Public Workshop

Cap-and-Trade Program: Emissions Leakage Research and Monitoring

July 30, 2012

Presentation Outline

1. Leakage Background
2. Allowance Allocation Approach for Addressing Emissions Leakage Risk
3. Tools for Reassessment of Leakage Risk
4. Leakage Monitoring Proposal

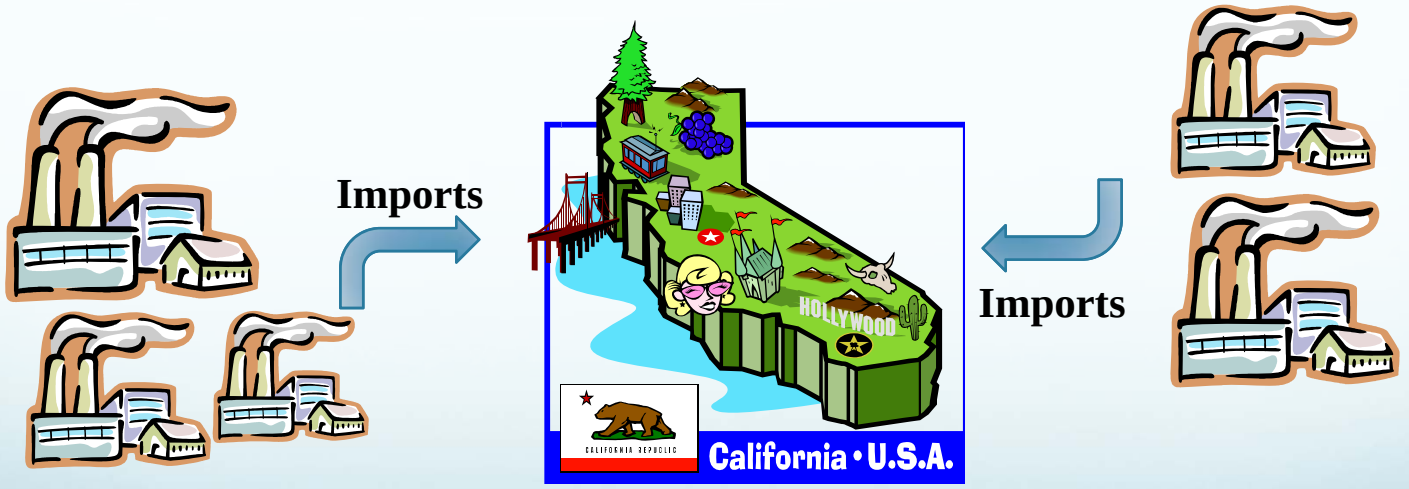
Leakage Background

What is Emissions Leakage?

- Leakage is a reduction in emissions of greenhouse gases within the State that is offset by an increase in emissions of greenhouse gases outside the State
- AB 32 requires ARB to design measures to minimize leakage to the extent feasible

Who is at Risk for Leakage?

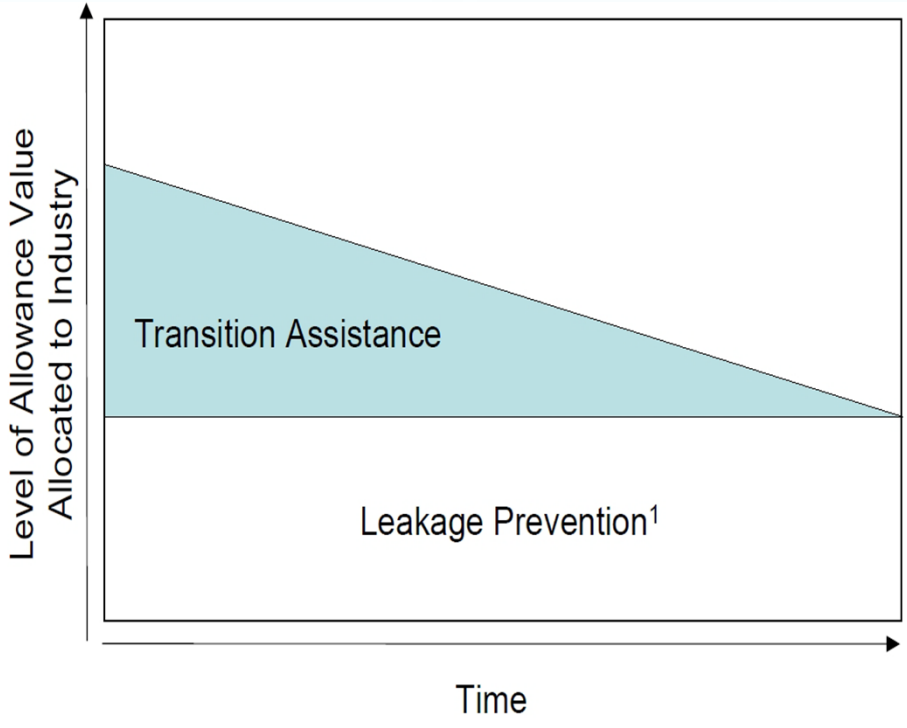
- Industries in which production is highly emissions intensive, leading to high compliance costs
- Industries in which competition is strong from out-of-State producers



