Carbon Tax Competitiveness Concerns:
Assessing a Best Practices Income Tax Credit

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RFF WORKSHOP

Addressing Competitiveness and Leakage Concerns in
a Carbon Tax: What are the Options?

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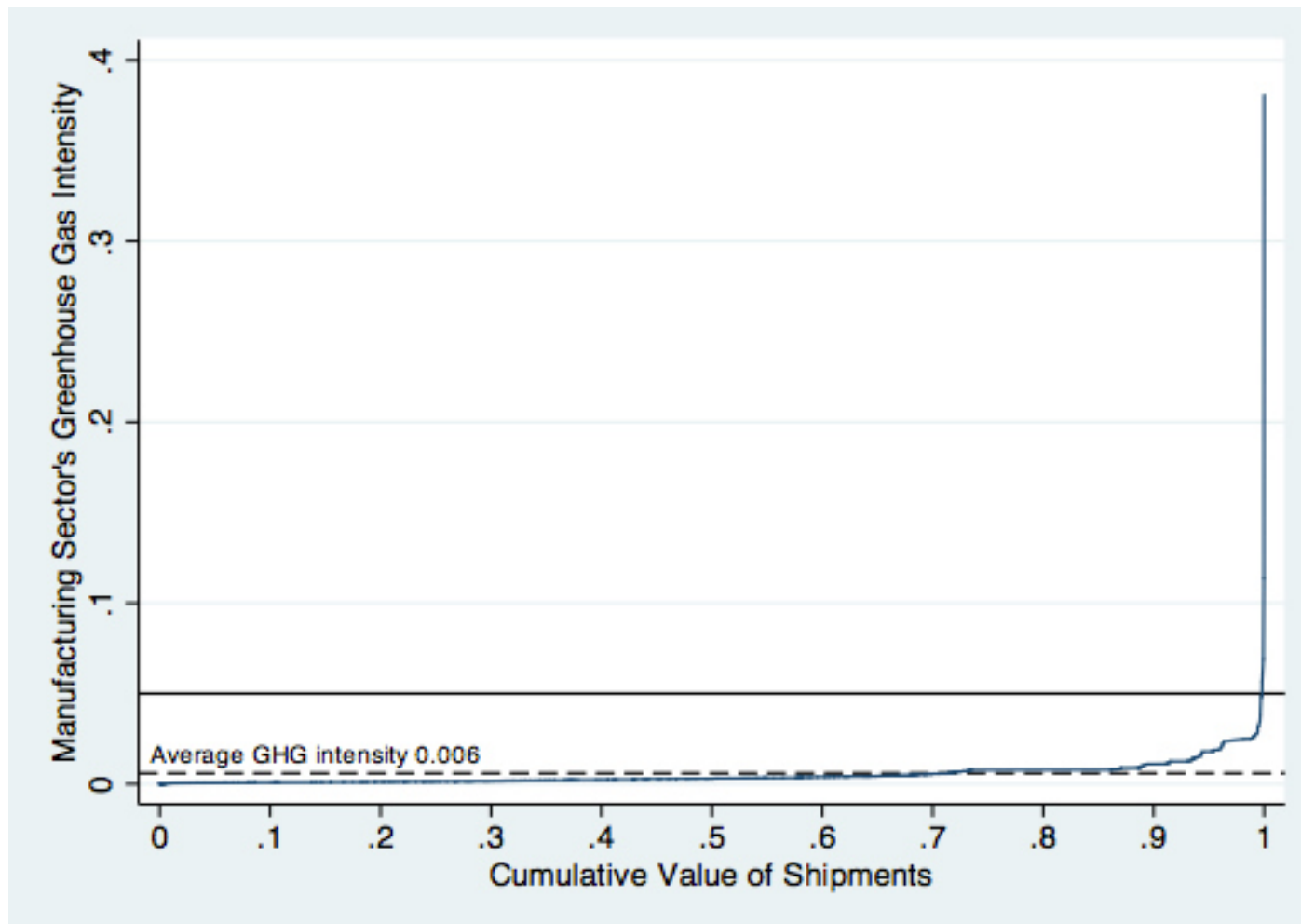
Energy Intensive Trade Exposed Sectors

- EITE sectors a concern in negotiations leading to H.R. 2454

- EITE treatment under a carbon tax reform
  - Should there be special treatment for EITE sectors?
  - What are the options?
  - How should we assess these options?

