Improving the
THEORY & PRACTICE
of Benefit-Cost Analysis

Eighth Annual Conference
and Meeting of the Society
for Benefit-Cost Analysis

Society for Benefit-Cost Analysis

Presentation Abstracts

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Contents

Session 1: Thursday, March 17, 2016, 9:00 – 10:30am

➢ A-1: EPA Implementation of Water Pollution Controls & the Role of Cost-Effectiveness

Chair: Sofie Miller, (sofiemiller@gwu.edu), GW Regulatory Studies Center

Discussant: Art Fraas, (fraas@rff.org), Resources for the Future

Presentations:

Three Decades of EPA Implementation of Technology-Based Water Pollution Controls Under the Clean Water Act (1981- 2015) and the Role of Cost-Effectiveness, *Kevin Bromberg,* * (kevin.bromberg@sba.gov), *US Small Business Administration*

The Clean Water Act requires all significant industrial dischargers to adopt a variety of technology- based controls, considering both the costs and effluent reductions. These provisions were intended to achieve "reasonable further progress toward the national goal of eliminating the discharge of all pollutant [and] require the elimination of discharges if… such elimination is technologically and economically feasible." The Congress specifically required the adoption of best practicable technology (BPT) and best available technology economically achievable (BAT) for existing industrial plants. The Regulatory Flexibility Act also requires consideration of alternatives BAT and BPT standards, and the cost-effectiveness of these alternatives. Analyses under the RFA nicely fit within the structure of the relevant Clean Water Act provisions. EPA developed a metric called "toxic weighted pound equivalents" in 1981, which assigns a toxicity weight for each controlled toxic pollutant. This metric has been used by EPA to measure the cost-effectiveness of the different levels of treatment technologies in different ELGs. The cost/TWPE has universally been held below $100/TWPE for all but a very few industrial ELGs over the history of ELGs. Several have commented on the implementation of this effluent guidelines programs and the role of cost-effectiveness. This study will review those commentaries, and will focus on the role of cost-effectiveness in the EPA determinations for the final rules, including the recent aberrant Steam Electric ELG. The study will also address the common pattern of EPA policy makers to exaggerate the benefits in the proposal, and then reduce those benefits in the final rule, and correspondingly, reduce the stringency of the final rule. As a participant in the EO Executive Order review process, I have observed about one dozen ELG rulemakings, giving me a unique perspective on this topic.

Evaluation of EPA's Calculation of Cost-Effectiveness of Water Pollution Controls – Is There an Incentive to Inflate Pollution Benefits? *Jack Waggener*,* (jack.waggener@aecom.com), *AECOM*

Since 1980, Jack Waggener, PE, has been involved in critiquing the cost-effectiveness of over 30 EPA Industrial Effluent Limitation Guidelines (ELG). As a result of this work, several ELGs have been significantly altered between the proposal and final rules. The presentation will provide examples of this work, along with highlights of the issues. The Clean Water Act required the adoption of best practicable technology (BPT) and best available technology economically achievable (BAT) for existing industrial plants. To help accomplish this, EPA evaluates the cost effectiveness of different treatment technological alternatives when developing the ELGs. In 1981, EPA established a procedure to determine the effectiveness of pollutant removal by

different technologies. All the different pollutants in the waste stream are assigned relative toxicity weights to develop the total "toxic weighted pound equivalents" (TWPE) that are projected to be removed by various treatment technologies. EPA estimates the annualized cost of the treatment technologies and calculates the cost per TWPE. Almost every industrial ELG that has been promulgated has had a cost effectiveness below $100/TWPE; only one was as high as $400/TWPE for direct dischargers. This level has become a benchmark as to which technology option has been selected by EPA. We often have found that EPA very significantly over estimates the TWPE and highly underestimates the cost, therefore artificially lowering the cost per TWPE. As a result, EPA has proposed treatment options that are very costly and that have a severe impact on industry. Frequently, this is corrected in the final rule, such as in the ELGs of Metal Products and Machinery, Transportation Equipment Cleaning, and others. However, the November 2015 Steam Electric Power ELG unfortunately failed to make the needed corrections.

Case Law Regarding Cost-Benefit Analyses under the Clean Water Act, *Jeffrey Longsworth,** (Jeffrey.Longsworth@btlaw.com), *Barnes and Thornburg LLP*

The Clean Water Act requires all significant industrial dischargers to adopt a variety of technology-based controls, considering both the costs and effluent reductions. These provisions were intended to achieve "reasonable further progress toward the national goal of eliminating the discharge of all pollutant [and] require the elimination of discharges if… such elimination is technologically and economically feasible." The Congress specifically required the adoption of best practicable technology (BPT) and best available technology economically achievable (BAT) for existing industrial plants. The extent to which EPA must use economic and cost considerations when establishing the different Clean Water Act technology standards to control effluent, varies. Sometimes Congress explicitly directed EPA to consider cost; sometimes Congress provided that cost was a factor EPA may consider; sometimes Congress said nothing at all about cost. In other words, while the Clean Water Act does not specifically define the various technology standards, it generally (but not always) enumerates specific factors EPA must consider in setting effluent limitation guidelines—and sometimes these include cost. In practice, EPA has taken different approaches to cost-benefit analyses under different mandates and technology standards, depending on the rulemaking at issue. EPA's cost-benefit approaches have been challenged in various court cases, both in terms of being too limited in the Agency's approach, as well as circumstances in which the Agency has reached arguably too far afield in assessing either costs or benefits. The presentation will include analysis of the important federal cases that have opined on EPA's statutory obligations to address, and how it addresses, cost-benefit analyses in water pollution cases, including application of the section 304(b) and 316(b) criteria. In 2009, the Supreme Court addressed the issue directly in Entergy Corp. v. Riverkeeper, Inc., 556 U.S. 208. Focus on that case will set the foundation for additional legal analyses.

➢ B-1: Applying Benefit-Cost Analysis to Risk Regulations

Chair: Stefanie Haeffele-Balch, (shbalch@mercatus.gmu.edu), Mercatus Center at George Mason University

Presentations:

Evaluating Risk-Based Regulations, *Laura Stanley,** (lstanle2@masonlive.gmu.edu)*,*
George Mason University

This paper explores whether the "scientification" of regulatory analysis—the persistent aim for increased quantification of the benefits and costs of regulation—leads to better regulatory outcomes. We argue that the gains from relying on these empirical methods to value risk-based regulations are minimal, due to the limitations of assessing the benefits and costs of risk-based regulations. Regulators face practical and theoretical limitations when assessing the degree to which a regulatory intervention will reduce the likelihood of, and mitigate the losses associated with, the negative health outcomes they aim to alter. We examine these limitations and use case studies to further highlight these constraints. We argue that regulators stand to see the most gains from conducting simple analyses early in the regulatory process, rather than conducting complex analyses for regulatory review.

Risk-Benefit-Cost Analysis of Interventions with Highly Uncertain Consequences, *Tony Cox,** (tcoxdenver@aol.com)*, Cox Associates*

Suppose that a costly proposed regulation is being evaluated for potential adoption, but most of its benefits are projected to occur in the future. How these benefits will be evaluated in the future is uncertain, perhaps because of uncertainties about: (a) consequences that the regulation will cause (e.g., reductions that it will actually achieve in real and perceived risks to health, safety, or the environment); (b) future preferences and values for recipients of these benefits; (c) actions of future regulators; (d) the future state of the world (e.g., sizes of future populations affected by the regulation), or (e) a confluence of such uncertainties. If uncertainties about future benefits are large enough so that the proposed regulation may be either desirable (benefits exceed costs) or undesirable (costs exceed benefits), depending on how present uncertainties are resolved, then how should it be evaluated? We argue that no single-number summary (e.g., risk-adjusted net present value or certainty-equivalent for net benefits) provides enough information to improve decisions if risk attitudes of the BCA recipients are unknown. Classical BCA results such as the Arrow-Lind theorem do not hold in such situations. Probabilistic risk assessment provides sufficient information to improve the decisions of a single decision-maker (e.g., a benevolent dictator) but leaves crucial collective choice issues (and intergenerational justice issues) unresolved. We advocate adaptive decision processes that assign value to future information and flexibility and that recognize the opportunity costs of irreversible commitments. These adaptive processes will often provide recommendations that are Pareto-superior to any one-shot decision procedure based on current assessments of probable future consequences. We illustrate these conclusions in the practical context of current and proposed air pollution regulations.

On Objective Risk, *Dima Yazji Shamoun,** (dshamoun@mercatus.gmu.edu)*, Mercatus Center at George Mason University, and Edward J. Calabrese*

Objectivity in the science of risk plays a monumental role in in the projection of the benefits from health and safety regulations, which themselves constitute the majority of the total reported benefits of all federal regulations. Claims concerning the accuracy of regulatory risk assessments have been untestable so far in that they focus on whether the risk assessment over- or under-estimates the risk of exposure to certain hazards; yet, such claims imply that a true level of risk is known. We propose to move the debate from the realm of the untestable to

the realm of the testable through study of the process objectivity of the science of risk. Consistency in adhering to a process that is meant to produce objectivity should yield objective results. In this paper, we consolidate the existing body of guidelines and recommendations produced by the federal government and scientific bodies on sound risk assessment practices. We propose that, in order to test the process objectivity of the science of risk as applied by the regulatory agencies, a third party chosen from outside the agencies themselves should conduct a systematic assessment of major regulatory risk assessments, according to the consolidated principles outlined in this paper. We show that our proposed process is testable, objective, and, if adhered to consistently, has the potential of shedding light on the accuracy of the benefits calculus of major federal regulations.

Historical Trends in Regulatory Impact Analysis at the United States Department of Agriculture, *Linda Abbott* * (LAbbott@oce.usda.gov), *and Robert Johansson, U.S. Department of Agriculture*

The Office of the Chief Economist and the Office of Risk Assessment and Cost-Benefit Analysis were created in 1994 to review the economic impact of all significant regulations proposed by the Department of Agriculture and to ensure that the regulatory impact analysis includes a risk assessment for major rules regulating issues of human health, human safety or the environment. This paper examines trends in the use of risk assessment by Departmental agencies to support regulatory actions and the incorporation of risk relevant information into the benefit cost assessments for regulations concerning human health, human safety or the environment. Trends in the composition of agencies putting regulatory impact analysis into Departmental and OMB review are also discussed, as well as changes in the types of regulatory actions promulgated by the agencies. Comparisons are made between the use of risk assessments in the benefit cost analyses conducted for regulatory actions classified as economically significant, significant or economically significant and major under the Federal Crop Insurance and Department of Agriculture Reorganization Act of 1994.

➢ C-1: Decision Rules for Benefit-Cost Analysis

Chair: Ronald Bird, (rbird@uschamber.com), US Chamber of Commerce

Discussant: Jim Laity (James_A._Laity@omb.eop.gov), Office of Management and Budget

Presentations:

Why the Net Present Value Criteria is Superior to the Potential Compensation Test for Benefit-Cost Analysis, *Richard Zerbe,** (richardozerbe@gmail.com), *University of Washington*

This paper explains why the Net Present Value rule (NPV), as defined here, is superior to the Potential Compensation Test (PCT). The PCT is unnecessary, unreliable and morally suspect as a justification for project acceptance using benefit cost analysis. It relies on a hypothetical, rather than actual, compensation and is subject to Scitovsky reversals. The NPV rule, by contrast, does not suffer from these defects and is consistent with standard welfare criteria. The NPV rule accepts projects for which sum of the compensating variations is positive. It allows the considerations of the willingness to pay for gains and the willingness to accept payment for

losses and the realization of moral or ethical concerns for which there is a willingness to pay are legitimate economic goods. The NPV rule that a project with the largest NPV is superior to alternatives is consistent with economic welfare. The moral justification for the NPV rule is the Pareto rule considered across all projects. This is called the consent justification.

Investment Decision in Situation of Risk, *Emile Quinet,** (emile.quinet@wanadoo.fr)*, Paris School of Economics and Bernard Lapeyre, Ecole nationale des ponts et chaussées*

This presentation links two research fields. The first field is cost-benefit analysis (CBA) of investment projects and, more precisely, prioritization rules: how to use NPV to choose among several alternatives or to decide when to implement a project. The second field is the inclusion of risk in economic calculus; important insights have been given to the way of reckoning the average expectation of NPV of a project, but this field of research has almost not addressed the above-mentioned practical issue of the rules of decision for a project. This study aims to fill this gap and attempt to assess decision rules about when, and whether, to implement a project in the presence of systematic risk. Using methods of stochastic calculus in finance, we find that, in the case of Brownian stochastic processes, the decision rule can be expressed as a threshold value of the First Year Advantage/Cost ratio, and that this threshold value is dependent on each of the parameters appearing in the relations defining those Brownian processes. This threshold can be expressed in a closed form including the means, standard deviations and correlations of the stochastic variables. Simulations with sensible current values of these parameters show that the most important ones are the three standard values of the processes, and especially the parameter of the construction cost of the project. Some extensions are explored. Others are suggested for further research.

SCBA Versus SROI in Evaluating Community Based Intervention for Alcohol Consumption Control, *Varangkanar Jirarattanasopha,** (jvarang@gmail.com)*, Mahidol University and Piya Hanvoravongchai, Chulalongkorn University*

Economic evaluation of health promotion is a complex exercise. Most activities involve many stakeholders and interventions, and the outcomes generally extend beyond health gains. Cost-effective analysis, which is a popular health policy tool, has limitation to capture all health promotion outcomes. Therefore, there is increasing interest in the use of cost benefit analysis or its variants in economic evaluation of health promotion. Social cost-benefit analysis (SCBA) and Social return on investment (SROI) analysis are two approaches that share similar evaluation techniques. There are key differences between them, however, such as active involvement of stakeholders in determining which outcomes are relevant in the SROI analysis. The two techniques have not been evidently compared. It is the objective of this study to clarify the differences between SCBA and SROI, using community-based intervention for alcohol consumption control in Thailand as a case study. A quasi-experiment study was conducted to compare the outcomes and impact of specific alcohol control interventions at the village level. Altogether four villages with intervention and four without were selected for comparison. SCBA and SROI analysis was separately done using data on the direct and indirect costs of intervention, included administration cost, activity cost, and participant cost. The outcomes of interest were measured before, during and after the intervention period. In each approach, the SCBA and SROI analysis was performed following the standard guidelines.

The variation between the two approaches in practice were assessed and documented. This includes the variation in underlying rationales, comparability, outcome determination, and final

figures on return to investment ratio. The key differences between the two approaches are further discussed in comparison to theoretical expectations and the implications towards the use of evidence in policy formulation.

➢ D-1: Evaluating Security

Chair: Tony Cheesebrough (tony.cheesebrough@hq.dhs.gov), U.S. Department of Homeland Security

Presentations:

The Impact of the Visa Waiver Program on Tourism and Business Travel to the United States, *Charles Baschnagel,** (cbasch@gmail.com), *Booz Allen Hamilton; Mary (Katie) Foreman and Bryan Roberts*

The Visa Waiver Program (VWP) enables citizens of participating countries to travel to the United States for business or tourism stays of 90 days or less, without first obtaining a visa. This effectively lowers the cost of short term travel to the United States for citizens of participating countries as compared to non-VWP countries, who must take the time and expense of first obtaining a visa. This paper examines the effect of the VWP on tourism and business travel to the United States, using the expansion of the VWP following the Implementing Recommendations of the 9/11 Commission Act of 2007 (P.L.110-53), to estimate the effect of the VWP on tourism and business travel. To do this, I first model the impact of the VWP expansion using a difference-in-differences linear regression. I then model the selection of new VWP countries and use various methods to correct for selection bias in the analysis of the impact of the VWP on the volume of short-term travel to the United States. These methodologies find that the VWP is associated with a 20% to 40% increase in travel to the United States, depending on the analysis method and control group used.

Risk-Return Prioritization Of Global Trade Inspections,
Paul Mwebaze,* (paul.mwebaze@csiro.au)*, Dean Paini; and Daniel Heersink, CSIRO; John Nielsen, Department of Agriculture*

The spread of invasive species continues to provide significant challenges to those government biosecurity agencies charged with protecting a country's borders. In an increasingly connected world, these invasive species are potentially able to spread further and more rapidly. Human mediated pathways such as ships and airlines are the most obvious ways in which invasive species can be spread. Direct routes from one port to another are currently monitored, but indirect pathways, in which a ship picks up an invasive species and then travels to a number of different locations before arriving at the final destination, present more challenging scenarios. For the Australian Government Department of Agriculture, one particular concern is for ships arriving into Australia carrying viable eggs of the Asian gypsy moth (Lymantria dispar). We are developing a real time tool that will analyze the pathways for incoming ships and determine the likelihood the ship could be carrying viable eggs. The tool will be combined with queuing theory to analyze optimal ship inspection regimes to target invasive species. This combined model is likely to deliver significant benefits in terms of increased efficiency of port inspections and reduced costs to the Department of Agriculture. In this paper, we will calculate the estimated benefits and costs of the proposed policy. We present some results of early analyses, and discuss the implications and the further work required.

Strategic Benefit-Cost Analysis for Security Threats, *Kerry Krutilla** (krutilla@indiana.edu)*, and Alexander Alexeev, Indiana University*

This research studies the economically efficient response of the U.S. government to the regular threat of security breaches to its computing systems. The decision-making context is modeled using game theory, reflecting the reality that cyber security investments by the U.S. will be met by counter measures from foreign governments. The model is based on a contest success function in which the foreign country allocates resources to maximize its expected gain from the cyber-attack, while the U.S. should allocate resources to minimize its expected losses. The model represents asymmetry in the effectiveness of the resource use by the U.S. and the attacking government, different valuations for gains and losses, and departures from the assumption of perfect rationality. A Nash equilibrium investment strategy is derived and used in numerical simulations for the relevant range of the parameters. The study illustrates the logic underlying benefit-cost analysis in a strategic, risky environment, and concludes with policy recommendations.

Can Home Internet Users Be Persuaded to Pay More for Improvements in Cyber Security? *Dallas Wood,** (dwood@rti.org)*, RTI International*

Home Internet users could benefit greatly from government policies that reduced the risk of identity theft or attacks from malicious software, such as requiring internet service providers to take a more active role in promoting cybersecurity. However, the security improvements generated by such policies might be undervalued since many home Internet users do not fully appreciate the current risks associated with threats to cybersecurity. The goal of this study is to determine whether educational information treatments can be used to persuade home Internet users to pay more for improvements in cybersecurity. To achieve this goal, we recruited 3,635 home Internet users from the comScore, Inc. online panel to participate in a web survey that included a discrete choice experiment. At the beginning of the survey, 3,182 participants were exposed to one of seven information treatments designed to educate them about the dangers of insufficient cybersecurity (453 participants saw no information treatment). The participants were also asked questions about their knowledge of cyber security issues. Next, each participant was asked to choose between hypothetical securities packages that could be offered by their Internet Service Provider. These packages differed both in terms of monthly monetary costs, non-monetary costs (like time associated with installing software), and how much security each package provided. Using the data collected from these questions, we estimated a Random Utility Model and found that home Internet users were willing to pay up to approximately $8 per month for their most preferred internet security package. In addition, we found that users that had a better understanding of cybersecurity issues were willing to pay more for improvements in their cybersecurity. However, we found no evidence that any of the information treatments influenced how much home Internet users were willing to pay for such improvements.

