

AB 32 Discussion Series

Information Needs for Analysis of Effectiveness of the Cap-and-Trade Regulation

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Abstract

In April 2012, a select group of environmental regulators and economic researchers convened in Santa Barbara to discuss the *ex post* economic analysis of California's Cap-and-Trade regulation. The symposium entitled "Information Needs for Analysis of the Effectiveness of the Cap-and-Trade Regulation" focused on the data, information, and types of analyses needed to monitor economic impacts throughout the implementation of the Cap-and-Trade regulation that went into effect January 1, 2013.

Discussions within the two-day event focused on the standard dimensions of the economic performance of a regulation. Researchers and regulators defined performance measures necessary to evaluate a regulation as well as the analytical methods, models, and data required to support program evaluation. Additional discussion focused on employment, health impacts, and the health of California's economy as implementation of the regulation unfolds.

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In April 2012 the University of California Center for Energy and Environmental Economics (UCE³) at UC Santa Barbara convened a symposium of leading economic experts and environmental regulators to discuss the analytic and data needs to support *ex post* analysis of the effectiveness of AB 32, California's Global Warming Solutions Act. Thus the purpose of the event was twofold: to define the performance metrics necessary to assess the potential economic impact of California's Cap-and-Trade program, and discuss the analytical methods, models, and data required to support a comprehensive evaluation of AB 32 as its portfolio of programs (including Cap-and-Trade) are implemented.

The symposium, titled *Information Needs for Analysis of Effectiveness of the Cap-and-Trade Regulation*, was held April 2-3, 2012, at the Bren School at the University of California at Santa Barbara. The event was sponsored by UCE³ in conjunction with the California Air Resources Board (ARB) and the Bren School and was organized by Charles Kolstad and Emily Wimberger of UCSB. The 34 invited attendees included academic and research economists as well as federal and state environmental regulators.² The first day of the symposium focused on the metrics necessary to assess the economic impacts of the Cap-and-Trade program while the second day of the event focused on specific topics thought to be of critical importance in the *ex post* analysis of the regulation. Each day consisted of panels that included topic introductions by a moderator, three presentations on the panel's topic, and substantive discussion between all symposium participants.

This report provides a summary of the symposium, focusing on the presentations and discussions contained within the five panels, as well as the research recommendations proposed by participants. This report will be followed by a call for research proposals as well as a work plan for the California Air Resources Board to use as a guide as the *ex post* analysis of AB 32 and the Cap-and-Trade program begins.

Introductory Remarks: Framing the Symposium

Chairman Mary D. Nichols of the California Air Resources Board opened the symposium with a brief overview of AB 32 and the current status of the Cap-and-Trade program.

Chairman Nichols began by tracing the origins of the symposium back to 2006 and the signing of AB 32 which set a mandate for California to reduce Greenhouse Gas (GHG) emissions to 1990 levels by 2020 and gave ARB the task of implementing the statute by designing a portfolio of complimentary programs which could include a market mechanism such as Cap-and-Trade. The Air Resources Board has thrice approved the use of a Cap-and-Trade program as part of AB 32's portfolio though the scope and mechanics of the program have received much scrutiny.³

² Appendix A includes a complete list of participants and their affiliations. Appendix B contains a schedule for the symposium.

³ The Board first adopted a preliminary Cap-and-Trade regulation in 2008, reaffirmed their support in 2010, and again in 2011.

In developing the Cap-and-Trade program and assessing its potential economic impacts, ARB has been advised by an Economic Advisory Committee, primarily composed of outside experts. There have also been six full-scale analyses detailing the impacts of the Cap-and-Trade program on the California economy. Estimated changes in gross state product range from an increase of 1.0% to a decline of 2.2% depending on the study.⁴ And while these macroeconomic studies have found the overall impact of the Cap-and-Trade program to be relatively small compared to California's overall economy, much uncertainty remains as to the impacts of the program on California's industries and consumers. In an effort to reduce the economic uncertainty surrounding the program, identify the economic impacts of the regulation of Californians, and help provide mid-course corrections as needed, leading economists with experience in environmental regulation were convened to identify the methodologies that are required for ARB to conduct rigorous *ex post* analyses of the Cap-and-Trade program as well as the data that must be collected to support these analyses.

Implementation of AB 32 and the Cap-and-Trade program has begun. The first allocation auction occurred in November 2012 and the first compliance period, covering the largest industrial sectors, will run through 2014. Natural gas and other fuels will then move into the program in 2015, along with an influx of auction revenue. Now is the time to identify the metrics and methodologies that will lead to substantive *ex post* analysis of the Cap-and-Trade program. The analyses have implications not only for the state of California but the nation and world as all eyes are on California to determine the feasibility of similar climate change regulations on an even larger scale.