Allowance Allocation Approach for Addressing Emissions Leakage Risk

Cap-and-Trade Program
Allocation Approach to Reduce Leakage

- Goals of free allocation to industry:
  - Short-term: Provide a transition period to smooth market start-up and address uncertainty in evaluation of leakage risk
  - Long-term: Reduce to a level of free allocation needed to prevent leakage



[1] Mitigation of carbon costs that cannot be passed on due to leakage risk

Cap-and-Trade Program
Allocation Approach to Reduce Leakage
(Continued)

- Free allocation will reduce leakage risk by reducing compliance costs
- Allocation approach maintains incentive to produce in California
- Cap-and-Trade Program allocates based upon assessed leakage risk and efficiency benchmarking

Basis for Leakage Classification Analysis

- In developing regulatory methods to address leakage, ARB examined the following programs:
  - European Union's Emission Trading Scheme (EU ETS)
  - American Clean Energy and Security Act of 2009 (ACES)
  - Australia's Carbon Pollution Reduction Scheme (CPRS)
- EU ETS, ACES, and CPRS all used a variations of emissions intensity and trade exposure metrics to develop programs to prevent leakage

How ARB Determined Sector Leakage Risk

- ARB determined leakage risk for industrial sectors by:
  - Defining industrial sectors through activity
  - Using a combination of two metrics applied to each sector
    - Emissions intensity of production
    - Trade exposure (i.e., cost pass-through ability)
- ARB used California's Mandatory Reporting Regulation (MRR), U.S. Census, and International Trade Commission data to assess risk
- Staff also requested public input in developing ARB's leakage prevention mechanisms

Defining Sectors and Activities

- A sector is an aggregation of industrial entities that produce reasonably homogeneous goods by reasonably homogenous processes
- Staff used the North American Industry Classification System (NAICS) at the 6-digit level (where able) to group industrial activities
  - The NAICS 6-digit level is the most disaggregated classification for manufacturing facilities that is widely used
  - In most cases, staff used MRR-reported NAICS codes
- Leakage risk is assessed by activity, not just sector classification

Assessing Emissions Intensity

ARB developed the following metric using MRR and U.S. Census data to measure the emissions intensity of a sector:

emissions intensity =
metric tons CO_2e / $million value added*

** Value added data from the Annual Survey of Manufacturers and the U.S. Economic Census*

The emissions intensity is categorized into four risk levels:

- High: > 5000 $mtCO_2e$/$M value added
- Medium: 4999 to 1000 $mtCO_2e$/$M value added
- Low: 999 to 100 $mtCO_2e$/$M value added
- Very Low: < 100 $mtCO_2e$/$M value added

Assessing Trade Exposure

ARB uses trade share to measure the trade exposure of a sector based upon the following:

trade share =
(imports + exports) / (shipments + imports)*

** Imports, exports, and shipments data from the U.S. Census Bureau and the International Trade Commission*

Trade share is categorized into three risk levels:

- High: > 19 %
- Medium: 19 to 10%
- Low: < 10%

Assessing Leakage Risk

ARB classifies leakage risk into three categories through combining the metrics of emissions intensity and trade exposure

Leakage Risk	Emissions Intensity	Trade Exposure
High	High	High Medium Low
	Medium	High
Medium	Medium	Medium Low
	Low	High Medium
Low	Low	Low
	Very Low	High Medium Low

Leakage Risk Classification and Allocations

From the leakage risk classification, an industry assistance factor (AF) is determined for use among other factors in calculating free allocations

	Industry Assistance Factor (AF)		
	Compliance Period *		
Leakage Risk	1st	2nd	3rd
High	100%	100%	100%
Medium	100%	75%	50%
Low	100%	50%	30%

*1st compliance period: 2013–2014
2nd compliance period: 2015–2017
3rd compliance period: 2018–2020

Potential to Increase Assistance Factor

- i.e., to increase percentages for medium- and low-risk categories for the second and third compliance periods

	Industry Assistance Factor (AF)		
	Compliance Period		
Leakage Risk	1st	2nd	3rd
High	100%	100%	100%
Medium	100%	75%	50%
Low	100%	50%	30%

- Potential way to ease transition into Cap-and-Trade Program, thereby minimizing leakage risk

Potential to Increase Assistance Factor
(continued)

- No change to classification of leakage risk from current categories of high, medium, and low
  - Research to determine if current risk classification should be changed (described later)
- No changes proposed to high risk category (i.e., will not receive more than 100%)
- Potential for regulatory change in 2013
- Comments are requested in writing

Tools for Reassessment of Leakage Risk

Reassessment of Sector Leakage Risk

- Per Board Resolution 11-32, ARB staff must
  - Initiate a study to analyze the ability of the agricultural sector, including food processors, to pass on regulatory costs to consumers, and
  - Recommend to the Board changes to the leakage risk determinations and allowance allocation approach, if needed, prior to allocation for the second compliance period
    - Any changes in leakage risk determinations would require regulatory amendments, which would need to be in place before industrial allocation occurs on November 1, 2014