➢ E-1: Key Analytical Methodologies Used in the Canadian Regulatory Context

Chair: Colin Code, (Colin.Code@ec.gc.ca), Environment and Climate Change Canada

Discussant: Troy Joseph (Troy.Joseph@cic.gc.ca), Immigration, Refugees and Citizenship Canada

Presentations:

The Cost-Benefit Analysis to Support Equivalency Agreement in Canada, *Ida Liu,** (ida-Jianqiao.Liu@ec.gc.ca), *Environment and Climate Change Canada*

A federal and a provincial / territorial environmental regulation may have equivalent provisions. To minimize the regulatory duplication, the Canadian Environmental Protection Act, 1999 (CEPA) authorizes the Minister of the Environment to enter into an equivalency agreement with the provincial / territorial government, and allows repeal of the federal regulations in the province. A cost-benefit analysis (CBA) is required to assess the associated incremental economic, environmental and social (e.g. human health) impacts on Canadians, businesses, and governments. In 2015, an *Agreement on the Equivalency of Federal and Nova Scotia Regulations for the Control of Greenhouse Gas Emissions from Electricity Producers in Nova Scotia* was published. When conducting the CBA for the repeal of the federal *Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations* in Nova Scotia, some analytical challenges were encountered, including the development of the business-as-usual scenario and the analytical timeframe for climate change policy. This presentation describes the uniqueness of Canadian regulatory landscape and focuses on how these challenges were addressed.

Canadian Regulatory Analysis in the Context of International Regulatory Alignment, *Jarett Cupolo*,* (jarett.cupolo@canada.ca), *Environment and Climate Change Canada*

The Government of Canada and the U.S. Environmental Protection Agency continue to have common policy objectives on reducing air emissions. In 2011, the Canada–United States Regulatory Cooperation Council was established to work towards better alignment of regulatory approaches between the two countries in a broad range of sectors, including vehicle emissions.

This new approach led to opportunities, challenges and lesson learned associated with the alignment of regulations between the two countries and particularly when developing analyses.

This presentation will describe some of the strategies employed to conduct cost benefit analyses, while addressing the regulatory alignment commitments. These strategies include developing preliminary estimates for initial policy guidance; conducting emissions and air quality modelling using the U.S. EPA models (or outputs from the U.S. EPA models) with Canadian data; strategies for estimating Canadian costs and benefits; and sharing economic expertise when reviewing main assumptions and approaches. There are several recent examples of Environment Canada regulations that align with those of the U.S. EPA, of which we will describe the strategies employed and the key CBA alignment methodologies and results. The examples focus on regulatory standards for emissions from vehicles and engines.

The One-for-One Rule: Measuring and Limiting the Growth of Administrative Burden Costs on Business in the Canadian Federal Regulatory System, *Timothy Folkins,** (Timothy.Folkins@tbs-sct.gc.ca), *Treasury Board Of Canada Secretariat*

The Government of Canada requires that all federal departments and agencies implement the "One-for-One" Rule (the Rule) to control administrative burden on business arising from regulatory changes. On April 24, 2015, it was announced that the Red Tape Reduction Act received Royal Assent in Canada's Parliament, enshrining the Rule in law. This was done after

more than three years of experience implementing the Rule through policy as a part of Canada's Cabinet Directive on Regulatory Management (CDRM).

Under the Rule when a new or amended regulation increases the administrative burden on business, regulators are required to offset – from their existing regulations – an equal amount of administrative burden cost on business. Regulators are required to provide offsets within two years of receiving final approval of regulatory changes that impose new administrative burden on business.

The estimate for changes in administrative burden costs caused by federal regulations—as well as the underlying methodology, assumptions, data and their limitations—must be included as a part of cost-benefit analysis which accompany regulatory proposals (where applicable).

In this presentation we will review the basic concepts of the Rule in Canada, the methodology (based on the internationally recognized Standard Cost Model) used to measure administrative burden cost changes, and the outcomes under the Rule. This presentation will also demonstrate the Regulatory Costing Calculator, a tool developed by the Treasury Board Secretariat of Canada and recommended to be used by federal departments and agencies in Canada to implement this methodology.

Session 2: Thursday, March 17, 2016, 10:45 – 12:15pm

➢ A-2: Issues in Climate Policy

Chair: Fran Sussman, (fsussman@rcn.com), ICF International

Presentations:

The Budgetary Implications of Climate Mitigation and Adaptation at the State Level in the U.S., *Elisabeth Gilmore** (gilmore@umd.edu) *and Travis St. Clair, School of Public Policy, University of Maryland*

While there has been considerable debate about the appropriate activities for mitigating and adapting to climate change for central governments, less attention has been paid to the role of subnational governments, despite the fact that state and municipal entities may be better positioned to identify opportunities - especially for adaptation. In this paper, we focus on the role of state governments in the U.S., and in particular on the implications of climate change for state budgets, which already face pressure from diverse areas, such as unfunded pensions, growing health care costs, education, and infrastructure. First, we review the current level of state policies and expenditures with respect to climate mitigation and adaptation activities. Second, we investigate a range of policy instruments and financing options that are available to states for additional investments, and offer tentative projections of state climate-related spending in the near- to medium-term. Finally, we explore the sensitivity of state expenditures to federal policies that may have a substantial impact on state-level regulations and tax incentives. We find that states have many opportunities to integrate climate-related investments and incentives with existing programs and that doing so can yield substantial benefits for state budgets over the long-term; however, states with lower capacity and greater budgetary pressures may face increased trade-offs in budget allocations in both the short- and long-term. We conclude with some initial thoughts on how states can manage these budgetary risks through a range of policy instruments and public and private financing options.

Political Feedbacks and the Social Cost of Carbon, *Michael Livermore,** (mal5un@virginia.edu)*, University of Virginia; Peter Howard and Trevor Turner*

Political and social consequences from increasing global temperatures can affect the ability of governments to adopt policies to limit greenhouse gas emissions. Prior climate damages that affect political stability or international relations could undermine the efforts of future societies to avoid additional harms posed by rising global temperatures. This positive sociopolitical feedback has the potential to increase damages in the long-run as societies fail to anticipate and respond to future climate risks.

This paper explores the potential effects of political-climate feedback loops on the social cost of carbon. Using a unique dataset, this paper explores the relationship between conflict and international environmental cooperation. Given the growing evidence that climate change increases the probability of social and political conflict (Hsiang et al., 2011; Hsiang and Burke, 2014), this paper provides the first evidence of a political-climate feedback loop. This paper then explores the potential consequences of sociopolitical feedbacks through two modeling experiments. Using DICE-2013, the first examines the effects on total damages if the rate of decay of emission intensity declines at a specified temperature threshold. Using RICE, the second examines the effects of increased difficulty in climate negotiation beyond the specified

temperature threshold. The paper finds substantial effects from sociopolitical feedbacks, with the social cost of carbon exhibiting substantial sensitivity to modeling assumptions around this effect. The paper concludes with a discussion of the next steps necessary in testing for the existence of these positive feedback effects.

Impact Of Market Conditions On Payments For Forest-Based Carbon Sequestration, *Seong-Hoon Cho,** (scho9@utk.edu), *University of Tennessee; Juhee Lee; Roland K. Roberts; Edward T. Yu; and Paul R. Armsworth*

Market fluctuations are an important source of uncertainty related to the benefits and costs of payment programs for forest-based carbon sequestration. Failing to anticipate the potential uncertainties in market dynamics that affect the benefits (expected return from forestland) and costs (expected returns in other uses—opportunity costs) of retaining forestland may undermine the cost efficiency of payment programs. The objective of this study is to determine the different payments to forestland owners needed to achieve a target level of carbon sequestration under different market conditions. We develop supply curves for sequestered carbon using the aforementioned relationship under three different market conditions, namely the 2001-2006 real estate upturn, the 2006-2011 period that includes the real estate downturn, and the 2001-2011 period that combines the two periods (pooled period). The empirical results using a case study of 17 Tennessee counties and 1 Kentucky county show that (i) a payment system may be more effective during an upturn than during the pooled period or during a downturn, (ii) higher payments are required for any given target level of carbon supplied during the pooled period or during the downturn than during the upturn, and (iii) a higher maximum amount of carbon supplied can be achieved during the upturn than during the pooled period or during the downturn. Given past literature, these findings may be controversial and thus interesting in the sense that we would expect the opposite if the decision were based on the opportunity cost of retaining forestland and forestland owners' willingness to accept payment, both of which depend on variations in the expected returns from competing land uses. Instead, our findings suggest that market conditions affect the dynamics of deforestation response to changes in the net return from forestland conversion to urban use and consequently affect the cost efficiency of payment programs.

Sensitivity of the Social Cost of Carbon to Analysis Framing Decisions, *Anne Smith,** (anne.smith@nera.com), *NERA Economic Consulting and Paul M. Bernstein*

In 2010, an Interagency Working Group (IWG) of the Federal government developed its own estimates of the social cost of carbon (SCC) that it recommended for use in regulatory impact analyses of Federal regulations that would alter carbon dioxide (CO_2) emissions. An updated set of SCC values was released in 2013. These Federal SCC estimates have been derived using three well-known climate change integrated assessment models (IAMs). The position of the IWG was that its SCC estimates could be considered representative of the best available science (and its uncertainty) because it used the existing IAMs without changing any of their internal assumptions about carbon cycling and economic damage relationships. This presentation discusses how an IAM analysis is also dependent on a variety of "framing choices" that are not scientific in nature and are in the hands of IAM users. It identifies four important analytical framing judgments made by the IWG for its SCC estimates, discusses the basis for those and potential alternative judgments, and demonstrates the sensitivity of the SCC estimates to reasonable alternative judgments, using the same IAMs that the IWG used. The results demonstrate that the IWG's range of SCC values has been determined as much by the choices of analytical framing assumptions made by the members of the IWG as it has been by

science and economic assumptions made by the original IAM developers. The relevance of decision context for selecting framing choices will also be discussed.

➢ B-2: Recent Examples of Benefit-Cost Analysis in Consumer Financial Regulation (Roundtable Discussion)

Chair: Howell Jackson, (hjackson@law.harvard.edu), Harvard Law School

For many years, benefit-cost analysis was not a common feature in consumer finance. Most financial regulators were not subject to OIRA oversight and even those that were did not find their regulatory impact statements subject to stringent review. Especially with respect to estimating the benefit of consumer financial regulation, the field has not traditionally been well developed. As recounted in Jackson & Rothstein (forthcoming 2016), however, federal agencies responsible for consumer finance have started to produce more substantial benefit analyses. This roundtable will focus on the benefit analysis in three recent regulations in the field of consumer financial regulation: a CFPB regulation on mortgage servicing, a SEC regulation on crowdfunding, and the Department of Labor's 2015 proposal on fiduciary duties. For each regulation, an economist from the academic community will first review and comment upon the benefit analysis employed by the agency's rulemaking. The emphasis would be on assessing how well the analysis in question made use of relevant academic work on the topic and on considering what future academic work might be useful for improving benefit-cost analysis on such subjects in the future. We have also invited agency representatives to respond to the academic economist's comments, both as to the content of the benefit analysis presented, and as to profitably lines of future academic research. This roundtable tracks a recommendation from Jackson & Rothstein that academic economists be engaged more directly in the work of agency benefit-cost analysis in the field of consumer finance.

Panelists:

Scott Bauguess, (bauguesss@sec.gov) *Securities and Exchange Commission*

Will Dobbie, (wdobbie@princeton.edu)*, Princeton University and NBER*

Paul Rothstein, (paul.rothstein@cfpb.gov)*, Office of Research, Consumer Financial Protection Bureau*

Erik Sirri, (sirri@babson.edu)*, Babson College*

Glen Weyl, (weyl@uchicago.edu)*, Microsoft Research New England and University of Chicago*

➢ C-2: Learning from Experience

Chair: Rose Odom, **(**rosemarie.a.odom@uscg.mil), US Coast Guard

Discussant: David Luskin (david.luskin@dot.gov), US Department of Transportation

Presentations:

Implementation-Infidelity Break-Even Analysis: A New Way to Evaluate the Potential Consequences of Scale-up, *Dan Acland,** (acland@berkeley.edu)*, University of California, Berkeley; and Ravi Agarwal*

Many programs in the domains of public health, such as social welfare, education, and criminal justice, among others, are developed and evaluated as pilots. Cost-effectiveness and benefit-cost analysis of such pilot programs are increasingly common, and increasingly important for policy makers. Frequently there are concerns about how the costs and effectiveness of such programs may be affected by changes in implementation that may occur as they are scaled up for implementation by government agencies or non-profit contractors. However, as yet there is no systematic methodology for quantitatively assessing the possible effect of what we call "implementation infidelities" on cost-effectiveness ratios or net-benefit calculations. In this paper we develop and apply a new methodology which we call "implementation infidelity analysis" (IIA), which provides an intuitively tractable tool for decision makers to consider the likelihood that specific, foreseeable implementation infidelities will undermine the cost-effectiveness or net benefits of programs under consideration for scale-up. Both costs and effectiveness are modeled as functions of key parameters that are intuitively comprehensible to decision makers. Break-even analysis relative to a benchmark or baseline is then conducted on those parameters. The method is presented using an illustrative example of a simple HIV testing program, and is then applied to a major pilot program for treatment of tuberculosis patients in India.

Tailored Comparison Groups: Implementing a Difference-in-Differences Analysis When the Timing of the Intervention Varies, *Chris Leggett,** (chris.leggett@bedrockstatistics.com) *Bedrock Statistics, LLC; Jennifer Baxter, Industrial Economics, Incorporated; Corttney Penberthy, Seth Renkema and Andrew Rollo, U.S. Customs and Border Protection*

Since October, 2011, U.S. Customs and Border Protection (CBP) has been operating a pilot program intended to streamline import processing for the trade community. Under the program, certain companies have the option to voluntarily join a CBP "Center of Excellence and Expertise" (or "Center") that specializes in processing imports associated with a specific subset of industries. By organizing import processing by industry, CBP intends to increase the efficiency and predictability of trade processing. To evaluate the program's effectiveness, we implemented a modified difference-in-differences analysis, focusing on efficiency-related performance measures. Under a standard difference-in-differences analysis, efficiency improvements for program participants would be compared with efficiency improvements for a comparison group, and the difference in these improvements would be attributed to program participation. This standard approach breaks down when participants are allowed to join the program at different points in time. In this case, the relevant comparison group differs across participants. We address this problem by developing benchmark performance rates for non-participants that vary over time and by analyzing participants' deviations from these benchmark rates before and after program participation. The results indicate that substantial efficiency gains may be attributable to program participation. This work was undertaken in the context of CBP's assessment of the benefits and costs of the program, and the methodology is applicable to retrospective benefit-cost analysis in a variety of policy contexts.

Identifying Differential Effects of Consecutive Adaptation Stages When Evaluating Climate Change Adaptation Scenarios, *Adriaan Perrels,** (adriaan.perrels@fmi.fi)*, Finnish*

Meteorological Institute; H.A. Aaheim, H.A.; G. Ahlert; D. Crawford-Brown; C. Heyndrickx; J. Kiviluoma; F. Prettenthaler; and T. Rosqvist

In ex-ante assessments of climate change adaptation strategies, it is common practice to assume that only planned adaptation efforts are of interest, whereas so-called autonomous (or automatic*) adaptation is either ignored or assumed to be represented by the simulated responses to climate change of the economic system in absence of planned adaptation efforts.

In the EU funded FP7 project ToPDAd (Tool supported Policy Development for regional Adaption**) both sector models and macroeconomic models were used to explore different adaptation steps. Based on shared climate and socioeconomic scenario pathways (in this case RCP/SSP combinations) 7 case studies at different spatial scales were carried out concerning impacts and adaptation potential in one or several of the energy, transport and tourism sectors, while trying to distinguish between stages of adaptation (from none via automatic to planned). Three different macroeconomic models (2 CGE, 1 econometric dynamic I/O) were used to explore (1) the joint effects of mitigation and adaptation efforts at macro level, (2) use results of selected case studies to assess effects of more precise sector impact information, and (3) explore labor market effects of climate change impacts on public health and differences in effectiveness between proactive and reactive infrastructure adaptation investment strategies.

In the paper we review to what extent models were able to distinguish adaptation stages, and to what extent effects of different adaptation stages could be inferred by comparing different model simulations. Also, the benefits and limitations of combined sector and macroeconomic model use will be discussed. Finally, we discuss what these experiences imply for communication with policy makers, and how further model development and experimentation with research set-up could improve matters.

*) In the 3rd Assessment Report of IPCC Working Group 2, both terms are defined. The paper will explain the difference between the two terms when applied to economic systems.
**) http://topdad.services.geodesk.nl/web/guest/home

➢ D-2: Benefit-Cost Analysis of Transportation Policy

Chair: Neil Eisner, (neileisner@gmail.com), Consultant

Discussant: Jack Wells, (jackwells1@mac.com), US Department of Transportation (former)

Presentations:

Benefit Cost Analysis of Lifesaving Regulations from the U.S. Department of Transportation, *Kerry Krutilla,* * (krutilla@indiana.edu), *Indiana University; Gabriel Pina; David H. Good; and John D. Graham*

This research evaluates the quality of Regulatory Impact Analyses (RIAs) prepared by the Department of Transportation (DOT) of rulemakings that are expected to reduce mortality risks, including transportation safety regulations. Together with EPA, DOT promulgates more lifesaving regulations than all other agencies combined. One indication of the result is the decline in US annual traffic fatalities from over 50,000 to about 32,000 in slightly over 30 years

(although there has been a significant uptick in fatalities in 2015) while the vehicle miles driven over the same period have doubled. State regulatory programs and market evolution toward safer vehicles have also contributed to this trend.

The sample of RIAs chosen for study assesses economically significant DOT regulations issued from 2011 through 2014. Federal register web pages were searched for "economically significant rules" for the DOT by year, and the resulting sample was further narrowed to rules that estimated lifesavings. The associated RIAs for the rules were searched for in regulations.gov, using the docket number of the rule. This procedure produced a sample of 11 RIAs.

A number of criteria were used to evaluate these RIAs, including the clarity and balance of the presentation; the reasonableness of the baseline; the credibility of the estimates of incremental changes from the baseline that the regulation is estimated to cause; and the characterization of the timing of capital investment and benefit streams. We also evaluated the uncertainty analysis of estimated lifesavings. Our study shows that the RIAs differ in quality along the attributes considered, and in the overall quality of the analysis. We make recommendations for standardizing and improving the evaluation, with respect to the baseline specification and the conduct of uncertainty analyses.

Comparisons of National Guidelines for Cost Benefit Analyses Applied to Transport Investments, *Emile Quinet,** (emile.quinet@wanadoo.fr)*, Ecole Des Ponts-Paris Tech and David Meunier; Université Paris-Est*

Cost benefit assessment of investments is an ongoing preoccupation that has gained interest from public authorities in many countries. Guidelines have recently been updated, including for transport investments, in several countries. In most countries several new issues are at stake, such as the so-called wider effects.

In Germany, for instance, the regular review and set-up of the Federal Transport Infrastructure Plan (FTIP) is based on assessment methodologies, which are updated regularly. The most recent update will be finalized soon. In France, the requirement for cost benefit assessment has long been enshrined in legislation concerning transportation, and it has recently been updated with a new set of guidelines. In the UK, an ongoing process of improvement is underway and incorporates many revisions to the processes used a decade ago.

This paper will review and compare the main methodological choices and updates made in national approaches (France, the Netherlands, Germany, the UK, Australia and some Nordic countries, as well as the general guidelines issued by the Commission of the European Union) including types of effects covered by CBA, comparison of some methodological choices, unit values adopted for some direct effects, and external costs (e.g. CO_2), with a focus on items which are non-specific to transport (treatment of risks, discount rate, cost of public funds, etc.). We will comment on the main convergences and differences, and try to relate them to national specificities.

New Developments in Cost-Benefit Analysis Applications to Transportation, *Mario Scott,** (mario.scott@sdgworld.net), *Steer Davies Gleave; and Pierre Vilain*

The last decade has seen a significant increase in the use of cost-benefit analysis (CBA) to guide transportation planning in the United States. This development has been tied to policies at

the federal level requiring CBA for projects seeking discretionary funding, but also reflects increasing use by regional and state transportation agencies as well.