Organization

The symposium was comprised of six panels: five were each oriented around a specific topic while the final panel presented a brief summary of the preceding panels. The first day of the symposium was comprised of three panels focused on defining the standard metrics of an economic analysis: costs, incidence, and leakage. The two topic panels on the second day of the symposium centered around the type of data and analyses relevant to estimating the impact of Cap-and-Trade on employment as well as public health. Each panel included an introduction by a moderator as well as three presentations within the panel topic. The remainder of the panel was devoted to discussion among all symposium attendees. The following provides a summary of the individual panels.

⁴ The six analyses include two conducted by the California Air Resources Board, two analyses by David Roland-Holst of UC Berkeley, and two analyses conducted by Electric Power Research Institute and Charles River Associates. All analyses were conducted between 2008 and 2010.

Defining and measuring the cost of the regulation

The first panel⁵ of the day addressed the question of how to quantify the costs of regulation. The discussion began with the presentation of a taxonomy of potentially affected parties, describing the channels through which regulatory costs could be transmitted. The panel emphasized the challenges inherent in quantifying costs, noting that determining the costs to entities directly regulated under similar programs has been elusive. Panelists noted that identifying the benefits and costs of implementing the Cap-and-Trade program in California could require researchers and policymakers to redefine the scope of analysis. One panelist reflected that previous estimates of the cumulative effects of the AB 32 programs have fixed many parameters, which are in fact likely to vary in the longer run. A panelist also noted that simulation models do not fully capture the coordinating role of policymakers in promoting innovation. Another panelist addressed the question of scope, emphasizing that a full analysis must set costs against policy outcomes. The panelist also stated that the impacts of specific design elements of the program should be evaluated in order to demonstrate that implementation can effectively be achieved elsewhere. Another panelist presented a discussion of the potential gains that could come from efficiently utilizing permit value and addressing preexisting tax distortions. The panelist cautioned ARB against the instinct to use permit revenue to over fund programs, which might seem in-line with the goals of AB 32, but may not otherwise be cost effective.

Key points

- The costs of the Cap-and-Trade regulation cannot be separated from those of AB 32 as a whole
- There is value in demonstrating that agents respond to carbon pricing and that allowance markets are functional and effective at achieving low-cost emissions reductions
- Before-the-fact estimates often overstate the costs of regulations
 - Existing distortions influence firms' responses to markets
 - General equilibrium models are limited in their ability to predict long-run economy-wide effects as well as sectoral and policy interactions, and the role of policymakers in promoting coordination
- Econometric models are required for *ex post* program evaluation
 - Establishment-level analyses based on revealed data are most useful for quantifying both short- and medium-run regulatory effects

Defining and measuring incidence and burden of costs

The measurement of incidence (i.e., who bears costs and benefits), the topic of the symposium's second panel, is closely related to the measurement of the costs of regulation. Incidence was framed as encompassing direct costs and also the distribution of allowance value and costs. This is inherently tied to the concept of baseline setting, in

⁵ This report, for the most part, refrains from identifying statements as coming from specific individuals. Rather, attribution is made to the group of presenters. Obviously, opinions attributed to a group are not necessarily shared by all members of the group. The identities of the panelists are found in Appendix B.

the sense that one's philosophical view of property rights determines how the incidence of the program is measured. The panel also echoed the sentiment of the previous panel, that it could be quite difficult to isolate the effects of the Cap-and-Trade program from the suite of complimentary programs nested within AB 32. One of the panelists discussed several national analyses that estimated the industrial regulatory impact over varying timeframes and identified sectors likely to be at risk of emissions leakage. One panelist noted that data from the Annual Census of Manufacturers could provide key inputs to a similar California-specific analysis. Another panelist then described several methods of performing after-the-fact program evaluations that can be used to isolate specific program effects, noting that these techniques would be useful for evaluating the cost-effectiveness of programs funded with allowance value. A third presenter concluded the panel with a discussion on the relative merits of general-equilibrium and econometric models for identifying indirect program effects and distribution, noting that survey data could provide valuable insights into how consumers respond to price changes resulting from AB 32 programs.

