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February 20, 2015

William Vance
California Air Resources Board
1001 "I" Street
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Research Proposal Entitled:
"Evaluation of a Variety of F-Gas Emission Reduction Strategies"
Principal Investigator – Professor C-Y Cynthia Lin
Requested Funds: $ 299,980.00
Period of Performance: 09/01/2015 – 08/31/2017

Dear Mr. Vance,

On behalf of The Regents of University of California, Davis, it is a pleasure to present for your consideration Professor Lin's proposal referenced above.

At the time that this proposal results in an award, we shall expect to enter into an agreement which contains terms and conditions conducive to and consistent with a public educational institution performing fundamental research. It is expected that UC Davis will invoice in accordance with the University's accounting requirements and generally accepted accounting practices.

Please call on Dr. Lin for scientific information. Administrative questions may be directed to me at the above contact information or at jssnyder@ucdavis.edu . We request that correspondence pertaining to this proposal and any ensuing award be sent to the Office of Research and to the principal investigator.

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Sincerely,

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Enclosures

Please refer to SPO Project# 201502707 on all future correspondences.

DRAFT PROPOSAL

Evaluation of a Variety of F-Gas Emission Reduction Strategies

Principal Investigator:

C.-Y. Cynthia Lin

Prepared for:

State of California Air Resources Board
Research Division
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February 19, 2015

Check if applicable:

Animal subjects ____
Human subjects ____

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Abstract

We propose to use economic and econometric modeling to identify the optimal policy or combination of policies needed to achieve targeted 2030 and 2050 reductions of fluorinated gas (F-gas) emissions in California. We will use economic and econometric modeling to determine the optimal design of an F-gas fee program, including distribution of fee revenues, and evaluate and compare the optimal F-gas fee program with other emission reduction strategies according to their cost-effectiveness, feasibility, economic efficiency and distributional effects, and interaction with other emission control programs. The results of our research will inform the design of ARB's medium and long-term F-gas emission control programs.

To ensure that future F-gas control programs achieve reductions in the most reliable, cost-effective and economically efficient manner, we will review relevant regulatory experience and will apply its lessons to a systematic comparative analysis of potential F-gas emission reduction strategies. Study goals will be accomplished in four phases: information collection; fee program analysis; optimal policy analysis and the final report.

In the first phase of our proposed research, we will review and summarize the peer-reviewed literature and other information relevant to primary study goals, organized around three broad themes: characterization of the F-gas sector; F-gas technology assessment; and control policy design insights from related regulatory experience.

In the second phase of our proposed research, we will use economic modeling to systematically evaluate options for both F-gas fee design and application of fee revenues.

In the third phase of our proposed research, we will use economic modeling to evaluate an inclusive menu of policy options, including sector-specific prohibitions, cap and trade variants, performance standards, deposit-refund schemes, targeted abatement and mitigation programs, as well as the fee program options specified in Phase 2.

Our proposed research will build upon my work developing economic and econometric models to analyze and design environmental policy in a variety of contexts, including my research analyzing the effects and efficiency of different types of renewable fuel policies and cost containment mechanisms; my work for the ARB examining multiple issues related to the costs of California's low carbon fuel standard and analyzing provisions designed to contain compliance costs at reasonable levels; and my work on the design and economics of low carbon fuel standards.

Our proposed research will also build upon my research designing the optimal gasoline tax in California and China; my work comparing cap and trade programs with price controls such as taxes or fees when the marginal damage from pollution is uncertain; my work on the design of transportation policies; my work on air quality regulation; my work on the effects of an E10 ethanol-blend policy on gasoline consumption and greenhouse gas reduction in California; and my ongoing work designing pollution control policies to best manage nitrogen pollution.

The econometric estimation of some of the parameters to be used in our analysis will build upon my research estimating and analyzing elasticities of demand in a variety of contexts, including the elasticity of demand for gasoline in the U.S., California and China, and the elasticity of demand in the world oil market.

The proposed research also builds upon my research on air quality, including my papers on ozone; on estimating air pollution externalities; and on the California's agriculture-related air pollution policy.

Introduction

High global warming potential (high-GWP) gases contribute to global warming at a level hundreds to thousands of times greater than carbon dioxide. A majority of future high-GWP emissions in California will be comprised of fluorinated gases (F-gases), which are used primarily in refrigeration, air conditioning, insulation and pesticide applications. Emissions of high-GWP F-gases are four percent of today's statewide GHG inventory, but they are the fastest-growing GHG source in California because F-gases are replacing ozone-depleting substances (ODS substances) in response to Montreal Protocol mandates. ARB Scoping Plan control programs already target high-GWP emissions, but even with these regulations in place, annual F-gas emissions in California are projected to increase by about 40 percent (from 18 to 25 MMTCO2e) between 2012 and 2020, and more than double by 2050, to 43 MMTCO2e.

High-GWP emissions from refrigeration, air conditioning and foam insulation are fugitive emissions due to leakage or inappropriate disposal. Other sources, such as inhalers, aerosol propellants, medical sterilants, industrial solvents, semiconductor manufacturing, and pesticides, are emissive by design. Control programs must address both types of emission sources.

The diversity of F-gas emission sources, a dearth of cost-effective, low-GWP alternatives, and the difficulty of enforcement in end-user sectors all pose challenges to future emission reduction programs.

We propose to use economic and econometric modeling to identify the optimal policy or combination of policies needed to achieve targeted 2030 and 2050 reductions of fluorinated gas (F-gas) emissions in California. We will use economic and econometric modeling to determine the optimal design of an F-gas fee program, including distribution of fee revenues, and evaluate and compare the optimal F-gas fee program with other emission reduction strategies according to their cost-effectiveness, feasibility, economic efficiency and distributional effects, and interaction with other emission control programs. The results of our research will inform the design of ARB's medium and long-term F-gas emission control programs.

To ensure that future F-gas control programs achieve reductions in the most reliable, cost-effective and economically efficient manner, we will review relevant regulatory experience and will apply its lessons to a systematic comparative analysis of potential F-gas emission

reduction strategies. Study goals will be accomplished in four phases: information collection; fee program analysis; optimal policy analysis and the final report.

Our proposed research will build upon my work developing economic and econometric models to analyze and design environmental policy in a variety of contexts. In Lin and Prince (2009), my Ph.D. student and I design the optimal gasoline tax for California. I also discuss the optimal gasoline tax for California in Lin (2007) and Lin (2012a). In Lin and Zeng (2014), my former Masters student and I design the optimal gasoline tax for China.

In a report for the California Air Resources Board, my Ph.D. student and I examine multiple issues related to the costs of California's low carbon fuel standard (LCFS) and analyze provisions designed to contain compliance costs at reasonable levels (Lade and Lin, 2013). We find that compliance costs may increase rapidly in the future if there are large differences in marginal costs between traditional fossil fuels and alternative, low carbon intensity fuels; or if there are capacity or technological constraints to deploying alternative fuels, particularly those with low carbon intensity. The potential for compliance costs to increase rapidly in the near future motivates our recommendation of a hard cap on LCFS credit prices to guarantee that compliance costs will never exceed either the credit window price or the non-compliance fee. Our research has also been featured in such media outlets as Platt's blog, Green Car Congress, Biodiesel Magazine, Ethanol Producer Magazine, and the Resources for the Future library blog. Our work has also resulted in a number of outreach publications (Lin, 2013b; Lin, 2013c; Lade and Lin, 2014).

In Lade and Lin (2015a), we examine the effects and efficiency of two types of mandates, a renewable share mandate similar to the federal Renewable Fuel Standard and a carbon intensity standard similar to California's low carbon fuel standard, as well as the effects of two cost containment provisions, a hard cap and a soft cap, on compliance credit prices. We discuss the design and economics of low carbon fuel standards in Lade and Lin (2015b).

In Lade, Lin and Smith (2015b), we analyze policy shocks and market-based regulations using evidence from the federal Renewable Fuel Standard, a policy that mandates large increases in biofuel consumption through 2022. The findings suggest that the goals of the Renewable Fuel Standard would be better served through more active management of tradeable credit markets by, for example, instituting a minimum and maximum allowable compliance credit price.

In Lade, Lin and Smith (2015a), we compare the Environmental Protection Agency's ex ante estimates of the costs and benefits of the Renewable Fuel Standard to measures of ex post costs implied by the price of compliance credits under the policy.

In Heres and Lin (2012), my former Ph.D. student and I compare cap and trade programs with price controls such as taxes or fees when the marginal damage from pollution is uncertain.

In Lin, Zhang and Umanskaya (2015), we analyze the design of policies in developing countries that restrict drivers from using their vehicles on given weekdays, based on the last digits of their vehicles' license plates, in order to reduce urban air pollution and traffic congestion.

In Lin (2010b) and Lin (2015), I develop a model of model of regulatory federalism in order to examine how the authority to set a regulatory standard and the authority to choose the combination of policies to meet the standard should be allocated between a central government and local governments. Results suggest that for many regulations, including those involving local air quality in the United States and the European Union, social welfare may be increased by reversing the form of delegation currently used.

In Lin, Zhang, Rouhani, and Prince (2009), my graduate students and I evaluate the effects of an E10 ethanol-blend policy on gasoline consumption and greenhouse gas reduction in California. I also discuss this work in Lin (2011c).

In Beaudoin, Farzin and Lin (2014), we develop a model to evaluate the extent to which traffic congestion should be accounted for when evaluating investment in public transit infrastructure when a Pigouvian congestion tax cannot be levied on auto travel.

The econometric estimation of some of the parameters to be used in our analysis will build upon my research on estimating and analyzing elasticities of demand in a variety of contexts, including the elasticity of demand for gasoline in the U.S. (Lin and Prince, 2013), California (Lin and Prince, 2009), and China (Lin and Zeng, 2013). In Lin (2011b), I estimate supply and demand in the world oil market.

In ongoing work, I am designing pollution control policies to best manage nitrogen pollution. In particular, I am designing a tradeable permit system that allows the trade of nitrogen permits between air and water emissions. With such a permit system, there will be cost savings from trading between air and water since farmers would be able to choose practices that reduce nitrogen emissions to air and water jointly at least cost. There will also be environmental

benefits from allowing sources to trade between air and water emissions permits, as a system that accounts for damages to air and water will internalize potential spillovers that would arise if air and water emissions were regulated separately and independently.

The proposed research also builds upon my research on air quality, including my papers on ozone (Lin, Jacob, Munger, and Fiore, 2000; Lin, Jacob and Fiore, 2001); on estimating air pollution externalities (Lin, 2010a; Lin, 2012b); and on the California's agriculture-related air pollution policy (Lin, 2011a; Lin, 2013a).

Objectives

The objectives of our proposed research are the following:

1. Characterize the F-gas sector, including the properties, sources and uses of F-gases; the market size, segmentation and structure of California's F-gas market; the pricing, sales and emissions inventory (historical and projected); drivers of demand for F-gases; and abatement opportunities through 2050 in the form of a marginal abatement cost curve.

2. Conduct an F-gas technology assessment by reviewing the most recent information on potential low-GWP replacement technologies for both F-gases and F-gas-using products and systems. Emerging technologies for leak detection and management, as well as recovery/destruction of F-gas "banks" will be included.