Interestingly, the current practice of CBA has included a substantial expansion in the scope of analysis from more traditional applications one would have seen in BCA textbooks from the 1990s (Mishan (1998)). We identify three major areas where CBA practice in transportation has expanded: accounting for environmental benefits and technological change; estimating wider economic benefits and; analysis of "state of good repair" projects.

Each of these extensions to the classic model reflects advances in how infrastructure is evaluated. New emissions models, combined with an increased understanding of health effects, have greatly improved the understanding of environmental impacts of transportation investments. Similarly, wider economic benefits incorporate what were primarily theoretical concepts of New Economic Geography (Krugman (1991)) into an empirical framework to assess the efficiency gains in production of improved accessibility. Finally, state of good repair projects have usually been considered too challenging to assess in a CBA context. While a CBA of these projects is still uncommon, there is a growing understanding of the data required to complete such an analysis, and increasing interest by decision-makers in this type of analysis.

➤ E-2: BCA Applied to Food and Agriculture in Developing Countries

Chair: Daniel Perez, (danielperez@gwu.edu), GW Regulatory Studies Center

Discussant: Carlos Santos-Burgoa (csantosburgoa@email.gwu.edu), The George Washington University

Presentations:

Socio-Economic Factors Influencing Productivity Among Cassava Farmers in East Africa, *Paul Mwebaze,** (paul.mwebaze@csiro.au)*, Sarina MacFadyen and Paul De Barro, CSIRO; John Colvin, Natural Resources Inst.; Christopher Omongo and Andrew Kalyebi, National Crops Resources Research Inst.; Donald Kachigamba, Dept. of Ag. Research Services, Malawi*

Cassava is the second most important food crop in Africa after maize. It is a major staple crop for more than 200 million people in East and Central Africa, most of them living in poverty in rural areas. Recently, cassava has gained importance as a cash crop for smallholder farmers in this region. However, its production is undermined by several factors, particularly the problem of emerging and endemic pests and diseases. The whitefly (*Bemisia tabaci*) is the most serious pest of cassava, causing significant yield losses through direct feeding damage and as a vector of virus diseases. However, there are few empirical assessments of the economic impacts of the whitefly on smallholder producers. We are conducting a comprehensive socio-economic study covering Uganda, Tanzania and Malawi to determine the status of cassava production with the following specific research questions:(1) Is cassava production profitable? (2) Are cassava producers technically efficient? (3) What is the current adoption rate of improved cassava production technologies? (4) What is the economic impact of the whitefly on smallholder farmers?

The primary data for this study is being collected from cassava farmers in Uganda, Tanzania, and Malawi, using a pre-tested survey questionnaire that is orally administered to individual farmers. A total of 1200 respondents were selected and interviewed using a multi-stage random sampling technique. An economic analysis is being conducted using gross margin (GM) analysis, cost-benefit analysis (CBA) and a stochastic frontier production model to evaluate the costs, returns and productivity of cassava farmers in this region. We present some of the preliminary results, discuss the implications, and the further work required.

Contract Farming Risks: A Quantitative Assessment, *Arkins Mwila Kabungo,* African Development Bank, and Glenn P. Jenkins, Eastern Mediterranean University*

The objective of this study is to identify the key risks facing each of the stakeholders in the export-focused paprika value chain in Zambia. Although a deterministic cost–benefit analysis indicated that this outgrower scheme would have a very satisfactory net present value (NPV), a Monte Carlo analysis using an integrated financial–economic–stakeholder model identifies a number of risk variables that could make this system unsustainable. The major risks include the variability of the real exchange rate in Zambia, the international price of paprika and the farm yield rates. This analysis points out that irrigation systems are very important for both stabilizing and increasing yields. The analysis also shows the limitations of loan financing for such outgrower arrangements, when at the sector level it is difficult - or even impossible - to mitigate the risks from real exchange rate movements and movements of international commodity prices. This micro-level analysis shows how critical real exchange rate management policies are in achieving sustainability of such export-oriented value chains.

Estimates of the Global Burden of Foodborne Disease & Their Implications for International Benefits Assessment, *Sandra Hoffmann,** (shoffmann@ers.usda.gov), *USDA ERS; Roger Cook; Willy Aspinall; Brecht Devleesschauwer; Amy Cawthorne; and Tine Hald*

Public health authorities view foodborne diseases as significant public health concerns in both high income and lower income countries around the world. Yet,even in high income countries, estimates of the incidence of foodborne disease have only been available in the past decade and a half. Cost of foodborne illness estimates have only become available in the U.S. in the past few years. In 2006, the World Health Organization (WHO) organized an effort to develop the first estimates of the global incidence, as well as the burden of foodborne disease. Burden is measured in terms of Disability Adjusted Life Years (DALY). The effort will develop comparable estimates of foodborne disease incidence and burden for 33 major microbial, parasitic and chemical causes of foodborne disease, for each of 6 WHO regions. The research initiative also conducted research attributing this disease burden to major food exposure pathways in 14 WHO global burden of disease sub-regions. This presentation will share results from the initiative on disease burden and attribution to food exposures. It will discuss the structure and use of DALY measures as providing a basis for comparison across diseases and regions. It will then discuss potential uses for results from this research initiative in analysis of national and international food safety policy and cost-benefit analysis. It will conclude with an exploration of the questions that this research initiative, and the global burden of disease initiatives as a body of work, raise about the role of economic benefits assessment in international health, safety and environmental policy.

Session 3: Thursday, March 17, 2016, 2:00pm - 3:30pm

➤ A-3: Storm'd at with Shot and Shell: How Economists and Non-Economists Collaborate

Chair: Bradley Brown, (Bradley.Brown@fda.hhs.gov), US Food and Drug Administration

The theme of this panel is practical advice from experienced regulatory analysts and developers on best collaborative practices between economists and non-economists. The intention of the panel is to provide regulatory analysts and developers with insights and tools for working together to develop policies, and the benefit-cost analyses that inform them.

The panel will address issues and best practices for economists working and communicating with non-economists on regulatory impact analyses during policy development. Panelists will be asked to address both the information-gathering phase and analysis-presenting phase of the regulatory analysis process. Panelists may also be asked to offer advice on specific examples of interactions from the moderator and audience.

Panelists:

Neil Eisner, (neileisner@gmail.com)*, Consultant*

Allen Fawcett, (fawcett.allen@epa.gov)*, US Environmental Protection Agency*

Clark Nardinelli, (Clark.Nardinelli@fda.hhs.gov)*, US Food and Drug Administration*

Stuart Shapiro, (stuartsh@rci.rutgers.edu)*, Rutgers University*

➤ B-3: Smoking and Vaping: Public Policy towards Cigarettes and E-cigarettes

Chair: Laura Stanley, (lstanle2@masonlive.gmu.edu), George Mason University

Presentations:

Valuing the first-hand health benefits of tobacco regulations, *Amber Jessup,** (amber.jessup@hhs.gov)*, Department of Health and Human Services*

As the U.S. Food and Drug Administration (FDA) implements its new authorities to regulate tobacco products, the Agency has had to confront some relatively unsettled questions in benefit-cost analysis. The primary benefits of tobacco regulations come from reducing mortality and morbidity among people who quit smoking or are deterred from ever starting. Available estimates of first-hand health benefits vary widely, from $20-30 per pack not smoked (Cutler 2002, Sloan et al. 2004, Gruber and Koszegi 2001) to $100-200 per pack (Viscusi and Hersh 2008). Having well-founded monetary estimates of the first-hand health benefits of reducing smoking is important, as FDA's ability to finalize and implement new regulations depends on how these and other benefits to consumers compare to costs borne by businesses and government. This paper presents new estimates of first-hand health benefits of reducing smoking, incorporating a number of methodological advancements. First, we incorporate recent

statistical estimates of expected increases in life expectancy and improvements in health-related quality of life, allowing these to differ by gender and the age at which a regulation changes a person's smoking status. Second, we incorporate recent draft guidance from the U.S. Department of Health and Human Services on valuing reductions in mortality and improvements in health-related quality of life in terms of quality-adjusted life years. Third, we value the lifetime health benefits of reducing smoking in present-discounted value terms, using both the standard counterfactual in which people smoke until they die and an alternative counterfactual in which they have some probability of quitting on their own. In brief, our estimates also show wide variation due to uncertainties about values of key variables. However, they are decidedly higher than $20-30 per pack and mostly fall in a $50-100 range. Implications for regulatory impact analysis of tobacco regulations are discussed.

Risk Beliefs and Preferences for E-Cigarettes, *W. Kip Viscusi,** (kip.viscusi@vanderbilt.edu)*, Vanderbilt University*

Drawing on evidence from a new nationally representative survey, this article examines several measures of risk beliefs for e-cigarettes. For both lung cancer mortality risks and total smoking mortality risks, respondents believe that e-cigarettes pose risks that are lower than the risks of conventional tobacco cigarettes. However, people greatly overestimate the risk levels of e-cigarettes compared to the actual risk levels. Risk beliefs for conventional cigarettes receive at least a two-thirds informational weight in the formation of e-cigarette risk beliefs. Public perceptions of nicotine levels of e-cigarettes are closer to the beliefs for conventional cigarettes than are their health risk perceptions. Consumers' desired uses of e-cigarettes are more strongly related to health risk perceptions than perceived e-cigarette nicotine levels. The overestimation of e-cigarette risks establishes a potential role for informational policies.

Optimal Taxes on E-Cigarettes, *Kyle Rozema,** (kyle.rozema@law.northwestern.edu)*, Northwestern University School of Law*

We study a model of optimal taxation on e-cigarettes, a healthier but addictive substitute to cigarettes. The model we develop has three key features. First, we account for heterogeneity in the population of smokers in terms of their predilection for nicotine addiction and preferences for e-cigarettes relative to conventional cigarettes. This allows the population of conventional cigarette smokers, e-cigarette users, and non-nicotine users to emerge endogenously in the model as a function of relative tax-inclusive prices for conventional cigarettes, e-cigarettes, and numeraire consumption. Moreover, it also allows us to evaluate the distributional impacts of e-cigarette taxation in addition to the direct efficiency costs. Second, we account for the possibility that smokers may only partly internalize the public health gains from switching from conventional cigarettes to e-cigarettes, reflecting behavioral failures. This is important because conventional smokers are less likely to switch to e-cigarettes on their own because they only partly internalize the harm caused by conventional cigarette consumption. Third, our model captures the possibility for e-cigarette consumption by non-smokers to 'gateway' to conventional cigarette consumption. This may offset the potential gains from smokers who switch from conventional cigarettes to e-cigarettes. To calibrate the model, we plan to estimate key elasticities of conventional and e-cigarette take-up using the Nielsen Homescan Consumer Panel dataset. While preliminary, the results from the optimal tax model suggest two policy recommendations. First, even under upper bound assumptions for the size of the gateway effect, the optimal size of e-cigarette taxes appears to be modest relative to cigarette taxes, although these results are very preliminary. Second, to the extent that the gateway effect is nontrivial, policy makers should act quickly to increase e-cigarette taxes.

The Challenges of Estimating the Benefits of Graphic Warning Labels on Cigarettes, *Don Kenkel,** (dsk10@cornell.edu)*, Cornell University*

Cigarette packs sold in the U.S. currently must show one of four rotating text Surgeon General's warnings about the health consequences of smoking. The Family Smoking Prevention and Tobacco Control Act of 2009 authorized the Food and Drug Administration (FDA) to require graphic warning labels (GWLs). Similar to labels in Australia, Britain and Canada, the proposed GWLs would contain graphic images and would cover fifty percent of the front and rear panels of each pack. The FDA's benefit-cost analysis of the GWL rule is controversial and the rule itself has been challenged in the courts. In this paper we discuss the challenges of estimating the benefits of GWLs. In particular, we focus on the research design challenges to develop credible estimates of the impact of GWLs on smoking outcomes. The FDA's analysis and other studies use a quasi-experimental design and compare smoking outcomes before-and-after the enactment of GWLs. Because GWLs are enacted nationally, these studies use other countries as the untreated control group. We discuss the validity of the assumptions required for this approach including; the comparability of the countries; common pre-trends in smoking; and the absence of other policy changes. We extend previous research to use alternative control groups: adjacent states and provinces in the US and Canada; and synthetic control groups. We also consider evidence from small-scale randomized experiments that gauge people's immediate reactions to different GWLs. Although these experiments do not raise the same questions of internal validity faced by the quasi-experimental studies, the experimental results might lack external validity and provide unreliable evidence about the impact of GWLs in the real-world.

➢ C-3: BCA Applied to Infrastructure Issues

Chair: Art Rios (Arturo.D.Rios@uscg.mil), US Coast Guard

Presentations:

Real Options and Cost-Benefit Analysis of Infrastructure: A Simplified Decision-Tree Approach to Value Flexibility, *Thomas van der Pol,** (t.p.van.der.pol@cpb.nl)*, CPB Netherlands Bureau for Economic Policy Analysis*

Real options theory stresses that flexible investment strategies are often superior to more rigid investment strategies. This also applies to infrastructure investments. However, the value of flexibility is ignored in the deterministic practice of cost-benefit analysis of infrastructure, which is common in the Netherlands and many other countries. This paper argues that a simplified approach to decision-tree analysis has the most potential to bridge the gap between real options theory and the deterministic practice of cost-benefit analysis of infrastructure. This paper elaborates on how simplified decision-tree analysis, a 'real options light method', can help to incorporate the key elements of real options theory, such as new information, multiple decision-moments and probabilistic states of the future. This is illustrated with numerical examples and two case-studies about Dutch road and flood risk infrastructure. The merits and limitations of the simplified decision-tree analysis are discussed and compared with contingent claims and other real options methods. These employ features like risk differentiation and stochastic assumptions that are often not understood by policy-makers and are difficult to communicate. Simplified

decision-tree analysis, in contrast, is easier to understand and communicate, and fits better in the practice of cost-benefit analysis of infrastructure.

Value for Funding: Evaluating Infrastructure Financing Alternatives in a Fiscal Context, *John Ryan** (jryan3@stanford.edu), *and Julie Kim, Stanford University Global Projects Center*

Public-private partnerships (P3s) are an important alternative source of financing for America's much-needed investment in public infrastructure. However, P3s are complex transactions and it is often difficult to evaluate their true costs and benefits in comparison to more traditional public-sector procurement methods.

Value for Money (VfM) is currently the standard BCA methodology for P3 comparative evaluation. VfM is a deterministic project-level analysis that can surface a P3's intrinsic efficiencies and cost savings in project construction and operation.

While a VfM analysis is always necessary, it is frequently not sufficient. When the public sector's long-term fiscal situation is constrained or stressed (as is now the case for many U.S. state and local governments) an additional level of analysis that explicitly considers fiscal context is required for a complete picture. Such an analysis will need to consider public-sector factors beyond the project itself. Since many of these factors are largely uncertain over the long-term, the analysis is intrinsically stochastic.

Stanford University's Global Projects Center is developing a new standard methodology, called 'Value for Funding' (VfF), to guide infrastructure financing comparative evaluation analysis. VfF focuses on a project's impact on fiscal factors in a stochastic framework. This presentation will introduce basic VfF methodology and illustrate the concepts with hypothetical examples of the differential fiscal impact of various P3 and traditional alternatives. The presentation will also include a report on empirical research done to-date.

Flood Insurance Take-up and Housing Prices: An Empirical Agent-Based Model Approach, *Okmyung Bin,** (bino@ecu.edu), *East Carolina University and Tatiana Filatova, University of Twente Faculty of Management and Governance*

Floods are one of the most common and widespread natural disasters in the United States, and yet the damage from flood events is usually not covered by homeowner's insurance policies. Flood coverage is offered federally through the National Flood Insurance Program (NFIP), established by the National Flood Insurance Act of 1968. Under current provisions, if communities choose to adopt minimum floodplain management policies, their residents become eligible for this insurance backed by the federal government. Federally regulated or insured lenders in the United States are mandated to require flood insurance on properties that are located in areas at high risk of flooding. Despite the existence of this mandatory flood insurance requirement, take-up rates for flood insurance have been low and the federal government's exposure to uninsured property losses from flooding remains substantial. In this paper we employ an empirical adaptive agent-based model to simulate the impacts of the flood insurance requirement on housing market under the scenario of the complete take-up. Our approach combines the empirical hedonic analysis with the computational economic framework to examine capitalization of insurance premiums in housing prices. A bilateral housing market allows exploring a shift between simulated hedonic equilibria while directly tracing the dynamics of implicit prices of flood risk over time. Results indicate that the requirement of flood insurance

would lead to decreases in housing prices. The effect is more pronounced for the Special Flood Hazard Areas than for the less risky areas.

Capturing or Illustrating the Highly Unlikely in a Regulatory Context, *Erik Gomez,* KPMG; Ali Gungor** (ali.gungor@uscg.mil), *and Rose Odom, United States Coast Guard*

Regulation is an intended set of government actions aimed at obtaining a socially optimal outcome. Sometimes a set of rules have the easily quantified goal of reducing or eliminating existing perilous risks, like making sure a plane engine meets mechanical adequacy. However, other rules' goals are far more difficult to quantify due to their abstract objective, such as reducing unforeseeable dangers like terrorist attacks, for example. So, how does one analyze the highly unlikely when standard statistical methodologies seem inadequate, at best? Some insights may be garnered from the 'Black Swan Theory,' a paradigm guided by the notion that by their very nature, the highly unlikely is nearly impossible to mathematically predict.

The proposed presentation will provide an overview of a rulemaking project (Dynamic Positioning Systems) to help illustrate the general approach that Coast Guard implemented in a regulatory analysis as it relates to the estimation of highly improbable events. Specifically, it critically evaluates the status-quo practices of benefit estimation, provides a framework for addressing 'un-predictable' events, and ultimately considers the validity of the 'Black Swan' paradigm in a regulatory context.

➢ D-3: Equity & Efficiency Concerns in Environmental Policy

Chair: Nicholas Mastron, (nmastron@gwmail.gwu.edu), The George Washington University

Presentations:

Social Benefits of Air Pollution Abatement Across Gender and Socioeconomic Position: Distribution Issues for CBA, *Luis Cifuentes,** (lac@ing.puc.cl)*, P Universidad Catolica de Chile and Nicholas Borchers*

Social benefits from air pollution abatement are often used as a justification for emission control measures. In a benefit cost analysis decision framework, these benefits are weighted against the costs of control, with little consideration for distributional issues, i.e. which part of the population bears the costs and which one the benefits. This work looks at the differences in the benefits from reductions in health impacts from air pollution, and their relative importance. We look at the differences across gender and socioeconomic position. We investigate the importance of differences in health effects base incidence rates, of the unit risk, of different exposure reductions, and of differences of willingness to pay to avoid health effects. Data for the analysis comes from analyses of air pollution abatement conducted in four Chilean cities that have different socio-demographic characteristics. The results show that unitary benefits can vary by as much as factor of 2. Without getting into ethical considerations, we discuss the implications of these results for designing air pollution abatement programs and measures.

Income Inequality and Carbon Emissions: Evidence from State-level Data, *John Voorheis,** (jlv@uoregon.edu), *University of Oregon*

A wide-ranging literature has suggested that there may be a relationship between economic inequality and environmental degradation, but has come to no consensus on the direction of the effect or credible identification of causality. I propose a way forward by combining new data with a new (to this literature) identification strategy. I leverage recently available State-level data on carbon emissions and income inequality over the period 1980-2012, combined with a simulated IV strategy to identify the causal effect of inequality on emissions. I find that increases in income inequality lead to decreases in the level of energy-related CO2 emissions and emissions per capita, concentrated in the electricity generation and transportation sectors. These results suggest that there may be a trade-off between addressing climate change and reducing income inequality.