Proposed Research on Agricultural Sector

- ARB is taking steps to refine the analysis of emissions leakage within California's food processing sector
  - With input from the California League of Food Processors and the Agricultural Council of California, ARB developed guidelines for the leakage analysis
  - Researchers are interested in performing the study, but are concerned about the willingness of food processors to provide facility-level data to perform the analysis

Industrial Sector Leakage Research Efforts

- ARB is sponsoring research efforts to establish a leakage baseline and to identify data-driven metrics to establish leakage risk through analysis of energy prices and trade flows
- Economic researchers with Resources for the Future and University of California at Berkeley are here today to discuss these efforts further

Defining and Measuring Incidence of Carbon Pricing: Leakage and Competitiveness Impacts of AB 32

Joshua Linn
Richard D. Morgenstern
Wayne Gray
CARB
July 30, 2012

RESOURCES FOR THE FUTURE

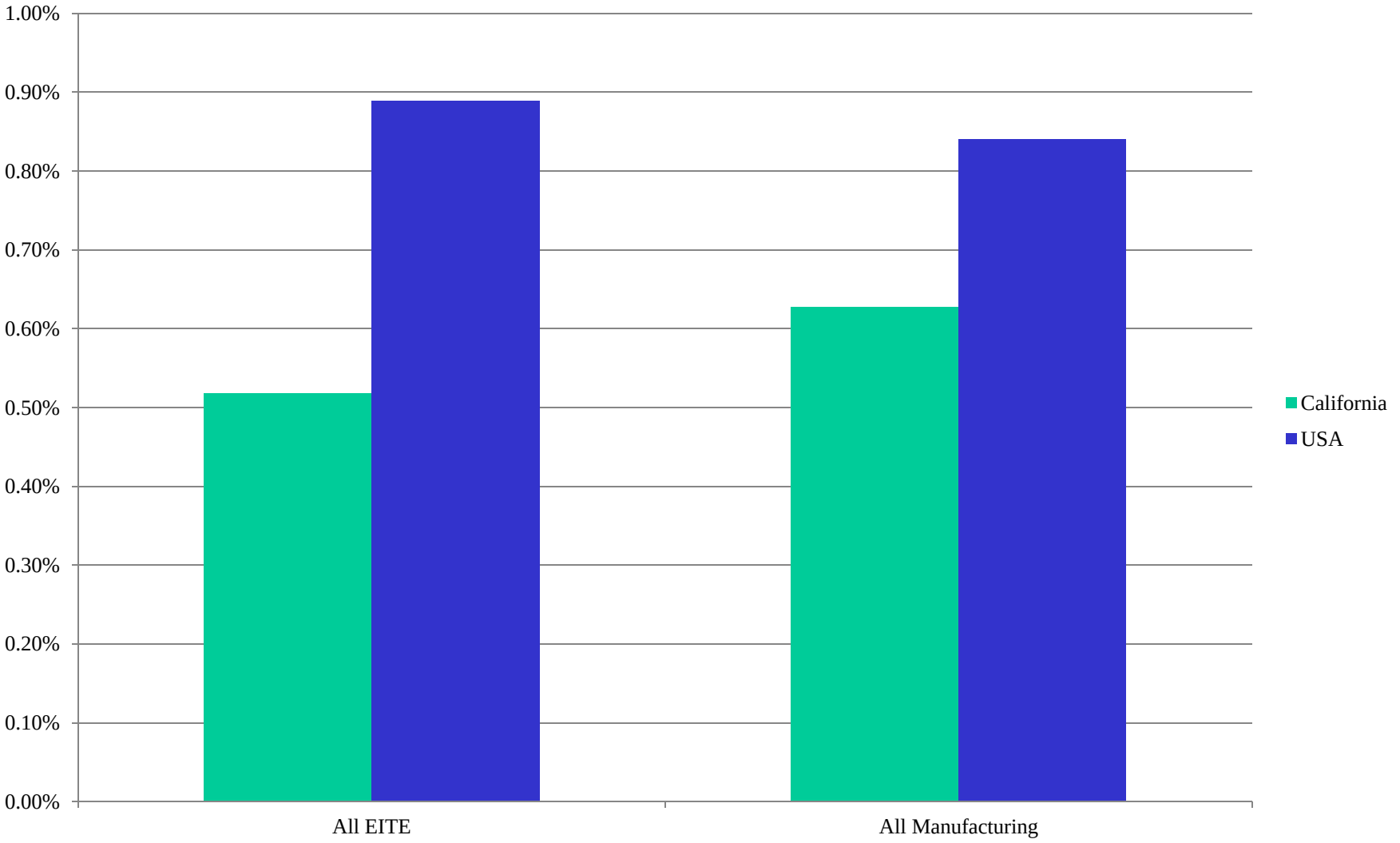
The Context

- Carbon pricing will increase the cost of using energy
  - Potentially adverse effects on prices, sales, profits, output, and employment in EITE industries
  - Output based rebates in AB 32 have the potential to offset some or all impacts, possibly overcompensate
- The importance of developing a rigorous baseline
  - Interested parties are likely to make conflicting claims
  - Limited data will be available in real time, although the carbon price and energy price are readily observed
  - Economic models can provide estimates of likely consequences of a given carbon price

How Can We Develop a Baseline?

