The causal impact of the EU ETS on Emissions

Ralf Martin

joint with Jonathan Colmer, Mirabelle Muuls and Ulrich Wagner

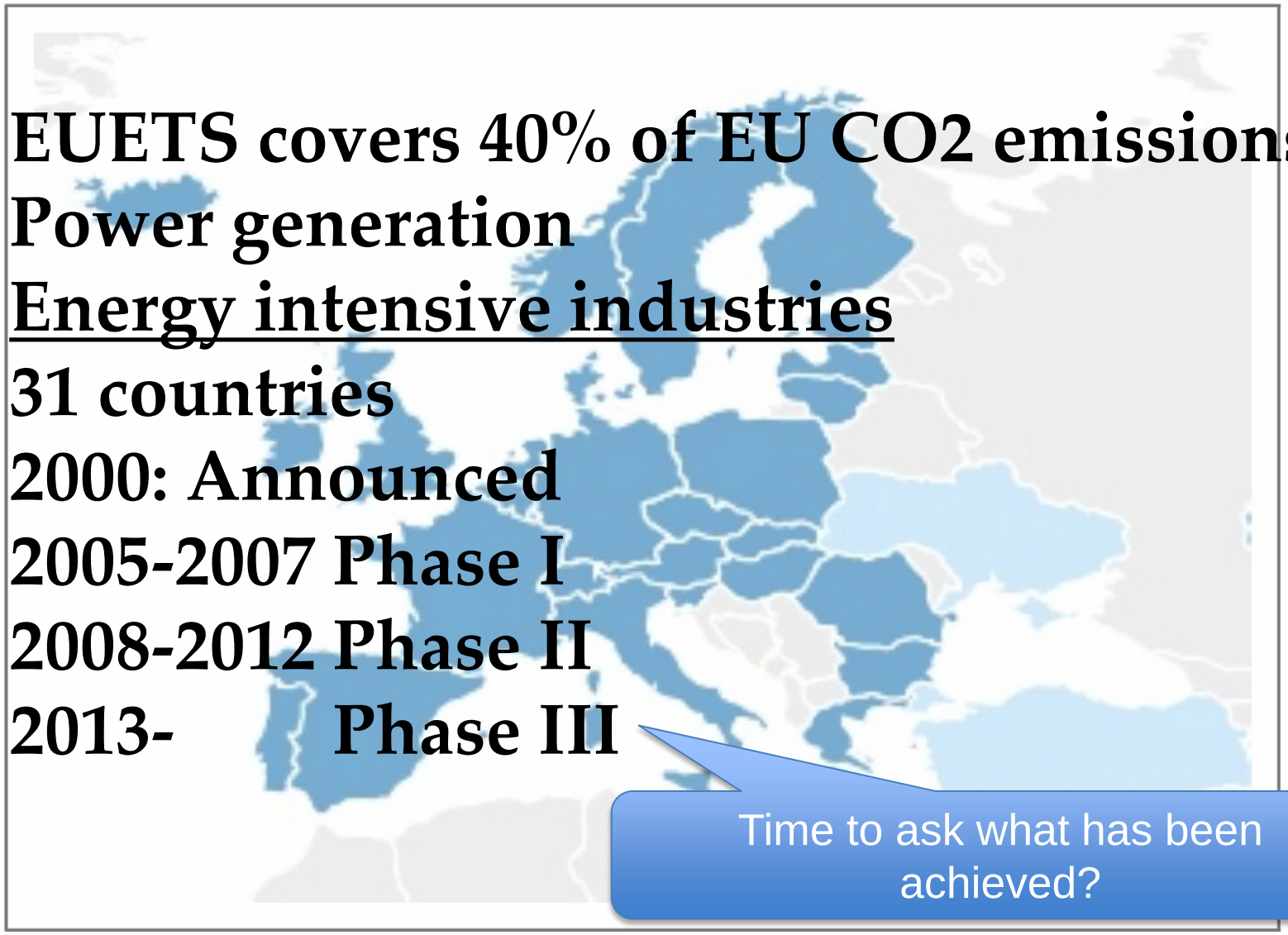
Imperial College London BUSINESS SCHOOL

LSE

Grantham Research Institute on Climate Change and the Environment

CENTRE *for* ECONOMIC PERFORMANCE

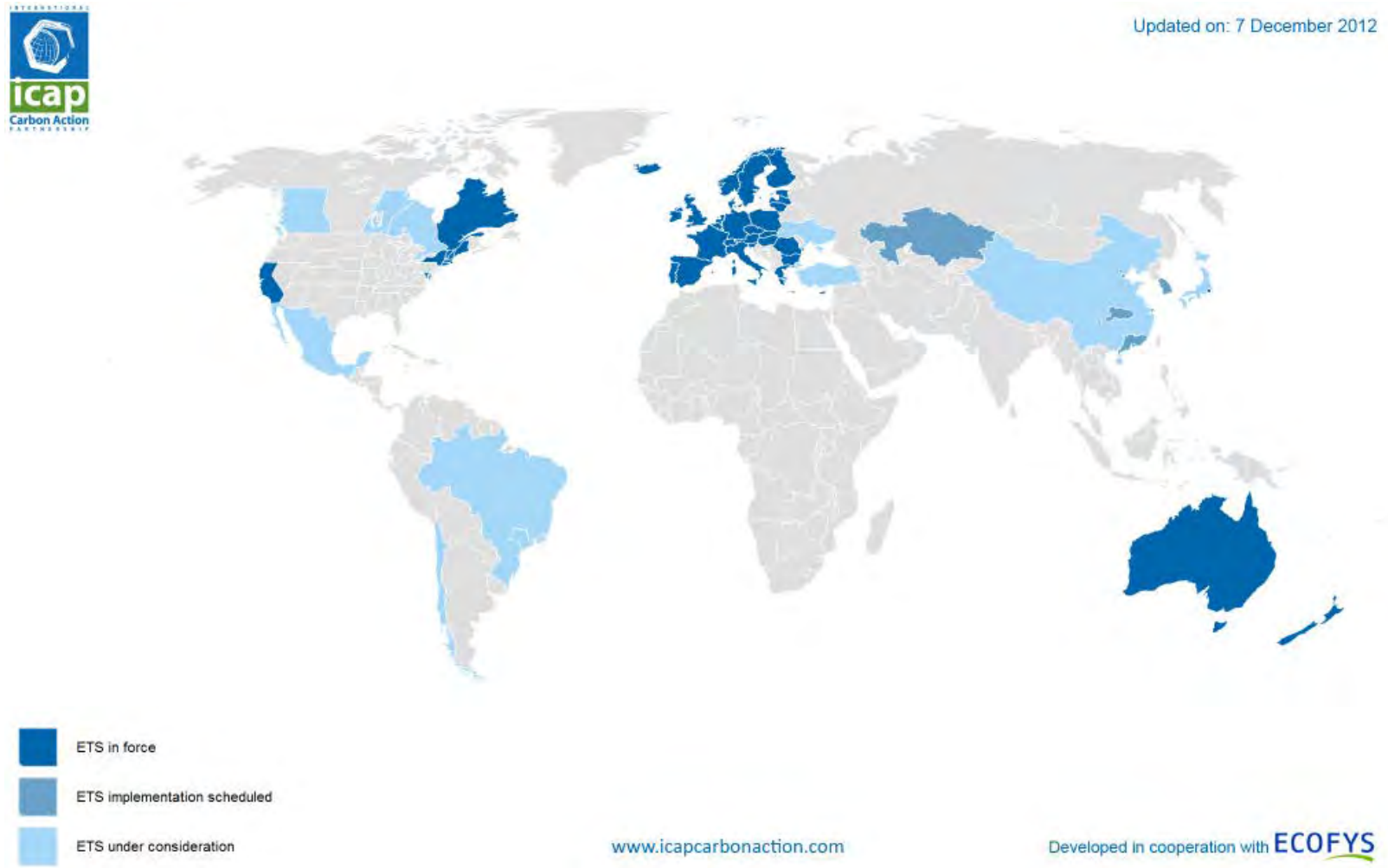
The greatest experiment to date



- EUETS covers 40% of EU CO2 emissions
- Power generation
- Energy intensive industries
- 31 countries
- 2000: Announced
- 2005-2007 Phase I
- 2008-2012 Phase II
- 2013- Phase III

Time to ask what has been achieved?

Even more experiments under way



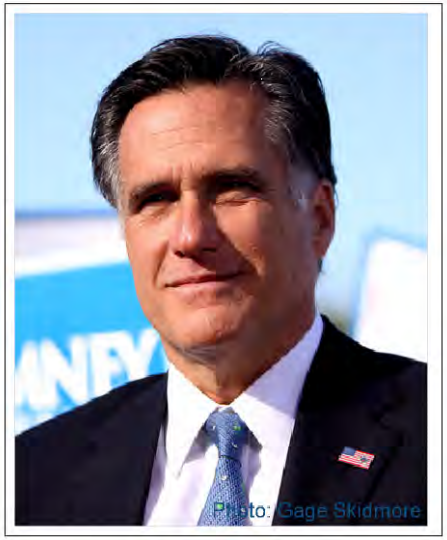
Diverging views on Carbon Trading

"The Administration is developing a comprehensive energy and climate change plan to (. . .) address the global climate crisis, and create new American jobs that cannot be outsourced. (. . .) This program will be implemented through a cap-and-trade system (. . .)."

Executive Budget Office of the President, 2009.

"I do not believe in a cap-and-trade program. (...) It loses jobs for Americans, and ultimately it won't be successful, because industries that are energy-intensive will just get up and go somewhere else."

Mitt Romney, Business Man
Former GOP Presidential Candidate,
October 2011, Pittsburgh



"The current proposal about Carbon Dioxide emissions would damage Germany's competitiveness in an unacceptable way and is not practicable".