Spatial Aspects of the Social Costs of Emissions: County, State, and Regional Results for the United States, *Jinhyok Heo,** (jinhyok.heo@cornell.edu), *Cornell University and Robert P. Strauss*

The Estimating Air Pollution Social Impact Using Regression (EASIUR) model and the Air Pollution Social Cost Accounting (APSCA) model were recently developed as an easy-to-use tool for estimating the public health costs (or social costs) of emissions in the United States. The EASIUR model was derived using regressions on a large dataset created by CAMx, a state-of-the-art air quality model, to estimate the social costs of emissions per ton of air pollutant emitted. Building upon the EASIUR model, the APSCA model allows one to identify emission sources for a given (receptor) location and to quantify their contributions efficiently and in unprecedented detail. The two models closely reproduce the social costs predicted by the sophisticated CAMx but without CAMx's high computational costs. They currently utilize national estimates of the value of a statistical life (VSL). In this study we propose to utilize county level personal income data for 2005 to allow the statistical cost of a life to vary spatially. When compared to the VSL method, this approach allows one to make detailed statements about the distributional effects of policy measures associated with changes in emissions. More specifically, we are interested in introducing equity measures into air quality policy. Using measures to evaluate the vertical and horizontal equity of tax policy, we will quantify the distributional effects of a major air regulation as a proof-of-concept.

Assessing Costs and Benefits from Implementing Real-Time Pricing of Electricity in Cypriot Power Market, *Sener Salci,** (sener.salci@gmail.com), *Queen's University*

This paper analyzes the impacts of real-time electricity pricing (i.e. marginal cost pricing for end consumers) in the Cypriot electricity market on power prices, peak and off-peak capacities, emissions from electricity generation, and renewable energy sources such as wind and solar. We apply the model to the real electricity market using real market data, such as hourly load demand and power supply data of the island. The results from the model show that dynamic pricing of electricity will increase capacity utilization during off-peak hours, decrease peak capacity, reduce power (costs) prices in Cyprus for poor off-peak users, reduce emissions from electricity generation, and increase the use of wind resources in the island. With introducing renewables such as wind and solar, we find that peak capacity decreases further so that capacity credits from solar and wind have a greater load factor as a percentage of peak demand. We find that there is a potential gain from smart metering even at small consumer response, and/or with a higher participation to the program. Therefore, the country should switch to smart metering and shift away from an average pricing of electricity, and authorities should let market participants react to changes in electricity prices. Costs of such programs outweigh benefits depending on range of demand elasticities and participation to the program.

Based on our benefit estimates from dynamic pricing, we also recommend that relevant authorities provide customers with accurate expectations about their bill savings from such programs so that the program will yield higher benefits to cover the cost of implementation.

➢ E-3: Improving Cost-Effectiveness of Hazard Mitigation Aid (Roundtable Discussion)

Chair: Brian Mannix, (BMannix@gwu.edu), GW Regulatory Studies Center

It is always a good idea to construct buildings and infrastructure to be resistant to damage from the natural hazards to which they may be exposed: hurricanes, floods, earthquakes, and tsunamis. In practice, many of these investment decisions are made in the wake of a natural disaster, when aid money is available, the risks are obvious to all, and reconstruction is proceeding urgently. Benefit-cost analysis has been used successfully in the U.S. and elsewhere to ensure that hazard mitigation funds are directed to projects with positive net benefits, but there are challenges in extending these methods to areas of the world where the availability of hazard data is more limited. This panel will explore the state of the art, and exchange ideas for advancing and improving the use of benefit-cost analysis for hazard mitigation in the context of international aid for development and disaster relief. Audience participation in the discussion will be encouraged.

Panelists:

Frits Bos, (f.bos@cpb.nl)*, CPB Netherlands Bureau for Economic Policy Analysis*

Joseph Cordes, (Cordes@gwu.edu)*, The George Washington University*

Sarah Lane, (lanesc@mcc.gov)*, Millennium Challenge Corporation*

Adam Rose, (Adam.Rose@usc.edu)*, University of Southern California*

Session 4: Thursday, March 17, 2016, 3:45pm - 5:15pm

➢ A-4: Accounting for External Environmental Benefits

Chair: Patrick Walsh, (walsh.patrick@epa.gov), US Environmental Protection Agency

Presentations:

Air Pollution and Defensive Expenditures: Evidence from Particulate-Filtering Facemasks, *Junjie Zhang,** (junjiezhang@ucsd.edu)*, University of California, San Diego and Quan Mu*

Rational individuals take preventive measures to avoid costly air pollution exposure. This paper provides new empirical evidence of pollution avoidance that Chinese urban residents purchase particulate-filtering facemasks against ambient air pollution. The analysis is conducted with detailed and comprehensive data available on daily facemask purchases and air quality that became available only very recently. We find that this transitory air pollution avoidance behavior exhibits dynamics and nonlinearities, with significant increases of facemask purchases during extreme pollution episodes. The daily model shows that a 100-point increase in Air Quality Index (AQI) increases the consumption of all masks by 54.5 percent and anti-PM2.5 masks by 70.6 percent. The estimates from the aggregated model with flexible pollution levels are used to simulate the benefit of air quality improvement. If 10 percent of heavy pollution days (AQI<=201) were eliminated, the total savings on facemasks alone would be approximately 187 million USD in China. This result suggests that reducing the occurrence of "airpocalypse" events represents a significant opportunity to improve social welfare. Nevertheless, our estimates are likely only the lower bound of the benefit of clean air because facemasks can only partially reduce the negative health effects of air pollution and the costs of other avoidance behaviors are not included.

Adding the Scenic Benefits to a Green-Roof Cost-Benefit Analysis, *Väinö Nurmi,** (vaino.nurmi@fmi.fi)*, Finnish Meteorological Institute; Athanasios Votsis; Adriaan Perrels; and Susanna Lehvävirta*

This presentation shares a green roof cost-benefit analysis. Green roofs are roofs that are partially or completely covered by vegetation. Here, we discuss the benefits and costs of lightweight self-sustaining vegetated roofs. We also review the state-of-art in the subject and compare our findings to relevant literature. The chosen valuation methods are applied first in Helsinki, Finland. Then we show how the results can be transferred to other urban locations.

Green roofs offer various kinds of ecosystem services, many of which are scarce in urban areas. These services accrue benefits to urban residents. The benefits include increased lifespan of the roof, energy cost reductions due to increased isolation and cooling, improved storm-water management, better air quality, improved noise insulation, scenic benefits, and improved biodiversity. The benefits can be further classified into private benefits (benefits the owner of the property) and public benefits (benefits the population of the area). Both the literature review and the results of this study show that private benefits are not high enough to justify the expensive investment for the private decision-maker. However, when the public benefits are added into the private benefits, social benefits are higher than the costs of green roofs in most cases.

Past research in this subject has quantified most of the benefits, excluding scenic and biodiversity benefits. In this study, special emphasis is placed on the valuation of scenic benefits; these are among the hardest to valuate in monetary terms. We employ hedonic pricing theory implemented via spatial regression models, and GIS-based green roof implementation scenarios, in order to estimate the aggregate willingness-to-pay for a "unit" of green roof (m^2). Our results show that the scenic value can be a significant attribute in cost-benefit calculations – when added into the cost-benefit analysis, the social benefits were larger than social costs in all cases.

Valuing Ecosystem Services from Coastal Wetlands: Benefits and Costs of Protection from Storm Surge, *Margaret Walls,* (*walls@rff.org*), Resources for the Future and Celso Ferreira*

Wetlands and other natural lands in coastal areas can provide a wide range of ecosystem services. One of the most important may be protection from hurricane storm surge-related flooding. The dense vegetation and shallow water within wetlands tends to slow the movement of surge inland and the vegetation dissipates waves, thereby reducing the amount of destructive wave energy that propagates on top of surge and worsens its impacts. As the climate warms, scientists predict that the worst hurricanes will increase in frequency along the Atlantic coast of the U.S., thus wetlands and other coastal natural lands may become more valuable in the future. In this paper, we integrate state-of-the-art mathematical modeling of storm surge and waves with a careful economic valuation exercise to calculate the value of coastal protective services from wetlands and other natural lands. Our study region is the Maryland counties on the Atlantic coast and bordering the Chesapeake Bay and its tidal waters. We combine results from surge and wave simulations using the ADCIRC+SWAN hydrodynamic and wave models, calibrated to the Chesapeake Bay, with detailed information on property values and land cover. Our benefit-cost exercise evaluates alternative land conservation, and wetlands restoration, scenarios; our measure of benefits is avoided economic losses due to property damages from hurricane flooding and the opportunity costs of permanently protecting, or restoring, those lands is our measure of costs. We evaluate benefits and costs under alternative scenarios for the location of wetlands conservation/restoration and under alternative future population growth scenarios, including the location of new households in the region. The research highlights how the value of ecosystems service is highly dependent on (i) the size, location and characteristics of wetlands, (ii) the track and intensity of storms, and (iii) the location of households and value of property that the wetlands are protecting.

Accounting for Externalities: Toward Benefit-Cost Analysis in Electricity Ratemaking, *Denise Grab* (*denise.grab@nyu.edu*), and Richard L. Revesz, Institute for Policy Integrity, NYU Law School*

As the social welfare implications of energy policy decisions become clearer, state utility commissions have begun re-evaluating their approaches to benefit-cost analysis. Traditionally, utility commissions have conducted their analyses of proposed policies from the perspectives of only certain stakeholders—for example, utilities under the Utility Cost Test, or consumers under the Ratepayer Impact Measure test. In recent years, utility commissions have begun to recognize the significant effects that their decisions may have on entities other than just ratepayers and utilities. Climate change has become especially salient, as electricity policy decisions can affect greenhouse gas emissions, and, in turn, climate change can exacerbate challenges to electricity grid resiliency. Given the increased attention on these and other externalities, a number of utility commissions have begun to recognize the importance of

conducting benefit-cost analysis from a broader societal perspective that considers a proposal's effects on both suppliers and consumers, as well as externalities.

However, even the leading states that have begun incorporating externalities into their assessments diverge from regulatory analysis best practices reflected in Office of Management and Budget guidance and federal agency practice. For example, the Social Cost Test used by many states fails to maximize social welfare because it is structured as a ratio-based test, rather than a net present value calculation, and therefore can mask the effect of scale for proposed policies. Some states include only selective externalities in their analyses, rather than all important indirect costs and benefits. Some states use inappropriately high discount rates for societal effects.

This presentation will examine the history of utility commissions' use of benefit-cost analysis tests, the approaches that commissions are taking to update their benefit-cost analysis tests in the face of a changing world, and additional steps that commissions can take to improve their benefit-cost analyses in order to maximize social welfare.

> ➢ B-4: Retrospective Benefit Cost Analysis

Chair: Stuart Shapiro, (stuartsh@rci.rutgers.edu), Rutgers University

Presentations:

A Retrospective Benefits-Cost Analysis of Applying Sex Offender Registration and Notification Laws to Juveniles, *Richard Belzer,** (rbbelzer@post.harvard.edu)*, Regulatory Checkbook*

State and federal governments have enacted laws to reduce the incidence of sex offenses committed against children. These include New Jersey's Megan's Law, the Jacob Wetterling Act, the federal Megan's Law, and the Adam Walsh Act. These laws established programs for the registration of sex offenders, and systems for notifying the public about the schools they attend, the places they work, and the homes in which they live. Advocates expected these regulations would deter future sex crimes, make it easier to identify and apprehend recidivist offenders who commit new sex crimes, and enable the public to better protect itself. Though juvenile offenders were not the intended target of these laws, the Adam Walsh Act explicitly brought them under the federal regulatory umbrella. Experts in child and adolescent psychology appear fairly united in the belief that this was a mistake, because juvenile and adult offenders are different, and egregiously harmful to juveniles caught in the web.

This paper summarizes a retrospective benefit-cost analysis of the application of registration and reporting requirements to juvenile offenders. No such analyses were prepared prior to the enactment of any of these laws, and no credible retrospective benefit-cost analysis appears to have been published over the intervening decades. Registration alone is estimated to yield annual net benefits of zero to -$1 billion. Public notification appears to produce no social benefits at all and impose about $10-$40 billion in annual costs. Juvenile offenders and their families bear a substantial fraction of these costs. However, most cost is borne by offenders' neighbors in the form of reduced property values. The extent to which net benefits are negative is highly uncertain due to limited information quality concerning juvenile sex offenses, no

systematic estimates of costs imposed on offenders, and only a few hedonic studies of property value effects.

Retrospective Benefit-Cost Analysis of the Cooperative Interstate Shipment Program, *Flora Tsui,** (flora.tsui@fsis.usda.gov)*, US Department of Agriculture, Food Safety and Inspection Service*

On May 2, 2011, USDA/FSIS published the final regulation to implement the cooperative interstate shipment (CIS) program. Under the new program, certain state-inspected establishments with 25 or fewer employees can apply to be selected and be eligible to ship meat and poultry products across the state-lines. The state in which the establishments reside must be already administering a cooperative state meat or poultry inspection (MPI) program and enforce food safety requirements "at least equal to" those under the Federal inspection program.

Using data from FY2011-2014, we examined the benefits and costs of the CIS program for its early stage performance. In particular, we compared the actual costs and benefits associated with the CIS program to date to those that we estimated in the Final Regulatory Impact Analysis (FRIA). We concluded that: (1) the program attained the benefits foreseen in the FRIA; (2) both the participating states and the Agency have kept the costs down, so the costs were below what FRIA estimated; and (3) with a total cost of the program being around $0.92 million, and a host of benefits including a $3.17 million sales revenue increase for the participating establishments, the program at this stage is cost-effective. This case study also highlighted the importance of retrospective BCA for regulations under which participation is voluntary and uncertain, and where the impact can be difficult to quantify ex ante in the prospective BCA.

The Costs and Benefits of OSHA Standards over 45 Years, *John Mendeloff,** (jmen@pitt.edu)*, University of Pittsburgh*

Have health and safety regulatory standards varied over time in their cost per unit of loss? This cost will vary as a function of the costs of reducing particular hazards and the levels that the standards are set at, which reflect the value placed on the risk reduction. One can think of many reasons why these costs might have varied:1) Presidents vary in their support for more protective regulation. 2) Earlier standards may have addressed "low-hanging fruit," which could lead to higher costs over time per unit of risk reduction. 3) New technologies could make risk reductions cheaper. 4) Rising incomes could justify higher valuations on reductions in risk. 5) Most directly, agencies and the White House could change the valuations that they use to establish or review new standards or the methods that affect them. In addition, newer information may result in better estimates of the always uncertain figures available when the decisions were made.

There have been only a few efforts to track the changing costs of new standards over time. This paper presents estimates of the cost per fatality equivalent prevented for Occupational Safety and Health Administration (OSHA) health standards from 1972 through 2014. Estimates are presented both by individual standard and by Presidential administration. Estimates of the magnitude of the health benefits over these periods are also presented. The paper also develops a method for converting non-fatal occupational health effects into fatality equivalents. This paper does not attempt formal tests of the impact of the factors listed above, but it does offer preliminary thoughts, and provide the raw data necessary for further examination. In brief,

we find that the cost per FEP has declined over time and that, surprisingly, most of the health effects were generated during Republican Administrations.

Retrospective Benefit-Cost Analysis of EPA's Renewable Fuel Standard, *Sofie Miller,** (sofiemiller@gwu.edu)*, The George Washington University Regulatory Studies Center*

The Renewable Fuel Standard (RFS), which requires gasoline refiners to blend specific amounts of ethanol into transportation fuel, was created to reduce both American dependence on foreign oil and domestic gasoline consumption. When the Environmental Protection Agency (EPA) issued rules implementing the RFS in 2010, RFS was expected to reduce carbon dioxide emissions by 2.34 million annual tons. However, new information about the environmental effects of biofuels and trends in energy prices have come to light since the RFS program was first authorized. This retrospective benefit-cost analysis uses new estimates of the carbon impact of renewable fuels and actual data on gasoline production and consumption to update EPA's initial estimates of the benefits and costs of the renewable fuel program.

➢ C-4: Methods for Estimating Costs

Chair: Richard Williams, (RWilliams@mercatus.gmu.edu), Mercatus Center at George Mason University

Discussant: Julia Marasteanu, (Ioana.Marasteanu@fda.hhs.gov), US Food and Drug Administration

Presentations:

A Method of Estimating Costs of Food Safety Interventions in the Meat and Poultry Industries, *Catherine Viator,** (viator@rti.org)*, RTI International; Mary Muth; and Jenna Brophy*

As the regulatory agency responsible for the safety of meat and poultry products, the U.S. Department of Agriculture's Food Safety and Inspection Service is required to conduct regulatory impact analyses of food safety-related regulations. This study developed estimates of the costs of food safety investments that can be used in conducting analyses of upcoming food safety regulations. The estimated costs apply to food safety investments incurred prior to slaughter – also known as pre-harvest – and during slaughter operations. The investments included in the study were animal vaccinations; vermin control and eradication; developing, validating, and reassessing food safety and sampling plans; food safety training for new employees; antimicrobial equipment and solutions; sanitizing equipment; third-party audits and certifications; and microbial tests. We collected cost inputs for initial and annual costs from two in-person expert elicitations, web searches, and contacts with vendors, and used these data to estimate capital equipment, labor, materials, and other costs associated with the investments. We developed separate estimates by establishment size (small and large) and species (beef, pork, chicken, and turkey), when applicable. For example, the cost of developing food safety plans can range from approximately $6,000 to $87,000 per establishment, depending on the type of plan and establishment size. Animal vaccinations cost between $1.32 and $8.42 per animal, depending on the type of animal and vaccination. The costs of third-party audits range from approximately $13,000 to $24,000 per audit, and establishments are often subject to multiple audits per year. These cost estimates can be multiplied by the number of

establishments required to comply with a regulatory requirement for comparison to the estimated health benefits. Knowing the cost of these investments will allow analysts to better assess the cost-effectiveness of regulatory alternatives in future rulemaking.

Estimating Welfare Costs of Shared Tax Bases, *William Hoyt,** (whoyt@uky.edu)*, University of Kentucky*

There has long been interest in "horizontal" fiscal externalities, the impacts of policies of one government (municipality, state, or federal) on the policies of others at the same level, and the possibility of competition among governments as a result. More recently there has developed a literature on "vertical" fiscal externalities. Vertical fiscal externalities arise when the policies of one level of government, for example, states, affect the policies of another level of government such as the federal government. Classic example are the impacts of changes in state (or federal) tax rates on the federal (state) tax revenues on shared tax bases such as income, tobacco, and motor fuels. The empirical literature on vertical tax externalities has generally focused on estimating reaction functions, that is, how tax policy of one level of government affects the tax choices of the other level of government (Devereux et al. (2007), Anderson et al. (2004), More and Sole-Olle (2001), Brulhart and Jametti (2006), Goodspeed (2000)). With few exceptions (Goodspeed (2000), Dahlby and Wilson (2004)) there have been few attempts to estimate the extent of these vertical fiscal externalities. While shared tax bases, such as taxation of the same commodity, will generate negative fiscal externalities, Hoyt (2015) shows that in a more general model, in which some tax bases are shared and others are not, these fiscal externalities need not be negative, depending on the cross-tax base elasticities. This being the case, the common wisdom, that tax bases should not be shared, is not necessarily correct. Here, an estimate of the extent of these vertical fiscal externalities is estimated using data on U.S. state and county tax revenues. Key to this study is the estimation of cross-tax base elasticities enabling the determination of a broader measure of fiscal externalities than previously considered.

Evaluation of Societal Costs of Damage to Buried Infrastructure in Quebec (Canada), *Nathalie de Marcellis-Warin,** (demarcen@hsph.harvard.edu)*, Harvard T. Chan School of Public Health; and Ingrid Peignier*

Vast networks of conduits and cables lie underground, delivering products and services to today's society. Underground infrastructures include telecommunication and electrical cables, gas conduits, sewers, water lines, drainage systems, oil pipelines, etc. The increasing number of networks, along with the fact that they are buried not far from the ground's surface translate into contractors striking them frequently while doing excavation or rehabilitation work of all kinds.