Key points

- Direct regulatory costs will be small relative to total allowance value
- The use of auction revenue will have a large impact on incidence and the efficiency of the Cap-and-Trade program
 - Addressing pre-existing distortions Is highly desirable from an efficiency perspective
 - Cap-and-Trade revenue may potentially be classified as a 'mitigation fee' which would require that any use of revenue to satisfy the Sinclair Nexus test implying that revenue can only be used to mitigate harm caused by GHG emissions
- Isolating program effects requires experimental design and data collection
 - Survey data can be useful in describing consumer response
- Incidence depends on the heterogeneity of responses to prices and programs
 - Estimates of the effects should be differentiated by income group as well as geographic region

Measuring and monitoring leakage

The first day of the symposium closed with a panel on leakage. The moderator opened the panel with an overview of emissions leakage and the issues relevant to academic researchers and California regulators as the Cap-and-Trade program is implemented. He identified the importance of defining the geographic market for California sectors at risk for leakage as well as the need for monitoring and guarding against leakage risk in future compliance periods. Panelist presentations focused on the modeling and monitoring of emissions leakage in a variety of regulatory settings. The first panelist described the ideal empirical application for estimating leakage as an exogenously-timed discontinuity in policy. He then identified the potential challenges to this first-best model, including data deficiencies on out-of-region emissions and trending variables that can potentially be correlated with emissions and regulations. Another panelist summarized lessons gathered from previous simulation and econometric models of emissions leakage, including the

importance of modeling market structure and changes in factor inputs, the impact of indirect leakage, and the role of updating output-based allocations in mitigating leakage. In the final presentation of the panel, the focus was on the challenges of measuring and monitoring potential leakage and re-shuffling within the electricity sector, a sector that with its rich and readily available data can be used as a model for data compilation.

Key Points

- Assessment of leakage risk is based upon identification of the relevant geographic market and a uniformly acceptable and a measurable definition of leakage
 - The Department of Justice Merger Guidelines use effective competition and the cost of switching between regional suppliers to determine relevant geographic markets
 - The definition of leakage may vary by industry but clear terminology facilitates transparent monitoring and data collection
- Leakage mitigation is revealed in policy design
 - Updating output-based allocation can be an effective mitigation method, however monitoring is necessary to prevent overcompensation of firms
 - Free allowances can help preserve the competitiveness of affected sectors
- *Ex post* leakage assessment combines simulation and regression analyses to identify both the potential expected effects as well as the revealed impacts of leakage
 - *Ex post* analysis requires establishment-level data before and after the regulatory event
 - Difficulty in obtaining out-of-region emissions variables may require proxy variables such as net imports and exports or production variables
- The definition of additional outcome measures such as jobs, output, and tax revenue can be used to assuage political as well as environmental leakage concerns

Employment, wages, and effects on state industries

Opening the second day of the symposium, the fourth panel identified the effect of the Cap-and-Trade regulation on employment and wages within state industries. The moderator opened with a call for a universal definition of ‘green jobs’ and stated the need to establish a common set of assumptions on which to base business-as-usual forecasts of employment and economic activity within the state. One of the panelists described an empirical framework, data needs, and assumptions for evaluating the effects of the Cap-and-Trade program, while another provided a theoretical framework for describing how firms adjust to relative price changes, demonstrating that analyses of historical energy price changes could be used to construct a reasonable range of future impacts of the Cap-and-Trade program. Another panelist provided advice on best practices from EPA’s recent analysis of the employment impacts resulting from several of their environmental

regulations, presenting results suggesting that the adverse effects of environmental regulations on employment have been somewhat overstated.

Key points

- Analytical frameworks for evaluating employment and intra-industry effects exist and suggests that environmental regulation has impacted employment
 - Decompose employment effects of pricing GHG emissions into higher costs and factor substitution as well as changes in demand for green and brown services
 - Labor supply may change as a consequence of higher consumption prices and changes in air quality while changes in environmental quality may impact productivity
- Additional data sources and employment classifications are required to estimate future employment demand effects
 - It is very difficult to link product demand to employment
 - More refined employment metrics may better reflect employment quality and long-run substitution in sector employment
- A balanced empirical strategy will compare estimates taken from historical prices changes with *ex post* analyses
 - Ongoing work will provide *ex ante* estimates using recent changes in energy prices and investments
 - Similar *ex post* analysis is possible for estimating the effects of costs and factor substitution

Public health and California's air quality

The final panel, on public health and California's air quality, opened with a discussion highlighting the challenges in obtaining access to health-related data and assessing the health impacts of AB 32. Panel presenters then discussed the data requirements and difficulties faced in their work estimating the health impacts of various environmental policies. The first panelist presented his work estimating the health effects of the NOx Budget Trading Program. The analysis required six individual-level data sets on health and pollution outcomes both pre-and post- regulation and found that the program health benefits were twice as large as abatement costs. Another panelist then discussed the spatial health effects of the SO₂ Cap-and-Trade program and the potential similarities to California's program, finding that the aggregate benefits of the SO₂ program greatly outweighed the costs and that trading drove the distributional effects of the policy, though no local environmental justice effects were found. A third panelist concluded with a summary of AB 32 early action items and a discussion of his work estimating the local health effects of airport congestion and taxi time in which he show that daily fluctuations in pollution impact hospital admissions and that airplane congestion impacts local air pollution.