Gerhard Schroder, Gazrom
Former German Chancellor,
June 2002

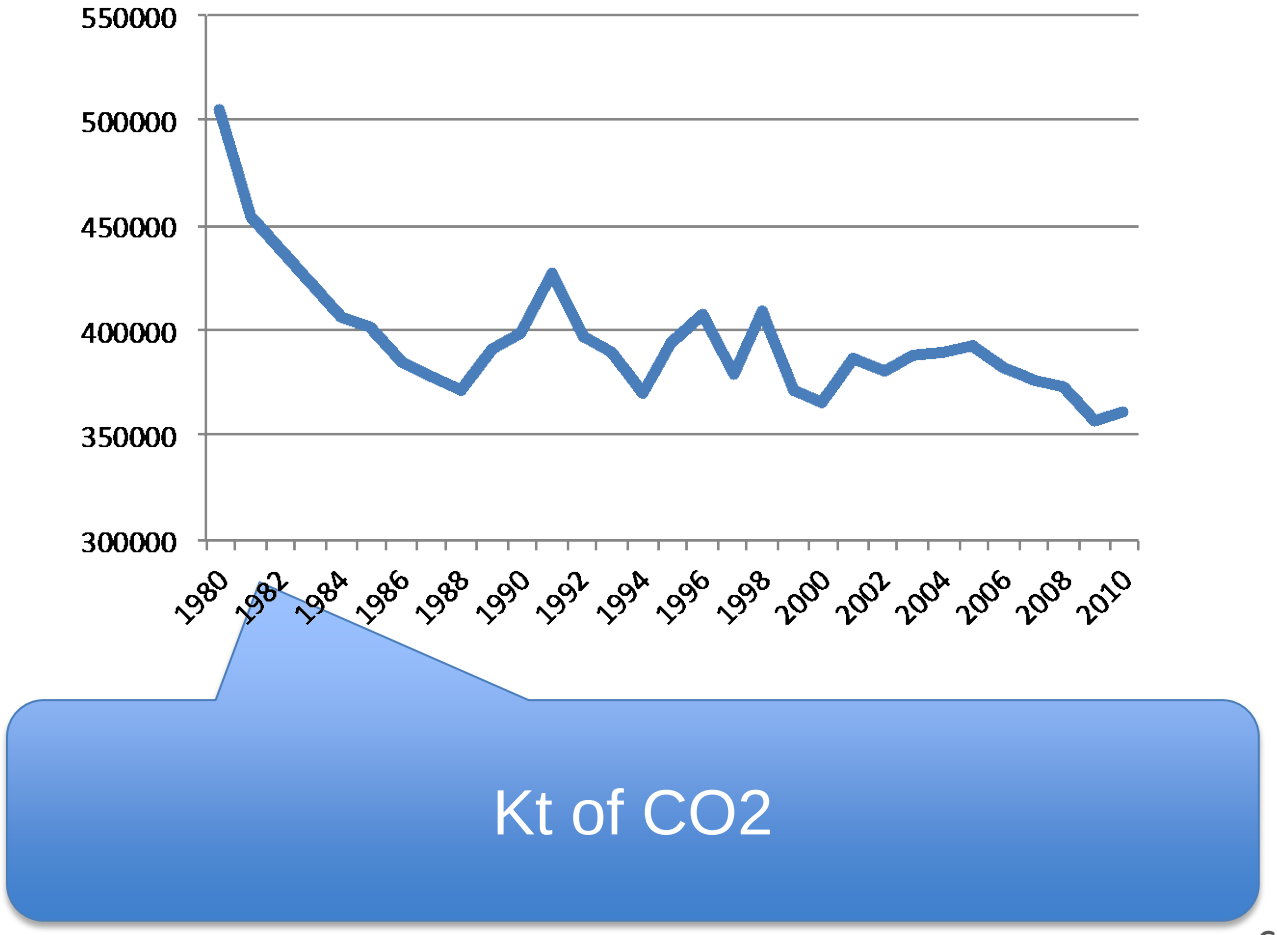
Is there any effect?

- On emissions?
- Employment?
- Competitiveness?
- (Clean) Innovation?
- Growth?

ETS effect on emissions

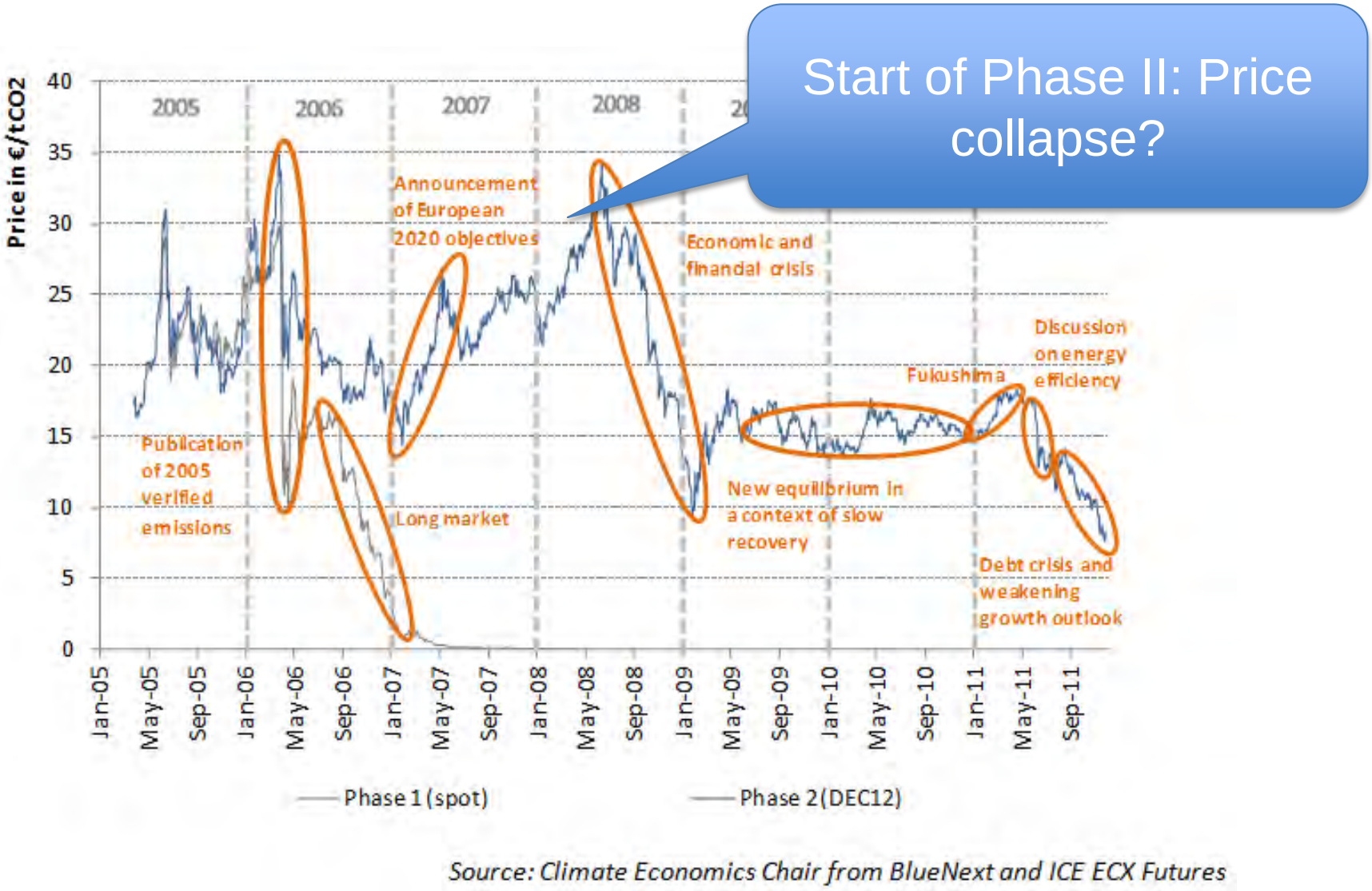
- By definition the EU ETS ensures that emissions of regulated firms do not exceed cap
- Hence if the cap is contracting/binding emissions must reduce
- However: this does not tell us by how much emissions have reduced due to the presence of the ETS
- Emissions might have reduced anyways

Aggregate figures for France



Source: Worldbank

ETS – much to ado about nothing?

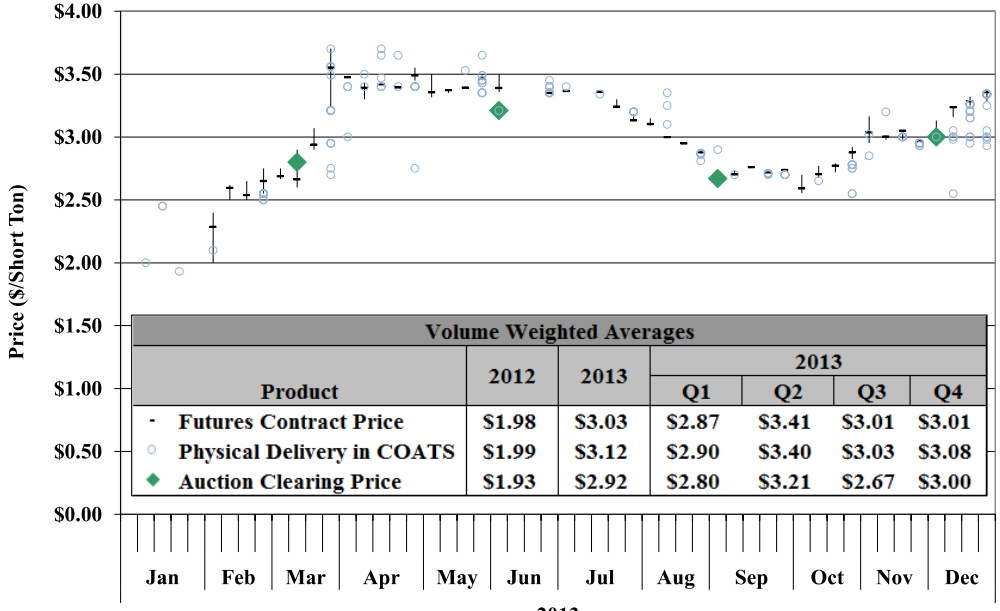


Source: Climate Economics Chair from BlueNext and ICE ECX Futures

ETS – much to ado about nothing?