In 2014, there was an average of 5 damaged underground infrastructures per day in Quebec (Canada). In 35 percent of cases the intervention of municipal emergency services was required and 84 percent resulted in service interruptions (Source: Info-Excavation, 2014). The general purpose of this research is to identify and quantify not only the direct costs, but to also assess indirect costs entailed by damages done to underground infrastructure in the province of Quebec. The study will be used towards damage prevention and as an incentive for best practices amongst contractors, municipalities and owners of underground infrastructures and clients.

Four specific objectives have been established to carry out the research project: (1) Develop a typology for damage related direct and indirect costs for underground infrastructures. (2) Quantify total related costs for four types of damages to underground infrastructures in the province of Quebec and estimate the ratio between direct costs and indirect costs. (3) Develop an assessment methodology for damage related indirect costs for the province of Quebec and assess the total indirect costs for 2014. (4) Examine Quebec's database to identify key factors behind damages, leading to a more effective damage prevention program.

Case studies were used to illustrate the evaluation methods regarding different types of costs and to assess the ratio between indirect and direct costs. These case studies are meant to represent damages to underground infrastructures in the province of Quebec.

➢ D-4: Valuing Health Investments

Chair: Suhui Li, (suhuili@gwu.edu), The George Washington University

Presentations:

Adjusting the Measurement of the Output of the Medical Sector for Quality: A Review of the Literature, *Anne Hall,** (anne.hall@bea.gov)*, Bureau of Economic Analysis*

In January 2015, the Bureau of Economic Analysis (BEA) released the first version of the health-care satellite account, which redefines the good being measured in health care output from a single service to an episode of treatment of a specific medical condition. This change follows multiple recommendations by the Committee on National Statistics and by international authorities on national accounting as applied to medical care. BEA now faces the intensely difficult problem of how to adjust the price indexes for the quality of health care. In this paper, I review and summarize a number of previous papers that created quality-adjusted price indexes for individual medical conditions. It divides them into those that use primarily outcomes-based adjustments and those that use only process-based adjustments. Outcomes-based adjustments adjust the indexes based on observed aggregate health outcomes, usually mortality. They usually do so by calculating a concept called net value, which is the monetized value of the improved health outcome minus the increased spending on the condition. Process-based adjustments adjust the indexes based on the treatments provided and medical knowledge of their effectiveness. Outcomes-based adjustments are easier to implement while process-based adjustments are more demanding in terms of data and medical knowledge. I then calculate outcomes-based adjustments using the net value method for the indexes in the health-care satellite account with mortality by cause of death with data from the Centers for Disease Control and Prevention. They show that improved outcomes in diseases of the circulatory system created positive net value and declining inflation for those conditions but most other categories of diseases exhibit increasing inflation because spending on them is higher than the value of the improved outcomes.

Economic Costs of Oral Care in the United States, *Uma Kelekar,** (ukelekar@marymount.edu)*, Marymount University*

The paper employs a variety of methodologies to estimate the direct and indirect costs associated with oral care and treatment in the United States in 2014. It combines research findings from the medical, economics, and the epidemiology literature in order to lay out the direct dental and medical (non-dental) costs associated with oral care. Cost savings in the

treatment of systemic diseases, pregnancy, and pneumonia are reported. Additionally, it attempts to quantity what, if any, savings can result from efficiency-enhancing reforms to the oral health delivery system. The financial implications of preventive strategies, specifically dental sealants and early detection of oral cancer are also discussed in this paper. All the cost estimates are consolidated to present a few estimates of return on investment in oral care. In conclusion, it discusses the findings within the context of the population needs, and existing public policy on dental coverage.

BCA in the Outcome Evaluation of Small Biomedical Research Portfolios, *Sue Hamann,** (sue.hamann@nih.gov), *National Institutes of Health; Joseph Cordes, George Washington University; Timothy Iafolla; and Sarah Glavin*

Science evaluators are increasingly asked to include economic variables and econometric analyses in their evaluation of the outcomes and impacts of federally funded research. The National Institutes of Health (NIH) recently convened an expert, external panel to consider the broad area of assessing the value of biomedical research; the panel put forward an overarching assessment and measurement framework that included health care costs as an output and health care related cost savings as an outcome (Scientific Management Review Board, 2014). Two recent econometric outcome studies from NIH (Battelle, 2011; Roth et al., 2014) demonstrated large economic returns on investments in NIH. Because econometric modeling to measure returns on investment in federally funded biomedical research is relatively recent, there are critical questions to be considered, including the identification of relevant direct and indirect economic costs related to health, the identification and measurement of federal biomedical research costs, and the attribution of changes in health outcomes to federally funded research.

In this presentation, we consider the feasibility and utility of including benefit-cost analyses to the outcome evaluation of small research portfolios in oral health: dental sealants, early childhood caries, validated cell lines in head and neck cancers, and oral HPV infection. For each portfolio, at least one peer-reviewed publication was available that advanced specific claims as to economics or epidemiology of oral health conditions or treatment. We examine, from an econometric perspective, the credibility of each specific claim and then explore measures for evaluating the contribution of the research portfolios to the claimed economic benefits. We also identify the aspects of biomedical research portfolios that facilitate or inhibit econometric modeling.

Exploring the Effect of Life Expectancy on Cross-Country Comparisons of the Ratio of VSL to Income, *Dean Jamison,** (djamison@uw.edu), *University of Washington and Angela Chang, Harvard University*

Due to the lack of value per statistical life (VSL) studies conducted in low- and middle-income countries (LMICs), researchers commonly extrapolate from a VSL of a high-income country by applying income elasticity to the income ratio. While it is evident that the VSL would increase as income increases, there is less consensus on what the right income elasticity is when transferring the VSL to LMICs. In addition to income, another key difference between the two populations is their life expectancies, and some have suggested that people may be willing to pay less for mortality risk reduction given fewer years of remaining life expectancy. It is unclear whether income elasticity accounts for the difference in life expectancy for populations facing different mortality risks. Given the lack of empirical data and consensus on the appropriate theoretical framework, we are interested in the relationship between income elasticity and life

expectancy. Starting with the U.S. VSL, we derive two VSL estimates for other countries: the first set uses the ratio of gross domestic product per capita between the U.S. and each country, and a range of income elasticity is applied. The second set of VSL is extrapolated using the ratio of remaining life expectancy at age 35. The two sets of VSL estimates allow us to derive two ratios of VSL-to-income for all countries. We explore the relationship between these two sets of ratios by applying different functional forms and comparing their correlation coefficients. Our findings suggest that, depending on the level of income elasticity and appropriate functional form, there is high correlation between the two ratios. Given the limited number of VSL studies in LMICs and lack of consensus on the appropriate theoretical framework, we propose a simple and defensible analysis to shed light on the relationship between life expectancy and income elasticity.

➤ E-4: Benefit Cost Analysis and International Trade

Chair: Douglas Scheffler (Douglas.W.Scheffler@uscg.mil), US Coast Guard

Presentations:

Costs and Benefits of Regulating and Restricting Chemicals: The European Union's REACH System and its Impacts on Austria, *Michael Getzner** (michael.getzner@tuwien.ac.at)*, and Denise Zak, Vienna University of Technology*

The European Union's regulation for chemical safety (REACH) addresses the registration, evaluation, assessment, and admission (or banning) of chemicals which are potentially harmful for both public health and the environment. Enforced in the EU member states since 2008, the REACH system has been evaluated regarding economic impacts (chemicals production, employment) as well as in terms of costs and benefits equally for companies, households, and society as a whole.

However, reliable evidence on economic costs and benefits of the REACH system is scarce since there are still huge gaps in natural sciences, especially in the fields of the diverse impacts of chemicals on human health and the environment. The current study deals with such an assessment of costs and benefits of REACH for Austria under uncertainties, and draws on a wide range of databases on public and workplace health, chemical accidences in households, and potential environmental impacts of harmful chemicals.

The uncertainties of valuing costs and benefits with respect to chemicals policies, of course, do not lie only in scarce natural sciences evidence but also in the economic valuation of health effects, especially with regards to, for instance, diverse allergies possibly connected with chemicals, as well as Multiple Chemical Sensitivity (MCS).

The approach of this CBA of the REACH system in Austria therefore rests on a wide range of conservative scenarios and estimations regarding the (positive) human health effects of restricting chemicals, and on the economic valuation of these health effects. Projected over a period of about 30 years, it turns out that the REACH system is efficient, and leads to net benefits for the Austrian economy even under the most conservative scenarios and assumptions. This CBA thus provides strong evidence for the positive effects of the REACH system even though many benefits are highly uncertain or unknown.

The Importance of Benefit-Cost Analysis in Decision-making, *Kristina Gogic,** (gogic.kristina@hotmail.com)*, Office of the Croatian Ombudsman*

Benefit Cost Analysis is simply rational decision-making, yet it remains a controversial regulatory tool. As a relatively simple and widely used technique for deciding whether to make a change, BCA might be the most efficient decision framework in efficiency terms: a successful decision occurs when total expected costs are less than total expected benefits; that's logical and results in the most profitable option. Each analysis is different and demands careful and innovative thought.

BCA is very important in political and governmental decisions. The European Commission uses BCA as a basis for decision-making on the co-financing of major projects included in operational programs (Ops) of the European Regional Development Fund (ERDF) and Cohesion Fund. They made Strategy for Europe 2020 through a new guide to BCA of Investments projects (2014.-2020.). The objective of the guide reflects a specific requirement for the European Commission to offer practical guidance on major project appraisals, as embodied in the cohesion policy legislation for the noted period.

Since 2007, the level of investments in the EU has dropped off by about 15 percent, as a consequence of the economic and financial crisis, so this Strategy was necessary and the European Union Investment Plan. Here we can see the importance of BCA, which the European Commission used for this purpose.

BCA is very important tool. An individual can make decisions "ad hoc" but big companies, Governments and, in this case, the European Commission, must conduct deeper analysis before deciding: from fiscal point of view, local point of view, social point of view, EU Member States point of view (in a mentioned case), provincial point of view, and of some others.

A Benefit-Cost Analysis of the Trade Adjustment Assistance (TAA) Program that Accounts for the Value of Free Trade, *Peter Schochet,** (pschochet@mathematica-mpr.com)*, Mathematica Policy Research; and Sarah Dolfin*

The Trade Adjustment Assistance (TAA) program has been a linchpin of Federal efforts since 1964 to help America's manufacturing workers rebound from job losses experienced from foreign competition. The program aims to help affected workers obtain reemployment at a suitable wage by providing training, wage subsidies, and temporary income (TRA) support, among other services. This paper presents findings of a benefit-cost analysis of the TAA program based on a large-scale quasi-experimental impact evaluation of the program using survey and administrative records data from 26 states. TAA benefits were measured as the increased output of participants, reduced use of training and reemployment services not funded by TAA, and reduced receipt of UI and public assistance benefits. We measured the costs of TAA as program outlays for TRA benefits, training, allowances, health coverage tax credits, wage supplements, and administration. Program benefits were compared to program costs from the perspectives of society, TAA participants, and the rest of society.

An innovation of the analysis was to value TAA's effects in the facilitation of free trade—a frequently cited rationale for the program. For this analysis, we used the literature from trade economics to obtain an estimate of the value of improvements in free trade, and made assumptions about the extent to which the TAA program is responsible for promoting free trade

policies, partly by examining spikes in the mention of "TAA" in major newspapers and the media during major trade agreement negotiations.

We find that without considering the benefits of TAA stemming from the possibility that it promotes free trade, the net benefit to society of the TAA program was negative $53,802 per participant. However, we find that if TAA makes even a relatively modest contribution to the ease of enacting free trade policies, the program's total benefits would outweigh its costs.

Analysis of Benefit-Cost Analysis in the U.S. and E.U. Agricultural Sectors, *Daniel Perez,** (danielperez@gwu.edu), *GW Regulatory Studies Center*

This paper analyzes the similarities and differences in the use of benefit-cost analysis for regulations affecting the agricultural sectors of the U.S. and the E.U., in an attempt to identify areas of opportunity and strengths that both trade partners can incorporate into the analytical models they use to develop regulation. Trade between the U.S. and E.U. accounts for around 40 percent of global flows in goods and services – nearly half of global GDP - and agriculture accounts for a large part of traded goods between the U.S. and the E.U. where significant barriers to trade still exist. Recent efforts to eliminate remaining barriers to trade include negotiation of the Transatlantic Trade and Investment Partnership (TTIP), whose goals include going beyond traditional tariff reduction by focusing on improved regulatory cooperation. However, cooperation will be all the more difficult if regulations are being developed using substantially different analytical models to inform policymakers.

Political decisions and domestic preferences account for much of the divergence in U.S. and E.U. regulatory outcomes. Although complete regulatory convergence or harmonization between both trading partners is unlikely, both sides stand to benefit from efforts regarding convergence of the analytical foundations that inform regulatory decision-making. Consistent and high-quality benefit-cost analysis could help avoid unnecessary regulatory divergence or point out areas of opportunity for agencies to expand good regulatory practices.

Session 5: Friday, March 18, 2016, 9:00am - 10:30am

➢ A-5: Assessing Costs and Benefits of EPA Regulations

Chair: Ann Ferris, (Ferris.Ann@epa.gov), US Environmental Protection Agency

Discussant: Anne Smith, (anne.smith@nera.com), NERA Economic Consulting

Presentations:

The Costs of the New U.S. Ozone Standard, *Alan Krupnick** (Krupnick@rff.org)*, and Josh Linn, Resources for the Future*

High concentrations of ground-level ozone, commonly known as smog, pose serious threats to a large and diverse swath of the U.S. population. The U.S. EPA has recently lowered the limit from 75 parts per billion (ppb) to 70 ppb, citing adverse health effects that occur at levels lower than the previous limit and providing future health benefits to many more people. The costs of meeting pollution standards have always been contentious, and the case of ozone is no exception. The new limit will impose additional costs on the U.S. economy, the estimates of which were hotly contested before the rule was finalized, with industry estimates exceeding EPA's by at least five times.

Most of the cost controversy circled around the differences in how EPA and industry valued the mitigation measures needed to meet the tighter standard. To calculate the cost of the alternative standard, EPA had to value the cost of almost half the needed NOx reductions using "unknown" technologies. Here is where the estimates from industry wildly diverge.

Our analysis indicates that EPA's cost estimates are likely to be closer to the mark than industry cost estimates. In part this is due to the more realistic emissions reductions estimates assumed by EPA. It is also true because many policies—such as cap-and-trade programs and gasoline taxes—can reduce emissions reductions at a relatively low cost, but industry critics ignored the efficiencies of these market-based options.

A Cost-Effectiveness Analysis of Agricultural Greenhouse Gas Mitigation Measures in Denmark, *Alex Dubgaard,** (adu@ifro.ku.dk)*, University of Copenhagen*

This presentation describes a cost-effectiveness analysis (CEA) of agricultural GHG mitigation measures in Denmark. The agricultural CEA is part of an appraisal at the national level of measures to realize a policy goal of a 40 percent reduction in total Danish GHG emissions by 2020 compared to 1990. A total of 31 agricultural GHG mitigation measures are included in the assessment. The applied approach bears a certain resemblance to a cost-benefit analysis in the sense that the CEA is conducted at a net cost basis where ancillary benefits associated with GHG mitigation are subtracted from the costs of implementing these measures.

Particular focus is placed on the methods used to estimate implementation costs and ancillary benefits. These estimates should reflect the welfare economic costs of GHG mitigation in terms of changes in consumption possibilities for Danish society. This implies that cost estimates at factor prices must be converted to the consumer price level, which is done through multiplication by a so-called standard conversion factor – specified as 1.325 by the Danish Ministry of

Finance. Also, the calculations incorporate estimated tax distortion costs – specified by the Danish Ministry of Finance as 20 percent of the tax revenue. The ancillary benefits comprise reductions in nitrate and ammonia emissions. Using a shadow price approach these benefits are evaluated at the estimated marginal social costs of abatement under existing Danish policy programs to reduce nitrate leaching and ammonia evaporation.

The CEA identified 11 agricultural GHG mitigation measures which can be considered as cost-effective at the national level. Together these measures represent a GHG reduction potential equal to about 25 percent of the targeted reduction in total Danish GHG emissions by 2020.

The Role of Health Co-Benefits in EPA Regulatory Impact Analyses, *Scott Bloomberg** (Scott.Bloomberg@nera.com)*, NERA Economic Consulting*

In this presentation, I will present EPA's health co-benefits as presented in EPA's regulatory impact analysis (RIA) for the Clean Power Plan. I will discuss how the health co-benefits are calculated (in general and in this RIA), starting from the reductions in PM2.5 and ozone precursor emissions through the monetization of changes in health outcomes. My review will highlight the interesting questions regarding the use of already-regulated pollutants as a basis for co-benefits in regulatory impact analyses.

➢ B-5: Addressing Uncertainty in BCA

Chair: Aaron Kearsley, (Aaron.Kearsley@fda.hhs.gov), US Food and Drug Administration

Presentations:

Understanding the Uncertainty of an Effectiveness-cost Ratio in Education: A Bayesian Approach, *Yilin Pan,** (yp2266@tc.columbia.edu)*, Center for Benefit-cost Studies in Education, Columbia University*

Despite wide-ranging support of the message that both effectiveness and cost should be taken into account for program selection, it is still unclear whether it is sufficient to compare the alternatives only based on a single, scalar efficiency measure, i.e., one cost-effectiveness ratio estimate. The ratio estimate conveys information about what happened, one time, in the specific evaluation settings. However, if the program is replicated, it is almost impossible to obtain the same cost-effectiveness ratio due to measurement error, time-to-time and site-to-site variability, or other factors that contribute to uncertainty. Therefore, compared to a single cost-effectiveness ratio estimate that tells what happened, more useful information for practitioners would be 1) the best guess for what to anticipate in terms of the trade-off between effectiveness and cost, and 2) the comparatively worst-case and best-case scenarios. The underlying methodological challenge is to identify a probability distribution of an efficiency measure. Given the necessity to bridge the gap between what happened and what is likely to happen, this paper aims to explore how to apply Bayesian inference to cost-effectiveness analysis so as to capture the uncertainty of a ratio-type efficiency measure. The first part of the paper summarizes the characteristics of the evaluation data that are commonly available in educational research, discusses the ratio property, and proposes two estimators. The second section synthesizes two sources of uncertainty, and reviews the conventional quantitative methods that address the uncertainty of a ratio under each perception. The third part proposes two Bayesian models that

differ in the assumption of site-level variability, and demonstrates the estimation, presentation and interpretation of the results using the comparison of two high school dropout prevention programs: New Chance and JOBSTART. The last section summarizes the strengths and limitations of the Bayesian method, and lists some directions for future research.

Attitudes toward Catastrophic Risks, *Christoph Rheinberger,** (christoph.rheinberger@echa.europa.eu)*, European Chemicals Agency; and Nicolas Treich, Toulouse School of Economics*

Catastrophic risks, such as those posed by natural disasters, financial collapse, and industrial accidents have met with growing policy interest. Economists have recently devoted much attention to the modeling of climate catastrophes. In doing so, they typically start from the premises of a representative agent who seeks to maximize expected utility over an uncertain consumption path and thereby faces the risk of a catastrophe. In a famous paper, Martin Weitzman (2009: p. 9, Rev. Econ. Stat. 91) puts it this way: "The basic idea is that a society trading off a decreased probability of its own catastrophic demise against the cost of lowering the probability of that catastrophe is facing a decision problem conceptually analogous to how a person might make a tradeoff between decreased consumption as against a lower probability of that person's own individually catastrophic end." This means standard economics presumes that society should be catastrophe averse in the very same way the representative agent is risk averse with regard to aggregated consumption. In this paper, we introduce an alternative framework. We conceptualize catastrophes as social risks that bear a small chance of many people dying together. We characterize the catastrophic potential of a risk by the spread in the distribution of fatalities within the population at threat; our social planner therefore cares about the coincidence of fatalities in each possible state of the world. Our main objective is then to explore defensible attitudes toward catastrophe: How do we behave in the face of a looming catastrophe? And how should we behave in order to optimally protect ourselves against catastrophes? We collect insights from decision theory, behavioral economics, psychology, social choice and risk management studies to reflect upon these questions.