Key Points

- Given the relative magnitude of emissions reductions from AB 32 and California's Cap-and-Trade program, the health impacts of GHG reduction will likely be too small to observe, however criteria pollutant co-benefits may potentially be identified
 - Dose response functions, despite potential non-linearity and variance by cohort, may be better suited to identify co-benefits than econometric estimation resulting in sector-specific pollution impacts
- There are gaping holes in the literature pertaining to environmental justice and distributional health impacts
- The scope and scale of data required for *ex post* analyses of the health implications of environmental regulation is a barrier
 - Availability of both public and private data presents a limitation to potential analyses

Recurring Themes and Conclusions

Two main issues that arose repeatedly throughout the symposium discussions highlighting the challenges inherent to regulatory *ex post* analysis and the divide between economic theory and the political world of policy.

- Defining the scope of the analysis
 - The economic impacts of the Cap-and-Trade program cannot and should not be parsed separately from those of AB 32
 - Identifying the correct policy counterfactual is critical
 - Identifying the political as well as economic evaluation metrics is necessary for comprehensive analyses
- Facilitating the identification, collection, and dissemination of data from regulated entities to researchers is necessary for substitutive *ex post* analysis of the regulation
 - Collecting establishment and individual-level data is required for the analysis of emissions leakage and health effects of the Cap-and-Trade regulation
 - Data availability, potentially through an agency-run centralized database is critical in the production of high caliber analyses

Appendix A: Symposium Participants

Researchers

Max Auffhammer, UC Berkeley
Elizabeth Bailey, UC Berkeley
Dallas Burtraw, Resources for the Future
Oliver Deschenes, UC Santa Barbara
Denny Ellerman, MIT
Meredith Fowlie, UC Berkeley
Wayne Gray, Clark University
Michael Hanemann, University of Arizona
Charles Kolstad, UC Santa Barbara
David Lea, UC Santa Barbara
Joshua Linn, Resources for the Future
Richard Morgenstern, Resources for the Future
Erich Muehlegger, Harvard University
Brian Murray, Duke
Paulina Oliva, UC Santa Barbara
Karen Palmer, Resources for the Future
Ian Parry, International Monetary Fund
Paul Portney, University of Arizona
Mar Reguant, Stanford
Wolfram Schlenker, Columbia
Emily Wimberger, UC Santa Barbara
Frank Wolak, Stanford
Catherine Wolfram, UC Berkeley

Participants from Regulatory Agencies

Edie Chang, ARB
Steve Cliff, ARB
Richard Corey, ARB
James Goldstene, ARB
Reid Harvey, EPA
Jason McPhee, ARB
Mary Nichols, ARB
Matthew Rodriguez, Cal EPA
Mark Wenzel, Cal EPA
Stanley Young, ARB
Matthew Zaragoza-Watkins, ARB

Appendix B: Symposium Program

AB 32 Technical Discussion Series
Information Needs for Analysis
of the Effectiveness of the Cap-and-Trade Regulation
UC Santa Barbara
April 2–3, 2012

This symposium is motivated by a need to develop a methodological framework, and identify specific data requirements, to effectively evaluate the performance and economic impacts of the AB 32 cap-and-trade program on an on-going basis.

The first day concerns standard dimensions of the economic performance of a regulation. Each panel will define performance metrics necessary to assess the economic impact of the regulation and discuss relevant analytical methods, models, and data requirements for supporting a comprehensive, on-going evaluation of the program.

The second day will include panels focusing on topics identified by ARB staff and academic researchers to be of critical importance for the on-going analysis of the Cap-and-Trade regulation, as well as highlight areas that need further scrutiny to ensure its success. Within the panels, the discussion will center around the specific methodologies and types of analyses appropriate for the evaluation of the economic impacts of the regulation as well as the development of a work plan to institute panel recommendations.