Energy Intensity and the Value of Shipments
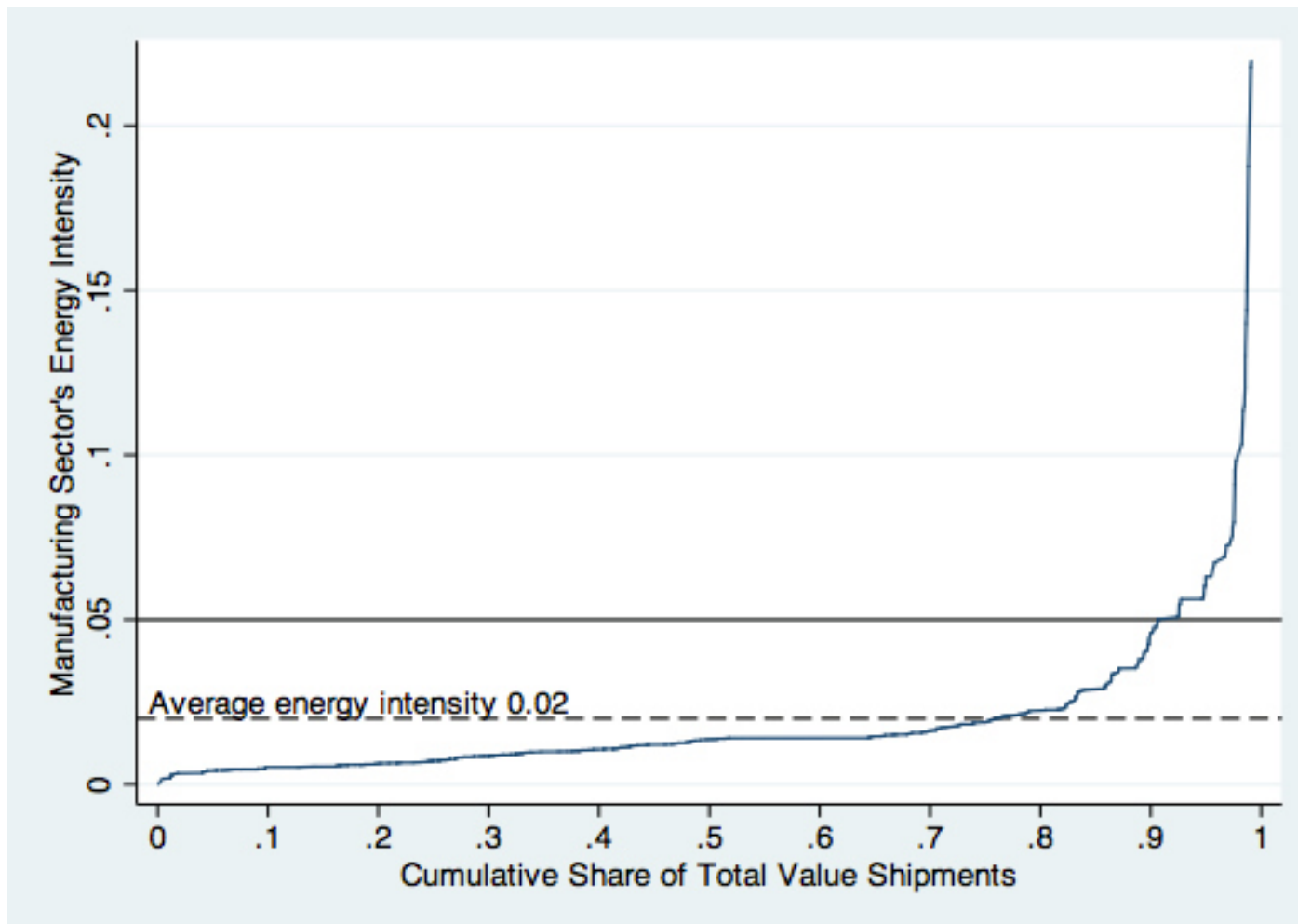
Greenhouse Gas Intensity and the Value of Shipments