3. Extract policy design insights from relevant GHG and high-GWP regulatory programs including market-based compliance systems, performance standards, fee, refund-deposit, voluntary and incentive programs. Feasibility, enforceability and potential economic impacts of design features will be considered.

4. Use economic modeling to systematically evaluate options for both F-gas fee design and the application of fee revenues.

5. Compare potential approaches to an F-gas fee program in California by systematically assessing their advantages, disadvantages and likely environmental and economic impacts.

6. Use econometric modeling to estimate the price elasticity of demand for F-gases and F-gas-intensive products/services.

7. Specify the parameters of the optimal fee program design, including: point of regulation; fee basis, form and level; implementation mechanism; formula; and means for adjustment.

8. Estimate fee collection revenues and costs.

9. Assuming a California F-gas fee program as designed above, assess the advantages and disadvantages of various approaches to distributing collected funds, while achieving targeted emission reductions. Potential applications of funds should include: “Fee & Dividend”; emission abatement; mitigation; incentive; research; demonstration; commercialization; and training programs. Prioritize potential uses of funds.

10. Evaluate F-gas fee collection and distribution program options by multiple criteria, including: estimated emission reductions and co-benefits; cost, cost-effectiveness; feasibility; economic impacts and their distribution; enforceability and the potential for leakage; interaction with other (state, federal, international) regulatory programs.

11. Use economic modeling to evaluate an inclusive menu of policy options, including sector-specific prohibitions, cap and trade variants, performance standards, deposit-refund schemes, targeted abatement and mitigation programs, and fee program options.

12. Applying transparent criteria and assumptions, use economic modeling to systematically compare F-gas emission reduction policy options to identify the policy or combination of policies that offers the optimal approach to achieving targeted 2030 and 2050 F-gas emission reductions. Policy options will be clearly defined and evaluated using multiple criteria, including, but not limited to: net environmental impacts; reliability and verifiability of reductions; co-benefits, including health impacts; cost and cost-effectiveness; administrative and technological feasibility; economic impacts and their distribution; enforceability and the potential for emissions/economic leakage; interaction with other regulatory programs and jurisdictions.

Our results will be beneficial to ARB as they will enable us to identify the optimal policy or combination of policies needed to achieve targeted 2030 and 2050 reductions of fluorinated gas (F-gas) emissions in California. The optimal design of an F-gas fee program, including distribution of fee revenues, will be specified in light of comparable regulatory experience. Emission reduction strategies other than fees will also be evaluated and compared according to their cost-effectiveness, feasibility, economic efficiency and distributional effects, and interaction with other emission control programs. The results of our research will inform the design of ARB's medium and long-term F-gas emission control programs.

Technical Plan

To ensure that future F-gas control programs achieve reductions in the most reliable, cost-effective and economically efficient manner, we will review relevant regulatory experience and will apply its lessons to a systematic comparative analysis of potential F-gas emission reduction strategies. Study goals will be accomplished in four phases: information collection; fee program analysis; optimal policy analysis and the final report. Interim deliverables will mark the completion of each of the first three phases.

Phase 1: Information Collection

In the first phase of our proposed research, we will review and summarize the peer-reviewed literature and other information relevant to primary study goals, organized around three

broad themes: characterization of the F-gas sector; F-gas technology assessment; and control policy design insights from related regulatory experience.

For F-gas sector characterization, we will characterize the F-gas sector, including the properties, sources and uses of F-gases; market size, segmentation and structure of California's F-gas market; pricing, sales and emissions inventory (historical and projected); and drivers of demand for F-gases. We will also quantify abatement opportunities through 2050 in the form of a marginal abatement cost curve.

There are three main categories of fluorinated gases: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). One major source of F-gas emissions come from the use of hydrofluorocarbons as refrigerants, aerosol propellants, solvents and fire retardants as a substitute for ozone-depleting substances. A second major source of F-gas emissions is from industry, where perfluorocarbons are produced as a by-product of various industrial processes associated with aluminum production and the manufacturing of semiconductors; where sulfur hexafluoride is used in magnesium processing and semiconductor manufacturing, as well as a tracer gas for leak detection; and where HFC-23 is produced as a by-product of HCFC-22 production. A third major source of F-gas emissions is in the transmission and distribution of electricity, where sulfur hexafluoride is used in electrical transmission equipment, including circuit breakers. In the transportation sector, hydrofluorocarbons are released through the leakage of refrigerants used in vehicle air-conditioning systems (EPA, 2014).

Among the sources of information we will use in our F-gas sector characterization will be Gallagher et al. (2014), who compare ambient-based versus inventory-based emission estimated of F-gas emissions in California; and Wolf (2011), who develops bottom-up estimates of F-gas emissions for 2010 and 2020 for solvent, fire protection and other applications.

For F-gas technology assessment, we will review the most recent information on potential low-GWP replacement technologies for both F-gases and F-gas-using products and systems. Emerging technologies for leak detection and management, as well as recovery/destruction of F-gas "banks" will be included.

For refrigerants used by businesses and residences emit fluorinated gases, emissions can be reduced by use of substitutes with lower global warming potentials and other technological improvements (EPA, 2014). Industrial users of fluorinated gases can reduce emissions by

adopting fluorinated gas recycling and destruction processes, optimizing production to minimize emissions, and replacing these gases with alternatives (EPA, 2014). Emissions of sulfur hexafluoride, an extremely potent greenhouse gas that is used for several purposes when transmitting electricity through the power grid, can be reduced by leak detection and repair, use of recycling equipment, and employee training (EPA, 2014). In the transportation sector, the leakage of refrigerants used in vehicle air-conditioning systems can be reduced through better system components, and through the use of alternative refrigerants with lower global warming potentials than those presently used (EPA, 2014). For non-greenhouse gas alternatives for solvent, fire protection and other applications, we will build upon the work of Wolf (2011).

For regulatory policy design, we will extract policy design insights from relevant GHG and high-GWP regulatory programs including market-based compliance systems, performance standards, fee, refund-deposit, voluntary and incentive programs. Feasibility, enforceability and potential economic impacts of design features will be considered.

After completing the first phase of our research, our interim deliverable will be a summary of findings, with abatement cost estimates.

Phase 2: F-gas Fee Program Analysis

In the second phase of our proposed research, we will use economic modeling to systematically evaluate options for both F-gas fee design and application of fee revenues.

To analyze F-gas fee design, we will compare potential approaches to an F-gas fee program in California by systematically assessing their advantages, disadvantages and likely environmental and economic impacts.

A *cost-effective* policy is one that minimizes the cost of achieving a given reduction in emissions. The cost of achieving a given reduction in emissions will be minimized if and only if the marginal costs of control are equalized for all emitters (Tietenberg and Lewis, 2015). If the F-gas fee is levied on each unit of F-gas emitted and if the same fee is charged on all sources of F-gas, then an F-gas fee will be cost-effective, as it will lead to equalized marginal costs of control for all emitters. Thus, the optimal cost-effective design for the F-gas fee would be to levy the fee on each unit of F-gas emitted and to charge the same fee on all sources of F-gas.

Because greenhouse gases like F-gas are stock pollutants that accumulate in the atmosphere over time and whose damage increases and persists as the pollutant accumulates, the

optimal level for the F-gas fee is the one that maximizes the present discounted value of the entire stream of net benefits from the present into the future, where net benefits is defined as total benefits minus total costs (Tietenberg and Lewis, 2015). In each period, the total benefits of an F-gas fee are the benefits from the F-gas emissions reduction and the total costs of an F-gas fee are the costs incurred to reduce (or abate) F-gas emissions. A policy is *dynamically efficient* if it maximizes the present discounted value of the entire stream of net benefits (Hartwick and Olewiler, 1998; Tietenberg and Lewis, 2015).

For our proposed research, we will research the abatement options available and marginal costs of abatement for each source of F-gas, including refrigeration, air conditioning and foam insulation, inhalers, aerosol propellants, medical sterilants, industrial solvents, semiconductor manufacturing, and pesticides. We will also research where the sources of fluorinated gas are located in California. We will use this information to determine the control costs for different F-gas emissions sources and also the distribution of control costs across California. With this information, we will determine the abatement costs incurred for each type of F-gas emission source, as well as the distribution of these abatement costs across California, for a given level of the F-gas fee that equals marginal abatement costs across sources.

To determine the dynamically efficient level for the F-gas fee, we will collect information on the damages caused by F-gas emissions and therefore the benefits from reducing F-gas from the present into the future. Since F-gas is a greenhouse gas, its damages relate to the damages from global climate change. We will use this information to determine the dynamically level of F-gas fee by finding the level of F-gas fee that maximizes the present discounted value of the entire stream of net benefits from the present into the future. We will then determine what the distribution of abatement costs would be across different emission sources and across California at the dynamically efficient level of F-gas fee.

Building upon my research on estimating and analyzing elasticities of demand in a variety of contexts, including the elasticity of demand for gasoline in the U.S. (Lin and Prince, 2013), California (Lin and Prince, 2009) and China (Lin and Zeng, 2013); and the elasticity of demand in the world oil market (Lin, 2011b), we will use also econometric modeling to estimate the price elasticity of demand for F-gases and F-gas-intensive products/services.

We will also specify the parameters of the optimal fee program design, including: point of regulation; fee basis, form and level; implementation mechanism; formula; and means for

adjustment. We will estimate fee collection revenues and costs. I similarly specify parameters in my previous research on optimal policy design, including my work on designing the optimal gasoline tax for California (Lin and Prince, 2009) and China (Lin and Zeng, 2014); and my work designing renewable fuel policy (Lade and Lin 2013; Lade and Lin, 2015a, Lade and Lin, 2015b).

To analyze the uses of F-gas fee revenues, we will assess the advantages and disadvantages of various approaches to distributing collected funds, while achieving targeted emission reductions and assuming a California F-gas fee program as designed above. Potential applications of funds should include: "Fee & Dividend"; emission abatement; mitigation; incentive; research; demonstration; commercialization; and training programs. We will prioritize potential uses of funds. We will build upon my research on designing the optimal gasoline tax and analyzing the distribution of tax revenue in California (Lin and Prince, 2009) and China (Lin and Zeng, 2014).

Both F-gas fee collection and distribution program options will be evaluated by multiple criteria, including estimated emission reductions and co-benefits; cost, cost-effectiveness; feasibility; economic impacts and their distribution; enforceability and the potential for leakage; and interaction with other (state, federal, international) regulatory programs.

Our evaluation will build upon my research analyzing the effects and efficiency of different types of renewable fuel policies as well as the effects of different cost containment mechanisms on compliance credit prices (Lade and Lin, 2015a); my work on the design and economics of low carbon fuel standards (Lade and Lin, 2015b); and my work on the effects of an E10 ethanol-blend policy on gasoline consumption and greenhouse gas reduction in California (Lin, Zhang, Rouhani, and Prince, 2009; Lin, 2011c).

After completing the second phase of our research, our Interim Deliverable will be the F-gas Fee Program Analysis findings and recommendations.