RGGI

Figure 1: CO_2 Allowance Prices in the Auctions and Secondary Market 2013



Volume Weighted Averages						
Product	2012	2013	2013			
			Q1	Q2	Q3	Q4
Futures Contract Price	$1.98	$3.03	$2.87	$3.41	$3.01	$3.01
Physical Delivery in COATS	$1.99	$3.12	$2.90	$3.40	$3.03	$3.08
Auction Clearing Price	$1.93	$2.92	$2.80	$3.21	$2.67	$3.00

Why would we expect any effect?

- Below we will see that we find ETS effects primarily after 2008; when price drop
- Counter intuitive?
- Capital + Phase II ⇒ Higher future price expectations (Management survey suggest average price expectation of £40 for 2020)

- Another possibility: Reduced uncertainty ⇒value of option to wait reduces

Having said that….

- Higher future price expectations are not a sufficient condition for emission reductions today
- Too high prices in the future could prompt future plant exit and reduction in current investment
- Might lead to increased emissions today

Investment options today

Very high future carbon price

Higher future price

Moderate future Carbon Price (Status Quo)

A quick summary

Using data for France we find

- **Negative effect on emissions: ~15%**
- **Driven mainly by improvements in efficiency (reductions in carbon intensity)**

- **<u>However:</u> We also find a negative impact on employment?**

- **Does this mean leakage? Probably not**

- **Effect mainly after 2008 (i.e. Phase 2)**

Data ends in 2010 (for now)

Previous work - Emissions

- **Limited number of previous studies**
- **Aggregate data**
- **Baseline derived from interpolating pre policy trends**
- **Most work only for Phase I**

- **Ellerman Buchner: -2.4% to 4.7% emission reduction 2005-6**
- **Ellerman, Convery & de Perthuis: -3% in Phase I**
- **Ellerman & Feilhauer (2008) for Germany: -6.3% industrial emissions, -4.1% power sector (average -5%)**
- **Anderson & DiMaria (2011, *ERE*): -2.8% EU wide**

Previous work – Other outcomes

Economic performance and competitiveness:

- **Evaluation studies at firm level: Abrell, Ndoye & Zachmann (2011 WP); Chan, Li & Zhang (2013 Energy Policy), Bushnell, Chong & Mansur (2013 AEJ:EP).**
- **Little evidence of adverse impacts on revenues, profits, employment**

Matching + Diff-in-diff to identify causal impact of cap & trade

- **Calel & Dechezlepretre (201x ReStat): impact of EU ETS on clean patents**

Parallel work

Wagner & Petrick for Germany:

- **CO2🡻 ~20% in Phase2**
- **However: no effect on employment**

This paper/project

- **First study to compare the change in emissions between regulated and non-regulated facilities over the introduction of the ETS (DiD)**

Two problems

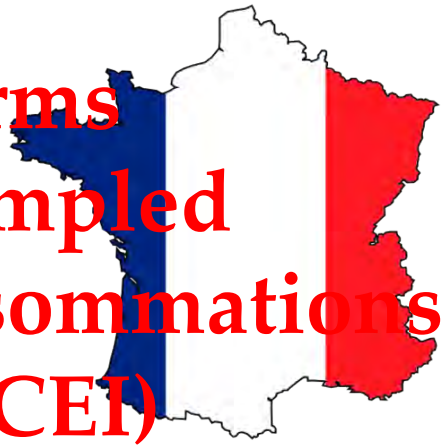
1. **Data for both ETS and non ETS plants from before and after ETS**
2. **Are there comparable non ETS plants?**

Structure

- Data
- Details on treatment & Econometric strategy
- Main results
- Leakage
- More (non) evidence on leakage
- Further discussion

Data

- CO2/Fuel consumption data from government business census data
- Access often difficult
- We have now access to relevant data for UK & France, Germany (probably NL & Norway)
- **Today: Initial results for France**
  - **Unbalanced panel of ~10000 firms**
  - **Smaller firms are randomly sampled**
  - **Enquete Annuelle sur les Consommations d'Energie dans l'Industrie (EACEI)**
- ETS participation information from CITL



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The treatment

Who is covered?

- Specific capacity thresholds for different industries

Examples:

- Paper mill above 20 tonnes per day production capacity
- Power plant with rated thermal input of more than 15MW

- Based on capacity – not consumption - so firms can get out only by closing down
- Also: we base ETS id on first treatment period
- Endogeneity? Only if (some) firms changed capacity in response to ETS before Phase I
- If that happened it will probably be a downward bias

Controls

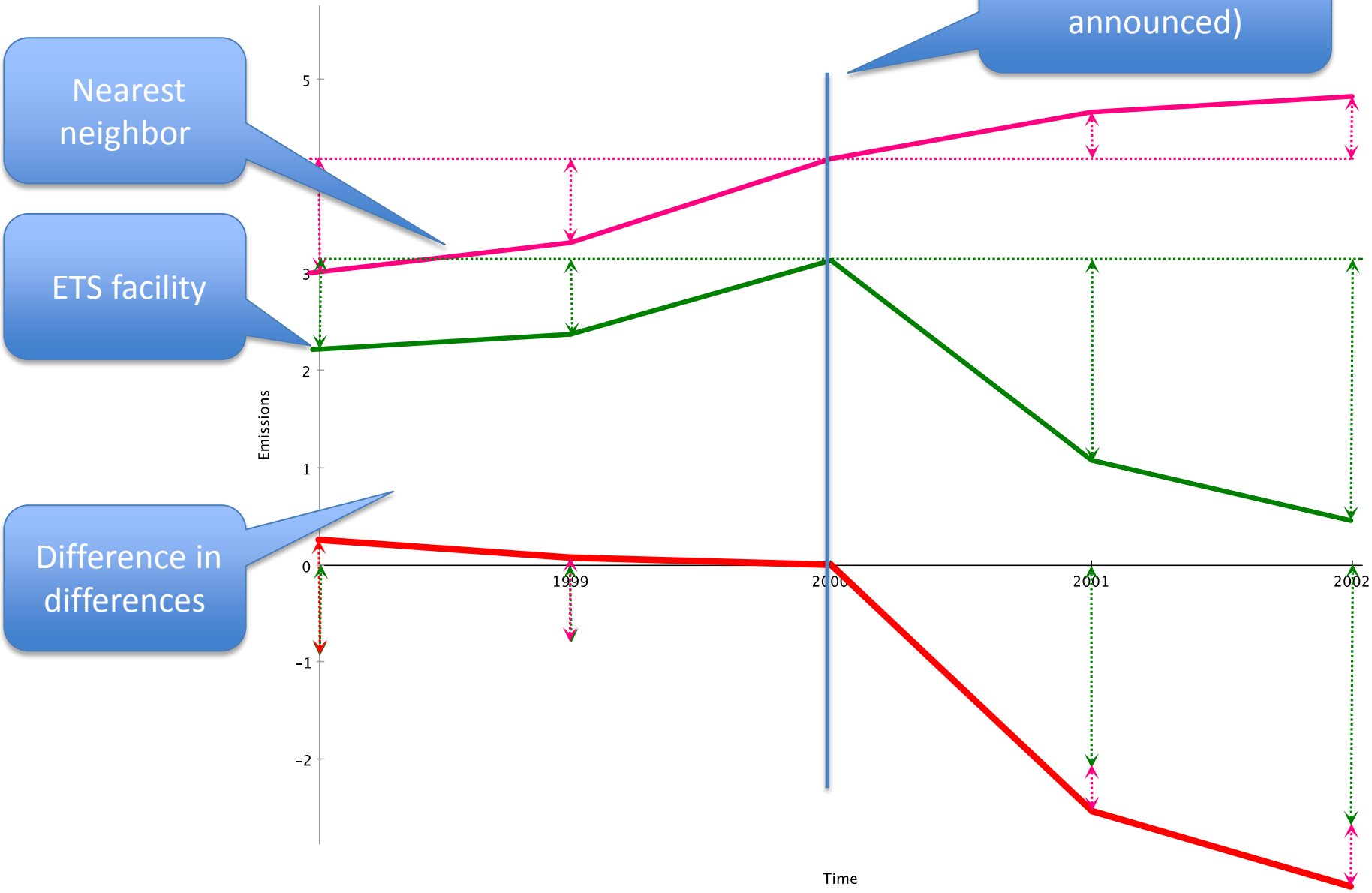
- Size thresholds means we will never have common support in terms of size related variables

- We match instead on CO2 intensity and (2digit) sector (nearest neighbour matching)

DiD-Matching estimator

$$SATT_t = \frac{1}{\#\,Plants} \sum_i \left(\left[y_{it} - y_{i2000} \right] - \left[y_{NN(i)t} - y_{NN(i)2000} \right] \right)$$