Metcalf (2014)

Workshop Framework

- Two broad approaches to addressing concerns of EITE sectors
  - Border adjustments on certain traded goods (Kortum and Weisbach)
  - Tax credits for certain domestic firms (Gray and Metcalf)
- Legal issues floating in the background that could affect design considerations (Tractman)
- Larger economic and political question of whether we need to do anything (Aldy)

Focus of This Paper

- Output-based tax credits in the corporate income tax for carbon tax payments
  - Best-practices design
  - Limited ability to use credits
- Similar to benchmark allocation approach in Phase III of EU-ETS
  - Also Pezzey and Jotzo (2013) "free carbon" idea

Questions for Analysis

- How to structure tax relief for firms in EITE sectors using the income tax?

- Focusing on a best-practices output-based tax rebate,

  – How are firms differentially impacted within sectors?

  – Do firms have sufficient tax appetite to use tax credits?

Research Approach

- Use Census establishment level data:
  - 2010 Manufacturing Energy Consumption Survey (MECS)
  - 2012 Census of Manufactures (CMF)
- Estimate carbon dioxide emissions and carbon tax liability at the establishment level
- Allocate corporate income tax liability to the establishment level

Findings of Paper

- Relatively few sectors with high total emissions also have high emissions rates
- There is considerable variation in emissions intensity within sectors (and variation across sectors in the shape of the intensity distribution)
- Emissions intensity is higher in pre-1976 plants, larger plants, and less productive plants
- Using sector-level income tax data, relatively few sectors are likely to have "unusable" carbon tax credits (exceeding their income tax liability)
  - But there is likely to be variation within sectors
  - *This conclusion is subject to further analysis with revised data*

(Selective) Previous Research

- Addressing Leakage Concerns with Cap and Trade Systems
  - Fischer and Fox (2007): OBA subsidizes production but requires higher MAC for given emission cap (2 distortions)
  - Monjon and Quirion (2011): focus on EU ETS comparing border adjustments with output-based allocations
- Consideration under a Carbon Tax
  - Fischer and Fox (2012): compare and contrast various leakage mechanisms including OB rebates
  - Metcalf (2014): focus on targeted relief comparing and contrasting various tax credits
- EMF29 (2012) modeling analysis of border carbon adjustments with unilateral carbon pricing policies focused on EITE sectors
  - Main focus on BCA; Leakage reduction on the order of 2-12 percent (8 percent on average across models)
  - Fischer and Fox (2012): compared BCA and OBR. Additional cost of OBR arises from tax interaction effects

# EITE Eligibility for Tax Relief

- Follow approach of H.R. 2454
- Presumptive eligibility if one or more of the following hold:
  - Energy intensity is 5 percent or greater, and trade intensity is 15 percent or greater
  - GHG intensity is 5 percent or greater, and trade intensity is 15 percent or greater
  - Energy intensity is 20 percent or greater
  - GHG intensity is 20 percent or greater

Presumptive Eligibility for Tax Credit

- EPA (2009) found 44 manufacturing and 2 mineral processing sectors presumptively eligible (out of ~500 6 digit sectors)
  - Data from 2006, 2007
  - H.R. 2454 called for eligibility updating every four years
- Metcalf (2014) updated eligibility and found fewer eligible sectors
  - Risk of cycling in and out of eligibility with eligibility updating