Phase 3: F-Gas Emission Reduction Optimal Policy Analysis

In the third phase of our proposed research, we will use economic modeling to evaluate an inclusive menu of policy options, including sector-specific prohibitions, cap and trade variants, performance standards, deposit-refund schemes, targeted abatement and mitigation programs, as well as the fee program options specified in Phase 2, above. Applying transparent

criteria and assumptions, we will systematically compare F-gas emission reduction policy options to identify the policy or combination of policies that offers the optimal approach to achieving targeted 2030 and 2050 F-gas emission reductions. We will consult ARB staff regarding legal authority or constraints. The optimal regulatory design and two "next-best" alternative control programs will be identified. Policy options will be clearly defined and evaluated using multiple criteria, including, but not limited to: net environmental impacts; reliability and verifiability of reductions; co-benefits, including health impacts; cost and cost-effectiveness; administrative and technological feasibility; economic impacts and their distribution; enforceability and the potential for emissions/economic leakage; and interaction with other regulatory programs and jurisdictions.

As explained above, if the F-gas fee is levied on each unit of F-gas emitted and if the same fee is charged on all sources of F-gas, then an F-gas fee will be cost-effective, as it will lead to equalized marginal costs of control for all emitters. Moreover, if the level of the F-gas fee is chosen optimally to maximize the present discounted value of the entire stream of net benefits, then it will be dynamically efficient as well. In addition to causing F-gas emission sources to choose a cost-effective allocation of the control responsibility, an F-gas fee also stimulates the development of newer, cheaper means of controlling emissions, as well as promoting technological progress, since with an F-gas fee, the firm saves money by adopting cheaper new technologies (Tietenberg and Lewis, 2015).

A drawback with an F-gas fee is that without full information on control costs, the control authority cannot establish the correct F-gas fee to achieve the desired level of emissions reduction on the first try, so the process for finding the appropriate level may take some experimenting. During the trial-and-error period of finding the appropriate fee level, sources would be faced with a volatile emissions fee, which may make planning for the future and for investments difficult (Tietenberg and Lewis, 2015).

An alternative policy that is also cost-effective but does not required a trial-and-error process to achieve the desired level of emissions reduction is a cap and trade program. Under a cap and trade program, the control authority issues exactly the amount of permits needed to produce the desired emissions level (Tietenberg and Lewis, 2015). One possible drawback with a cap-and-trade policy, however is that compliance costs can be extremely high (Lade and Lin, 2013; Lade and Lin, 2015a; Lade, Lin and Smith 2015a; Lade, Lin and Smith 2015b). To

contain compliance costs at reasonable levels, regulators should combine a cap and trade program with a containment cost mechanism (Lade and Lin, 2013; Lade and Lin, 2015a; Lade, Lin and Smith 2015b).

In contrast to market-based instruments such as an F-gas fee or a cap and trade program, command-and-control approaches such as an emissions standard, a performance standard or a technology standard are not cost effective because they do not minimize the cost of achieving a given emissions reduction. Since different sources of F-gas have different marginal costs of reducing F-gas emission, a given emission reduction would be achieved at lower cost if sources with lower marginal costs of abatement did more of the reduction than did sources with higher lower marginal costs of abatement, compared to a policy that required both lower marginal abatement cost sources and higher marginal abatement cost sources to reduce their emissions by the same amount. Moreover, since emissions standards are often based on specific technologies and tightened as new technologies are discovered, command-and-control policies do not provide as much incentive for the development of newer, cheaper means of and technologies for controlling emissions as market-based incentives do (Tietenberg and Lewis, 2015).

To evaluate different policy options, will be develop an economic model to accounts for the different abatement costs of different types of sources of F-gas. We will use our model to simulate the costs, benefits and welfare of alternative policy options.

Our evaluation of different policy options will build upon my research using economic modeling to analyze and evaluate different types of renewable fuel policies and cost containment mechanisms along various criteria (Lade and Lin, 2015a); my work on the design and economics of low carbon fuel standards (Lade and Lin, 2015b); and my work for the ARB examining multiple issues related to the costs of California's low carbon fuel standard (LCFS) and analyzing provisions designed to contain compliance costs at reasonable levels (Lade and Lin, 2013).

Our evaluation of different policy options will also build upon my research comparing cap and trade programs with price controls such as taxes or fees when the marginal damage from pollution is uncertain (Heres and Lin, 2012); my work on the design of transportation policies (Lin, Zhang and Umanskaya, 2015; Beaudoin, Fazrin and Lin, 2014); my work on air quality regulation (Lin, 2010b; Lin, 2015); and my work on the effects of an E10 ethanol-blend policy on gasoline consumption and greenhouse gas reduction in California (Lin, Zhang, Rouhani, and

Prince, 2009; Lin, 2011c). In ongoing work, I am designing pollution control policies to best manage nitrogen pollution.

The proposed research also builds upon my research on air quality, including my papers on ozone (Lin, Jacob, Munger, and Fiore, 2000; Lin, Jacob and Fiore, 2001); on estimating air pollution externalities (Lin, 2010a; Lin, 2012b); and on the California's agriculture-related air pollution policy (Lin, 2011a; Lin, 2013a).

After completing the third phase of our research, our Interim Deliverable will be the F-gas Policy Scenario Analysis Findings.

Phase 4: Final Report and Recommendations

Our final report will integrate and summarize the findings and interim deliverables of the first three study activities. It will include a detailed presentation of the short-listed regulatory program designs and estimated impacts. A summary matrix will be included.

Our major tasks therefore consist of the following:

Task 1: Information collection.

Task 2: F-gas fee program analysis.

Task 3: F-gas emission reduction optimal policy analysis.

Task 4: Write draft of final report.

Task 5: Revise final report.

References

Beaudoin, Justin, Y. Hossein Farzin, and C.-Y. Cynthia Lin. (2014). Evaluating public transit investment in congested cites. Working paper, University of California at Davis. URL: http://www.des.ucdavis.edu/faculty/Lin/transit_congestion_paper.pdf

Environmental Protection Agency [EPA]. (2014). Emissions of Fluorinated Gases. [online: web]. Accessed 16 February 2015. URL: http://epa.gov/climatechange/ghgemissions/gases/fgases.html

Gallagher, G., T. Zhan, Y.-K. Hsu, P. Gupta, J. Pederson, B. Croes, D.R. Blake, B. Barletta, S. Meinardi, P. Ashford, A. Vetter, S. Saba, R. Slim, L. Palandre, D. Clodic, P. Mathis, M. Wagner, J. Forgie, H. Dwyer, and K. Wolf. (2014). High-global warming potential F-gas emissions in California: Comparison of ambient-based versus inventory-based emission estimated, and implications of refined estimates. Environmental Science and Technology, 48, 1084-1093.

Hartwick, J.M., and N.D. Olewiler. (1998). The Economics of Natural Resource Use. 2nd edition. New York: Addison-Wesley.

Heres, David R., and C.-Y. Cynthia Lin. (2012). Quantity and price controls for the correction of externalities under uncertain damages: Evidence from a laboratory experiment. Working paper, University of California at Davis. URL: http://www.des.ucdavis.edu/faculty/Lin/Heres_Lin_experi_paper.pdf

Lade, Gabriel E., and C.-Y. Cynthia Lin. (2013). A report on the economics of California's low carbon fuel standard and cost containment mechanisms. Prepared for the California Air Resources Board. Institute of Transportation Studies, University of California at Davis, Research Report UCD-ITS-RR-13-23. URL: http://www.des.ucdavis.edu/faculty/Lin/California_LCFS.pdf

Lade, Gabriel E., and C.-Y. Cynthia Lin. (2014). Controlling compliance costs for California's LCFS with a price ceiling. Policy brief, University of California at Davis Institute of Transportation Studies. URL: http://www.des.ucdavis.edu/faculty/Lin/cost_containment_policy_brief.pdf

Lade, Gabriel E., and C.-Y. Cynthia Lin. (2015a). Mandating green: On the design of renewable fuel policies and cost containment mechanisms. Working paper, University of California at Davis. URL: http://www.des.ucdavis.edu/faculty/Lin/mandate_cost_containment_paper.pdf

Lade, Gabriel E., and C.-Y. Cynthia Lin. (2015b). The design and economics of low carbon fuel standards. Working paper, University of California at Davis. URL: http://www.des.ucdavis.edu/faculty/Lin/LCFS_Review_paper.pdf

Lade, Gabriel E., C.-Y. Cynthia Lin, and Aaron Smith. (2015a). Ex-post costs and RIN prices under the Renewable Fuel Standard. Working paper, University of California at Davis. URL: http://www.des.ucdavis.edu/faculty/Lin/RFS2_Review_paper.pdf

Lade, Gabriel E., C.-Y. Cynthia Lin, and Aaron Smith. (2015b). Policy shocks and market-based regulations: Evidence from the Renewable Fuel Standard. Working paper, University of California at Davis. URL: http://www.des.ucdavis.edu/faculty/Lin/RFS_policy_shocks_paper.pdf

Lin, C.-Y. Cynthia. (2007). California's gasoline tax. California State Controller John Chiang Statement of General Fund Cash Receipts and Disbursements, 1 (7), 5-8.

Lin, C.-Y. Cynthia. (2010a). A spatial econometric approach to measuring pollution externalities: An application to ozone smog. Journal of Regional Analysis and Policy, 40 (1), 1-19.

Lin, C.-Y. Cynthia. (2010b). How should standards be set and met?: On the allocation of regulatory power in a federal system. B.E. Journal of Economic Analysis and Policy: Topics, 10 (1), Article 51.

Lin, C.-Y. Cynthia. (2011a). An assessment of the effectiveness of California's local air pollution controls on agricultural sources. In Mohamed K. Khallaf (Ed.), The Impact of Air Pollution on Health, Economy, Environment and Agricultural Sources (pp. 323-330). InTech – Open Access Publisher.

Lin, C.-Y. Cynthia. (2011b). Estimating supply and demand in the world oil market. Journal of Energy and Development, 34 (1), 1-32.

Lin, C.-Y. Cynthia. (2011c). The effects of an E10 ethanol-blend policy on California. California State Controller John Chiang Statement of General Fund Cash Receipts and Disbursements, 5 (5), 6-7.

Lin, C.-Y. Cynthia. (2012a). California should raise its gasoline tax. Energy Dimensions. URL: http://www.energydimensions.net/california-should-raise-its-gasoline-tax/

Lin, C.-Y. Cynthia. (2012b). Using spatial econometrics to measure ozone pollution externalities. Journal of Environmental Protection, 3 (9A), 1117-1123.

Lin, C.-Y. Cynthia. (2013a). California's agriculture-related air pollution policy. Journal of Environmental Protection, 4 (8A1), 24-27.

Lin, C.-Y. Cynthia. (2013b). Containing the costs of California's low carbon fuel standard. California State Controller John Chiang Statement of General Fund Cash Receipts and Disbursements, 7 (12). URL: http://www.sco.ca.gov/eo_2013_12_summary_analysis_featured_column.html

Lin, C.-Y. Cynthia. (2013c). On designing and analyzing policies for renewable fuels. Energy Dimensions. URL: http://www.energydimensions.net/on-designing-and-analyzing-policies-for-renewable-fuels/

Lin, C.-Y. Cynthia. (2015). A theory of regulatory federalism. Working paper, University of California at Davis. URL: http://www.des.ucdavis.edu/faculty/Lin/fedlism_paper.pdf

Lin, C.-Y. Cynthia, Daniel J. Jacob, & Arlene M. Fiore. (2001). Trends in exceedances of the ozone air quality standard in the continental United States, 1980-1998. Atmospheric Environment, 35, 3217-3228.