AB 32 Technical Discussion Series
Information Needs for Analysis
of the Effectiveness of the Cap-and-Trade Regulation
April 2–3, 2012

Monday April 2, 2012

- 9:00 – 10:00 Welcome and Status of AB 32 Implementation
Mary D. Nichols, Air Resources Board
- 10:00 – 12:00 Defining and measuring the cost of the regulation
Moderator: Meredith Fowlie, UC Berkeley
Presenters: Denny Ellerman, MIT
 Michael Hanemann, UC Berkeley
 Ian Parry, International Monetary Fund
Rapporteur: Edie Chang, Air Resources Board
- 12:00 – 1:00 *Lunch*
- 1:00 – 3:00 Defining and measuring incidence and burden of costs
Moderator: Dallas Burtraw, Resources for the Future
Presenters: Richard Morgenstern, Resources for the Future
 Brian Murray, Duke University
 Catherine Wolfram, UC Berkeley
Rapporteur: Matthew Zaragoza-Watkins, Air Resources Board
- 3:00 – 3:30 *Break*
- 3:30 – 5:30 Measuring and monitoring leakage
Moderator: Charlie Kolstad, UC Santa Barbara
Presenters: Erich Muehlegger, Harvard University
 Karen Palmer, Resources for the Future
 Frank Wolak, Stanford, University
Rapporteur: Mar Reguant, Stanford University
- 5:30 – 6:30 Reception followed by dinner for invitees

Tuesday April 3, 2012

- 9:00 – 10:30 Employment, wages, and effects on state industries
Moderator: Paul Portney, University of Arizona
Presenters: Reid Harvey, Environmental Protection Agency
 Paulina Oliva, UC Santa Barbara
 Josh Linn, Resources for the Future
Rapporteur: Elizabeth Bailey, UC Berkeley
- 10:30 – 11:00 *Break*
- 11:00 – 12:30 Public health and California’s air quality
Moderator: Max Auffhammer, UC Berkeley
Presenters: Olivier Deschenes, UC Santa Barbara
 Wayne Gray, Clark University
 Wolfram Schlenker, Columbia and UC Berkeley
Rapporteur: Steve Cliff, Air Resources Board
- 12:30 – 1:30 *Lunch*
- 1:30 – 3:00 Presentation of panel summaries
Moderator: Emily Wimberger, UC Santa Barbara
 Edie Chang, Air Resources Board
 Matthew Zaragoza-Watkins, Air Resources Board
 Mar Reguant, Stanford University
 Elizabeth Bailey, UC Berkeley
 Steve Cliff, Air Resources Board
- 3:00 – 3:30 Closing remarks
 Charlie Kolstad, UC Santa Barbara

Definition of Panel Roles

For each panel, there will be a moderator, rapporteur, and three presenters. As can be inferred by the list of participants, these roles are equal in terms of contributing to the substance of the symposium.

Day 1 panel structure:

Moderator introduction:	15 min
Presentation 1	15 min
Presentation 2	15 min
Presentation 3	15 min
Discussion	60 min

Day 2 panel structure:

Moderator introduction:	15 min	Presentation 1	15 min
Presentation 2	15 min	Presentation 2	15 min
Presentation 3	15 min	Presentation 3	15 min
Discussion	30 min	Discussion	30 min

General Guidance

Keep in mind that the purpose of this symposium is two-fold. We wish to identify analytic approaches to conducting *ex post* analysis of the efficacy of AB 32's Cap-and-Trade program. We also wish to identify data needs, particularly ones that are not currently being met, in order to accomplish the analytic goals. This is truly a working symposium with a goal of producing a tangible research and analysis agenda.

Moderator

A moderator will facilitate each panel and will be responsible for keeping the discussion on topic and flowing in a timely manner. The primary purposes of the moderator are (1) to define and highlight the breadth of the issues in the session and (2) to focus the discussion on substance in terms of identifying data and analysis needs. The moderator will begin the panel by introducing the panel participants, framing the topic, and identifying the main issues that are relevant to the ensuing discussion. The moderator will also be responsible for introducing the presentations and how they are relevant within the scope of the panel. After the presentations, the moderator will also facilitate discussion among panelists and the audience for the remainder of the panel.

Presenters

Each presenter will prepare a 10-15 minute presentation on a topic of relevance and import within the scope of the panel. PowerPoint slides are encouraged. This should not simply be a report of the presenter's research but rather an offer of tangible proposals for conducting *ex post* analysis. Presenters are then encouraged to participate in the discussion following the presentations.

Rapporteur

The rapporteur is responsible for distilling the session (moderator's comments, the presentations, and ensuing discussion) into one PowerPoint slide. The rapporteur will then present the panel summary slide at the end of the symposium and participate in the discussion of how the symposium discussions can be translated into a work plan for the analysis of the Cap-and-Trade regulation.