Measuring Sector Variability
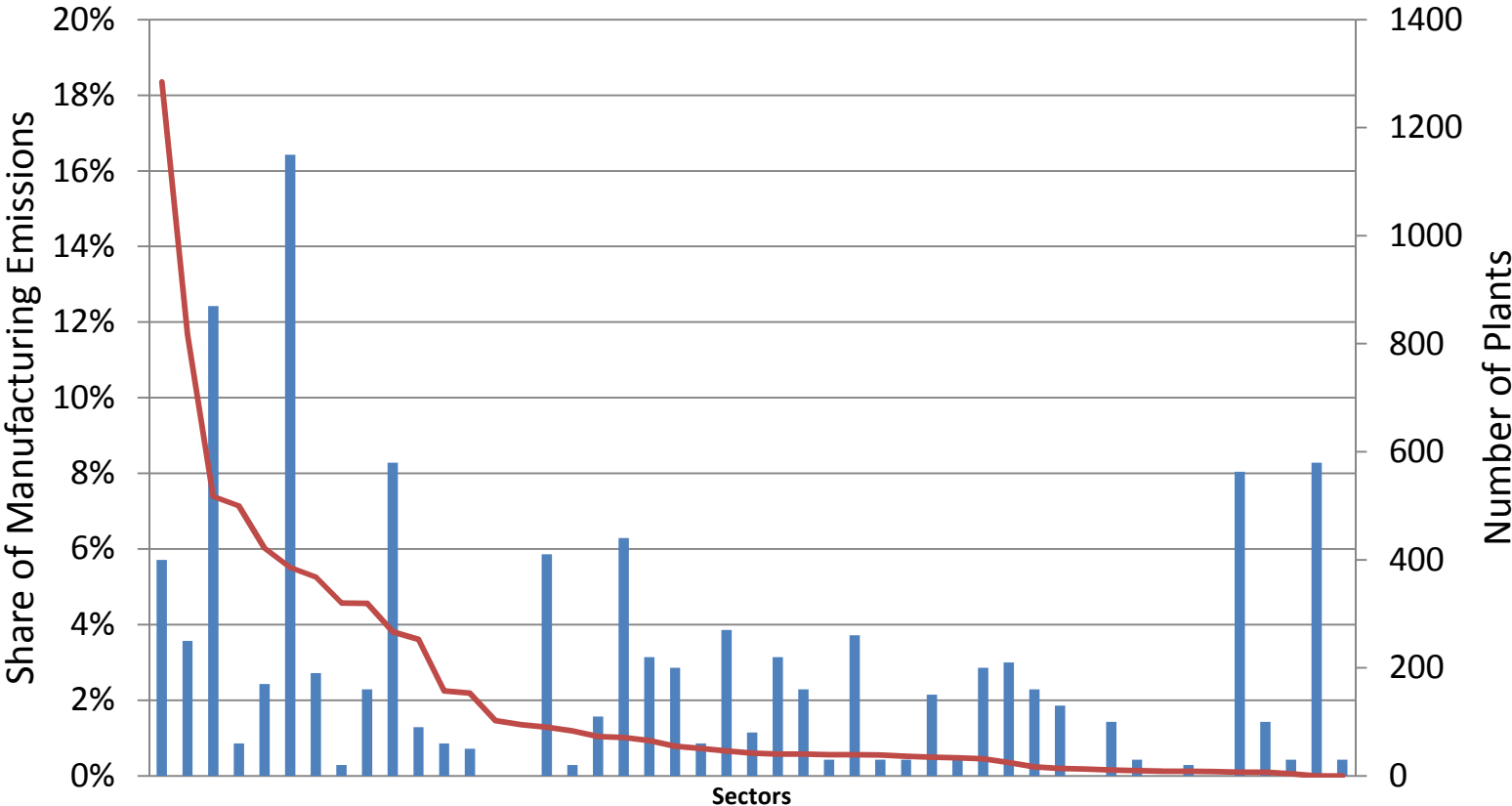
Sectors sorted by descending share of manufacturing emissions (higher emitters on the left); vertical bars show approximate number of plants per sector)

Modeled Carbon Tax

- $20 per ton on energy-related emissions in 2012 modeled

- SR revenue estimate: ~$100 billion before tax offset

- EITE sector carbon tax revenue: $11.4 billion

Attributing Emissions to Plants

- 2012 CMF
  - Total expenditure on fuels
  - Electricity expenditure and quantity consumed
- 2010 MECS
  - Detailed fuels expenditure and quantity consumed
- 2012 emissions derived separately from
  - Electricity consumption
  - Fossil fuel use
  - Process emissions

Electricity Related Emissions

- Electricity related emissions available at the zip code level from EPA's Emissions & Generation Integrated Resource Database (eGRID)

- CO_2 emissions per MWh for each establishment generated based on zip code location of plant

Fossil Fuel Consumption Related Emissions

- Using 2010 MECS data, construct expenditure shares for coal, natural gas, and petroleum conditional on sector, region, and plant age

- Allocate fuel expenditures in 2012 CMF based on fossil fuel expenditure shares from MECS

- Convert to quantities using EIA State Energy Data Systems (SEDS) prices for state-level industrial fuels

- Convert to emissions using national average emission factors

Process Emissions

- For sectors with significant process emissions, we follow EPA's Emissions Inventory approach for relevant sectors

- In general, process emissions are a linear function of output.