Nuclear War as a Global Catastrophic Risk: Analysis Issues, *James Scouras,** (james.scouras@jhuapl.edu)*, Johns Hopkins University Applied Physics Laboratory*

This paper explores challenges in applying both risk analysis and benefit-cost analysis to evaluate measures intended to reduce the risk of nuclear war. Like many other global catastrophic risks, large uncertainties in both likelihood and consequences of nuclear war, as well as the benefits and costs of measures intended to reduce either dimension of risk, complicate the evaluation of mitigation strategies. Moreover, nuclear war has unique characteristics that set it aside from natural catastrophes and even from other anthropogenic catastrophes. In particular, there is a critical linkage between the likelihood of nuclear war and its anticipated consequences. The strategy of mutual assured destruction exploits this linkage by maintaining the specter of horrific consequences in order to keep the likelihood of large nuclear war low. Also, nuclear strategy intentionally maintains uncertainty in the potential for smaller nuclear wars to lead to larger nuclear wars, thereby reinforcing the taboo against any scale nuclear war. However, nuclear strategy may be changing as we face the possibility of nuclear war arising from non-state actors and new nuclear states, against which traditional deterrence may be more prone to failure.

Uncertainty in Estimates of Benefits for BCA, *George Gray,** (gmgray@gwu.edu)*, The George Washington University*

The tools of human health risk assessment are often used to estimate benefits for benefit-cost analysis (BCA).   The benefits addressed by risk assessment may include reductions in morbidity, mortality, or other environmental effects. However, current practice in risk assessment grew up to address regulatory questions focused on standard setting (e.g., pesticide residues, soil cleanup standards, air quality standards) and not BCA. Science policy judgments are made in the face of the many uncertainties involved in risk assessment. Regulatory risk assessment, in general, uses conservative science policy approaches to serve the needs of standard setting and similar decisions. However, these science policy choices may not be appropriate for use in BCA. This presentation will detail the interplay of science, science policy and analysis in risk assessment and identify specific cases in which current practice fails to meet the needs of practitioners of BCA.

- ➢ C-5: Discounting Methods

Chair: Ali Gungor, (ali.gungor@uscg.mil), US Coast Guard

Discussant: Richard Zerbe, (richardozerbe@gmail.com), University of Washington

Presentations:

Hyperbolic Discounting in Benefit-Cost Analysis, *Charles Moss,** (cbmoss@ufl.edu)*, University of Florida, Troy Schmitz,* Arizona State University, Dwayne Haynes and Andrew Schmitz, University of Florida*

We revisit our Schmitz, Haynes, and Schmitz (2013) and Schmitz and Haynes (2015), where the latter emphasized the role of interest rates in discounting. We used the 2004 U.S. Tobacco Buyout as a case study. The 2015 study improved upon the 2013 study by including present value calculations in benefit-cost ratios over two distinct periods. We further this analysis by applying hyperbolic discounting to individual components that are a part of a given benefit-cost ratio, within a general equilibrium framework. Importantly, we use hyperbolic discounting to account for cases where the benefits and/or costs of a policy may not be realized until sometime in the future, which is an extension of its traditional use as it relates to consumers' motivation to constrain their own future choices (Laibson, 1997; Diamond and Köszegi, 2003; and Dasgupta and Maskin, 2005). This analysis can be extended to varying markets where the long term impacts of policies are evaluated.

Declining Discount Rates, Hurdle Rates, and Intergenerational Equity in Policy Analysis, *Daniel Wilmoth,** (daniel.wilmoth@sba.gov)*, SBA Office of Advocacy*

Some economists have argued that uncertainty about the appropriate discount rate implies that policies should be evaluated using a discount rate that declines with time. The implications of a declining discount rate for intergenerational equity are explored by investigating the relationship between declining discount rates and compensation criteria. Under some circumstances, the use of a declining discount rate corresponds to switching between two criteria so that the criterion most favorable to future generations is always applied. Under other circumstances, net benefits under a declining discount rate may be positive although neither criterion is satisfied. These issues make the use of declining discount rates objectionable, and an alternative method

for addressing uncertainty about the appropriate discount rate is developed. The private sector addresses similar uncertainty through the use of hurdle rates, and the simultaneous use of hurdle rates from each end of the probability distribution is shown to be both more equitable and more reliable than the use of declining discount rates. The use of such hurdle rates corresponds broadly to the analyses currently performed by federal agencies in the US, where regulatory impacts are discounted using rates of both three percent and seven percent. However, those values were not chosen to address the general uncertainty analyzed here, and their suitability as hurdle rates is discussed.

Mazur Discounting and the Private Benefits Paradox, *Brian Mannix,** (BMannix@gwu.edu)*, GW Regulatory Studies Center*

In recent years, federal regulatory agencies have used risk-free social discount rates to assign large "private benefits" to energy efficiency regulations. The paradox is that the individuals and businesses who experience these benefits reveal, through their choices, that they would prefer not to. The paradox can be resolved by a discounting procedure first suggested by economist Michael Mazur, the author of OMB's original guidance on Regulatory Impact Analysis, shortly before his death in 1989.

➢ D-5: The Regulatory Process, from Design to Analysis to Execution

Chair: Christine Kymn, (christine.kymn@sba.gov), US Small Business Administration

Presentations:

What Would a Redesigned Regulatory System Look Like? An Agency Theory and Public Choice Perspective*, Patrick McLaughlin,** (pmclaughlin@mercatus.gmu.edu)*, Mercatus Center at George Mason University*

Much research on the merits and demerits of the regulatory system takes the current regulatory system as its starting point and suggests specific reforms that address identified problems. Instead, we start from a "constitutional" perspective – that is, if we were building a regulatory system from scratch, what would we build? We use economic principles to consider the benefits and costs of different designs of a regulatory system in a theoretically "greenfield" jurisdiction. We use this thought experiment to develop a "model" regulatory system. A primary focus of our analysis relates to the review of agency theory's contribution to solving the principal-agent problem that is inherent in delegated lawmaking (such as regulation), which we synthesize with foundational public choice literature on the design of institutions for collective decision-making and bureaucratic behavior. We then consider how the current federal regulatory system compares to our "model" system, and what reforms could get us closer to it. By virtue of this comparison, we highlight several features of the existing regulatory system that can be targeted for reform, including missing elements, redundancies, superfluous elements, misaligned incentives, and failures of oversight.

Complexity and the Regulatory Process, *Stephen Jones,** (stephenmjones108@gmail.com)*, Mercatus Center at George Mason University*

Regulatory complexity may be beneficial. As economic complexity mounts, a more complex regulatory code may be necessary to address the wider scope of concern. However, a more complex regulatory code also has greater administration costs and could decrease aggregate compliance rates because the costs of understanding a complex system of regulations is nonzero. Law and economics scholars, such as Kaplow (1995), Parisi (2001), and Tullock (1995), therefore argue that the legal code should be as complex as it needs to be, but no more. A potential interpretation is that the marginal regulation exerts a negative effect on the regulatory stock by making the stock more complex. Absent a process to compare the marginal effect of a more complex regulatory code with its purported benefit of fitting to new conditions, regulation may be oversupplied. We use the regulatory database, RegData, to construct novel metrics of regulatory complexity. Our results suggest that the regulatory process has no tendency towards such an optimum, consistent with the idea that regulation, in the aggregate, is oversupplied.

Evaluating the Quality and Use of Regulatory Impact Analysis: The Mercatus Center's Regulatory Report Card, 2008-13, *Jerry Ellig,** (jellig@mercatus.gmu.edu)*, Mercatus Center at George Mason University*

The Mercatus Center at George Mason University initiated the Regulatory Report Card project in 2009 to assess how well executive branch agencies conduct and use regulatory analysis and identify ways to motivate improvement. Evaluation criteria reflect the regulatory analysis principles articulated in Executive Order 12866 and OMB Circular A-4. Evaluations of 130 economically significant, prescriptive regulations proposed between 2008 and 2013 reveal that the quality and use of analysis are low on average and highly variable. Agencies rarely make provisions for retrospective review when they issue regulations. Factors associated with better analysis include presence of a presidentially-appointed OIRA administrator rather than an acting administrator and high-impact regulations with benefits or costs exceeding $1 billion. Administrations of both parties tolerate worse analysis from agencies that are more likely to share their policy preferences. "Midnight regulations" and regulations left for the next administration to finalize have lower-quality analysis. The quality of analysis is also correlated with statutory constraints on agency decision-making criteria. There is no significant difference in the quality of analysis based on which party controls the presidency, the existence of statutory or judicial deadlines, or general constraints on agency decision-making authority, such as requirements that the agency must issue a new regulation or a statute prescribing the form, stringency, or coverage of the regulation. Little of the variability in quality is associated with agency-specific factors. Finally, after controlling for other factors, there is no evidence that civil rights, environmental, financial, security, or safety regulations have lower-quality analysis than economic regulations.

Objections to Regulatory Reform: Counter Arguments, *Richard Williams,** (RWilliams@mercatus.gmu.edu)*, Mercatus Center at George Mason University*

Despite the fact that we have not had significant changes to the Administrative Procedures Act in 75 years, a number of thoughtful objections have been raised to the dozens of bills now working their way through Congress. Looking closely at these objections, we find that many do not merit rejecting meaningful reform.   Reform efforts need to start with authorizing legislation, continue into the production of regulations by agencies, and finally review and modification or elimination of existing regulations. This paper will examine common objections to reform efforts and whether those objections withstand scrutiny.

➤ E-5: International Development and Finance

Chair: Gareth Harper, (Gareth.harper@optimityadvisors.com), Optimity Advisors

Presentations:

A Redistribution Mechanism and Network Approach in Microcredit, *Can Sever,** (sever@econ.umd.edu)*, University of Maryland*

In this paper, I propose a joint liability mechanism in microcredit. It is based on an income redistribution scheme among peers. In case of risk neutral agents, it does not affect expected utilities, whereas it increases social welfare in egalitarian terms. Assuming the observability of outputs, but private efforts, the mechanism is able to yield the equilibrium eliminating moral hazard problem in case of costly effort. Since it acts as an income smoothing mechanism, it also improves individual utilities when borrowers are risk averse. Extending the environment to a two-period world with market and reinvestment opportunities, it creates a new credit channel and increases expected utilities. Despite the fact that the social network is the key in microlending, there is a lack of theoretical papers which applies network tools to microfinance. To address this gap, I finally incorporate the network approach into the mechanism, considering the role of key players in a social network. Under the presence of the redistribution mechanism, if microlending penetrates to key players in the network, people who are not eligible for microcredit due to their position in a social network may have access to credit. While doing this, the mechanism also increases utilities of existing peers, and hence welfare increases in both individual and social levels. This paper produces policy recommendation illustrating that 'true' mechanisms may improve welfare for specific network structures.

Poverty Alleviation through Innovation in the Value Chain for Small Rudiments in the Somali Region of Ethiopia, *Mikhail Miklyaev,* (mikhail.miklyaev@cri-world.com)*, Eastern Mediterranean University and Cambridge Resources International*

The traditional value chain for small rudiments in the Somali Region of Ethiopia is to sell live animals to meat packers located near to the capital of the country, or to move live animals to the coast for export to the countries of the Gulf. As they are trekked to border markets, the result is a tremendous loss of weight and death of the animals. The innovation of this project is to slaughter the animals in a modern meat packing plant in the pastoral region of Faafan village, Somali State, and then export chilled or frozen meat to the Gulf countries. Until now the security situation in the region has prevented investors setting up such a facility in this region. With USAID assistance such a plant has been build and is successfully operating. The financial feasibility of the facility is essential for the project success, and it has proven to be highly profitable with a net present value at a 12% discount rate of about equal to the initial investment cost. The main purpose of this analysis, however, is to estimate the economic returns and the net benefits created for all the project stakeholders, namely: the small holder livestock producers, the livestock traders, the private operator, the labor employed by the facility, and the Government of Ethiopia. An integrated investment appraisal has shown that the initial benefits to the herders of the pastoral region are at least three times that of the meat packing plant. Due to the large supply of live animals and the profitability of this first facility, other investors are

expected to enter, this competition for the live animals will further benefit the animal producing pastoralists of the region.

A Cost-Benefit Analysis of Local Production of Ready to Use Therapeutic Foods In Uganda, *Glenn Jenkins,** (jenkins@cri-world.com)*, Queen's University and Eastern Mediterranean University*

The prevalence of malnutrition, vitamin-A deficiency, and anemia is high in Uganda. Of children under 5 years of age, 33 percent are stunted and 5 percent wasted. The rate of anemia among women and children is as high as 50 percent. The aim of this study is to identify if a 5 year off-take contract that would provide a sufficient incentive for the private sector to establish a factory for the production of Ready to Use Therapeutic Food (RUTF) production. At the present time this RUFT has been largely imported from Europe. The base-line analysis revealed that the financial incentive for the investment would exist if the off-take price is at the RUTF's world price level. The proper structure of the deal would also result on significant benefits arising to more than 4,000 HIV/AIDs infected farmers supplying pea nuts to the factory. The government of Uganda would also benefit by US$1.54 mill over the 10-year life of the project. The critical challenge to the production of in Uganda is to control the level of aflatoxins that are associated with the peanut input to the production of RUFT.

Session 6: Friday, March 18, 2016, 10:45 – 12:15pm

➢ A-6: The Energy Paradox

Chair: Art Fraas, (fraas@rff.org), Resources for the Future

Discussant: Timothy Brennan, (brennan@umbc.edu), UMBC and Resources for the Future

Presentations:

The Energy Efficiency Paradox: Evidence from Three Industry Case Studies, *Ann Wolverton,** (wolverton.ann@epa.gov)*, Heather Klemick and Elisabeth Kopits, U.S. Environmental Protection Agency*

Economic theory suggests that profit maximizing firms should have an incentive to incorporate technologies into their products that are cost-effective, absent consideration of environmental externalities. Even in the presence of uncertainty and imperfect information – conditions that hold to some degree in every market – firms are expected to make decisions that are in the best interest of the company owners and/or shareholders. However, simple net present value calculations comparing upfront costs of fuel-saving technologies to future savings suggest this is not always the case. This puzzle has been observed in a variety of contexts and is commonly referred to as the "energy efficiency paradox." A growing number of empirical studies in the peer-reviewed literature examine why households may under-invest in energy efficiency. To our knowledge, far fewer studies examine whether similar undervaluation occurs on the part of businesses. While a variety of hypotheses could explain this behavior, lack of empirical evidence on why businesses do not always invest in seemingly cost-effective energy saving technologies limits our ability to judge whether and when a given hypothesis is likely to be valid. We investigate capital investment decisions in three different industry contexts - heavy duty trucking, supermarket refrigeration, and data center investments – using a combination of focus groups and interviews. Consistent with the economics literature, in each case we distinguish between market failures, behavioral anomalies, and other factors not accounted for in typical net present value or payback calculations for energy efficient technologies. We then discuss key similarities and differences across the three case studies with regard to the way in which investment are made and the evidence we find of an energy efficiency paradox.

Searching for Hidden Costs: A Technology-Based Approach to the Energy Efficiency Gap in Light-Duty Vehicles, *Gloria Helfand,** (helfand.gloria@epa.gov)*, U.S. Environmental Protection Agency; Jean-Marie Revelt; Lawrence Reichle; Kevin Bolon; Michael McWilliams; Mandy Sha; Amanda Smith; and Robert Beach*

The benefit-cost analysis of standards to reduce vehicle greenhouse gas emissions and improve fuel economy by the U.S. Environmental Protection Agency and Department of Transportation displayed large net benefits from fuel savings for new vehicle buyers. This finding pointed to an energy efficiency gap: the amount of energy-saving technology provided in private markets appeared not to include all the technologies that produce net private benefits. The finding of a gap involves three pathways. First, the energy-saving technologies must be effective in achieving fuel reductions. Second, the cost estimates for those technologies must be lower than the present value of fuel reductions. Third, possible "hidden costs" -- undesirable aspects of the new technologies – must not exceed the net financial benefits. This study

examines the existence of hidden costs in energy-saving technologies through a content analysis of auto reviews of model-year 2014 vehicles.

Content analysis involves systematic identification in texts of key concepts and coding of those concepts; it makes qualitative assessments available for quantitative analysis. Auto reviewers, as professional evaluators, are likely to be sensitive to the existence of positive and negative characteristics of vehicles. It is unlikely that they would miss important problems, although they may identify negative characteristics that some vehicle owners may not notice.

Results suggest that it is possible to use fuel-saving technologies on vehicles without imposing hidden costs. For each of the technologies examined, the number of reviews that evaluated them positively exceeded the number that spoke negatively. There is scant evidence of a robust relationship between the technologies and vehicles' operational characteristics, such as handling or acceleration. It seems possible to implement these technologies without adverse effects on vehicle quality; hidden costs do not appear to explain the efficiency gap for vehicle fuel-saving technologies.

Regulating Use of Energy-Saving Technologies: The Case of Aerodynamic Devices on Heavy-Duty Trucks, *Randall Lutter,** (randall.lutter@virginia.edu)*, Batten School, University of Virginia; Art Fraas; Zach Porter; and Alex Wallace*

In a 2015 proposal to require heavy-duty vehicle manufacturers to use energy-saving technologies, the US Environmental Protection Agency estimated that the value of such savings greatly exceeds the cost of achieving them. This finding raises questions about cost-minimization in competitive industries.

To address these questions, we collected and analyzed data on aerodynamic energy-saving devices on more than 200 trucks operating on U.S. interstate highways during the summer of 2015. We hypothesize that device use increases with miles per vehicle per year, fleet size, and proximity to California, which has mandated devices on trailers since 2013. We also hypothesize that firms operating at the margin because of limited access to capital markets and/ or various management issues, etc., use aero devices less often. We develop a measure of such issues by constructing an index of noncompliance with federal requirements for hours of service and vehicle maintenance. Using these variables, we model use of aerodynamic devices.

Alcott and Greenstone (2012), Klemick et al., (2015) and EPA (2015) have suggested that adoption of energy-saving technologies may be hindered if owners of capital equipment where such technology is deployed are different from the entities that would enjoy the benefits of such technology. Accordingly, we test whether aerodynamic energy saving devices are less common on trailers towed by tractors with different owners. We find scant evidence of such an effect.

Our findings suggest market failures associated with energy conservation technology may be more limited than claimed by EPA for the trucking industry. More broadly, claims that issues like ownership differences in competitive markets interfere with the adoption of energy-savings technologies merit careful scrutiny. We make practical suggestions about how to conduct economic analysis in instances where benefits to users of new technologies seem to greatly outweigh the costs.

➢ B-6: VSL and Risk Preferences in Public Health and Safety

Chair: Rene Pana-Cryan, National Institute for Occupational Safety and Health

Presentations:

Eliciting Risk Aversion in the Context Of Health, *Rebecca McDonald,** (rebecca.mcdonald@wbs.ac.uk*), University of Warwick; Susan Chilton; Michael Jones-Lee; and Hugh Metcalf*

We present a conceptual framework for the elicitation of risk preferences from choices between lotteries whose outcomes are health states. To demonstrate the potential application of this framework in a survey setting, a specific procedure for eliciting health risk preferences is developed and tested in a survey (n=112) and shown to be straightforward to implement. Financial Coefficients of Relative Risk Aversion are also elicited, and correlation between these and the health risk preference measures is shown to be positive and significant, but low in practical terms, casting doubt on the domain generality of risk preferences and strengthening the case for a domain-specific alternative based within our conceptual framework. The specific interpretation of any such risk preference measure in health is also considered. Because there exists no unique, interval or ratio-scale cardinal measure of health, values or utilities are used to measure the health states over which gambles are defined. We show that if the value and/or utility functions for health are non-linear, then the elicited health risk preference coefficient provides a measure of probabilistic risk aversion (if values are used), or risk aversion relative to the average member of the population (if population average utility scores are used).