DiD-Matching estimator

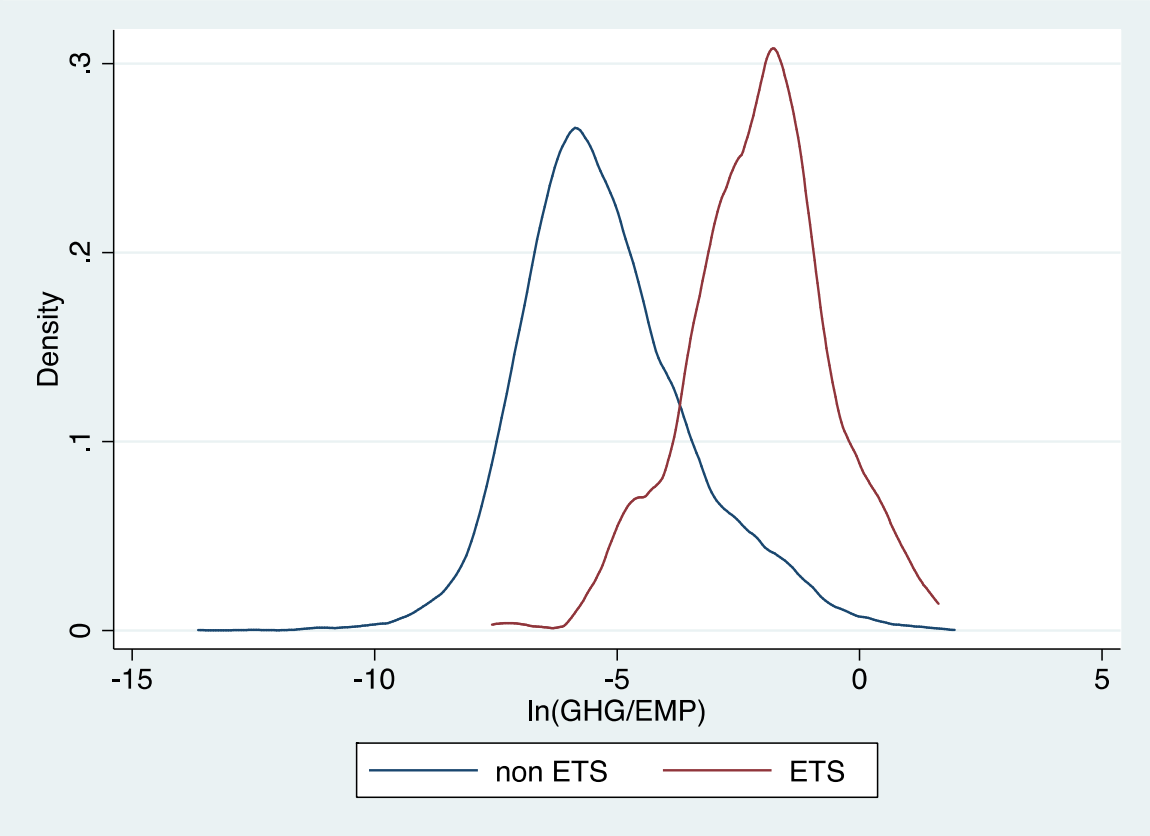


What do we identify

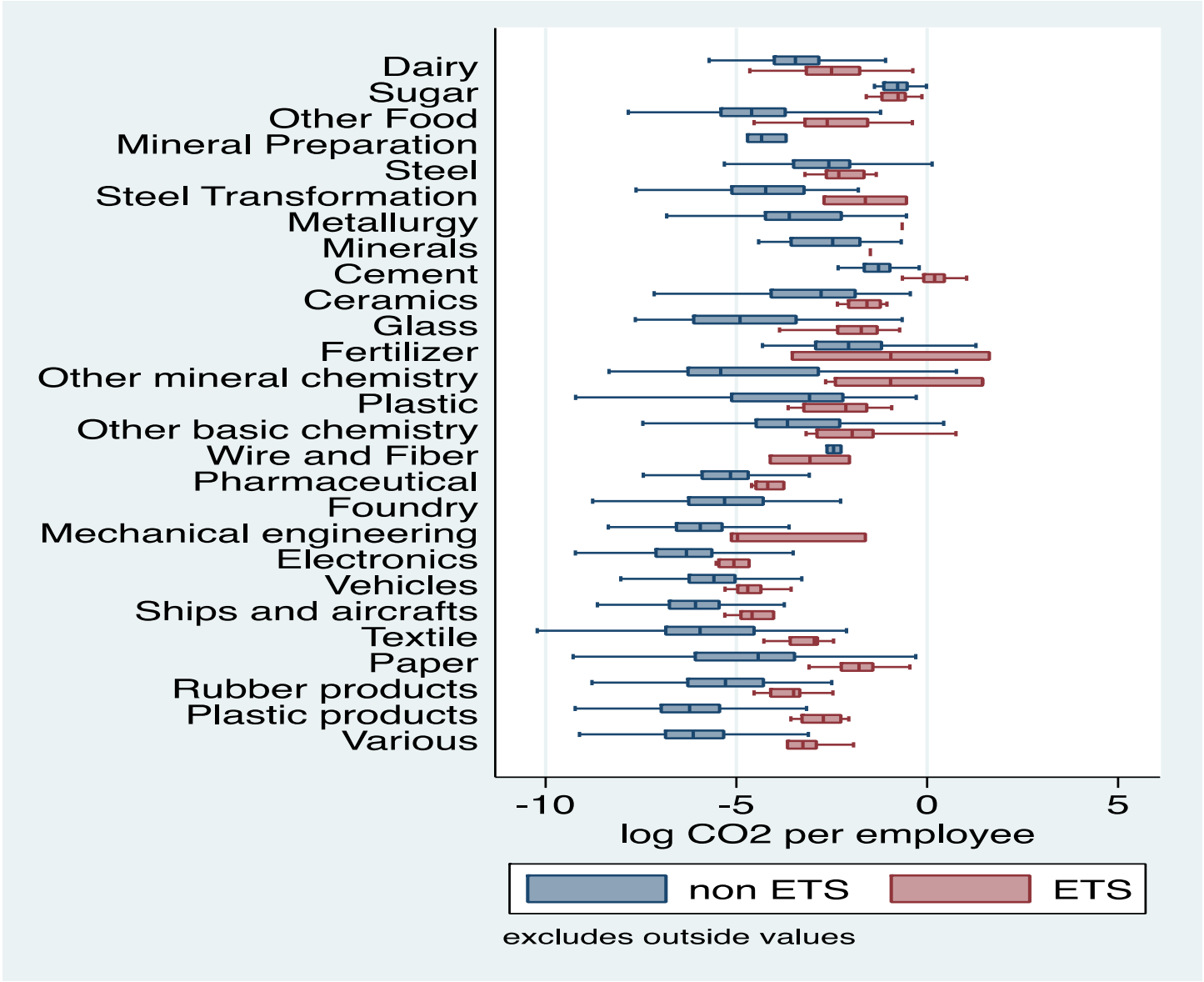
- Relative effect between ETS and non ETS
- Maybe substitution between regulated and non regulated plants?
- Maybe carbon leakage?
- We can say a little bit about that by looking at multi-plant firms with plants covered and not covered