Distribution of CO2 Emissions Intensity

NAICS	Industry	Emissions Share	Mean	SD	Skew	C.V.
331111	Iron+Steel	18.35%	943	1,547	6.44	1.64
327310	Cement	11.68%	23,511	5,515	2.14	0.24
325199	Organic Chem	7.39%	787	1,037	6.03	1.32
325110	Petrochem	7.14%	618	863	4.58	1.40
322121	Paper	6.02%	1,754	2,895	9.82	1.65
325211	Plastics	5.52%	394	918	13.14	2.33
325311	Nitrogen Fertilizer	5.26%	7,688	2,007	9.46	0.26
331311	Alumina Refining	4.57%	12,408	3,229	2.70	0.26
331312	Primary Aluminum	(grouped with 331311)	6,472	4,217	0.93	0.65
322130	Paperboard	4.56%	2,085	1,205	1.13	0.58

Understanding Variation in Emissions Intensities Within Sectors

Dependent Variable = log (CO_2 Intensity)

MODEL	1	2	3	4	5
Age	0.001			-0.003*	-0.002
Pre-1976 dummy	0.224*			0.220*	0.216*
log(employees)		0.098*		0.092*	0.087*
log(productivity)			-0.094*	-0.109	-0.112*
Sector	x	x	x	x	
Region	x	x	x	x	
Sector*Region					x
N	~7500				
R-squared	0.609	0.614	0.606	0.620	0.634

* = coefficient significant at 5% level

Sectoral Variation in Total Emissions and Emissions Intensity

NAICS	Sector	Emissions Share	CO2 intensity	Value of Shipments ($1,000)
331111	Iron+Steel	18.35%	943	102,186
327310	Cement	11.68%	23,511	10,620
325199	Organic Chemicals	7.39%	787	81,997
325110	Petrochem	7.14%	618	77,662
322121	Paper	6.02%	1,754	46,291
325211	Plastics	5.52%	394	85,232
325311	Nitrogen Fertilizer	5.26%	7,688	5,524
331311	Alumina Refining	4.57%	12,408	1,337
331312	Primary Aluminum	*	6,472	6,657
322130	Paperboard	4.56%	2,085	25,355

Emissions share = share of total emissions from 45 EITE sectors
CO2 intensity = lb CO2 per $1000 shipments

Sectoral Variation in Total Emissions and Emissions Intensity (2 of 3)

NAICS	Sector	Emissions Share	CO2 intensity	Value of Shipments ($1,000)
325188	Inorganic Chemicals	3.81%	1,235	22,829
327410	Lime Manufacturing	3.61%	21,041	1,876
311221	Wet Corn Milling	2.24%	1,433	12,117
325181	Alkalies/Chlorine	2.19%	4,267	6,371
331511	Iron Foundries	1.29%	1,078	11,796
322122	Newsprint Mills	1.19%	4,093	3,441
325222	Noncellulosic Fiber	1.04%	614	6,963
327212	Other Glass	1.01%	1,180	4,317
321219	Wood Product	0.93%	1,047	6,896
331419	Non-Fe Smelting	0.78%	729	5,987
327213	Glass Containers	0.73%	1,787	4,899
327993	Mineral Wool	0.66%	1,169	6,147
325131	Inorganic Dyes	0.60%	623	5,690
311613	Meat Processing	0.57%	1,047	3,564
327211	Flat Glass	0.57%	1,915	3,421
325182	Carbon Black	0.56%	3,492	1,488

Sectoral Variation in Total Emissions and Emissions Intensity (3 of 3)

