. For this group, the

estimated VSL is virtually the same for the subsamples valuing the smaller and larger risk changes. Results for

the two groups presented with risk ladders fall between these extreme cases.

Table 1: WTP as a Function of Risk Reduction  
(Models estimated separately by subsample)

	No aid	Linear	Logarithmic	Dots
Intercept	5.448 (0.141)	5.630 (0.145)	5.333 (0.145)	5.067 (0.141)
Large risk reduction[a]	0.097 (0.198)	0.318 (0.202)	0.503 (0.198)	0.658 (0.209)
Sample size	277	288	264	275
Reject insensitivity?	no	no	yes**	yes***
Reject proportionality?	yes***	yes*	no	no
Median WTP (small, large)	\$232 \$256	\$279 \$383	\$207 \$342	\$159 \$306
Ratio of WTP	1.10	1.37	1.65	1.93
Median VSL (small, large) (millions)	\$4.6 \$2.6	\$5.6 \$3.8	\$4.1 \$3.4	\$3.2 \$3.1

Notes: Standard errors in parentheses.

[a] Dummy variable equal to one if respondent offered larger risk reduction.

\*, \*\*, \*\*\* = significant at 10%, 5%, 1%.

## Conclusion

Contingent valuation is an extremely flexible method for eliciting preferences about health risks. There are few alternatives for obtaining empirical estimates of the value of reducing mortality risk to a specified population. For CV to fill this need, investigators need to develop methods for conducting CV studies that yield demonstrably valid results. An important criterion for evaluating validity is consistency with other information, including the predictions of reasonable theories of decision making and valuation of health risk. In particular, VSL estimates from studies that do not demonstrate the near-proportionality between estimated WTP and risk reduction implied by theory must be viewed with some skepticism.

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