- Simulation modeling:
  - How does an increase in energy costs affect equilibrium output and prices by region and industry?
  - Because industries are aggregated, this approach is most useful for broad-scale analysis
- Econometric Analysis:
  - Use past variation in energy prices as a “natural experiment”
  - Advantages: confidential plant-level data enables much more disaggregated analysis, fewer assumptions on market structure

California vs US: Changes in Output from $15/ ton of CO2 Tax



(Morgenstern and Moore 2010)

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Overview of Econometric Analysis

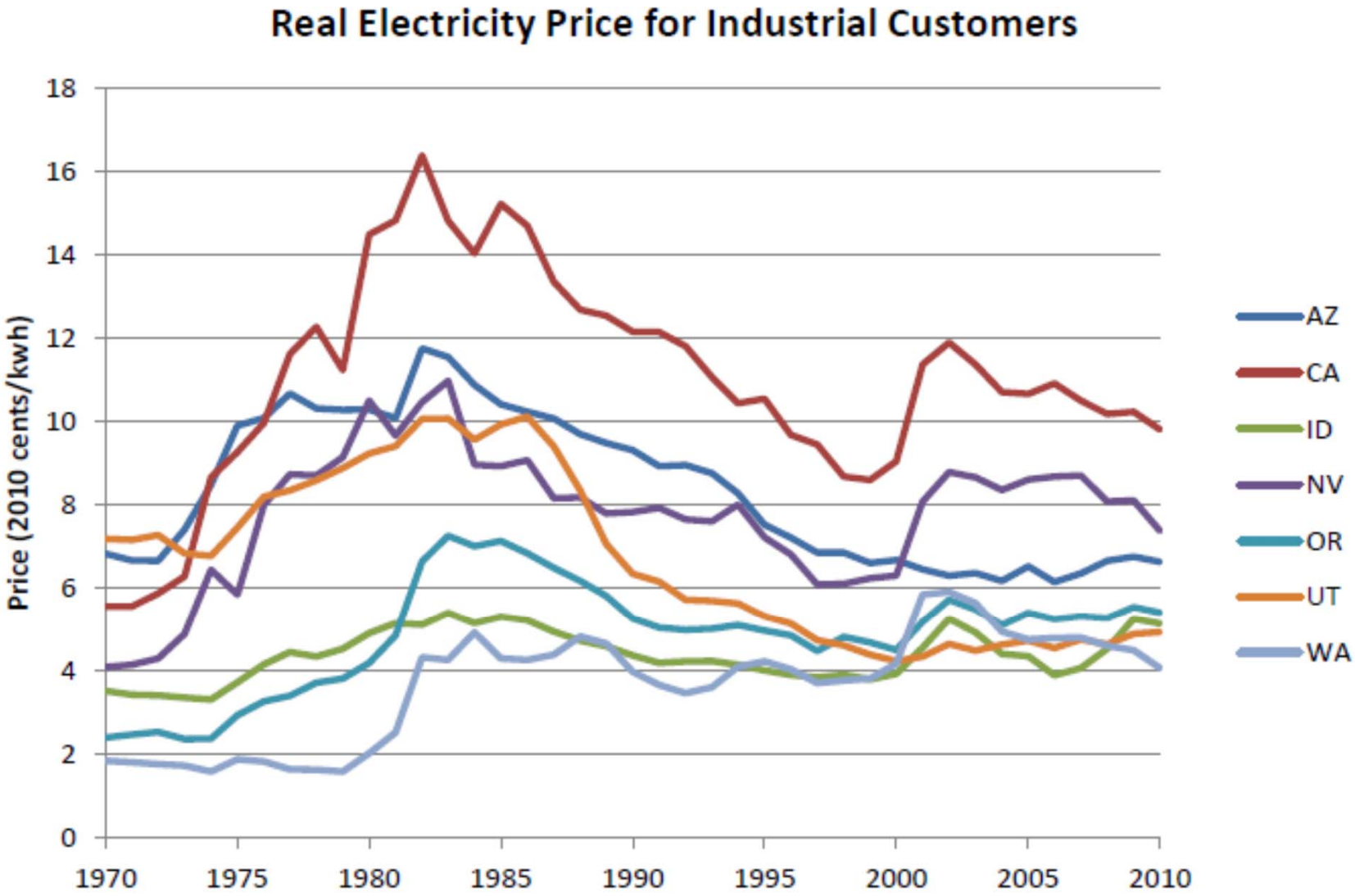
- Use energy prices as proxy for carbon price (natural experiment)
  - Lots of historical variation in energy prices, over time and across regions
  - How do plants respond to energy prices in their own and neighboring regions?
  - Cost metrics include value of shipments, profits, employment, investment, consumption (output plus net imports)
- Counterfactual analysis
  - Suppose energy prices in CA were higher, how would plants inside and outside of CA have responded?
  - Assess leakage/competitiveness effects of a carbon price