NAICS	Sector	Emissions Share	CO2 intensity	Value of Shipments ($1,000)
327992	Ground Mineral Mfg	0.56%	838	2,827
331112	Ferroalloy Product	0.55%	3,565	1,320
322110	Pulp Mills	0.52%	1,343	5,027
325212	Synthetic Rubber	0.49%	373	8,254
325192	Cyclic Crude	0.48%	732	5,948
313111	Yarn Spinning Mills	0.45%	839	5,011
331210	Steel Pipe/Tube	0.36%	323	8,637
327122	Ceramic Tile	0.19%	558	1,126
327125	Nonclay Refractory	0.15%	644	1,372
311213	Malt manufacturing	0.14%	743	787
325221	Cellulosic Fiber	0.12%	852	926
327111	China Plumbing Fixtures	0.12%	311	868
327112	China Pottery	0.10%	554	784
327113	Porcelain Electric Supply	0.10%	549	737
327123	Other Clay Products	0.05%	1,147	243

Output Based Credit

E_{ij} – emissions of plant i in sector j

C_{ij} – tax credit for plant i in sector j

Y_{ij} – value of shipments for plant i in sector j

$\hat{\phi}_j^{\ \mu}$ - measure of emissions per value of shipments in sector j

τ – carbon tax rate

$$C_{ij} = \tau\hat{\phi}_j^{\ \mu}Y_{ij}$$

Credited Emissions	Non-Credited Emissions
$\hat{\phi}_j^{\ \mu}Y_{ij}$	$E_{ij} - \hat{\phi}_j^{\ \mu}Y_{ij}$

Crediting Base

90th percentile emissions intensity

Median emissions intensity

Emissions Intensity $\left(E_{ij} \middle/ Y_{ij} \right)$

$$C_{ij} = \tau \hat{\phi}_j{}^{\mu} Y_{ij}$$
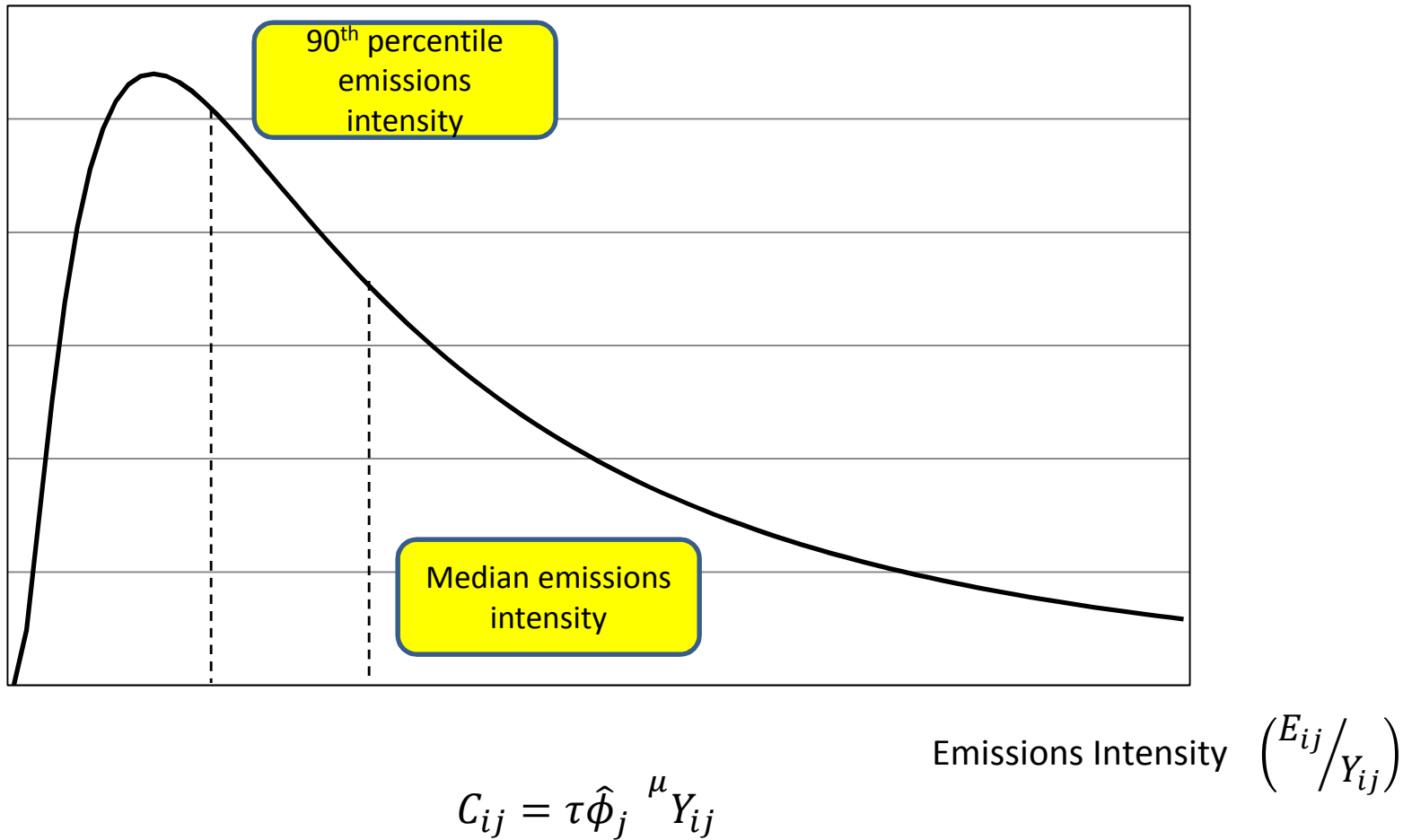
Best Practices Credit