Lin, C.-Y. Cynthia, Daniel J. Jacob, J. William Munger, & Arlene M. Fiore. (2000). Increasing background ozone in surface air over the United States. Geophysical Research Letters, 27 (21), 3465-3468.

Lin, C.-Y. Cynthia, and Lea Prince. (2009). The optimal gas tax for California. Energy Policy, 37 (12), 5173-5183.

Lin, C.-Y. Cynthia, and Lea Prince. (2013). Gasoline price volatility and the elasticity of demand for gasoline. Energy Economics, 38, 111-117.

Lin, C.-Y. Cynthia, and Jieyin (Jean) Zeng. (2013). The elasticity of demand for gasoline in China. Energy Policy, 59, 189-197.

Lin, C.-Y. Cynthia, and Jieyin (Jean) Zeng. (2014). The optimal gasoline tax for China. Theoretical Economics Letters, 4 (4), 270-278.

Lin, C.-Y. Cynthia, Wei Zhang, Omid Rouhani, & Lea Prince. (2009). The implications of an E10 ethanol-blend policy for California. Agricultural and Resource Economics Update, 13 (2), 1-4.

Lin, C.-Y. Cynthia, Wei Zhang, and Victoria I. Umanskaya. (2015). On the design of driving restrictions: Theory and empirical evidence. Working paper, University of California at Davis. URL: http://www.des.ucdavis.edu/faculty/Lin/driving_ban_paper.pdf

Tietenberg, T., and L. Lewis. (2015). Environmental and Natural Resource Economics. 10th edition. Boston: Peason.

Wolf, K. (2011). Developing a California inventory for industrial applications of perfluorocarbons, sulfur hexafluoride, hydrofluorocarbons, nitrogen trifluoride,

hydrofluoroethers and ozone depleting substances. Prepared for the California Air Resources Board and the California Environmental Protection Agency. Agreement Number 07-313. URL: http://www.irta.us/reports/CARB%20-%20Final%20Report.pdf

Project Schedule

Task 1: Information collection.

Task 2: F-gas fee program analysis.

Task 3: F-gas emission reduction optimal policy analysis.

Task 4: Write draft of final report.

Task 5: Revise final report.

	TASK					
	1	2	3	4	5	
MONTH						
1						
2						
3						P
4						
5						
6						P
7						
8						
9						P
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12						P, M
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15						P
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18						P,D,M

19						
20						
21						P
22						
23						
24						P, D,M

P = Deliver quarterly progress report by end of month

D = Deliver draft final report by end of month (to be submitted 6 months prior to contract expiration)

F = Deliver final report by end of month

M = Meeting with ARB staff

C.-Y. Cynthia Lin

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FACULTY APPOINTMENTS

Associate Professor (with tenure) July 2013 to present
Department of Agricultural and Resource Economics, and Department of Environmental Science and Policy
University of California at Davis

Assistant Professor July 2006 to June 2013
Department of Agricultural and Resource Economics, and Department of Environmental Science and Policy
University of California at Davis

OTHER APPOINTMENTS

President, U.S. Association for Energy Economics Bay Area Chapter	June 2012 to present
Member, California State Controller's Council of Economic Advisors	April 2007 to present
Faculty Affiliate, UC-Davis Institute of Transportation Studies	November 2006 to present
Faculty Member, UC-Davis Graduate Group in Transportation Technology and Policy	March 2007 to present
Faculty Member, UC-Davis Graduate Group in Applied Math	March 2007 to present
Faculty Member, UC-Davis Graduate Group in Ecology	October 2007 to present
Member, Bioenergy Research Group at UC-Davis	December 2006 to present
Faculty Associate, UC-Davis Air Quality Research Center	December 2006 to present
Member, Giannini Foundation for Agricultural Economics	July 2006 to present
Member, California Biomass Collaborative	October 2007 to present
Faculty Expert, UC-Davis John Muir Institute of the Environment	September 2008 to present
Associated Faculty, UC-Davis Center for Environmental Policy and Behavior	July 2010 to present
Affiliated Faculty, University of California Center for Energy and Environmental Economics	June 2011 to present
Research Associate, Harvard University John F. Kennedy School of Government	June 2006 to Oct. 2013
Fossil Fuels Track Director, Sustainable Transportation Energy Pathways Program, UC-Davis Institute of Transportation Studies	Dec. 2006 to Sep. 2012

EDUCATION

Harvard University Cambridge, MA
Ph.D. in Economics, June 2006.

Harvard University Cambridge, MA
A.M. in Economics, November 2005.

Harvard University Cambridge, MA
A.B. *summa cum laude* in Environmental Science and Public Policy, June 2000.

FIELDS OF INTEREST

Environmental and natural resource economics
Energy economics
Industrial organization
Applied econometrics
Applied microeconomics

HONORS, AWARDS, FELLOWSHIPS

Gordon and Betty Moore Foundation Data-Driven Discovery Investigator Competition semi-finalist (2014)
Associated Students of University of California at Davis Excellence in Education Award nominee (2012)
University of California at Davis Hellman Fellow (2011)
International Society for New Institutional Economics Award for the Best Ph.D. Dissertation (2006)
Stone Fellow Award for Best Paper Written by a Doctoral Student in Environmental and Resource Policy (2006)
Repsol YPF–Harvard Kennedy School Fellows Program Conference Travel Grant (2006)
The Partnership University Fellow (2005-2006)
Environmental Economics Program at Harvard University Pre-Doctoral Conference Travel Grant (2004)
Repsol YPF–Harvard Kennedy School Fellows Program Conference Travel Grant (2004)
1st Lindau Meeting of the Winners of the Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel, young economist participant, selected to give closing remarks on behalf of students (2004)
Harvard University Department of Economics Research and Travel Award (2004)
Repsol YPF–Harvard Kennedy School Fellows Program Research Travel Grant (2004)
Harvard Committee on Undergraduate Education Certificate of Distinction in Teaching (Fall 2003)
Repsol YPF–Harvard Kennedy School Pre-Doctoral Fellowship in energy policy (2003)
Jens Aubrey Westengard Scholarship (2003)
Harvard Graduate School of Arts and Sciences Summer Research Award (2002)
Harvard Committee on Undergraduate Education Certificate of Distinction in Teaching (Fall 2002)
National Science Foundation Graduate Research Fellowship (2001)
Jacob K. Javits Fellowship (2001, declined in favor of EPA fellowship)
Environmental Protection Agency Science to Achieve Results Graduate Fellowship (2000-2003)
Rita Ricardo-Campbell Fellowship in Economics (2000)
Environmental Economics Program at Harvard University Pre-Doctoral Fellow (2000-2006)
Thomas Temple Hoopes Prize for the top 64 Harvard senior theses (2000)
Donald and Cathleen Pfister Prize for excellence in the natural sciences (2000)
Junior-year Phi Beta Kappa (1999)
Morris K. Udall Scholarship for excellence in environmental policy (1999)
Harvard College Research Program research fellowship (1999)
President Chao Nee Memorial Scholarship (1999)
John Harvard Scholarship (1997, 1998, 1999, & 2000)
Elizabeth Cary Agassiz Scholarship (1997, 1998 & 1999)
Detur Book Prize (1997)
First Place Grand Award at International Science and Engineering Fair (1996)

PEER-REVIEWED PUBLICATIONS

Jardine, Sunny L., C.-Y. Cynthia Lin, & James N. Sanchirico. (forthcoming). Measuring benefits from a marketing cooperative in the Copper River Fishery. American Journal of Agricultural Economics.

Pfeiffer, Lisa, & C.-Y. Cynthia Lin. (forthcoming). The effects of energy prices on groundwater extraction in agriculture in the High Plains Aquifer. American Journal of Agricultural Economics.

Lin, C.-Y. Cynthia, & Lisa Pfeiffer. (2015). Strategic behavior and regulation over time and space. In Kimberly Burnett, Richard Howitt, James A. Roumasset, and Christopher A. Wada (Eds.), Routledge Handbook of Water Economics and Institutions (pp. 79-90). New York: Routledge.

Ghandi, Abbas, & C.-Y. Cynthia Lin. (2014). Oil and gas service contracts around the world: A review. Energy Strategy Reviews, 3, 63-71.

Lin, C.-Y. Cynthia, & Jieyin (Jean) Zeng. (2014). The optimal gasoline tax for China. Theoretical Economics Letters, 4 (4), 270-278.

Pfeiffer, Lisa, & C.-Y. Cynthia Lin. (2014). Does efficient irrigation technology lead to reduced groundwater extraction?: Empirical evidence. Journal of Environmental Economics and Management, 67 (2), 189-208.

Bremson, Joel, Alan Meier, C.-Y. Cynthia Lin, & Joan M. Ogden. (2013). New approach to modeling large-scale alternative fuel and vehicle transitions. Transportation Research Record, 2385, 61-69.

Herath Mudiyanselage, Nisal, C.-Y. Cynthia Lin, & Fujin Yi. (2013). An analysis of ethanol investment decisions in Thailand. Theoretical Economics Letters, 3 (5A1), 14-20.

Lin, C.-Y. Cynthia. (2013). California's agriculture-related air pollution policy. Journal of Environmental Protection, 4 (8A1), 24-27.

Lin, C.-Y. Cynthia, & Jieyin (Jean) Zeng. (2013). The elasticity of demand for gasoline in China. Energy Policy, 59, 189-197.

Lin, C.-Y. Cynthia, & Lea Prince. (2013). Gasoline price volatility and the elasticity of demand for gasoline. Energy Economics, 38, 111-117.

Lin, C.-Y. Cynthia, & Erich J. Muehlegger. (2013). On the use of heuristics to approximate competitors' private information. Journal of Economic Behavior and Organization, 86, 10-23.

Lin, C.-Y. Cynthia. (2013). Strategic decision-making with information and extraction externalities: A structural model of the multi-stage investment timing game in offshore petroleum production. Review of Economics and Statistics, 95 (5), 1601-1621.

Lin, C.-Y. Cynthia, & Zachary D. Liscow. (2013). Endogeneity in the environmental Kuznets curve: An instrumental variables approach. American Journal of Agricultural Economics, 95 (2), 268-274.

Lin, C.-Y. Cynthia. (2012). Using spatial econometrics to measure ozone pollution externalities. Journal of Environmental Protection, 3 (9A), 1117-1123.

Pfeiffer, Lisa, & C.-Y. Cynthia Lin. (2012). Groundwater pumping and spatial externalities in agriculture. Journal of Environmental Economics and Management, 64 (1), 16-30.

Ghandi, Abbas, & C.-Y. Cynthia Lin. (2012). Do Iran's buy-back service contracts lead to optimal production?: The case of Soroosh and Nowrooz. Energy Policy, 42, 181-190.

Leighty, Wayne, & C.-Y. Cynthia Lin. (2012). Tax policy can change the production path: A model of optimal oil extraction in Alaska. Energy Policy, 41, 759-774.

Lin, C.-Y. Cynthia. (2011). Learning an opponent's strategy in Cournot competition. International Journal of Strategic Management, 11 (1), 94-112.