Estimation Details

- Sample
  - Assemble data set of plant-year observations that combines Census (every five years) and Annual Survey of Manufactures, 1972-2009
- Key variables
  - Dependent variables: plant-level output, employment, profits
  - Key independent variables: plant-level electricity and natural gas prices, plus energy prices in nearby utility service territories
  - Additional control variables: plant, year, industry fixed effects

Additional Estimation Issues

- Plant energy prices may be correlated with unobserved factors (e.g., productivity)
  - Use instrumental variables for electricity and gas prices
- Effects of environmental regulation could be correlated with energy prices
  - Control for environmental expenditures and/or nonattainment status
- Competitiveness of imports could be correlated with energy prices
- Estimation and simulations rely on cross-state and temporal variation in energy prices



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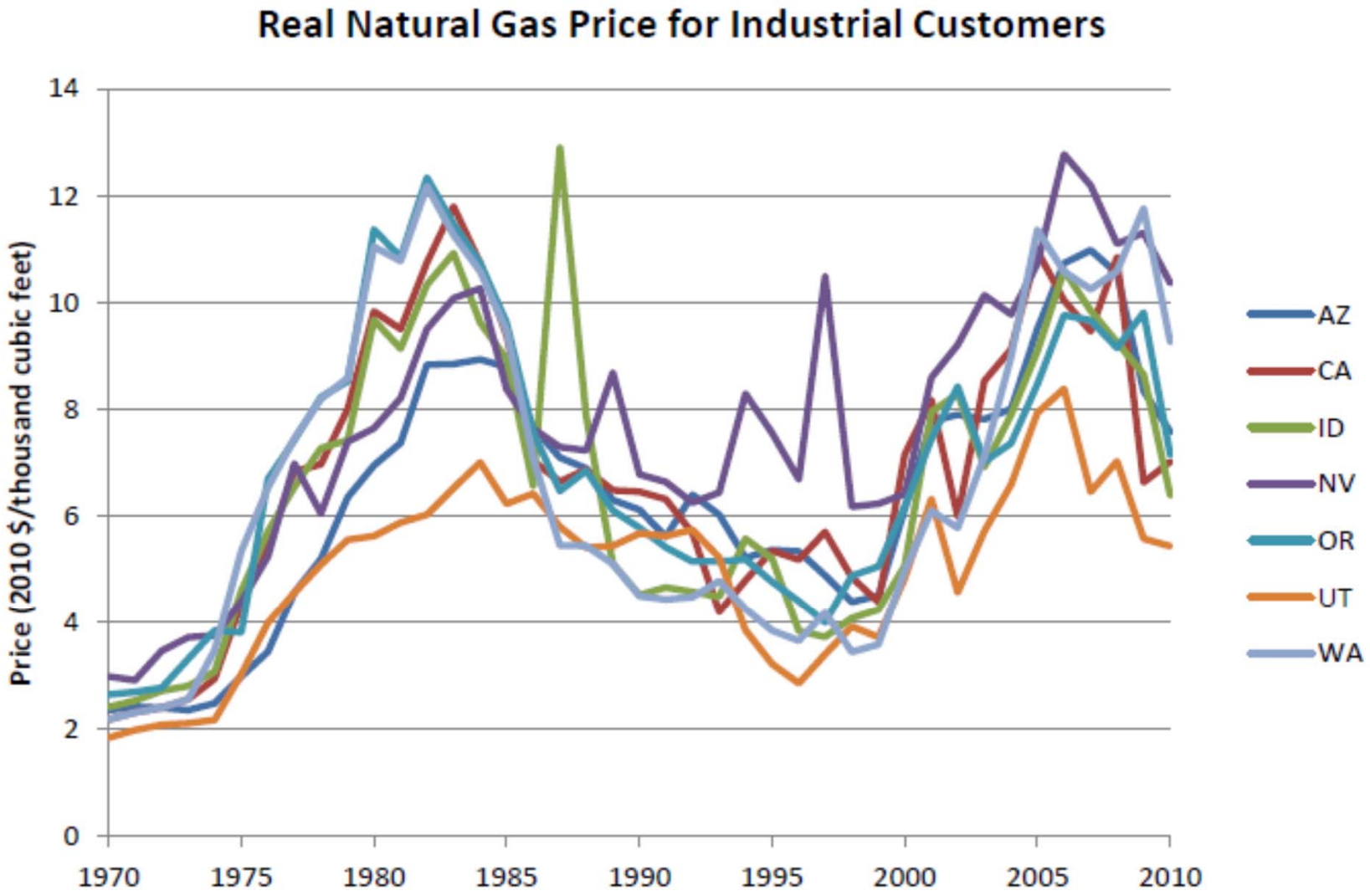
Source: EIA



Source: EIA

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Correlations Between State Growth Rates

Panel A: Electricity Prices

	Arizona	California	Idaho	Nevada	Oregon	Utah
California	0.63					
Idaho	0.52	0.56				
Nevada	0.52	0.74	0.51			
Oregon	0.64	0.56	0.69	0.47		
Utah	0.59	0.56	0.68	0.53	0.8	
Washington	0.41	0.44	0.4	0.27	0.75	0.42