- An output based credit that addresses competitiveness issues

- Set appropriately, it minimizes tax appetite problems

- Incentivizes best practices and investments in new technologies to reduce emissions

- *But...* output based credits inefficient on the final demand margin

Plant Specific Tax Credit

- Construct distribution of emissions intensity (emissions to value of shipments ratio) for each sector;

- Measure emissions intensity of plant with "best practices" – emissions intensity below 95 percent of all other plants in sector $\left(\widehat{\phi}_j^{\ \mu} \right)$

  – We vary cutoff percentile and consider unweighted distributions and distributions weighted by sales

- Plant *i* in sector *j* allowed an income tax credit equal to carbon tax times $\widehat{\phi}_j^{\ \mu} Y_{ij}$

Tax Related Questions

- What is the distribution of carbon tax payments across sectors?

- What is the aggregate value of the income tax credit resulting from this policy?

- How many firms receive a tax credit greater than their carbon tax liability?

- Do firms have sufficient tax appetite to use the tax credit?

- *Note: we currently use sector-level tax data; a future revision will use firm-level tax appetite data from the Census Bureau's Quarterly Financial Reports*

Cost of Tax Credit

Credit Limits?	Carbon Tax Payments	Tax Credit Cut-Off:			
		95%	90%	75%	50%
No	11.45	4.41	5.14	7.04	9.94
Yes	11.45	4.38	5.05	6.65	8.44
Billions of dollars					

Carbon Taxes by Sector

NAICS	Industry	Emissions Share	Carbon Tax Owed	Credit - 95% Cutoff	Credit - 75% Cutoff	Credit - 95% Cutoff + Cap	Credit - 75% Cutoff + Cap
331111	Iron+Steel	18.35%	1,724	278	772	270	697
327310	Cement	11.68%	1,480	1,035	1,320	1,035	1,278
325199	Organic Chem	7.39%	760	194	370	193	344
325110	Petrochem	7.14%	369	160	178	160	175
322121	Paper	6.02%	638	96	276	95	248
325211	Plastics	5.52%	576	80	225	78	204
325311	Nitrogen Fertilizer	5.26%	778	676	707	676	704
331311	Alumina Refining	4.57%	192	150	165	150	163
331312	Primary Aluminum	4.56%	520	164	278	163	260
322130	Paperboard	4.56%	636	269	415	265	391

Carbon taxes and credits in $ millions

Carbon Taxes by Sector (2 of 3)