ETS vs non ETS

- ETS plants in sample: 384
- Non ETS plants: 5,573

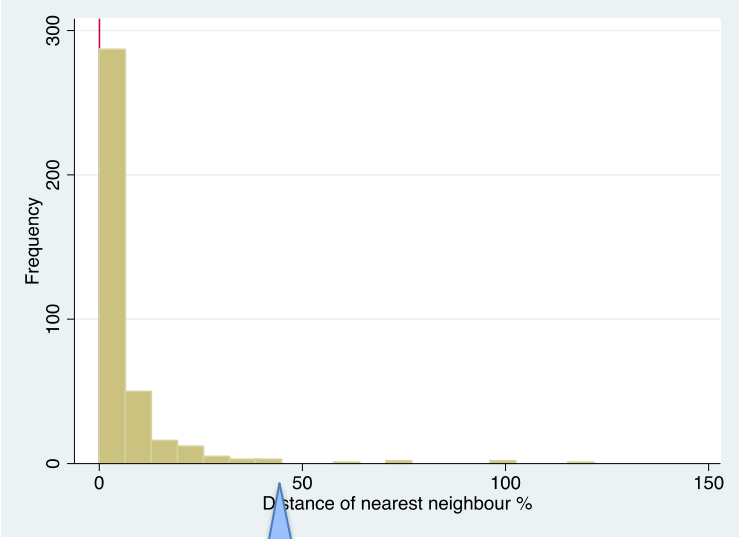


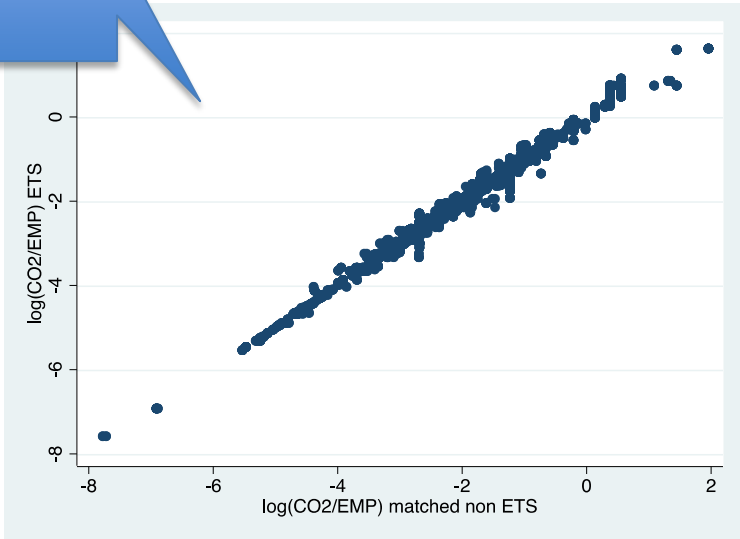
ETS vs non ETS



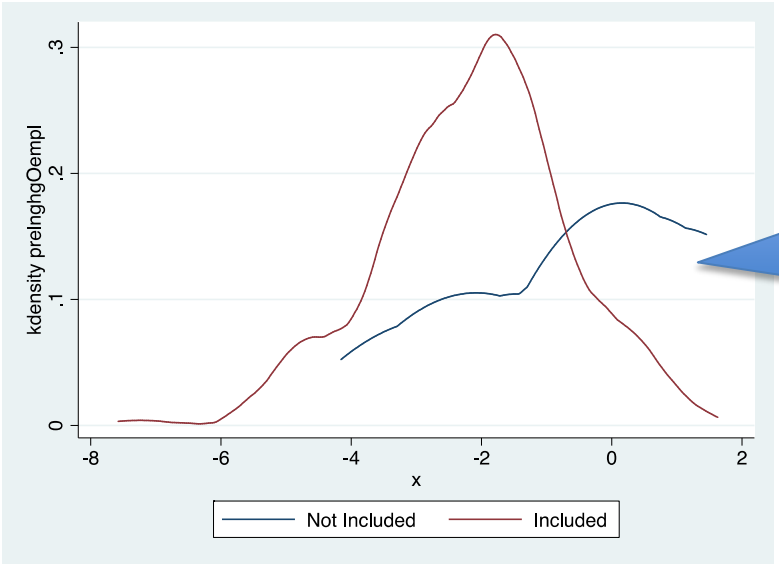
Matching

Treated vs. NN GHG intensity





Distance to nearest neighbor: 50% cut – off captures most of the sample



Non matched are within the support of matched

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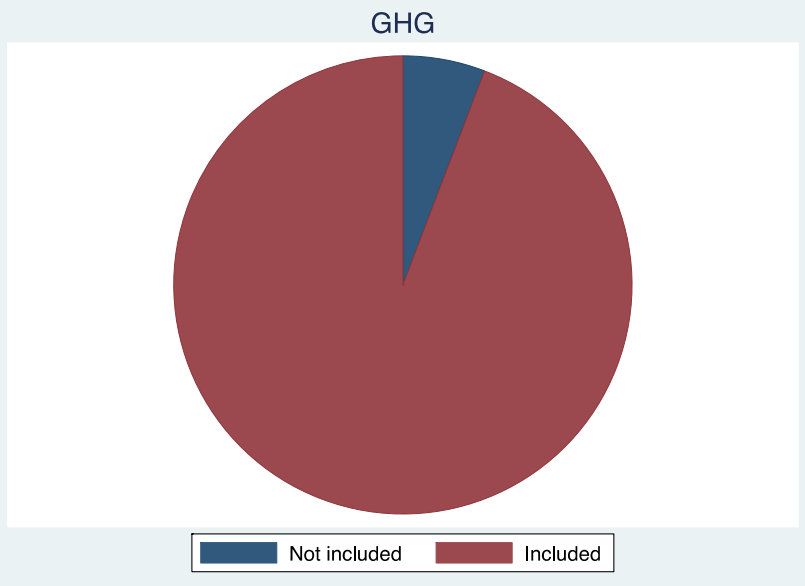
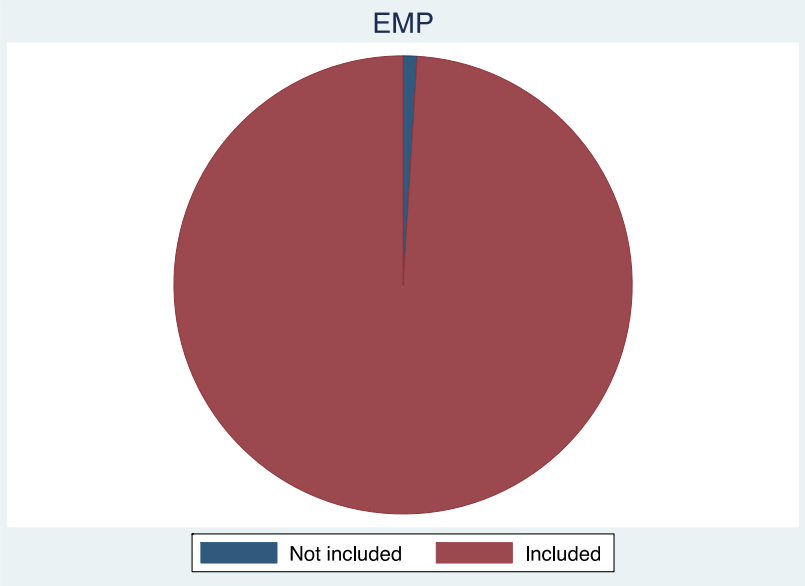
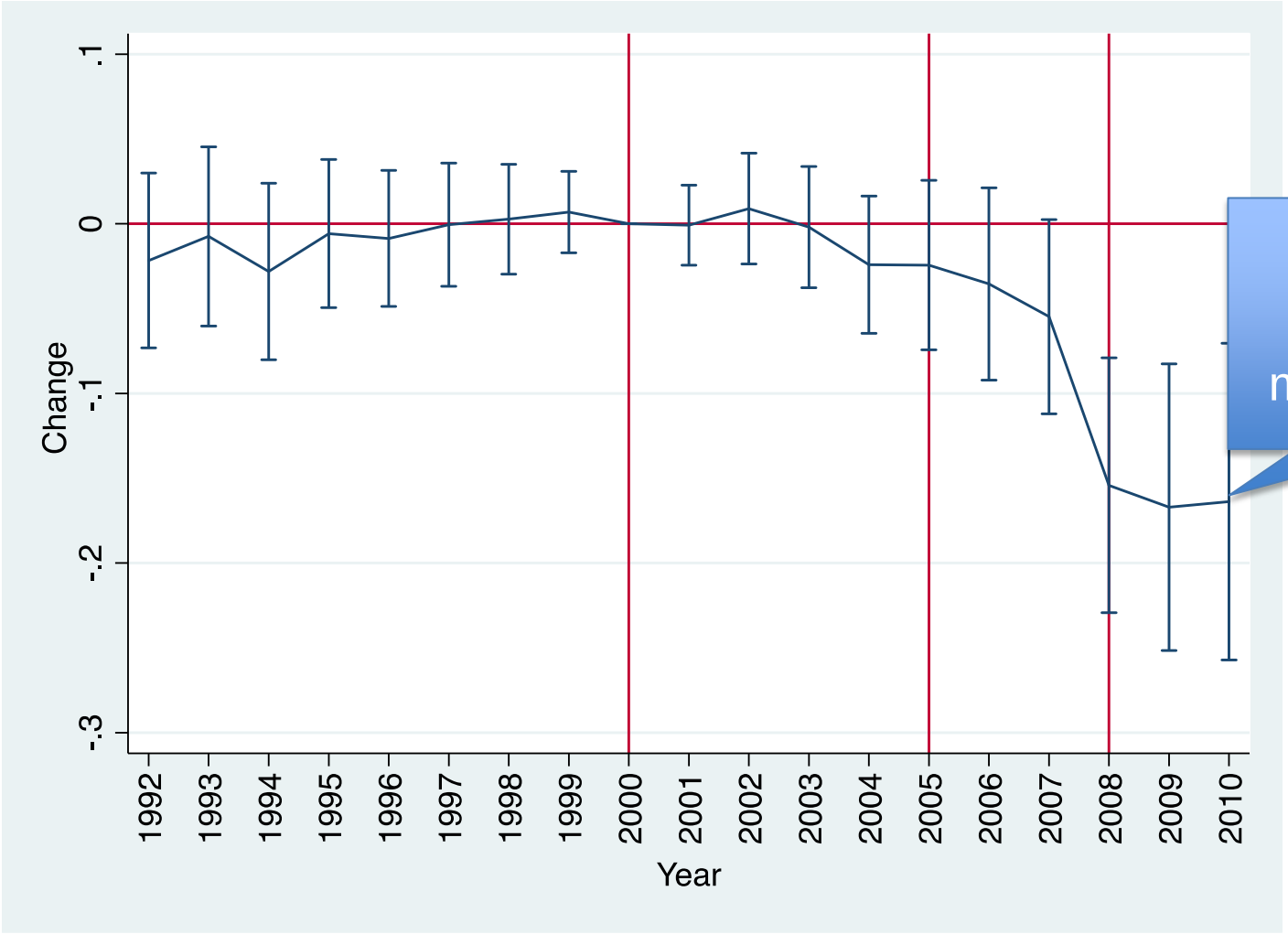
Share of GHG and EMP in matched sample





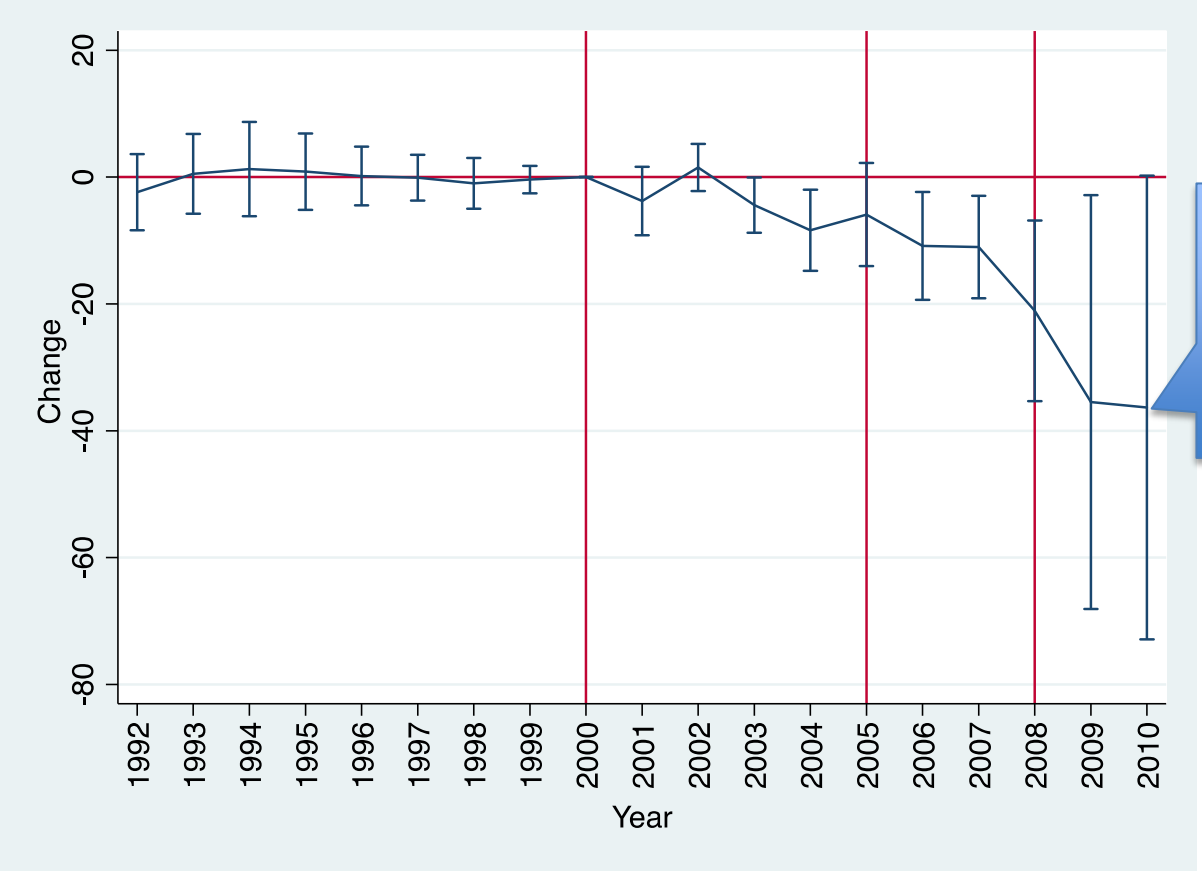
50% cut captures most GHG and employment