Lin, C.-Y. Cynthia. (2011). Estimating supply and demand in the world oil market. Journal of Energy and Development, 34 (1), 1-32.

Corderi, David, & C.-Y. Cynthia Lin. (2011). Measuring the social rate of return to R&D in coal, petroleum and nuclear manufacturing: A study of the OECD countries. Energy Policy, 39 (5), 2780-2785.

Pfeiffer, Lisa, & C.-Y. Cynthia Lin. (2010). The effect of irrigation technology on groundwater use. Choices, 25 (3).

Lin, C.-Y. Cynthia. (2010). A spatial econometric approach to measuring pollution externalities: An application to ozone smog. Journal of Regional Analysis and Policy, 40 (1), 1-19.

Adjemian, Michael K., C.-Y. Cynthia Lin, & Jeffrey Williams. (2010). Estimating spatial interdependence in automobile type choice with survey data. Transportation Research Part A: Policy and Practice, 44, 661-675.

Lin, C.-Y. Cynthia. (2010). How should standards be set and met?: On the allocation of regulatory power in a federal system. B.E. Journal of Economic Analysis and Policy: Topics, 10 (1), Article 51.

Lin, C.-Y. Cynthia. (2010). Instability, investment, disasters, and demography: Natural disasters and fertility in Italy (1820-1962) and Japan (1671-1965). Population and Environment, 31 (4), 255-281.

Lin, C.-Y. Cynthia, & Lea Prince. (2009). The optimal gas tax for California. Energy Policy, 37 (12), 5173-5183.

Farinelli, Barbara, Colin A. Carter, C.-Y. Cynthia Lin, & Daniel A. Sumner. (2009). Import demand for Brazilian ethanol: A cross-country analysis. Journal of Cleaner Production, 17, S9-S17.

Lin, C.-Y. Cynthia. (2009). Estimating strategic interactions in petroleum exploration. Energy Economics, 31 (4), 586-594.

Lin, C.-Y. Cynthia, Haoying Meng,, Tsz Yan Ngai, Valeria Oscherov, & Yan Hong Zhu. (2009). Hotelling revisited: Oil prices and endogenous technological progress. Natural Resources Research, 18 (1), 29-38.

Lin, C.-Y. Cynthia. (2009). Insights from a simple Hotelling model of the world oil market. Natural Resources Research, 18 (1), 19-28.

Lin, C.-Y. Cynthia. (2008). An evaluation of Keynes' projected possibilities. American Journal of Economics and Sociology, 67 (2), 315-329.

Lin, C.-Y. Cynthia, & Gernot Wagner. (2007). Steady-state growth in a Hotelling model of resource extraction. Journal of Environmental Economics and Management, 54 (1), 68-83.

Lin, C.-Y. Cynthia. (2005). The investment timing game in petroleum production: An econometric model. Physica A, 355 (1), 62-68.

Lin, C.-Y. Cynthia, Daniel J. Jacob, & Arlene M. Fiore. (2001). Trends in exceedances of the ozone air quality standard in the continental United States, 1980-1998. Atmospheric Environment, 35, 3217-3228.

Lin, C.-Y. Cynthia, Daniel J. Jacob, J. William Munger, & Arlene M. Fiore. (2000). Increasing background ozone in surface air over the United States. Geophysical Research Letters, 27 (21), 3465-3468.

OTHER PUBLICATIONS

Lin, C.-Y. Cynthia. (forthcoming). California's nitrogen-related air quality regulations. In California Nitrogen Assessment. University of California Press.

Ghandi, Abbas, & C.-Y. Cynthia Lin (2015). Is resource nationalism on the rise?: Evidence from service contracts in eight countries. International Association for Energy Economics Energy Forum, 24 (1), 35-37.

Lin, C.-Y. Cynthia. (2014). The benefits of investing in energy research and development. California State Controller John Chiang Statement of General Fund Cash Receipts and Disbursements, 8 (8). URL: http://www.sco.ca.gov/eo_2014_08_summary_analysis_guest_column.html

Lin, C.-Y. Cynthia (2014). Modeling ethanol investment decisions. In Alberto Adrego Pinto and David Zilberman (Eds.), Modelling, Dynamics, Optimization and Bioeconomics I (pp. 487-497). Springer.

Pfeiffer, Lisa, & C.-Y. Cynthia Lin. (2014). Perverse consequences of incentive-based groundwater conservation programs. Global Water Forum, Discussion Paper 1415.

Lade, Gabriel E., & C.-Y. Cynthia Lin. (2014). Controlling compliance costs for California's LCFS with a price ceiling. Policy brief, University of California at Davis Institute of Transportation Studies.

Lin, C.-Y. Cynthia. (2014). Strategic interactions during oil exploration in the Gulf of Mexico. In Morena J. Acosta (Ed.), Advances in Energy Research, Volume 20 (pp.201-212) New York: Nova Science Publishers, Inc.

Lin, C.-Y. Cynthia. (2013). Containing the costs of California's low carbon fuel standard. California State Controller John Chiang Statement of General Fund Cash Receipts and Disbursements, 7 (12). URL: http://www.sco.ca.gov/eo_2013_12_summary_analysis_featured_column.html

Lade, Gabriel E., & C.-Y. Cynthia Lin. (2013). A report on the economics of California's low carbon fuel standard and cost containment mechanisms. Prepared for the California Air Resources Board. Institute of Transportation Studies, University of California at Davis, Research Report UCD-ITS-RR-13-23.

Lin, C.-Y. Cynthia. (2013). Paradox on the Plains: As water efficiency increases, so can water use. California WaterBlog. URL: http://californiawaterblog.com/2013/08/13/paradox-on-the-plains-as-water-efficiency-increases-so-can-water-use/

Lin, C.-Y. Cynthia. (2013). The unintended consequences of incentive-based groundwater conservation programs: A study using spatial data. Energy Dimensions. URL: http://www.energydimensions.net/the-unintended-consequences-of-incentive-based-groundwater-conservation-programs-a-study-using-spatial-data/

Lin, C.-Y. Cynthia. (2013). Incentive-based groundwater conservation programs may have unintended results. California State Controller John Chiang Statement of General Fund Cash Receipts and Disbursements, 7 (6), 5-6.

Yi, Fujin, C.-Y. Cynthia Lin, & Karen Thome. (2013). An analysis of the effects of government subsidies and the renewable fuels standard on the fuel ethanol industry. Policy brief, University of California at Davis Policy Institute for Energy, Environment and the Economy.

Lin, C.-Y. Cynthia. (2013). On designing and analyzing policies for renewable fuels. Energy Dimensions. URL: http://www.energydimensions.net/on-designing-and-analyzing-policies-for-renewable-fuels/

Lin, C.-Y. Cynthia. (2013). Activities of the newly-formed Bay Area Chapter in Northern California. U.S. Association for Energy Economics Dialogue, 21 (2).

Lin, C.-Y. Cynthia. (2013). Instability, investment and natural disasters. In Biljana Raskovic & Svetomir Mrdja (Eds.), Natural Disasters: Prevention, Risk Factors and Management (pp.243-258). New York: Nova Science Publishers, Inc.

Lin, C.-Y. Cynthia. (2012). An analysis of ethanol investment decisions. In Roy I. Henry & Billy P. Woods (Eds.), Ethanol: Production, Cellular Mechanisms and Health Impact (pp. 121-128). New York: Nova Science Publishers, Inc.

Lin, C.-Y. Cynthia. (2012). California should raise its gasoline tax. Energy Dimensions. URL: http://www.energydimensions.net/california-should-raise-its-gasoline-tax/

Lin, C.-Y. Cynthia. (2012). On designing and analyzing policies for renewable fuels. California State Controller John Chiang Statement of General Fund Cash Receipts and Disbursements, 6 (12), 4-5.

Lin, C.-Y. Cynthia. (2011). An assessment of the effectiveness of California's local air pollution controls on agricultural sources. In Mohamed K. Khallaf (Ed.), The Impact of Air Pollution on Health, Economy, Environment and Agricultural Sources (pp. 323-330). InTech – Open Access Publisher.

Heres del Valle, David R., & C.-Y. Cynthia Lin. (2011). Sub-national state's climate policy: The case of California. In Ibon Galarraga, Mikel Gonzalez-Eguino, & Anil Markandya (Eds.), Handbook of Sustainable Energy (pp. 555-573). United Kingdom: Edward Elgar.

Lin, C.-Y. Cynthia. (2011). Fossil fuels. World Book Encyclopedia. Chicago: World Book.

Lin, C.-Y. Cynthia. (2011). The effects of an E10 ethanol-blend policy on California. California State Controller John Chiang Statement of General Fund Cash Receipts and Disbursements, 5 (5), 6-7.

Lin, C.-Y. Cynthia. (2011). A Hotelling model of steady-state growth in coal extraction. In James J. Stewart (Ed.), Coal Extraction (pp. 147-154). New York: Nova Science Publishers, Inc.

Lin, C.-Y. Cynthia. (2010). Gasoline price volatility. California State Controller John Chiang Statement of General Fund Cash Receipts and Disbursements, 4 (11), 6-8.

Lin, C.-Y. Cynthia, Wei Zhang, Omid Rouhani, & Lea Prince. (2009). The implications of an E10 ethanol-blend policy for California. Agricultural and Resource Economics Update, 13 (2), 1-4.

Lin, C.-Y. Cynthia. (2009). Biofuels for transport: Global potential and implications for sustainable energy and agriculture (book review). American Journal of Agricultural Economics, 91(4), 1155-1157.

Pfeiffer, Lisa, & C.-Y. Cynthia Lin. (2009). Incentive-based groundwater conservation programs: Perverse consequences? Agricultural and Resource Economics Update, 12 (6), 1-4.

Lin, C.-Y. Cynthia. (2008). On the distribution of regulatory power between state and local governments. In Albert Tavidze (Ed.), Progress in Economics Research, Volume 12 (pp. 189-208). New York: Nova Science Publishers, Inc.

Lin, C.-Y. Cynthia. (2007). California's gasoline tax. California State Controller John Chiang Statement of General Fund Cash Receipts and Disbursements, 1 (7), 5-8.

Lin, C.-Y. Cynthia. (2006). Environmental federalism and regulatory delegation: An incomplete contracting approach. In Raimund Bleischwitz & Oliver Budzinski (Eds.), Environmental Economics: Institutions, Competition, Rationality (pp. 129-149). Berlin: VWF.

Lin, C.-Y. Cynthia. (2006). Oil prices, stock effects and endogenous technological progress. In Cordelia L. Frankhouse (Ed.), Economics of Agriculture and Natural Resources (pp. 111-125). New York: Nova Science Publishers, Inc.

Lin, C.-Y. Cynthia. (2006). Three essays on the economics of the environment, energy and externalities. Ph.D. dissertation, Harvard University.

Lin, C.-Y. Cynthia. (2005). Estimating annual and monthly supply and demand for world oil: A dry hole? In William W. Hogan (Ed.), Repsol YPF – Harvard Kennedy School Fellows 2003-2004 Research Papers (pp. 213-249). Cambridge, MA: Harvard University.

Lin, C.-Y. Cynthia. (2005). The multi-stage investment timing game in offshore petroleum production: A framework for an econometric model. In William W. Hogan (Ed.), Repsol YPF – Harvard Kennedy School Fellows 2003-2004 Research Papers (pp. 201-211). Cambridge, MA: Harvard University.