NAICS	Industry	Emissions Share	Carbon Tax Owed	Credit - 95% Cutoff	Credit - 75% Cutoff	Credit - 95% Cutoff + Cap	Credit - 75% Cutoff + Cap
325188	Inorganic Chem	3.81%	473	127	163	126	157
327410	Lime Manufacturing	3.61%	534	344	502	343	482
311221	Wet Corn Milling	2.24%	254	67	188	65	172
325181	Alkalies/Chlorine	2.19%	468	111	242	110	224
331511	Iron Foundries	1.29%	148	41	77	40	71
322122	Newsprint Mills	1.19%	117	77	95	76	93
325222	Noncellulosic Fiber	1.04%	51	12	40	11	36
327212	Other Glass	1.01%	66	7	32	7	29
321219	Wood Product	0.93%	81	10	49	9	43
331419	Non-Fe Smelting	0.78%	153	18	19	18	19
327213	Glass Containers	0.73%	94	52	63	51	61
327993	Mineral Wool	0.66%	76	2	29	2	24
325131	Inorganic Dyes	0.60%	70	6	48	6	42
311613	Meat Processing	0.57%	51	3	22	3	19
327211	Flat Glass	0.57%	59	17	42	17	37
325182	Carbon Black	0.56%	79	67	71	67	70

Carbon taxes and credits in $ millions

Carbon Taxes by Sector (3 of 3)

NAICS	Industry	Emissions Share	Carbon Tax Owed	Credit - 95% Cutoff	Credit - 75% Cutoff	Credit - 95% Cutoff + Cap	credit - 75% cutoff + cap
327992	Ground Mineral Mfg	0.56%	35	3	13	3	11
331112	Ferroalloy Product	0.55%	97	39	74	39	69
322110	Pulp Mills	0.52%	56	25	35	24	34
325212	Synthetic Rubber	0.49%	59	6	19	5	17
325192	Cyclic Crude	0.48%	63	9	21	9	18
313111	Yarn Spinning Mills	0.45%	38	14	29	14	27
331210	Steel Pipe/Tube	0.36%	51	9	16	8	15
327122	Ceramic Tile	0.19%	11	2	7	2	6
327125	Nonclay Refractory	0.15%	11	1	2	1	2
311213	Malt manufacturing	0.14%	13	4	9	4	8
325221	Cellulosic Fiber	0.12%	14	7	7	7	7
327111	China Plumbing Fixtures	0.12%	3	1	2	1	2
327112	China Pottery	0.10%	3	0	1	0	1
327113	Porcelain Electric Supply	0.10%	5	1	3	1	3
327123	Other Clay Products	0.05%	2	0	1	0	1

Carbon taxes and credits in $ millions

Percent of Plants Receiving Tax Credits in Excess of Carbon Tax Liability

	"High-Efficiency" Cut-Off Levels for Tax Credit			
	95th	90th	75th	Median
Weighted	10	20	40	65
Unweighted	5	10	25	50

Note: aggregated across all industries; weighted by value of shipments

Sectors with Carbon Tax Credit Exceeding Income Tax Liability

NAICS	Industry	Emissions Share	Share of Plants with Unused Credits			
			95% cutoff	90% cutoff	75% cutoff	50% cutoff
327310	Cement	11.7%	82.1%	83.2%	86.0%	87.2%
331311	Alumina Refining	4.6%	63.1%	63.1%	66.5%	72.1%
331312	Primary Aluminum	4.6%	0.0%	0.0%	18.7%	64.2%
327410	Lime Manufacturing	3.6%	90.0%	91.5%	93.2%	93.6%
322122	Newsprint Mills	1.2%	12.0%	21.8%	29.1%	36.1%

Note: All other sectors had no plants with tax credit exceeding their income tax liability. The "share of plants" reflects the changes in exceedances as the weighted cut-off level for the carbon tax credit is changed from 95% to 50%.

Preliminary numbers to be revised – do not quote or cite these numbers

Summary

- There is considerable variation in emissions intensity within sectors (and variation across sectors in the shape of the intensity distribution)

- Emissions intensity is higher in pre-1976 plants, larger plants, and less productive plants

- Using sector-level income tax data, relatively few sectors are likely to have "unusable" carbon tax credits (exceeding their income tax liability)
  - But there is likely to be variation within sectors with a sizeable fraction with insufficient tax appetite for carbon credits
  - *Further analysis needed on this point – question is not resolved as of now*

Thank you!