Average impact: ln(GHG)



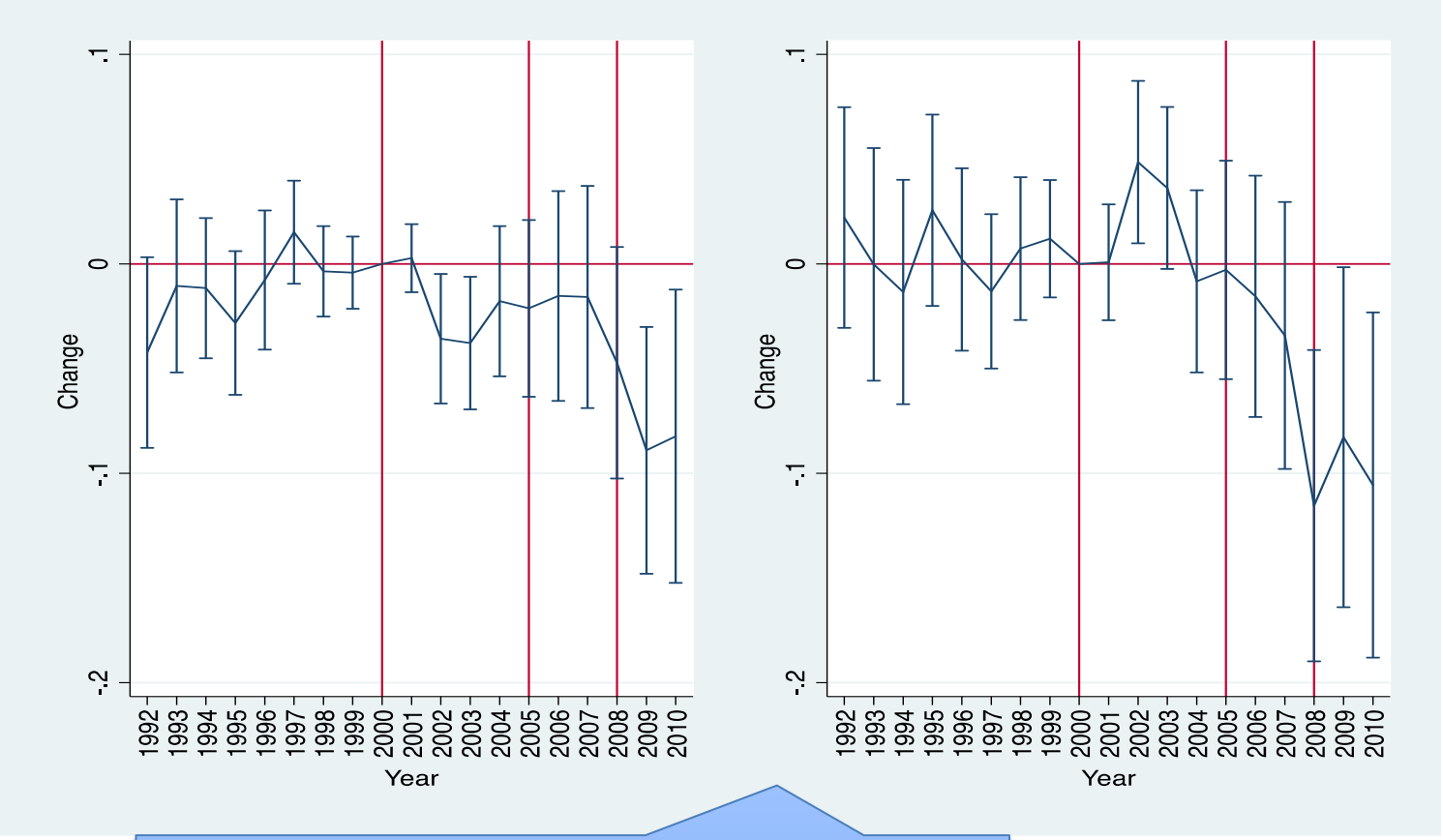
Average reduction of more than 15%

Average impact: GHG



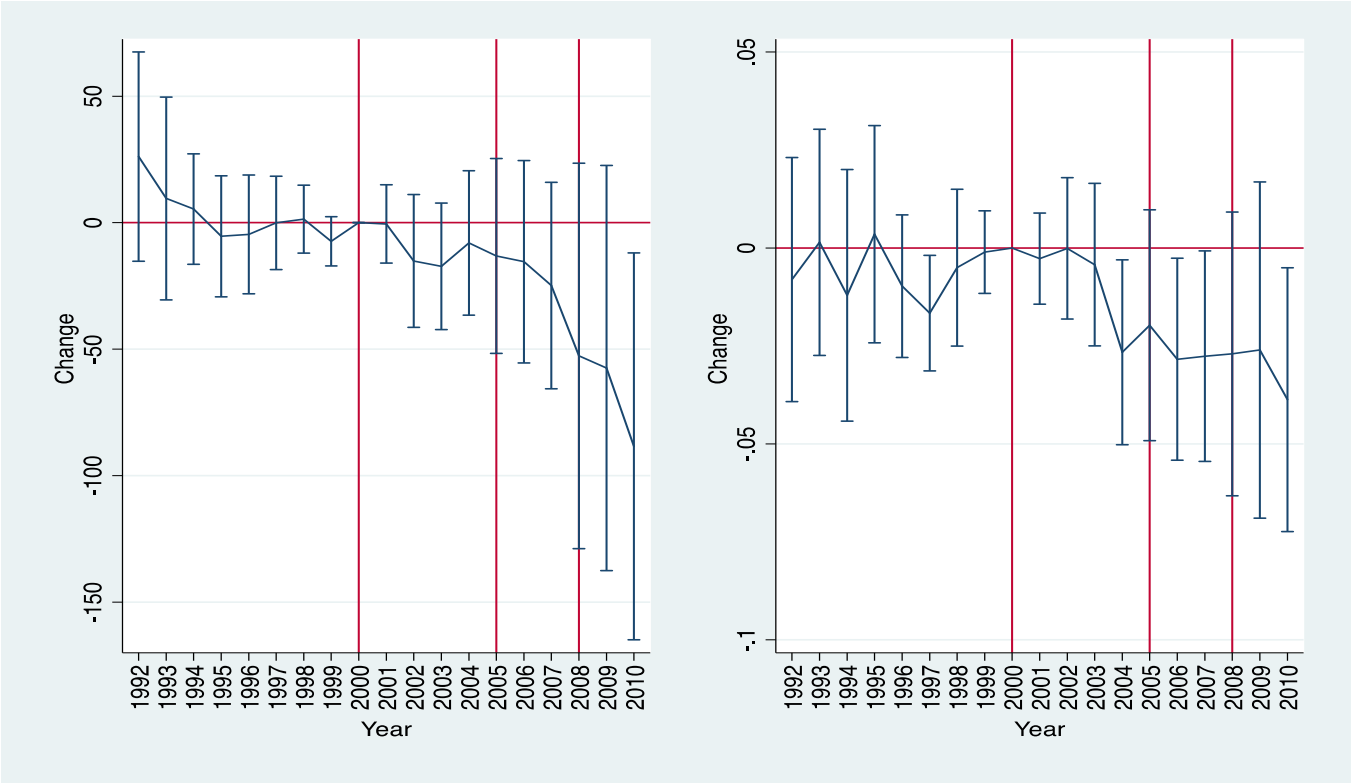
Average reduction of approx. 40,000t of CO2

ln(EMP) and ln(GHG/EMP)



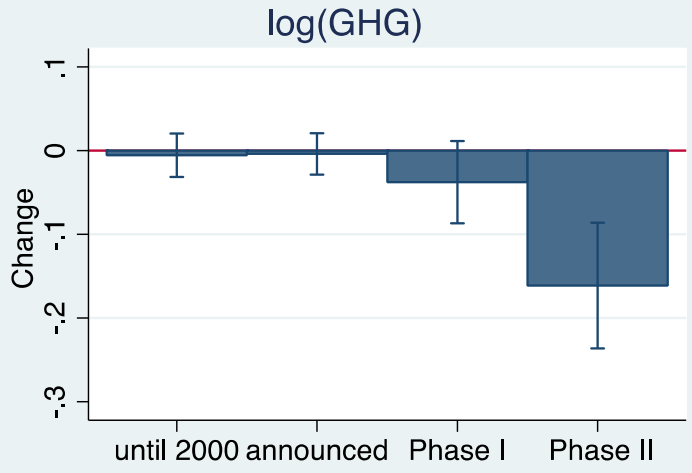
Decline in employment as well but GHG intensity declines nevertheless