Lin, C.-Y. Cynthia. (2005). Optimal world oil extraction: Calibrating and simulating the Hotelling model. In William W. Hogan (Ed.), Repsol YPF – Harvard Kennedy School Fellows 2003-2004 Research Papers (pp. 251-266). Cambridge, MA: Harvard University.

Lin, C.-Y. Cynthia. (2004). Regulatory delegation: Theory and application to environmental federalism. In Gregory T. Papanikos (Ed.), Competition, Regulation and Protection: Essays from an International Conference on Industrial Organization, Law and Economics (pp. 79-90). Athens: Athens Institute for Education and Research.

Lin, C.-Y. Cynthia. (2001). The scholar as activist: A colloquium explores these dual roles. Harvard Graduate School of Arts and Sciences Bulletin, XXX (9), 1-3.

Lin, C.-Y. Cynthia. (2000). Trends in ozone smog. Senior thesis, Harvard University.

WORKING PAPERS

"Mandating green: On the design of renewable fuel policies and cost containment mechanisms", with Gabriel E. Lade

"On the design of driving restrictions: Theory and empirical evidence", with Wei Zhang and Victoria I. Umanskaya (revise and resubmit, Journal of Environmental Economics and Management)

"Wind turbine shutdowns and upgrades in Denmark: Timing decisions and the impact of government policy", with Jonathan A. Cook (under review)

"Evaluating public transit investment in congested cities", with Justin Beaudoin and Y. Hossein Farzin (under review)

"Policy shocks and market-based regulations: Evidence from the Renewable Fuel Standard", with Gabriel E. Lade and Aaron Smith

"An analysis of the effects of government subsidies and the renewable fuels standard on the fuel ethanol industry: A structural econometric model", with Fujin Yi and Karen Thome

"Does employment growth increase travel time to work?: An empirical analysis using military troop movements", with Geoffrey M. Morrison

"Market power in the world oil market: Evidence for an OPEC cartel and an oligopolistic non-OPEC fringe" (under review)

"Investment in corn-ethanol plants in the Midwestern United States: An analysis using reduced-form and structural models", with Karen Thome

"The rate of return to research and development in energy", with David Corderi (under review)

"Market power in nonrenewable resource markets: An empirical dynamic model", with Wei Zhang (under review)

"What factors affect the decision to invest in a fuel ethanol plant?: A structural model of the ethanol investment timing game", with Fujin Yi

"On the rate of return and risk factors to international oil companies in Iran's buy-back service contracts", with Abbas Ghandi (under review)

"Ex-post costs and RIN prices under the Renewable Fuel Standard", with Gabriel E. Lade and Aaron Smith

"The effects of energy policies in China on energy consumption", with Ming-Jie Lu and Song Chen

"The macroeconomic rebound effect in China", with Jiangshan Zhang (under review)

"Driving in force: The influence of workplace peers on commuting decisions on U.S. military bases", with Geoffrey M. Morrison (under review)

"A theory of regulatory federalism" (under review)

"An analysis of the economic efficiency of Iraq's oil service contracts", with Abbas Ghandi (under review)

"The producer surplus associated with gasoline fuel use in the United States", with Yongling Sun, Mark A. Delucchi and Joan M. Ogden

"The effects of energy policies in China on GDP, industrial output and new energy profits", with Ming-Jie Lu and Song Chen

"Quantity and price controls for the correction of externalities under uncertain damages: Evidence from a laboratory experiment", with David R. Heres del Valle

"A nonparametric instrumental variable approach to estimating the environmental Kuznets curve for water pollutants at the global level", with Krishna P. Paudel and Mahesh Pandit (under review)

"Ethanol plant investment in Canada: A structural model", with Fujin Yi

"Property rights and groundwater management in the High Plains Aquifer", with Lisa Pfeiffer (under review)

"The conditional relationship between risk and return in Iran's stock market", with Mahdieh Rezagholizadeh, Kazem Yavari and Bahram Sahabi (under review)

"The effects of innovation on income inequality in China", with Qingchun Liu (under review)

"The design and economics of low carbon fuel standards", with Gabriel E. Lade (under review)

"Public transit investment and sustainable transportation: A review of transit's impact on traffic congestion and air quality", with Justin Beaudoin and Y. Hossein Farzin (under review)

"Using observed ozone-temperature relationships to project the effect of future climate change on ozone exceedances in the northeastern United States", with Loretta J. Mickley, Katharine M. Hayhoe, Ed P. Maurer, Christian Hogrefe, Patrick L. Kinney, and Daniel J. Jacob

GRANTS

National Center for Sustainable Transportation Federal Research Seed Grant ($25,000). Principal Investigator: C.-Y. Cynthia Lin. Awarded July 2014.

Resources for the Future Retrospective Studies of Regulatory Performance Grant ($37,686.94). Principal Investigators: Aaron Smith, C.-Y. Cynthia Lin, and Gabriel E. Lade. Awarded September 2013.

Giannini Foundation of Agricultural Economics minigrant ($24,851). Principal Investigator: C.-Y. Cynthia Lin. Awarded June 2012.

UC-Davis Committee on Research Academic Senate Faculty Research Grant ($12,000). Principal Investigator: C.-Y. Cynthia Lin. Awarded June 2012.

UC-Davis Sustainable Transportation Center Faculty Research Grant ($59,995.99). Principal Investigator: C.-Y. Cynthia Lin. Awarded August 2011.

Giannini Foundation of Agricultural Economics minigrant ($24,585). Principal Investigator: C.-Y. Cynthia Lin. Awarded June 2011.

UC-Davis Sustainable Transportation Center Seed Grant ($9,919.34). Principal Investigator: C.-Y. Cynthia Lin. Awarded June 2011.

UC-Davis Hellman Fellowship ($20,638). Awarded May 2011.

ITS Multi-campus Research Program and Initiative on Sustainable Transportation grant ($17,000). Principal Investigator: C.-Y. Cynthia Lin. Awarded January 2011.

UC-Davis Chevron Research Grant ($301,037). Principal Investigator: C.-Y. Cynthia Lin. Awarded December 2007.

UC-Davis Chevron Research Grant ($369,308). Principal Investigator: C.-Y. Cynthia Lin. Co-PIs: Mark Delucchi, Christopher Knittel, and Daniel Sperling. Awarded February 2007.

TEACHING EXPERIENCE

University of California at Davis
ARE 175/ESP 175: Natural Resource Economics (2008 - present)
ARE 254: Dynamic Optimization Techniques with Economic Applications (2011 - present)
ARE 255 (formerly ARE 276 and ARE 298): Applied Dynamic Structural Econometric Modeling (2007 - present)
ECL 298: Environmental Policy and Human Ecology Core Course (Winter 2010)
ARE 199: Special Study for Advanced Undergraduates (2007 - present)
ECN 194HB: Honors Thesis in Economics (2011-2012)
Faculty Mentor, Vertical Integration of Research and Education in the Mathematical Sciences (VIGRE) Research Experiences for Undergraduates (Summer 2007)
Guest Lecturer, ARE 176: Environmental Economics (November 17, 2009)
Guest Lecturer, Engineering Civil and Environmental (ECI) 269: Transportation – Air Quality (May 2, 2007)
Guest Lecturer, Engineering Biological Systems (EBS) 216: Energy Systems (March 14, 2007)

Harvard University
Participant in Discussion Leading Master Class, Harvard University Derek Bok Center for Teaching and Learning (2005-2006)

Teaching Fellow for Prof. Martin Weitzman, Economics 1690: "Theory of Capital and Income" (Fall 2002 and Fall 2003)

PRESENTATIONS

"The economics of energy: Dynamic behavior, strategic interactions and government policy." CITRUS@Berkeley Research Exchange Seminar. Berkeley, CA. November 2014.

"Wind turbine shutdowns and upgrades in Denmark: Timing decisions and the impact of government policy." Harvard Environmental Economics Program Research Workshop. Cambridge, MA. October 2014.

"Wind turbine shutdowns and upgrades in Denmark: Timing decisions and the impact of government policy." Texas A&M. College Station, TX. September 2014.

"Market power in the world oil market: Evidence for an OPEC cartel and an oligopolistic non-OPEC fringe." 37th International Association for Energy Economics International Conference. New York City. June 2014.

"Dynamic optimization and dynamic games in economics." Graduate Group in Applied Math Mini-Conference. University of California at Davis. January 2014.

"The effects of energy prices on groundwater extraction in agriculture in the High Plains Aquifer." American Economic Association Annual Meeting. Philadelphia. January 2014.

"Strategic decision-making with information and extraction externalities: A structural model of the multi-stage investment timing game in offshore petroleum production." Georgia Institute of Technology. Altlanta, Georgia. August 2013.

"Energy prices and groundwater extraction in agriculture." Association of Environmental and Resource Economists Conference. Banff, Canada. June 2013.

"An analysis of the effects of government subsidies on the fuel ethanol industry: A structural econometric model." Berkeley Bioeconomy Conference. Berkeley, CA. March 2013.

"Strategic decision-making with information and extraction externalities: A structural model of the multi-stage investment timing game in offshore petroleum production." American University. Washington, DC. February 2013.

"Strategic decision-making with information and extraction externalities: An empirical analysis of investment timing decisions in offshore petroleum production." American Economic Association Annual Meeting. San Diego. January 2013.

"The effects of policy and strategic factors on investment in fuel-ethanol plants." American Economic Association Annual Meeting. San Diego. January 2013.

"Strategic decision-making with information and extraction externalities: An empirical analysis of investment timing decisions in offshore petroleum production." 31st United States Association for Energy Economics (USAEE) — International Association for Energy Economics (IAEE) North American Conference. Austin. November 2012.

"Strategic decision-making with information and extraction externalities: An empirical analysis of investment timing decisions in offshore petroleum production." University of Wisconsin-Madison. September 2012.

"An analysis of ethanol investment decisions." 3rd Annual All-UC Conference on Energy and Environmental Economics. Berkeley. June 2012.

"Research highlights." UC-Davis Sustainable Transportation Energy Pathways Advisory Board Meeting. University of California at Davis. June 2012.

"Economic, policy and business strategy in energy." Brightsource Energy. Oakland, CA. March 2012.

"The effects of policy and strategic factors on investment in fuel-ethanol plants." Berkeley Bioeconomy Conference. Berkeley, CA. March 2012.

"Climbing gas prices." Insight, Capital Public Radio. March 2012.

"Endogeneity in the environmental Kuznets curve: An instrumental variables approach." American Economic Association Annual Meeting. Chicago. January 2012.

"Gasoline demand elasticities, gasoline price volatility, and the optimal gas tax for California." Sacramento Economics Roundtable. September 2011.

"The effects of policy and strategic factors on investment in fuel-ethanol plants." Rice University. September 2011.

"The effects of policy and strategic factors on investment in fuel-ethanol plants." Association of Environmental and Resource Economists Conference. Seattle. June 2011.

"Do firms interact strategically?: An empirical analysis of investment timing decisions in offshore petroleum production." University of California at Riverside. April 2011.