The implications of our work for BCA and policy are as follows. When individuals' preferences over health states and fatality risks are elicited, our techniques tend to use risks as the item under valuation (in traditional WTP-based VSL elicitations) or as the response mechanism (in Standard Gamble or Risk-Risk studies). Risk preferences over health and safety are likely to influence the responses in such studies, and subsequent allocation recommendations might be influenced by the level of health-specific risk aversion of the respondents. Understanding the nature of these risk preferences will help to improve the robustness of our policy recommendations.

What Is a Life Year Worth? Exploring the Methodology and Assumptions Behind The Full Income Approach, *Angela Chang,** (angela.chang@mail.harvard.edu*), Harvard School of Public Health; Lisa A. Robinson; James K. Hammitt; and Stephen Resch*

Background: The 2013 Lancet Commission on Investing in Health (CIH) estimates the value of improved health using a full income approach, adding the value of increased life expectancy to the value of predicted growth in gross domestic product (GDP). This approach captures the intrinsic value of health as well as its effect on economic production. The CIH finds that the value of an additional life year (VLY) averaged 2·3 times GDP per capita in low- and middle-income countries (LMICs), given the increase in life expectancy from 2000 to 2011. Examining related uncertainties provides insights into these findings, as well as options for applying the estimates in other contexts.

Methods: We investigate the sensitivity of the VLY estimates to the underlying assumptions, incorporating recent research, exploring alternative characterizations of the affected population, and examining the sequencing of the calculations. Our analysis addresses the VLY's

relationship to income, age, and life expectancy as well as the effects of adjusting the results for particular age groups.

Results: We find that the VLY estimates are particularly sensitive to the assumptions regarding the effects of income and age-specific survival rates; reasonable alternative assumptions may reduce the estimates significantly. However, the CIH also adjusts the values for young children downwards; eliminating this adjustment increases the estimates. These estimates reflect a specific shift in population life expectancy and may underestimate the value of this shift particularly when health improvements disproportionately accrue at older ages.

Conclusion: Given the lack of primary research on the value that LMIC populations place on a year of life extension, these values must be extrapolated from available research. The CIH develops one such approach. When applying this approach elsewhere, care must be taken to tailor the estimates to the impacts of the intervention and the affected population and to appropriately characterize uncertainty.

Valuing Quality-Adjusted Life Years for Benefit-Cost Analysis, *Lisa A. Robinson** (robinson@hsph.harvard.edu)*, and James K. Hammitt; Harvard Centers for Risk Analysis & Health Decision Science*

Benefit-cost analysis plays an important role in informing regulatory and other policy decisions, by providing information on how those affected value the benefits they receive in comparison to the costs the policy imposes. However, the usefulness of these analyses is currently hindered by the lack of willingness to pay (WTP) estimates for nonfatal health conditions. As a result, analysts often rely on estimates of quality-adjusted life years (QALYs), valued using a constant WTP per QALY, as a rough proxy. Both theory and empirical research suggest that that this approach is inconsistent with individual preferences: the value per QALY is likely to vary depending on the severity and duration of the condition as well as other characteristics of the risk and the affected individual. Several studies are now available that provide estimates of WTP per QALY for various health conditions. We combine the results of these studies to develop a function that can be used to estimate WTP per QALY, which may depend on the size of the gain. We find that this approach is promising but yields uncertain estimates given the limitations of the available research. Our research has implications for the values used as cost-effectiveness thresholds as well as for benefit-cost analysis, suggesting that these thresholds should be varied for different types of health conditions.

Evaluation of the Distribution of VSL Values by Combining New Vehicle Safety Estimates With a Model of Vehicle Choice, *Damien Sheehan-Connor,** (dsheehanconn@wesleyan.edu)*, Wesleyan University*

Many of the studies estimating the value of statistical life (VSL) use labor market estimates that may apply best to a subset of the population that is relatively homogeneous in terms of income and other characteristics. Since many households choose to own automobiles, the safety implications of this choice can be used to estimate the distribution of VSLs and its correlation with income and other demographic variables using broad support in the explanatory variables. A recently developed model of automotive safety (Economic Inquiry 53(3): 1606-29) uses Fatality Analysis Reporting System (FARS) data to estimate the level of safety of vehicles at the model by model year level. Specifically, the probability of someone dying in a particular vehicle over the course of a year is calculated. This probability is a complex function of vehicle weight, class, manufacturer, vehicle age, mean number of vehicle occupants, age of vehicle occupants,

and number of miles driven in a year. The safety estimates are combined with information on vehicle costs and data from the National Household Travel Survey (NHTS) to calculate the marginal cost of saving a statistical life for each vehicle type for a particular household. The NHTS provides data from a random selection of households about household characteristics, the vehicle(s) owned by those households, and the way in which these vehicles are used. The safety cost variable is included in a regression model of vehicle choice with a rich set of control variables to impute a VSL for each household in the NHTS. The resulting distribution of VSLs provides evidence about the variation in risk preferences within the population and the correlation of these preferences with income and other demographic variables of interest.

➢ C-6: Methods for Estimating Benefits

Chair: Linda Abbott, (LAbbott@oce.usda.gov), US Department of Agriculture

Presentations:

Exploring the Accuracy of Traffic-Noise Benefits Transfers, *Henrik Andersson,** (henrik.andersson@tse-fr.eu)*, Toulouse School of Economics; Jan-Erik Swärdh, VTI, Sweden; and Mikael Ögren, University of Gothenburg, Sweden*

One of the most common approaches to conducting benefit-cost analysis (BCA) is to rely on benefits transfers (BT). A benefit transfer takes already existing values from a study case (site) and creates a benefit estimate for a policy case (site) and thereby allows for a BCA to be conducted when direct estimates at the policy case are too time-consuming or expensive to be directly estimated. A recent review of BT studies (Kaul et al., JEEM, 2013) found that only one BT study had been conducted using the hedonic pricing technique. Since the hedonic pricing technique is one of the most influential non-market valuation techniques it is of interest to examine how well this technique works for BT. This study aims to provide evidence of how well the technique performs for BT by using a very rich Swedish data set on property prices and traffic noise. The findings suggest that:

1. The errors in estimates from adopting a BT approach can be significant. For instance the naïve BT in most cases produces non-negligible transfer errors (TE) (> 40%).
2. There is a large variation in how well BT works depending on from which study case values are transferred to which policy case.
3. BT adjusted based on income and the usage of benefit-transfer functions can reduce TE, but not systematically (i.e. TE may also be larger when using more sophisticated methods than the naïve BT method).

Overall, the findings from this study suggest that BT transfers based on estimates from the hedonic regression technique can result in large errors. Hence, policy makers should be cautious when using values from hedonic pricing studies.

Economic Analyses of Benefits And Costs of USDA Conservation Programs: What We Can Do Better, *LeRoy Hansen,** (lhansen@ers.usda.gov)*, USDA Economic Research Service*

USDA conservation program expenditures in 2014 were an estimated $5.5 billion. Despite the size of the expenditure, there are few studies that have attempted to estimate the benefits and costs of USDA programs. Economists and other scientists have employed a variety of innovative analytic techniques that have allowed some benefits and costs of some programs in some parts of the country to be estimated.

There are very challenging aspects of USDA conservation program benefit-cost analyses that are probably limiting progress, including 1) a program's effectiveness at initiating conservation practices differs across the country, 2) the ecological effects of practices vary, and 3) social values of marginal changes in environmental amenities differ spatially. Future benefit-cost analyses can build on the past. Additionally, future analyses will produce more policy-relevant results by incorporating methods and techniques discussed here. The first objective of this paper is to specify and verify the available refinements. Two examples of refinements are 1) results of future research will better support program decision making by following federal guidelines for carbon sequestration benefit analyses and 2) benefits transfer will provide more reliable results when analysts apply (or transfer) marginal-value (not average-value) estimates to marginal changes in environmental amenities. The second objective is to generate estimates of the economic effects that the proposed methods might have.

Lessons in Applied Benefit Transfer Using Meta-Analysis, *Patrick Walsh,** (walsh.patrick@epa.gov)*, Julie Hewitt, Steve Newbold and Matt Massey; US Environmental Protection Agency*

This study explores several important issues in the use of meta-analysis in an applied benefit transfer. Although there are many studies on best practices of both conducting a meta-analysis and performing a benefit transfer, there are far less studies on the best practices for using a meta-analysis as a benefit transfer function. On the other hand, federal rules are increasingly using meta-analyses for benefit transfers, especially at the U.S. Environmental Protection Agency (EPA). In order to highlight several important theoretical and empirical issues in using a meta-analysis for benefit transfer, this paper employs data from a past EPA rule. The focus of the meta-analysis is water quality benefits and EPA's 2003 CAFO rule is used as the example. The meta-analysis is based on a meta-dataset of 51 stated preference studies, published between 1985 and 2011. Each of these studies used a stated preference approach to elicit survey respondents' willingness to pay for water quality improvements. We look at several variations in the construction of the meta-analysis function, based on differences in theoretical and empirical assumptions. For example, although Diamond's "adding-up" property has received a fair bit of attention in the stated preference literature, it has received very little attention in the meta-analysis and benefits transfer literatures, and violations of it can imply strange results. In the context of water quality, a meta-analysis function that violates this property (which most previous meta-analyses do), implies that the WTP for several small rules would be higher than one rule that accomplishes the same change. After applying our functional form variations to the CAFO rule data, our results indicate that the variations in the meta-analysis function explore yield significantly different benefit estimates, and have several important implications for future applications.

Cost-Benefit Analysis in the Social Sector, Bahman Kashi,* Queen's University; *Zuzanna Kurzawa*, University of British Columbia; and Josh Folkema, World Vision Canada*

For a long time, players in the social sector have debated over the use of quantitative tools for measuring the impact of social programs. Advocates maintain that it would facilitate higher

levels of professionalism and better use of funds. Opponents however argue that such tools are unsuitable for the social sector. While some newly developed quantitative tools, such as SROI, have gained momentum in recent years, their usefulness for decision making has been subject to criticism. This study has two objectives. The first is to highlight fundamental issues that must be addressed before any quantitative methodology can be effectively applied in the social sector. The second is to provide an abstract framework to overcome such challenges.

➤ D-6: Evaluating the Effects of Regulation on Small Businesses: Practitioner Perspectives (Roundtable Discussion)

Chairs: Patrick Delehanty (patrick.delehanty@sba.gov) and Lindsay Scherber (lindsay.scherber@sba.gov), US Small Business Administration

Under Executive Orders 12866 and 13563, and OMB Circular A-4, federal agencies are required to develop regulatory impact analyses (RIAs) for all economically significant rules. As part of the rulemaking process, agencies are also required to evaluate small business impacts under the Regulatory Flexibility Act (RFA), including the identification of compliance costs and less burdensome alternatives.

Featuring economists from across the federal government, this session will highlight how regulatory agencies can integrate small business impact analyses into their broader RIA efforts. As BCA practitioners, panelists will share their strategies for locating high quality small business data, estimating small business impacts during the RIA development stage, and incorporating small business concerns into their broader regulatory analyses and proposals. They will also discuss methods for overcoming analytical challenges unique to the industries they regulate.

Panelists:

Alexei Alexandrov, (Alexei.Alexandrov@cfpb.gov)*, Consumer Financial Protection Bureau*

Thomas Henry, (Thomas.Henry@fda.hhs.gov)*, U.S. Food and Drug Administration*

Jonathan Porat, (jonathan.porat@sba.gov)*, U.S. Small Business Administration*

Amanda Thomas, (Amanda_L._Thomas@omb.eop.gov)*, Office of Management and Budget*

➤ E-6: Costs and Benefits of Social Investments

Chair: Lynn Karoly, RAND Corporation

Presentations:

Reasonable Accommodation and Sheltered Workshops for People with Disabilities: Costs and Returns of Investments, *Gareth Harper,** (Gareth.harper@optimityadvisors.com)*, Optimity Advisors; Rory Tierney; and Quentin Liger*

We conducted an economic analysis in support of an assessment for the European Parliament on programs intended to help disabled people find or remain in employment. As well as synthesizing existing economic literature from the U.S. and Europe and assessing national-level policy initiatives, we conducted cost-benefit analyses of two relevant programs: a Lithuanian program to help people with hearing disabilities find work through the use of recruitment agents who could communicate in sign language, and a Hungarian sheltered workshop for mentally disabled individuals.

Data on costs and effectiveness of these programs was collected through interviews and effects were valued using publicly-available wage, tax and benefits data for each country. Although these data were not complete, by making conservative assumptions around entry into employment, length of employment, and earnings, and by conducting break-even analysis for the Lithuanian program, we were able to calculate benefit-cost ratios for each program from the societal and government perspectives, and net benefit to the participants themselves.

The project provides a good example of how benefit-cost analysis can be used to provide a pragmatic assessment, even when data are limited, and help support recommendations to policymakers (namely that facilitating entry into open labor market employment is likely to be cost-beneficial, while traditional sheltered employment is likely only valuable for those whose disabilities are severe enough that open labor market employment is not possible). Future research into the intangible benefits of employment for disabled individuals, which we were not able to quantify, would provide a useful addition to cost-benefit analysis in this area.

Money Talks: Applying Cost-Benefit Analysis to Policies Combatting Intimate Partner Violence, *Nicholas Mastron,** (nmastron@gwmail.gwu.edu)*, The George Washington University*

Gender-based violence is increasingly seen as a problem within America. However, policies combatting this violence often evoke opposing visceral reactions amongst policymakers and citizens alike. Studies thus far primarily employ discourse analysis to assess the ideological themes present. However, this paper argues that cost-benefit analysis (CBA) could theoretically yield a far more comprehensive evaluation of gender violence. Given that gender violence represents a broad range of crimes, the study focuses specifically on heterosexual intimate partner violence (IPV). Therefore, the paper seeks to first examine the existing federal legal framework and the rationales justifying IPV policy creation; then to articulate the applicability of CBA in evaluating IPV policies; and finally to apply its findings to current CBA practices in the IPV field.

Federal regulatory foundations construct the justification basis of enacting IPV policies. The vast majority of pertinent federal rules historically fall under the legal requirement in Executive Order 12866. Regulations such as the Violence Against Women Act require establishing specific female employee protections (i.e. wage equality, discrimination adjudication, etc.) and these protections act as deterrents of IPV. However, E.O. 12866 also supplies an alternative administrative interpretation, specifically providing that "other compelling public need" may justify regulation. Ultimately, this has seen far less IPV application due to its broad potential interpretations.

Next, this paper asserts that cost-benefit analysis can help establish these "public need" interpretations for IPV regulations and also evaluate pre-existing policies. CBA's use in measuring IPV can be framed by the human capital argument; employees suffering abuse

directly correlate with lower productivity outputs, thereby lower revenues. Extending upon productivity concerns, the value of efficiency over time also produces substantive divergence in social cost functions in IPV cost-benefit analyses. Finally, the existing IPV cost models are analyzed using CBA, and these results are summarized.

Can the Ticket to Work Program Be Self-Financing? *Craig Thornton,** (cthornton@mathematica-mpr.com), *Mathematica Policy Research*

The evaluation of the Social Security Administration's Ticket to Work (TTW) program provides a convenient way of examining how benefit cost methods can be used to address several challenging issues. The first challenge stemmed from the program's very nature. It functioned less as a specific program and more as an effort to stimulate the market for employment services in order to help beneficiaries find jobs and become economically self-sufficient. Second, key decision makers in the SSA Office of the Actuary favored analytical approaches that differed from what economists and many other benefit-cost analysts tend to do. Finally, the program was implemented in a way that essentially precluded accurate estimation of program impacts. To address these challenges, the analysis used the available cost information to compute how big impacts would have to be in order to generate net benefits to SSA. It then used the available data and literature to make an assessment of whether impacts that big were at all plausible. The bottom line is that the program is relatively inexpensive and would only need to move a few thousand (out of 10 million) beneficiaries into substantial employment each year to generate net benefits measured just from the government budget perspective. While such an impact is not assured, it was certainly plausible. This approach could be useful in other cases where we lack the impact estimates we would like to have.

The Costs and Benefits of Recycling in New York City, *Ken Acks,* Cost-Benefit Group, LLC*

On April 22, 2015, NYC Mayor de Blasio declared that by 2030 the city would no longer send any garbage to landfills. New York would join San Francisco, Seattle, and other cities in moving toward a "zero waste" policy.

On October 3, 2015, in "The Reign of Recycling," the fifth most emailed New York Times article over the past 30 days, John Tierney, reprises a 1996 article and argues that recycling was, and is, wasteful when it comes to the bottom line, both economically and environmentally.

Tierney claims that despite decades of exhortations and mandates, it is still typically more expensive for municipalities to recycle household waste than to send it to a landfill. Prices for recyclables have plummeted; the national rate of recycling has stagnated in recent years and as cities move beyond recycling paper and metals, and into glass, food scraps and assorted plastics, the costs rise sharply while the environmental benefits decline and sometimes vanish. He claims that to offset the greenhouse impact of one passenger's round-trip coach flight between New York and London, you'd have to recycle roughly 40,000 plastic bottles without counting costs of rinsing. He also claims that all the trash generated by Americans for the next 1,000 years would fit on 0.1 percent of its grazing land, and that landfills are typically covered with grass and converted to parkland, such as the Freshkills Park on Staten Island, once at capacity. Furthermore, washing plastic in water heated by coal-derived electricity results in a net increase in CO_2; some landfill operators capture methane for electricity and; modern water-to-electricity incinerators release so few pollutants that they've been widely accepted in eco-conscious Europe and Japan.

This paper will utilize a variety of sources to estimate total costs of recycling and alternatives now and in 2030. Costs/Benefits include CO_2, methane, air pollution, traffic congestion, water use, energy, transportation, land use, and materials.

Session 7: Friday, March 18, 2016, 2:00 – 3:30pm

➢ A-7: Influences of Wally Oates: Extensions of Fiscal Federalism and Environmental Regulatory Design and their Implications for Benefit Cost Analysis

Chair: George Parsons, University of Delaware

Presentations:

A Review of the Contributions of Wallace E. Oates and their Implications for Benefit Cost Analysis, *Al McGartland* and David A. Evans,* US Environmental Protection Agency*

We provide an overview of Wallace E. Oates' contributions and their implications for policy analysis and benefit cost analysis on the provision of public goods. Oates made seminal contributions in the fields of both public finance and environmental economics. In public finance he explored the relationship among different levels of government in a federalism system on the provision of public goods of varying scales. This work in fiscal federalism considered the possibilities of public good spillovers across jurisdictions, mobility, the allocation and form of taxation, and the capitalization of the benefits and costs of programs into asset values. He was the first to show that the effects of government policies can be capitalized in property values – findings incredibly relevant to federalism arguments, environmental economics, and benefit cost analysis more broadly. In addition to applying the insights from fiscal federalism, he expanded our understanding of the performance of various approaches to environmental regulation. He helped us all think about the economics of many environmental policy issues, including: whether green subsidies performed as well as pollution taxes, the pros and cons of emission charges vs. pollution standards, the implications of environmental federalism, and the distributional consequences of environmental policy. We argue that his insights help identify which benefits and costs are particularly relevant to understand given the objectives of a regulation, how to use theory to limit the consideration of the scope of options to be evaluated using benefit-cost analysis, how to consider the role of decision makers at various levels of government, and that they emphasize the importance of accounting for long-run changes in benefit-cost analysis.