Panel B: Natural Gas Prices

	Arizona	California	Idaho	Nevada	Oregon	Utah
California	0.68					
Idaho	0.48	0.37				
Nevada	0.4	0.42	0.28			
Oregon	0.57	0.33	0.49	0.25		
Utah	0.61	0.67	0.33	0.28	0.36	
Washington	0.66	0.65	0.41	0.49	0.6	0.61

Source: Calculated from EIA

RESOURCES FOR THE FUTURE

Key Datasets

- Longitudinal Research Database (LRD)
- Manufacturing Energy Consumption Survey (MECS)
- Longitudinal Business Database (LBD)
- Standard Statistical Establishment List (SSEL)
- Pollution Abatement Control Expenditures (PACE)
- Commodity Flow Survey (CFS)
- Attainment/nonattainment status by county
- Utility Service Territory data
- I-O tables

Industries to be Studied

NAICS Code	Industry Name
311	Food Mfg.
3152	Cut and Sew Apparel Mfg.
312120	Breweries
322121	Paper (except Newsprint) Mills
322130	Paperboard Mills
324110	Petroleum Refineries
324199	All Other Petrolem and Coal Products Mfg.
325120	Industrial Gas Manufacturing
325188	All Other Basic Inorganic Chemical Mfg.
325199	All Other Basic Organic Chemical Mfg.
325311	Nitrogenous Fertilizer Mfg.
331511	Iron Foundries
333611	Turbine and Turbine Generator Set Units Mfg.

NAICS Code	Industry Name
325412	Pharmaceutical Preparation Mfg.
325414	Biological Product (except Diagnostic) Mfg.
327211	Flat Glass Mfg.
327213	Glass Container Mfg.
327310	Cement Mfg.
327410	Lime Mfg.
327420	Gypsum Product Mfg.
327993	Mineral Wool Mfg.
331111	Iron and Steel Mills
331221	Rolled Steel Shape Mfg.
331314	Secondary Smelting and Allyoing of Aluminum
331492	Secondary Smelting, Refining, and Alloying of Nonferrous Metal (except Copper and Aluminum)
336411	Aircraft Mfg.
331511	Iron Foundries
333611	Turbine and Turbine Generator Set Units

Short-Run and Long-Run Analysis

- Short run
  - Short-run includes operational responses within a year
  - Estimate effect of plant's and regional energy prices on output, employment, etc.
- Long run
  - Consider longer time horizons using cinquenial Census years
  - Analyze capital stock adjustments using plant level investment as dependent variable
  - Analyze entry and exit by utility territory and year

Expected Research Outputs

- Estimated short-run elasticities of employment, output, and other metrics w.r.t energy prices for NAICS industry
- Simulation of short run impact of AB 32 on plant level output, employment, and emissions for NAICS industries
- Comparable results for long run analysis

Thank you

Trade exposure and emissions leakage: measurement and analysis

Meredith Fowlie
UC Berkeley
Mar Reguant
Stanford University
Stephen Ryan
MIT

July 30, 2012

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The big picture

- Incomplete environmental regulation creates the potential for adverse competitiveness impacts and emissions leakage.
- Leakage can operate through multiple channels:
  - Immediate loss of market share to competitors in unregulated jurisdictions.
  - Long run changes in investment/entry/exit decisions.

Three distinct but related objectives

1. Refine/improve upon measures of trade exposure and trade responsiveness.
2. Establish credible and well substantiated baseline measures of trade activity for use in leakage monitoring.
3. Construct precise estimates of key parameters in economic models used to model leakage/competitiveness impacts.

Current approach

- Leakage risk assessment is currently based on two measures: emissions intensity and trade exposure.

- Rationale: Adverse competitiveness impacts most likely to manifest in emissions intensive industries that face competition from entities in unregulated jurisdictions.

Leakage Risk	Emissions Intensity	Trade Exposure
High	High	High Medium Low
	Medium	High
Medium	Medium	Medium Low
	Low	High Medium
Low	Low	Low
	Very Low	High Medium Low

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Current metric

- Trade share used to identify sectors facing competition from unregulated entities:

$$s_i = \frac{foreign\ imports_i + foreign\ exports_i}{shipments_i + foreign\ imports_i}$$

- Seemingly simple metric difficult to construct using publicly available data.

Overcoming immediate data challenges

- Limitations of public data well documented by ARB staff:
  - State level data on imports and exports unavailable.
  - Regional trade data are aggregated to 4 digit NAICS.
  - No per unit price data.

- We propose to use transaction-level and establishment level data to more accurately construct trade share metric.

<u>Key data sets include:</u>

  - Annual Survey of Manufactures (ASM)
  - Census of Manufactures (CM)
  - Longitudinal Firm Trade Transaction Database
  - Data collected from trade organizations.

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Refining measures of leakage risk

- Current trade share metric is an imperfect measure of carbon cost pass through potential.

- Some potential shortcomings of current approach:
  - Treats all imports/exports and sourcing strategies equally.
  - Ignores interstate, intra-national trade.
  - Ignores structural differences across industries.