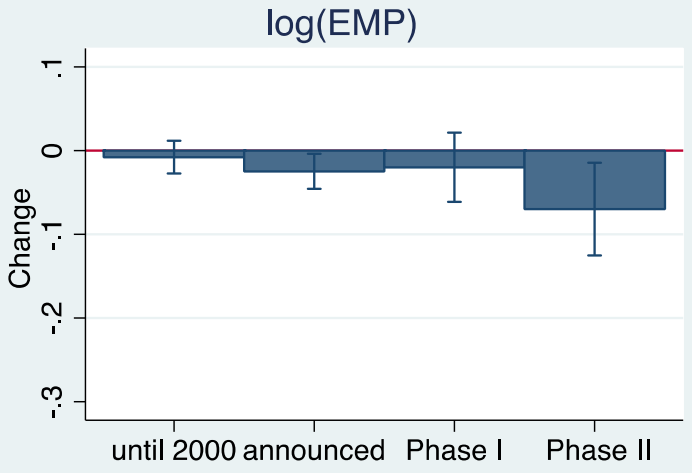
EMP and GHG/EMP

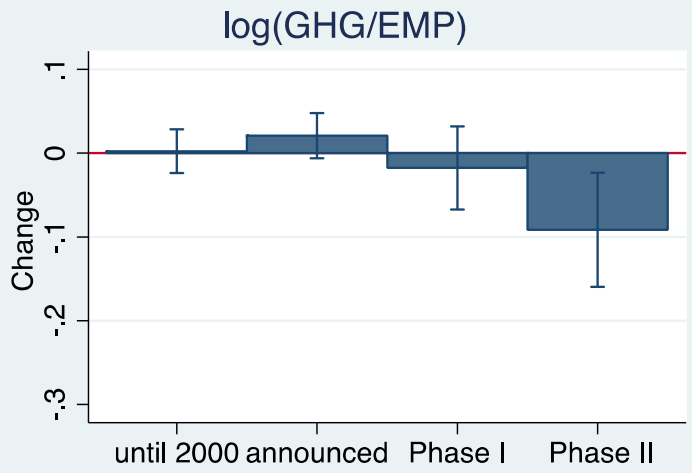


Decline in employment as well but GHG intensity declines nevertheless

Summary %

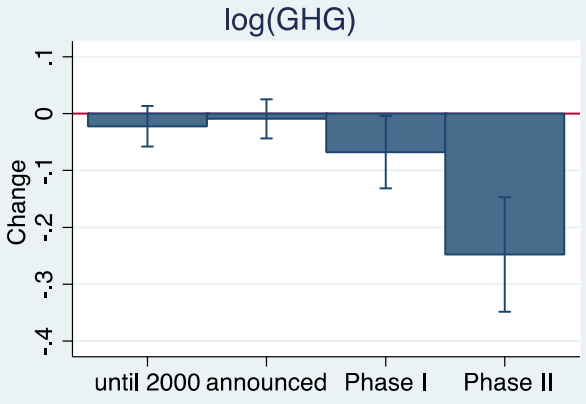


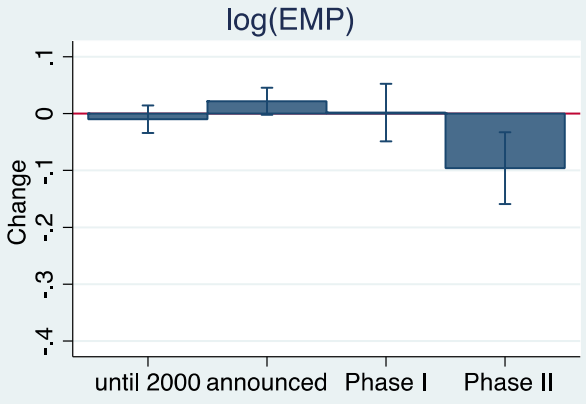


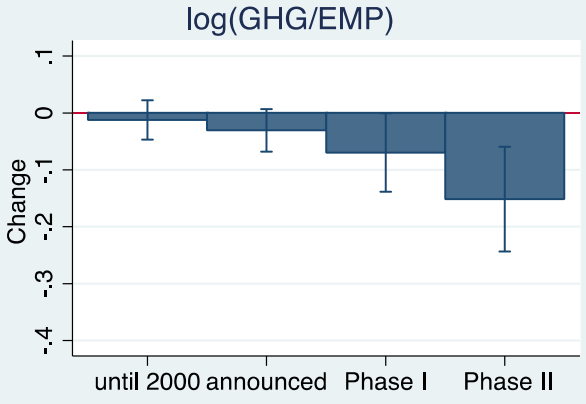


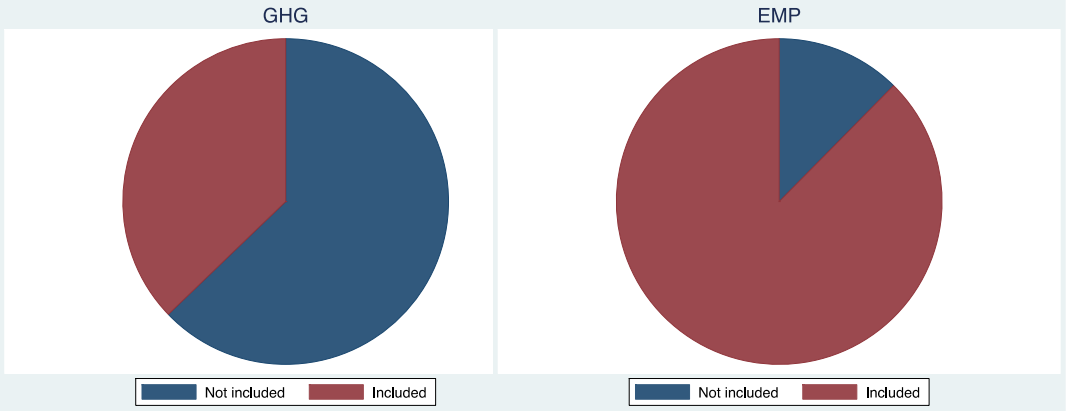
Almost 20% average reduction in GHGs

Robustness – 10% NN only

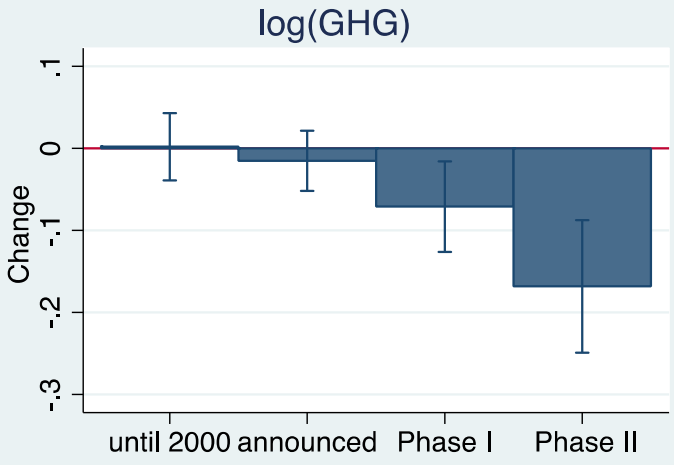


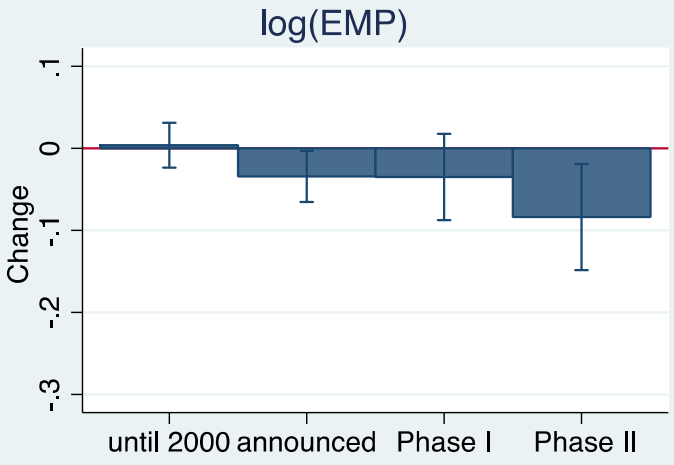


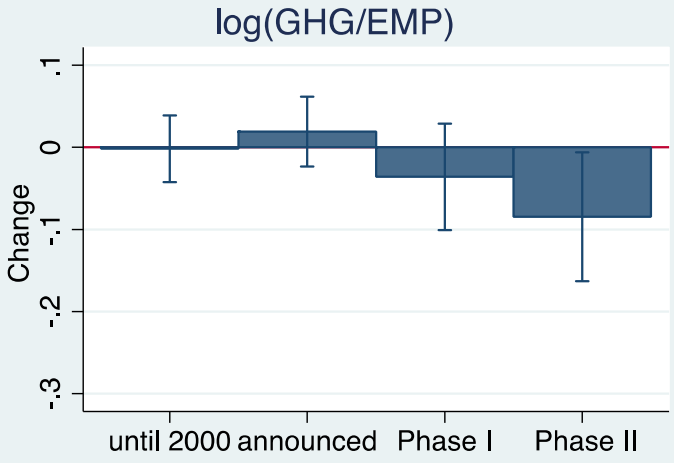


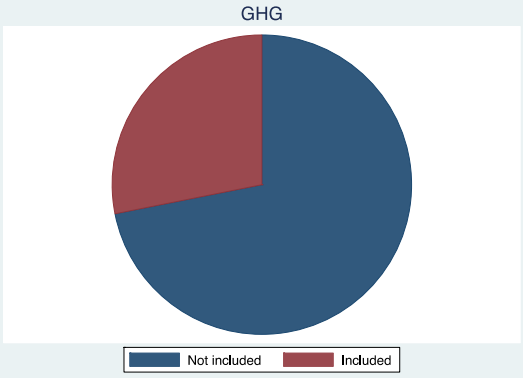


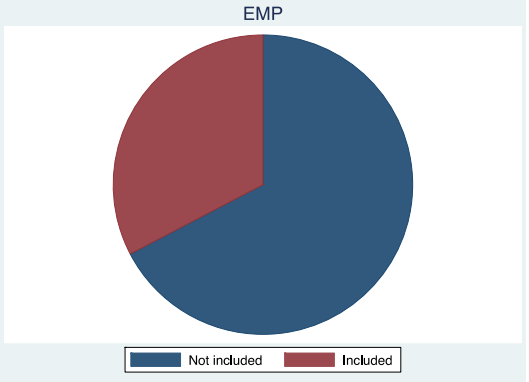
Robustness – balanced sample











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Leakage?