Economy-Wide and Sectoral Climate Policies and how they Interact: Results from EMF 24, *Allen Fawcett,* US Environmental Protection Agency*

The Energy Modeling Forum 24 (EMF 24) study, originally published in The Energy Journal (Vol. 35, Special Issue 1, 2014), focused on the interactions between different climate policy architectures and advanced energy technology availabilities in the U.S. The study included a set of policy scenarios designed to compare economy-wide market-based and sectoral regulatory approaches of potential U.S. climate policy, and compared the results of seven different models. This presentation highlights some of the key insights from the study, in particular: the relative cost effectiveness of economy-wide carbon pricing policies, sectoral policies, and combined policies; the impact of alternative cost metrics; and, the importance of baseline assumptions.

Environmental Valuation across Time: the Implicit Price of Water Quality through the Recent Recession, *Patrick J. Walsh,* Charles Griffiths, Dennis Guignet, Heather Klemick*

The recent recession caused large swings in home sales prices around the country, which has caused some concern with hedonic property analyses that rely on home sales data. The theory underlying hedonic analysis assumes the market is in equilibrium, so non-equilibrium behavior could impact the validity and interpretation of the results of a hedonic analysis. Boyle et al. (2012) examine this issue and identify several variables that can help identify non-equilibrium conditions. Bin et al., (2014) investigate the hedonic analysis of water quality over a period that spans the recent recession. Results indicate that even during the bust time when home sales are decreasing rapidly, the value of water quality is actually higher than normal, implying that the recession did not crowd out people's WTP for environmental values. Our paper builds on the Bin et al., (2014) paper by analyzing multiple housing markets during the recent recession. Our data includes over 200,000 homes sales across 14 counties in Maryland and focuses on water quality. The recession had a very different effect across counties, which allows us to further explore the impact of the recession and potential non-equilibrium behavior on environmental valuation. We split the data into several different phases of the housing market cycle and compare across phases. Results indicate that although there is still evidence of positive WTP for water quality during bust periods, there is also significantly more variation in the estimates during that time period, generally resulting in less significant coefficients. While the recession does not appear to be crowding out environmental values, as some past literature has suggested, there is still some concern with non-equilibrium behavior. Our analysis is similar to previous analyses of the Tiebout model of local finance, which holds that individuals seek out neighborhoods that reflect their demands for local services, which should be capitalized in both property prices and local tax rates. Wallace Oates proposed some early empirical tests of the Tiebout model (Oates, 1969) and published several papers (and book chapters) related to it. Although he demonstrated violations of the pure Tiebout model, he found that it has several important implications for behavior (Oates, 1981). Our paper indicates the local capitalization is likely a dynamic process that can change over time, and may suggest caution when evaluating the Tiebout hypothesis using limited data.

➤ B-7: Applying Behavioral Insights in BCA

Chair: Sharon Brown-Hruska, NERA Economic Consulting

Presentations:

How Much Relevance Does Reality Imply? (Re)Considering the Endowment Effect,
Timothy Brennan, UMBC and Resources for the Future*

The endowment effect - that someone's willingness to pay for a gain or accept a loss depends on whether that person treats a good or level of income as something they already have - figures in debates about how to conduct benefit-cost analysis. As the endowment effect is often seen as a threat to conventional ways of doing economics, discussions of the endowment effect are often polarized. Social practices indicate the reality and significance of the endowment effect; advertising and Buddhism are useful, if differentiated, examples.

The reality of an endowment effect is consistent with neoclassical principles and thus does not explain WTP/WTA differences, risk-preferring behavior below the endowment, or kinks in a demand curve at the endowment point. The above examples suggest that changing peoples' minds regarding their endowment takes more than reframing a question (WTP vs. WTA) or redistributing coffee mugs to seminar students. Differences in responses to WTP vs. WTA may

well be based on different responder interpretations of the endowment, but if so that imposed that WTP and WTA involve different questions, not reframing of the same question, and thus different responses are consistent with (economic) rationality. A similar form of the effect—not selling an item at a price above what one would be willing to pay to the obtain that item—could reflect either real options or specific history that makes something more valuable once owned.

The reality of an endowment effect, however, requires taking seriously the issue of what is being asked of winners and losers when a change in policy is being considered. If pre-policy setting, especially if long standing, indicates perceived endowments, BCA should be based on winners' WTP and losers' WTA, creating a status quo bias for policy, just as in behavior.

Reference Dependence and the Choice of Welfare Measure: WTP or WTA When Beneficiaries Pay the Costs and When They Do Not, *Jack Knetsch,* Simon Fraser University*

In spite of dictates of standard theory calling for the WTA measure to assess losses, and reductions of losses, in people's welfare, nearly all benefit and cost assessments, regardless of their sign or nature, continue, in practice, to be measured by people's willingness to pay for them. Unfamiliarity, skepticism over the available evidence of large disparities between people's valuations of many gains and losses, and the lack of accepted estimation methods to assess WTA values, are undoubtedly partially responsible for this seeming violation of accepted principles. However, the absence of widely accepted theory-based criteria for choosing the most accurate/useful measure in particular cases seems to also be a major contributor. This lack has led to a variety of seemingly plausible assertions, such as, "WTP, rather than WTA, is of course the preferred approach to monetization when a proposed public policy will compel people (taxpayers, workers, investors, consumers) to bear the costs of implementing it." -- suggestions that may often be at odds with their intent.

This paper reports on analyses of choice of measure criteria when valuations are subject to reference dependence and exhibit significant WTA/WTP disparities. These will include criteria for what appear to be the more problematic cases in which the same people benefiting from a change are those responsible for bearing its costs -- while many analysts may accept WTA valuations of environmental damages caused by a foreign private firm, the same may not extend to similar losses imposed by a local government (i.e., taxpayer) owned enterprise. The suggested criteria will be illustrated with several value-of-statistical-life (VSL) estimates arising in differing contexts. To the extent that these improved choice-of-measure criteria can improve welfare outcomes of proposed projects and policy changes, they should reduce the bias stemming from current practice.

The Losses from Lemons, *David Simpson,* US Environmental Protection Agency*

George Akerlof's seminal paper "The Market for Lemons," added "asymmetric information" to a list of market failures that already included imperfect competition, public goods, and externalities. In cost-benefit analysis we calculate Harberger triangles to inform antitrust policy, and estimate the marginal external damage from pollution to compute Pigovian taxes. In contrast to the extensive literature on estimating the benefits of correcting other market failures, however, I am aware of little work estimating "the losses from lemons". I take this topic up using the simple, illustrative two-type model Akerlof introduced.

Social losses arise when an asset that would be more valuable to a potential buyer than it is to its current owner does not change hands. This can happen if the buyer is uncertain as to the

quality of the asset offered for sale and the seller is unable to signal its true quality. Using incentive compatibility conditions, I am able to derive a simple expression for the "loss from lemons" and bound it. This bound is only a small fraction of the value of the asset itself. While I confine my attention to the simple model, my finding may prove to be general. Intuitively, losses arise because sales are not made, and sales are not made if would-be sellers have reservation prices that are not that much less than potential buyers would pay; that is, if the efficiency loss from not selling is small. This suggests that the legitimate societal concern over markets compromised by asymmetric information may arise more from an offense to our sense of equity than from efficiency concerns.

While I do not conduct statistical work, I motivate my analysis and results by reference to research on markets for potentially contaminated real estate.

Rational Benefit Assessment for an Irrational World, *W. Kip Viscusi,* Vanderbilt Law School and Ted Gayer, Brookings Institution*

Behavioral economists have identified certain biases in decision-making that lead people to make decisions that harm themselves, but there is insufficient guidance for estimating benefits in the presence of such behavioral failures. This gap in principles and standards for benefit-cost analysis has led government agencies at times to adopt arbitrary and excessive benefit valuations. This article describes an approach to incorporating behavioral market failures into benefit estimation, first by advocating a higher level of scrutiny to use before applying behavioral findings from narrow contexts to broader populations subject to regulation, and then by comparing the outcomes from the self-harming behavior to a policy reference point in which people are assumed to be fully informed and to act fully rationally in their own self-interest. This approach, which is grounded on systematic, well-documented, and context-specific findings of behavioral failings, would reduce instances of agencies assuming that behavioral findings in some contexts provide sufficient rationale for overriding consumer preferences in other contexts. It would also establish a consistent approach to government policy, for example by creating symmetry between advancing policies that seek to discourage consumption of products for which consumers underestimate the health risks and fostering accurate risk beliefs to address erroneous individual choices based on risk overestimation.

➤ C-7: The Effect on Benefit Estimates of Discarding Scientific Input Data

Chair: Dima Yazji Shamoun, Mercatus Center at George Mason University

Discussants: Kerry Krutilla, Indiana University School of Public & Environmental Affairs and George Gray, The George Washington University

Presentations:

The Effect on Benefit Estimates of Discarding Data from Human Chamber Studies,
Richard Belzer,* Regulatory Checkbook

Since the 1980s, several controlled chamber studies on human volunteers have been performed by USEPA and industry; the most recent study related to ozone is Schelegle et al. 2009. A common research protocol is used, including previously described clinical pulmonary

function tests. The most recent study (Schelegle et al. 2009) reported statistically significant decrements in pulmonary function at 70 ppb ozone. Two to four maneuvers were conducted for each test. In accordance with the standard clinical protocol, each test was represented by a single value, however. Other maneuver data were discarded prior to statistical analysis. In this paper, discarded data are simulated based on reported results and alternative values for inter-maneuver variance. Differences between concentrations are shown to be sensitive to the missing data. Benefit estimates are analogously affected. REFERENCES Schelegle et al. 2009. 6.6-hour inhalation of ozone concentrations from 60 to 87 parts per billion in healthy humans. Am Journal Resp Crit Care Med 180:265-272.

The Effect on Benefit Estimates of Discarding Data from Observational Epidemiology Studies, *R. Jeffrey Lewis,* ExxonMobil Biomedical Sciences, Inc.*

Since the 1980s, several observational epidemiology studies have been performed by various academic and government research teams to estimate pulmonary function decrements in various subpopulations from differences in ambient air concentrations for various pollutants. The current clinical pulmonary function protocol (Miller et al. 2005), or a predecessor, was adopted or adapted. In each case, multiple "maneuvers" were performed for each test, and a single value representing that test was recorded and used for statistical analysis. Other maneuver data were discarded prior to statistical analysis. In this paper, discarded data will be simulated based on reported results from an observational epidemiology dataset (where data can be obtained) and alternative values for inter-maneuver variance. Differences between concentrations are shown to be sensitive to the missing data. Benefit estimates are analogously affected. REFERENCES: Miller et al. 2005. Standardization of spirometry. Eur Resp J 26:319-338.

➢ D-7: Evaluating the Impacts of U.S. Border Enforcement Activities: Methodology Roundtable Discussion

Chair: Seth Renkema, US Customs and Border Protection

Panelists:

Joseph Cordes, The George Washington University

Alan Fox, U.S. International Trade Commission

Bryan Roberts, Institute for Defense Analysis

John Whitley, Institute for Defense Analysis

➢ E-7: BCA of Research and Emerging Issues

Chair: Jan Lewandrowski, USDA

Discussant: Andrew Estrin, US Food and Drug Administration

Presentations:

The Economic Benefits of Genomics Research: New Assays for Foodborne Pathogens,
Brian Morrison,* Industrial Economics, Incorporated; Amelia Geggel; and Mary McGee

The Genomics Research and Development Initiative (GRDI) coordinates Canada's federal science departments and agencies in the field of genomics research. Its long-term goals are to protect and improve human health, develop new treatments for chronic and infectious diseases, protect the environment, manage agricultural and natural resources in a way that is sustainable, and thus support the health and economic welfare of all Canadians.

The GRDI has funded genomics research at a number of federal departments and agencies, including Health Canada, since 1999. Scientists at Health Canada have achieved success on a variety of research initiatives. As is often the case, however, it can be difficult to quantify the long-term implications of emerging science, and measuring its benefits in economic terms is a challenge. Developing a better understanding of these benefits is an important consideration in Treasury Board decisions concerning future funding of genomics research.

This presentation summarizes Health Canada's first step in attempting to quantify the economic benefits of its genomics research programs. It presents a case study of an emerging GRDI success story: the identification and validation of whole genome sequencing techniques that facilitate the tracking of Campylobacter and Listeria, pathogens that are important causes of food poisoning. The study examines the potential benefits of new Campylobacter and Listeria assays in improving the ability of food safety agencies to detect and trace the sources of these pathogens. These benefits are quantified with respect to potential reductions in the incidence of illness and death attributable to consumption of contaminated food, and valued in accordance with Treasury Board guidance on the economic analysis of changes in health risks.

Quantifying Breakeven Price Distribution in Stochastic Techno-Economic Analysis,
Wallace E. Tyner ,* Xin Zhao, and Guolin Yao, Purdue University

Techno-economic analysis (TEA) is a well-established modeling process in which benefit-cost analysis (BCA) is used to evaluate the economic feasibility of emerging technologies. Most previous TEA studies focused on creating reliable cost estimates but returned deterministic net present values (NPV) and deterministic breakeven prices. Nevertheless, the deterministic results cannot convey the considerable uncertainties embedded in techno-economic variables, such as capital investment, conversion technology yield, and output prices. We obtain distributions of NPV, IRR, and breakeven price. The breakeven price is the most important indicator in TEA because it is independent of scale and communicates results effectively. The deterministic breakeven price is the price for which there is a 50 percent probability of earning more or less than the stipulated rate of return. For an investment under relatively high uncertainty, it is unlikely that investors would provide financing to a project with a 50 percent probability of loss. The point estimate breakeven price, therefore, does not represent the threshold under which investment would occur. In this study, we introduce the stochastic techno-economic analysis in which we incorporate Monte Carlo simulation into traditional TEA. A case of cellulosic biofuel production from fast pyrolysis and hydroprocessing pathway is used to illustrate the method of modeling stochastic TEA and quantifying the breakeven price distribution. The input uncertainties are translated to outputs so that the probability density distribution of both NPV and breakeven price are derived. Two methods, a mathematical method and a programming method, are developed to quantify breakeven price distribution in a

way that can consider future price trend and uncertainty. We analyze two scenarios, one assuming constant real future output prices, and the other assuming that future prices follow an increasing trend with stochastic disturbances. We demonstrate that the breakeven price distributions derived using our methods are consistent with the corresponding NPV distributions regarding the percentile value and the probability of gain/loss.

Cost-Benefit Analysis of Research, Development and Innovation Infrastructures: An Exploratory Evaluation Framework, *Emanuela Sirtori,* CSIL Centre for Industrial Studies; Massimo Florio; and Chiara Pancotti*

Policy makers have growing expectations on research, development and innovation (RDI) infrastructures, as an essential component of technological and scientific progress, and hence economic growth. The stakes associated with their selection and evaluation are therefore high. Cost-benefit analysis of RDI infrastructures is a new field. The intangible nature of some benefits and the uncertainty associated to the achievement of research results have often discouraged the use of a proper CBA for RDI infrastructures. The new Guide for the CBA of investment projects adopted by the European Commission (2014) gives some instructions to appraise RDI projects, but admits that due to lack of experience and best practices, the methodological framework still needs to be improved.

Our paper aims at fine-tuning and expanding the appraisal techniques recommended by the European Commission, in order to provide policy makers, researchers and project analysts with practical suggestions on how to perform a proper socio-economic analysis of RDI infrastructure projects.

We break down benefits into two broad classes: i) use benefits, held by different categories of infrastructure's users, such as scientists, firms, students and general public visitors, and ii) non-use benefits, denoting the social value for the discovery potential of the RDI infrastructure regardless of its actual or future use. We argue that the social value of discovery can be estimated with contingent valuation techniques. Another significant feature of our approach is the stochastic nature of the CBA model, intended to deal with the uncertainty and risk of optimism bias in the estimates.

The methodological approach laid down in our paper has been already tested with two case studies and is going to be discussed in a workshop involving the European Commission, the European Investment Bank, the European Strategy Forum on Research Infrastructures and several other stakeholders.

Session 8: Friday, March 18, 2016, 3:45 – 5:15pm

➢ A-8: Opportunities and Challenges for Benefit-Cost Analysis in the Paris Climate Agreement (Roundtable Discussion)

Chair: Elisabeth Gilmore, University of Maryland

Benefit-cost and economic analysis has the potential to play an important role in supporting the Paris climate agreement. In this roundtable, we will discuss the opportunities and challenges for BCA and economic analysis for both the mitigation and adaptation dimensions of the agreement as well as specific provisions, such as evaluating the benefits and costs of achieving a "well below 2C target", reviewing the level of ambition in the Intended Nationally Determined Contributions (INDCs), supporting adaptation at the project level as well as the allocation of climate finance, plus regulatory and other legal issues. Cross cutting issues include accounting for the costs and especially the benefits, verification and monitoring of mitigation and adaptation efforts, new modeling needs and capacity building, as well as the scope and limitations of BCA for climate change policy.

Panelists:

Allen Fawcett, US Environmental Protection Agency

James Neumann, Industrial Economics, Incorporated

Jonathan Wiener, Duke University

Gary Yohe, Wesleyan University

➢ B-8: Role of BCA in Government Decisions (Roundtable Discussion with Agency Chief Economists)

Chair: Stuart Shapiro, Rutgers University

Panelists:

Timothy Brennan, UMBC and Resources for the Future

Randall Lutter, University of Virginia

Robert Johansson, USDA

Al McGartland, US Environmental Protection Agency

Rose Odom, US Coast Guard

Jack Wells, US Department of Transportation (former)

➢ C-8: Teaching Benefit-Cost Analysis (Roundtable Discussion)

Chair: Peter Linquiti, The George Washington University

Benefit-cost analysis draws together scholars, analysts, practitioners, and decision makers from a wide variety of backgrounds and settings. As a consequence, teaching BCA well can be a formidable challenge. The purpose of this session is to share thoughts and tips on teaching BCA. Three panelists, who have more experience than they might like to admit, will make presentations, but ample time will be saved for comment and discussion by all.

Panelists:

Joseph Cordes, The George Washington University

Don Kenkel, Cornell University

Glenn Blomquist, University of Kentucky

➢ D-8: Benefit-Cost Analysis of Development Projects: Recent Experience at the Millennium Challenge Corporation (with a USAID Application)

Chair: Craig Thornton, Mathematica Policy Research

The Millennium Challenge Corporation (MCC) is an independent U.S. foreign assistance agency that is helping lead the fight against global poverty. Since its creation in 2004, it has made over $11 billion in grants to some of the world's poorest nations that have committed themselves to good governance, economic freedom and investments in their citizens. Benefit-cost analysis has proven to be a useful tool for assessing the value of the activities covered by past grants and for planning future grants. This session illustrates the use of benefit-cost analysis and highlights some of the challenges faced by analysts investigating the returns from development programs.

Presentations:

Economic Rates of Return at MCC – a Summary of Results, *Sandra Ospina,* Millennium Challenge Corporation*

This paper reviews how MCC does Cost Benefit Analyses and summarizes the full set of MCC's analyses of the economic rate of return generated by completed grants.

Benefit Cost Analysis of the BRIGHT Program in Burkina Faso, *Ali Protick,* Mathematica Policy Research*

The BRIGHT program was designed to improve the educational outcomes of children in Burkina Faso. The benefit-cost study draws on a rigorous evaluation of program impacts using data from

almost 300 villages. The results show that the net value of the investments depends crucially on the returns to education.

Benefit Cost Comparisons of Road Maintenance and Reconstruction Strategies – A Dollar in Time Saves Nine, *Andrew Carter* and Sarah Olmstead,* Millennium Challenge Corporation*

This paper employs the World Bank's widely-used HDM-4 model of road pavement conditions and their effects on vehicle operating costs to simulate the potential benefits of improvements in road maintenance regimes relative to MCC's early practice of reconstructing host country nominated roads. This approach has important implications for policy making given the substantial investments being made in roads and transportation.

USAID's Assessment of Food Security Risks Within a Benefit Cost Framework, *Sarah Lane,* Millennium Challenge Corporation*

This paper looks at techniques to expand risk analysis to incorporate intertemporal variation in key indicators and adverse shocks to the system. It will draw on examples in both agriculture and infrastructure investments.