- Census data and econometric modeling can be used to construct and evaluate alternative measures of trade exposure and trade responsiveness.

Three distinct but related objectives

1. Refine/improve upon measures of trade exposure and trade responsiveness.
2. Establish credible and well substantiated baseline measures of trade activity for use in leakage monitoring.
3. Construct precise estimates of key parameters in economic models used to model leakage/competitiveness impacts.

Baseline measures of trade activity

- Experiences with other cap-and-trade programs have demonstrated the importance of establishing a credible baseline against which to measure ex post observed outcomes.

- Future measures of production and trade activity can be compared against baseline measures in order to identify the effects of carbon policy.

- Comparing measures both across jurisdictions and across time helps to control for other confounding determinants of trade activity

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Baseline measures an essential input to leakage monitoring going forward

- Surprisingly little is known about trade flows/sourcing strategies in EITE industries.
- Transaction-level and establishment-level Census data (covering 1995-2012) will allow us to measure short-term and long-term trends in:
  - Industry-specific, state-specific import and export shares and intensity.
  - Sourcing strategies by state/industry.
  - Determinants of firm-level sourcing decisions.

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Baseline measures of trade responsiveness

- Trade responsiveness parameters capture response of trade flows to relative changes in operating/supply costs?
- These parameters are essential inputs to economic modeling of emissions leakage.
- Existing parameter estimates are very imprecise.
- Highly disaggregated data can be used to estimate these parameters with unprecedented precision.

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Econometric Estimation approach

- Estimate trade responsiveness parameters at industry and state/regional level.
- Control for time varying factors that can shift the demand for imports/exports, including industry specific GDP, measures of construction activity, domestic energy costs, currency exchange rates, etc.
- Use naturally occurring, exogenous variation in transportation costs (freight rates), exchange rates, ad valorem duties to identify how imports and exports respond to changes in relative operating costs.
- Because economic and market shocks are often associated with time lags, specifications will accommodate lagged responses.

Three distinct but related objectives

1. Refine/improve upon measures of trade exposure and trade responsiveness.
2. Establish credible and well substantiated baseline measures of trade activity for use in leakage monitoring.
3. Construct precise estimates of key parameters in economic models used to model leakage/competitiveness impacts.

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Improved modeling of policy impacts

- Economic modeling of the impacts of carbon policies is highly sensitive to demand elasticities and trade responsiveness parameters.
- Census data allow us to estimate these parameters with unprecedented precision.
- Economic models can be recalibrated in order to more accurately capture short run impacts of AB 32 on plant level sourcing strategies, trade flows, industry profits, and emissions leakage.

In summary

- Leakage works through changes in relative production, investment, and trade flows which are observable in principle.

- High resolution, high quality census data, together with state-of-the-art analytical techniques, can be used to construct detailed measures of production activity, trade activity, and trade responsiveness in EITE sectors.

- These measures can be used to assess relative leakage potential, calibrate economic simulation models, and serve as a benchmark for analysis going forward.

Opportunity to ask Questions about Leakage Research

Leakage Monitoring Proposal

Leakage Monitoring Need

- Ability to measure and monitor leakage in a timely manner is essential to the success of the Cap-and-Trade Program and ARB's other efforts to address climate change
- Per Board Resolution 11-32, ARB staff are directed to continue to review information concerning the emissions intensity, trade exposure, and in-State competition of industries in California

Leakage Monitoring Proposal

- To better monitor leakage, staff is proposing to collect the following facility-level economic data from industry, possibly through MRR:
  - Total value of product shipped and other receipts;
  - Annual payroll before deductions;
  - Total capital expenditures;
  - Cost of materials, parts, packaging, fuels, and electricity;
  - Number of production workers and other employees.
- Collection of these data would allow for timely monitoring of leakage, which would allow ARB to refine or develop policies to minimize leakage

Data Confidentiality

- All non-emissions data collected under this proposal for the purpose of evaluating emissions leakage would be held as confidential information, pursuant to California Code of Regulations sections 91000–91022
- In addition, staff is exploring U.S. Census methods for handling confidential business information

Current Availability of Data

- Staff has investigated several state and federal agencies that collect data that may indicate leakage
  - California agencies
    - Employment Development Department
    - Board of Equalization
    - Franchise Tax Board
    - California Energy Commission
  - Federal agencies
    - Bureau of Labor Statistics
    - Internal Revenue Service
    - Energy Information Administration
  - Dun and Bradstreet

Current Availability of Data
(continued)

- Although some of these agencies collect data that may be useful in a leakage analysis, none of them collects all the necessary data
  - Some agencies may have different methodologies and definitions in data collection
- Some of these agencies have rigorous regulatory and statutory restrictions on access to the disaggregated data due to issues of confidentiality
  - ARB needs data disaggregated to at least the 6-digit NAICS code level
  - Most of these data are only available at highly aggregated levels

CARB Leakage Monitoring Proposal

Wayne Gray
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CARB Leakage Workshop
July 30, 2012