"Have OPEC producers colluded?: An empirical dynamic model of OPEC and non-OPEC." OPEC at 50: Its past, present and future in a carbon-constrained world. National Energy Policy Institute/University of Tulsa. March 2011.

"Global energy issues." UC-Davis International Relations Student Association Guest Speaker. University of California at Davis. February 2011.

"Investment in biofuels: The role of oil companies." UC-Davis Sustainable Transportation Energy Pathways (STEPS) Symposium. University of California at Davis. January 2011.

"The effects of policy and strategic factors on investment in fuel-ethanol plants." IO Fest 2010: The Annual Berkeley-Stanford Conference in Industrial Organization. Stanford University. November 2010.

"Do firms interact strategically?: An empirical analysis of investment timing decisions in offshore petroleum production." University of Alberta. October 2010.

"Investment in corn-ethanol plants in the Midwestern United States." Duke University. October 2010.

"Do firms interact strategically?: An empirical analysis of investment timing decisions in offshore petroleum production." Triangle Resource and Environmental Economics Seminar. North Carolina. October 2010.

"How should standards be set and met?: On the allocation of regulatory power in a federal system." University of Nevada at Reno. October 2010.

"Investment in fuel-ethanol plants." Research Sketch. National Bureau of Economic Research (NBER) Summer Institute Environmental and Energy Economics Workshop. July 2010.

"The economics of investment in biofuels." Third Berkeley Conference on the Bioeconomy. Berkeley, CA. June 2010.

"The optimal gas tax for California." U.S. Energy Policy in Transition conference. Gainesville, FL. March 2010.

"Strategic behavior and government policy." Graduate Group in Applied Math Mini-Conference. University of California at Davis. January 2010.

"Gasoline demand elasticities, gasoline price volatility, and the optimal gas tax for California." 11th Occasional California Workshop on Environmental and Natural Resource Economics. Santa Barbara. October 2009.

"Gasoline demand elasticities, gasoline price volatility, and the optimal gas tax for California." 2009 Harvard Environmental Economics Alumni Workshop. September 2009.

"Research on natural resources." Visiting Delegation from Henan Province of P.R. China. University of California at Davis. September 2009.

"Understanding, modeling and analyzing energy markets." UC-Davis Sustainable Transportation Energy Pathways Advisory Board Meeting. Asilomar. July 2009.

"How should standards be set and met?: On the allocation of regulatory power in a federal system." University of California at Riverside. June 2009.

"An empirical dynamic model of OPEC and Non-OPEC." Harvard University. February 2009.

"An empirical dynamic model of OPEC and Non-OPEC." University of California at San Diego. January 2009.

"Energy outlook: Prospects and policies." California State Controller Council of Economic Advisors meeting. Sacramento. December 2008.

"Dynamic and strategic decision-making in the energy industry." Exxon-Mobil campus visit. Institute of Transportation Studies, University of California at Davis. July 2008.

"How should standards be set and met?: On the allocation of regulatory power in a federal system." 10th Occasional Workshop on Environmental and Resource Economics. Santa Barbara. March 2008.

"Do firms interact strategically?: A structural model of the multi-stage investment timing game in offshore petroleum production." University of California at Berkeley. February 2008.

"Do firms interact strategically?: A structural model of the multi-stage investment timing game in offshore petroleum production." American Economic Association Annual Meeting. New Orleans. January 2008.

"An empirical dynamic model of OPEC and Non-OPEC." 1st International Association for Energy Economics (IAEE) Asian conference. Taipei. November 2007.

"Modeling OPEC and non-OPEC behavior: A structural econometric approach." IO Fest 2007: The 13th Annual Berkeley-Stanford Conference in Industrial Organization. Berkeley Haas School of Business. October 2007.

"Estimating and testing a dynamic model of OPEC and non-OPEC." 27th United States Association for Energy Economics (USAEE) — International Association for Energy Economics (IAEE) North American Conference. Houston. September 2007.

"Business and investment strategies for clean tech commodities." Panel on Biofuels: Successful Business Models for Clean Tech Commodities. Clean Technology Group, Entrepreneurship Program, MIT Club of Northern California. Google, Mountain View, CA. September 2007.
"Fossil fuels research highlights." UC-Davis Sustainable Transportation Energy Pathways Advisory Board Meeting. Asilomar. August 2007.
"Strategic behavior and government policy." Research Sketch. National Bureau of Economic Research (NBER) Summer Institute Workshop on Public Policy and the Environment. July 2007.
"Managing energy markets: Policies and implications." Swedish Parliament visit: New Energy and Techniques for a Better Future. University of California at Davis. June 2007.
"Energy: A Giannini jingle." Annual Meeting of the Giannini Foundation of Agricultural Economics. UC-Berkeley. May 2007.
"A theory of regulatory delegation, with a framework for application to ozone smog regulation." Ronald Coase Institute Conference on Institutional Research. Chicago. Dec. 2006.
"Do firms interact strategically?: An empirical analysis of investment timing decisions in offshore petroleum production." 9th Occasional Workshop on Environmental and Resource Economics. Santa Barbara. Nov. 2006.
"How should standards be set and met?: An incomplete contracting approach to delegation in regulation." University of California at Berkeley. Oct. 2006.
"How should standards be set and met?: An incomplete contracting approach to delegation in regulation." University of California at Davis. Oct. 2006.
"Do firms interact strategically?: An empirical analysis of investment timing decisions in offshore petroleum production." 3rd World Congress of Environmental and Resource Economists. Kyoto. July 2006.
"How should standards be set and met?: An incomplete contracting approach to delegation in regulation." 3rd World Congress of Environmental and Resource Economists. Kyoto. July 2006.

2003-2006:
International Industrial Organization Conference, 2006
University of California, Berkeley, 2006
University of California, Davis, 2006
University of Hawaii, Manoa, 2006
Rice University, 2006
Soka University, 2006
Repsol YPF – Harvard Seminar on Energy, 2005
Harvard University Environmental Economics and Policy Seminar, 2005
Harvard Environmental Economics Workshop, 2005
Interdisciplinary Spatial Statistics Workshop, 2004 (Paris)
INFER Conference 2004: Environmental Economics: Institutions, Competition, Rationality, 2004 (Wuppertal, Germany)
First Bonzenfreies Colloquium on Market Dynamics and Quantitative Economics, 2004 (Alessandria, Italy)
NBER Summer Institute Workshop on Public Policy and the Environment, 2004 (research sketch)
Second World Congress of the Game Theory Society, 2004 (Marseille)
International Conference on Industrial Organization, Law and Economics, 2004 (Chalkidiki, Greece)
Harvard University Environmental Economics and Policy Seminar, 2004
Repsol YPF – Harvard Seminar on Energy, 2003
NBER Summer Institute Workshop on Public Policy and the Environment, 2003 (research sketch)

WORKSHOPS, SUMMER PROGRAMS AND OTHER PROFESSIONAL MEETINGS

National Bureau of Economic Research Summer Institute Econometrics Minicourse (2007)
Stanford University Woods Institute for the Environment Inter-University Scholars Program: Engaging with California Government on Climate Change (2006)
Harvard University Christensen Discussion-Leading Seminar (2005-2006)
Ronald Coase Institute Workshop on Institutional Analysis (2004)

EAERE-FEEM-VIU Summer School: Dynamic Models in Economics and the Environment, scholarship recipient (2004)
XIV Seminario Repsol YPF ~ Harvard, A Coruña (2004)
EAERE-FEEM-VIU Summer School: Political Economy of the Environment (2003)
Interuniversity Centre for Game Theory and its Applications Summer School on Game Theory and the Environment, fellowship recipient (2002)
Social Science Research Council Program in Applied Economics Summer Workshop: Risk and Uncertainty (2002)
Social Science Research Council Program in Applied Economics Summer Workshop (2001)

SERVICE

Professional

Reviewer, University of Texas at Austin Bureau of Economic Geology promotion case (2015)
Member, Program Committee for the 4th Annual Summer Conference of the Association of Environmental and Resource Economists (2015)
Presidential Advisor, U.S. Association for Energy Economics (2014- present)
Reviewer, Columbia University Center on Global Energy Policy (2014)
Reviewer, Resources for the Future Senior Fellow promotion case (2014)
Reviewer, Handbook of Water Economics and Institutions (2014)
Guest editor, Research in Transportation Economics Special Issue on Sustainable Transportation (2014-present)
Reviewer, National Science Foundation economics grant (2013)
Reviewer, three-volume set on Public Economics: The Government's Role in American Economics (2013)
Member, U.S. Association for Energy Economics Membership Committee (2013-present)
President, U.S. Association for Energy Economics Bay Area Chapter (2012-present)
Member, Energy Dimensions Advisory Panel (2012-present)
Associate Editor, Environmental Studies, Versita (2012-2013)
Session chair, Association of Environmental and Resource Economists session, Agricultural and Applied Economics Association Annual Meeting (2012)
Session chair, American Economic Association Annual Meeting (2012)
Member, U.S. Association for Energy Economics Bay Area Chapter Steering Committee (2012)
Reviewer, National Science Foundation economics grant (2012)
Reviewer, Annual Meeting of the Western Agricultural and Resource Economics Association (2012)
Associate Topic Editor, CAMEL (Climate, Adaption, Migration, Electronic Learning) (2011- present)
Referee, University of California Transportation Center research grant (2011)
Peer reviewer, EPA grant on "Research on the Design of Policies for Pollution Control Using Market Mechanisms" (2009)
Member, California State Controller's Council of Economic Advisors (2007-present)
Session chair, 3rd World Congress of Environmental and Resource Economists (2006)
Session chair, International Industrial Organization Conference (2006)
Referee, American Journal of Agricultural Economics [6]
Referee, Australian Journal of Agricultural and Resource Economics
Referee, American Journal of Economics and Sociology
Referee, B.E. Journal of Economic Analysis and Policy
Referee, Canadian Journal of Economics
Referee, Contemporary Economic Policy
Referee, Empirical Economics
Referee, Energy Economics [4]
Referee, Energy Journal [2]
Referee, Energy Policy [7]
Referee, Energy Research and Social Science
Referee, Energy Strategy Reviews
Referee, European Economic Review

Referee, International Journal of Agricultural Management and Development
Referee, International Journal of Production Economics
Referee, Journal of Agricultural and Applied Economics
Referee, Journal of Agricultural and Resource Economics
Referee, Journal of Comparative Economics
Referee, Journal of Environmental Economics and Management [8]
Referee, Journal of Environmental Economics and Policy
Referee, Journal of Political Economy
Referee, Journal of the Association of Environmental and Resource Economists
Referee, Journal of Urban Economics
Referee, Land Economics
Referee, Public Choice
Referee, Review of Development Economics
Referee, Review of Environmental Economics and Policy
Referee, Society of Petroleum Engineers Economics and Management [3]
Referee, Theoretical Economics Letters
Referee, Transportation Research Part A: Policy and Practice
Referee, Water Resources and Economics [2]
Referee, Water Resources Research

University of California at Davis
Chair, Institute of Transportation Studies Outstanding Thesis Award committee (2014)
Judge, Economics and Business Student Association Business Plan Competition (2014)
Member, Selection Committee for the Provost's Dissertation Year Fellowships (2013)
Speaker, Passport to Air Quality and Health, Santa Rosa Girl Scouts UC-Davis visit (2009)
Panelist, Gender and the job market panel (2007)

UC-Davis Agricultural and Resource Economics Department
Member, Applied Econometrics Faculty Search Committee (2014-2015)
Member, AES proposal ad-hoc review committee (2014)
Member, Graduate Administrative Committee (2013-present)
Member, Ad-hoc appraisal review committee (2013)
Member, Econometrics Faculty Search Committee (2012-2013)
Chair, Seminar Committee (2012-present)
Reviewer, Econometrics Prelim Committee (2012)
Member, Environmental and Resource Economics Field Courses Committee (2012)
Member, Best Dissertation Selection Committee (2012)
Member, Mock interviewer for job market candidate (2011)
Member, AES proposal ad-hoc review committee (2011)
Member, AES proposal ad-hoc review committee (2010)
Member, Undergraduate Advisory Committee (2006-2013)
Member, Environmental and Resource Economics Field Courses Committee (2009-2010)
Member, Economics of Agricultural Sustainability Faculty Search Committee (2006-2007)

UC-Davis Environmental Science and Policy Department
Member, Ad-hoc fiscal-year term review committee (2013)
Member, Ad-hoc merit review committee (2013)
Member, Ad-hoc merit review committee (2013)
Member, Ad-hoc merit review committee (2012)
Member, AES proposal ad-hoc review committee (2012)
Member, Ad-hoc appraisal review committee (2011)
Member, Ad-hoc merit review committee (2011)
Member, Ad-hoc merit review committee (2010)
Member, Ad-hoc merit review committee (2009)

Harvard University Department of Economics
Panelist, Job market panel (2006)

MEDIA CITATIONS

"Five myths about California's drought". Washington Post, 29 August 2014. URL: http://www.washingtonpost.com/opinions/five-myths-about-californias-drought/2014/08/29/6a6b8ed4-2c69-11e4-994d-202962a9150c_story.html

"Odd odd-number experiment has odd consequences. What are the odds?". Institute for Research in Economic and Fiscal Issues, 27 March 2014. URL: http://en.irefeurope.org/Odd-Odd-Number-Experiment-Has-Odd-Consequences-What-Are-The-Odds,a0983

"A report on the economics of California's Low Carbon Fuel Standard and cost containment mechanisms", Resources for the Future Library Blog, 2 January 2014. URL: https://rfflibrary.wordpress.com/2014/01/02/a-report-on-the-economics-of-californias-low-carbon-fuel-standard-and-cost-containment-mechanisms/

"UC Davis report finds LCFS compliance costs may rise rapidly; recommends offsetting measures", Green Car Congress, 30 December 2013. URL: http://www.greencarcongress.com/2013/12/20131230-lcfs.html

"UC Davis report addresses compliance costs of California's LCFS", Biodiesel Magazine, 30 December 2013. URL: http://www.biodieselmagazine.com/articles/9475/uc-davis-report-addresses-compliance-costs-of-californias-lcfs

"Report addresses compliance costs of California's LCFS", Ethanol Producer Magazine, 27 December 2013. URL: http://www.ethanolproducer.com/articles/10596/report-addresses-compliance-costs-of-californias-lcfs

"Big changes in California LCFS are called for in a new report", The Barrel, Platts, 19 November 2013. URL: http://blogs.platts.com/2013/11/19/lcfs-report/

"UC Davis report examines economics of LCFS, cost containment mechanisms", UC-Davis Institute of Transportation Studies, November 2013. URL: http://www.its.ucdavis.edu/research/research-findings/uc-davis-report-examines-economics-of-lcfs-cost-containment-mechanisms/

"Whiskey is for drinking; water is for fighting", AgChallenge2050, Farm Foundation, 26 July 2013. URL: http://www.agchallenge2050.org/adaptability-resilience/2013/07/whiskey-is-for-drinking-water-is-for-fighting/

"Programs to reduce ag's water use must be strengthened, not cut," AgMag BLOG, Environmental Working Group, 28 May 2013. URL: http://www.ewg.org/agmag/2013/05/programs-reduce-ag-s-water-use-must-be-strengthened-not-cut

"Wells dry, fertile plains turn to dust," New York Times, 19 May 2013. URL: http://www.nytimes.com/2013/05/20/us/high-plains-aquifer-dwindles-hurting-farmers.html?pagewanted=all&_r=0

"Profile: C.-Y. Cynthia Lin, 2011 Hellman Fellow, Agricultural and Resource Economics, UC Davis," Hellman Fellows Program 2011 Annual Report, Dec. 2012.

"Sex, lies and natural disasters," The Guardian, 27 Jan. 2012. URL: http://www.guardian.co.uk/lifeandstyle/2012/jan/28/shortage-of-school-places-floods-gloucestershire

"Climbing gas prices," Insight, Capital Public Radio, 5 March 2012.

"Research leader focus," STEPS Newsletter, Nov. 2009, p.4.

"ARE Faculty Profile: C.-Y. Cynthia Lin," Agricultural and Resource Economics Update, 12 (4), Mar./Apr. 2009.

"Chiang names new economic advisory council," 27 Apr. 2007.

"Dutch energy company opens American branch in West Sacramento," The California Aggie, 9 Feb. 2007.

"Academia boot camp," The Sacramento Bee, 3 Dec. 2006.

"New ways to look for work." Harvard Magazine, May-June 1998. URL: http://harvardmagazine.com/1998/05/alumni.new.html

MISCELLANEOUS

Results from Lin et al. (2001) featured in Denman, K.L., et al. (2007). Couplings between changes in the climate system and biogeochemistry. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., et al., (eds.)]. Cambridge: Cambridge University Press.

FORMER GRADUATE STUDENTS

Michael Adjemian
Ph.D., Agricultural & Resource Economics, 2009
Economist, USDA Economic Research Service

Joel Bremson
Ph.D., Transportation Technology & Policy, 2012

Michael Castelhano
Ph.D., Agricultural & Resource Economics, 2014
Market Monitoring Analyst, California ISO

Jonathan A. Cook
Ph.D., Agricultural & Resource Economics, 2013
Senior Consultant, Nexant

Joeri de Wit
Ph.D., Agricultural & Resource Economics, 2013
Energy Economist, World Bank

Barbara Farinelli
M.S., Agricultural & Resource Economics, 2008
Energy consultant, World Bank

David Heres del Valle
Ph.D., Agricultural & Resource Economics, 2009
Assistant Professor, Department of Economics, Center for Research and Teaching in Economics (CIDE), Mexico

Sunny Jardine
Ph.D., Agricultural & Resource Economics, 2013
Assistant Professor, School of Marine Science and Policy, University of Delaware

Wayne Leighty
M.S., Transportation Technology and Policy, 2008
Commercial Regulatory Analyst, Shell Oil Company

Ana McPhail
Ph.D., Civil and Environmental Engineering, Rice University, 2014
Socially Responsible Investment Planning Assistant, Communitas Financial

Geoffrey Morrison
Ph.D., Transportation Technology and Policy, 2013
M.S., Agricultural and Resource Economics, 2011
ORISE Fellow, Office of Fuel Cell Technologies, Department of Energy

Lisa Pfeiffer
Ph.D., Agricultural & Resource Economics, 2009
Economist, NOAA National Marine Fisheries Service Northwest Fisheries Science Center

Karen Thome
Ph.D., Agricultural & Resource Economics, 2012
Postdoctoral scholar, Agricultural & Resource Economics, 2012-2014
Research Agricultural Economist, USDA Economic Research Service

Fujin Yi
Ph.D., Agricultural & Resource Economics, 2011
Postdoctoral scholar, Agricultural & Resource Economics, 2012
Associate Professor, College of Economics and Management, Nanjing Agricultural University

Jieyin (Jean) Zeng
M.S., Transportation Technology and Policy, 2014
Tax Associate, Economic and Valuation Services, KPMG

Wei Zhang
Ph.D., Agricultural & Resource Economics, 2013
Postdoctoral scholar, University of California Agricultural Issues Center, 2013-2014
Assistant Professor, Department of Economics, Connecticut College

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Agricultural and Applied Economics Association
American Economic Association
Association of Environmental and Resource Economists
Canadian Economics Association
Econometric Society
International Association for Energy Economics
Royal Economic Society
U.S. Association for Energy Economics
U.S. Association for Energy Economics Bay Area Chapter

PREVIOUS WORK EXPERIENCE

Harvard University, Research Assistant in Economics for Prof. Dale Jorgenson	Summer 2001
Harvard University, Research Assistant in Atmospheric Chemistry for Prof. Daniel Jacob	9/1998 to 9/2000
Environmental Policy Intern for Massachusetts State Senator Lois G. Pines	Summer 1998
Harvard University, Radcliffe Research Partner for Barbara Goldoftas	Summer 1998
Biotech Investment Consultant for Wiltshire Associates, Ltd.	Summer 1997

CONSULTING

Economic and Planning Systems, Inc. (wind energy) (2010)

SKILLS

Computer languages: IDL, R/S-Plus, Matlab, C, Fortran, TSP, Stata.

Foreign languages: Proficient in Mandarin and French.

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updated February 16, 2015

Preliminary Cost Proposal

	TASK 1	2	3	4	5	**Total**
Salaries and Wages	$19,290	$38,579	$39,158.25	$19,868.75	$39,737.50	$156,633
Fringe Benefits	$853	$1705	$1770	$917.50	$1835	$7080
Materials & Supplies	$875	$1750	$1000	$125	$250	$4000
Domestic Travel	$63	$125	$125	$62.50	$125	$500
Total Student Assistance/Support	$13,684	$27,367.50	$28,736.25	$15,052.50	$30,105	$114,945
Indirect Costs	$2108	$4215.90	$4205.45	$2097.50	$4195	$16,822
Total Project Costs	$36,871	$73,742.40	$74,994.95	$38,123.75	$76,247.50	**$299,980**

Budget Justification

Senior Personnel: Funds are requested for 8.33% of Dr. Lin's time throughout the project. She is the principal investigator and will coordinate the overall project and manage personnel and the budget. She will oversee the development of the economic and econometric models, and the analysis of the results. She will also lead the dissemination of the results through meetings and presentations.

Other Personnel: Funds are requested to support three resident graduate students to provide research assistance in all phases of the project. The graduate students will each be hired at a 46.9% appointment for 3 quarters during the academic year and at a 25% appointment for the 3 summer months for each summer during the first two years of the project.

Fringe Benefits: A benefit rate for the PIs follows the newly required composite rate of 17.0% with a slight increase in subsequent years. A benefit rate of 1.3% has been applied to the graduate students' salaries.

Equipment: No equipment has been requested.

Materials and Supplies: Funds are requested each year for supplies that will cover computer software and data acquisition costs for running the economic models ($500 per year). Additionally, funds are requested in year 1 for one computer to be used to run the computationally intensive economic models ($3,000).

Publication Costs/Documentation/Dissemination: No funding for publication costs has been requested.

Travel:
Domestic travel: To provide funds for the PIs and graduate students to attend domestic conferences/meetings, and to disseminate the research results, amounts of $250 per year have been budgeted for each year to cover costs of airfare, lodging, per diem, and local taxi/airport shuttle service.

Foreign travel: None.

Indirect Costs: 10% of the modified total direct cost (MTDC).