Leakage Monitoring Goals

- Important to address leakage
  - Impacts on California economy
  - Limits the actual aggregate reductions in GHG
- Important to address leakage efficiently
  - Likely to be variations across industries
  - Avoid over- or under-correction
- Assistance Factors
  - Free allocations to reduce leakage risk
  - Based on emissions intensity and trade exposure
  - Interaction of EI and TE factors
- Decreasing Assistance Factors over time
  - Highest leakage risk group gets 100% free
  - Middle, low groups get declining % free

Census Research

- RFF project – energy price differences
  - Historical variations in energy prices
  - Cross-state and international energy price differences
  - Impacts on output, employment, and profits
  - Comparison of outcomes in CA vs. other states
  - Models differences in impacts across EITE industries
- UCB project – trade exposure
  - Detailed Census data on exports and imports
  - Focus on international effects
  - Better measures of trade exposure
  - Models differences in trade responsiveness across EITE industries

Census Research

- Census Data
  - Long history of detailed establishment-level data
  - National data - California and surrounding states
  - International – trade flows, energy prices
  - Allows estimation of econometric models
  - Short- and long-run responsiveness
  - But not timely data – several years old
- Results predict differences in sensitivity of EITE industries to impact of A.B. 32
  - Could test for significant differences in impact
  - Could also test for overall level of impact
  - Could adjust Assistance Factors (groups and levels)

Leakage Monitoring Project

- Collect annual data from all MRR reporters
- Questions based on Census questions
  - Output and specific products
  - Labor inputs, capital investment, materials
  - Additional information on energy usage and costs
- Much more timely data to address leakage
- Provides larger sample size of California facilities
  - But doesn't contain non-California facilities
- Comparable data not available elsewhere
  - Range of information from single source
  - Consistency with Census data questions

Specific Data Requested

1. SALES, SHIPMENTS, RECEIPTS, OR REVENUE

A. Total value of products shipped and other receipts _____ ($000)

B. Top three (highest-revenue) product categories

	Product category	NAICS code	value of shipments ($000)
i.	_____	_____	
ii.	_____	_____	_____ ($000)
iii.	_____	_____	_____ ($000)

Specific Data Requested

2. EMPLOYMENT AND PAYROLL

	Production workers	All workers
A. Number for pay period Including March 12		
B. Annual payroll before deductions (exclude employer's cost for fringe benefits)	($000) _____	_____ ($000)

3. CAPITAL INVESTMENT

A. Total capital expenditures for new and used buildings, machinery and equipment _____ ($000)

Specific Data Requested

4. MATERIALS AND ENERGY

A. Cost of materials, parts, containers, packaging, etc.; cost of products bought and sold without further processing

_____ ($000)

B. Total fuels and electricity spending ($000)

	Cost	Quantity Consumed
i. Electricity	_____ ($000)	_____ (000 kwh)
ii. Natural Gas	_____ ($000)	_____ (Mbtu)
iii. Other _____ (type)	_____ ($000)	_____ (Mbtu)
iv. Other _____ (type)	_____ ($000)	_____ (Mbtu)

Leakage Monitoring Analysis (1)

- Direct measures at establishment level
  - Annual measures of output and employment
  - Annual measures of energy costs and usage
- Ability to examine changes over time
  - Variation in annual changes across EITE industries
  - Variations in changes within industry
  - Variations in energy costs within and across industries
- California only – some comparisons possible
  - BLS-CES – national employment, detailed industries
  - BLS-QCEW – state employment, less industry detail

Leakage Monitoring Analysis (2)

- Test research predictions from historical data
  - Census research predicts industry responsiveness
  - Compare industry-level outcomes to predictions
  - Identify variation in outcomes within industry
  - Identify variation in energy cost/usage
- Identify outcome deviations (actual – predicted)
  - Average impact across all industries
  - Impact on specific industries
  - Impact on establishments within industries
- Analyze data to explain deviations

Leakage Monitoring Analysis (3)

- Long-run analysis (eventually)
  - After accumulating multiple years of data
  - Variation in output, employment changes over time
  - Distribution of changes in industry's energy costs
- Possible to expand research analysis
  - Taking advantage of similarity to Census questions
  - Combine Post-AB 32 results with Census research
- Re-estimate research models
  - More precise estimates of impacts on industries
  - Identify changes in industry parameters over time

Leakage Monitoring Program Results

- Provides detailed data relatively quickly
  - Much quicker than waiting for new Census data
  - Much more industry detail than published sources
  - Can identify differences in outcomes within industry
- Comparable to Census data
  - Reduces respondent burden (familiar questions)
- Permits multiple layers of analysis
  - Comparisons of outcomes across industries
  - Deviations from Census research predictions
  - Eventual updating of Census research results

Thank you

Opportunity to ask Questions about Leakage Monitoring Proposal

Comments

- Staff is requesting feedback on the following:
  - Potential increase in assistance factors for medium and low leakage risk categories
  - Proposal to collect facility-level economic data as a major means by which to monitor for leakage, especially
    - Collecting the data through Mandatory Reporting Regulation
    - Suggestions for additional data to collect
- Please submit written comments by August 30, 2012 at:

  http://www.arb.ca.gov/cc/capandtrade/comments.htm