Are our results due to

- Global net reductions?
- Or leakage?

We cannot assess directly

However we can provide circumstantial evidence

Multi-plant firms and leakage

	Multiplant ETS only firms	Mulitplant ETS & non ETS	Single plant ETS
Plants	100	130	154
Firms	57	76	154

- For them within country leakage should be easier
- If leakage drives emission reductions we expect stronger effects for this group
- We also expect emission increases for **non ETS plants** of ETS f***irms***

Multi-plant firms and leakage

		(2) Part ETS	(3) Only ETS	(4) Non-ETS
Panel A: GHG Emissions				
Δln(GHG Emissions)				
Pre-Announcement SATT		0.0112	-0.0148	0.0174
		(0.0287)	(0.0147)	(0.0214)
Announcement Phase SATT		-0.0460	-0.00610	0.0180
		(0.0292)	(0.0178)	(0.0347)
Phase I (2005-2007) SATT		-0.0506	-0.0409	-0.00179
		(0.0545)	(0.0339)	(0.0709)
Phase II (2008-2010) SATT		-0.160**	-0.238***	0.0226
		(0.0691)	(0.0643)	(0.0648)

Only ETS plant effects stronger

No (significant) positive effect for non ETS plants in ETS firms

Other indicators of leakage

Firm level non-EU imports increase	*Working on it but initial results find no evidence*
Material shares increase	*Working on it*

Indicators of non-leakage

Investment increases	*Working on it*

Firm level

	(5) Base Year (2000)
GHG emissions ($\Delta ln(GHG)$)	
Pre-Announcement SATT	0.008
	(0.013)
Announcement Phase SATT	0.013
	(0.017)
Phase I (2005-2007) SATT	-0.003
	(0.032)
Phase II (2008-2010) SATT	-0.104**
	(0.043)

Exports?

	(1) log(Total Exports)	(2) log(Total)	(3) log(EU)	(4) log(EU)	(5) log(Non-EU)	(6) log(Non-EU)
Pre-Announcement SATT	-0.033	-0.034	-0.046	-0.048	0.007	0.007
	(0.030)	(0.031)	(0.030)	(0.031)	(0.026)	(0.026)
Announcement Phase SATT	0.011	0.013	0.017**	0.022**	-0.000	-0.002
	(0.008)	(0.008)	(0.008)	(0.025)	(0.010)	(0.011)
Phase I (2005-2007) SATT	0.017	0.022	0.028	0.038	-0.008	-0.012
	(0.021)	(0.024)	(0.022)	(0.025)	(0.022)	(0.026)
Phase II (2008-2010) SATT	-0.026	-0.018	-0.007	0.005	-0.032	-0.030
	(0.032)	(0.038)	(0.032)	(0.037)	(0.031)	(0.037)

Could be a sign of negative competitiveness effects

Fuel switching?

	Coal Share	Oil Share	Gas Share	Steam Share
Pre-Announcement SATT	-0.000	-0.006	0.012	-0.000
	(0.004)	(0.008)	(0.009)	(0.001)
Announcement Phase SATT	-0.014**	-0.011*	0.021**	0.005*
	(0.006)	(0.005)	(0.008)	(0.003)
Phase I (2005-2007) SATT	-0.021*	-0.023*	0.037**	0.007
	(0.011)	(0.012)	(0.017)	(0.006)
Phase II (2008-2010) SATT	-0.044***	-0.044***	0.073***	0.008
	(0.014)	(0.016)	(0.022)	(0.006)

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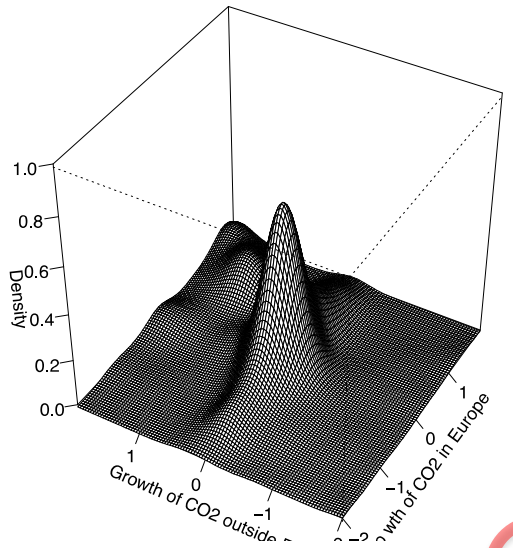
Further evidence on leakage

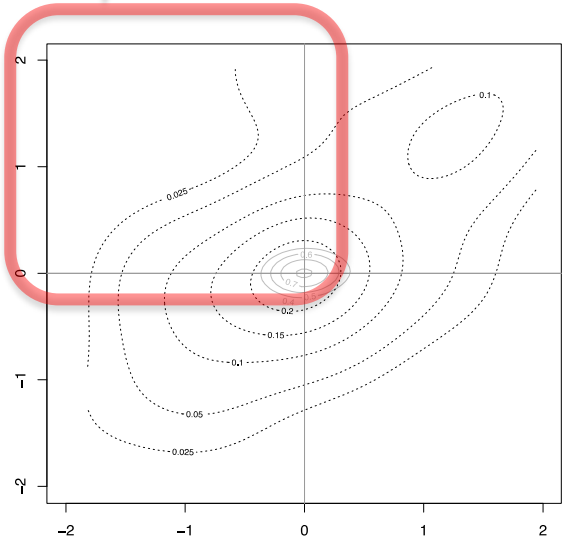
- Dechelepretre, Gennaioli, Martin, Muuls (2014, Grantham), Searching for carbon leaks in MNEs:
- Data from Carbon Disclosure Project (CDP) for ~400 MNEs,2007-2009 on carbon emissions by country
- We compare changes in emissions in EU vs non EU

EU vs RoW emissions

(a) Firms with positive CO_2 in EU in base year



Any leaks here?



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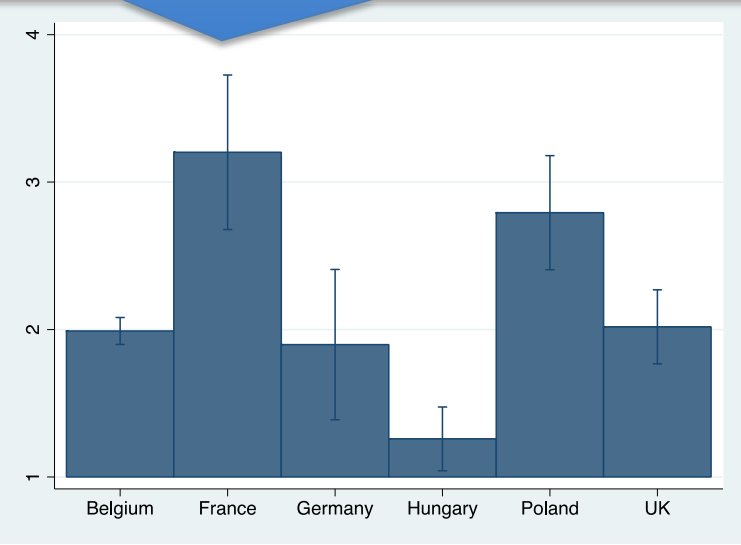
Discussion & Triangularisation

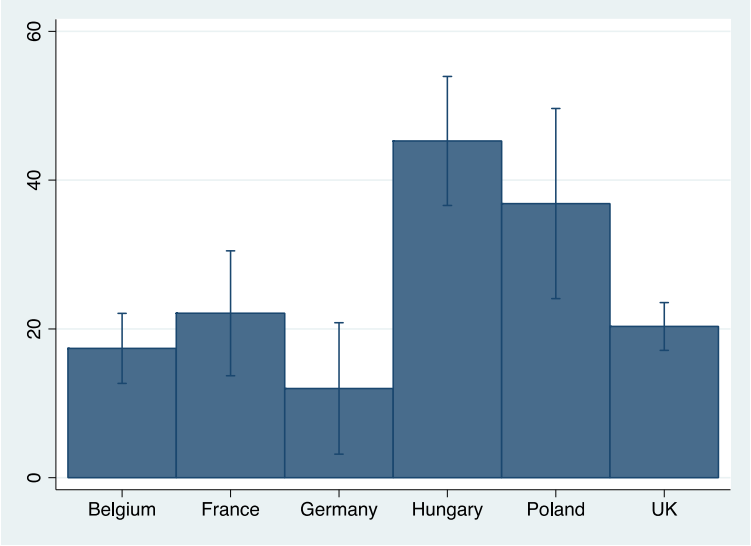
➔ **Martin, Muuls, de Preux & Wagner (2014, AER, EE):**

- **Interviews with managers approx 800 managers in 6 European countries in summer 2009**
- **Open dialog but scores (1-5) capturing various aspects of business activities (Bloom van Reenen style)**
- **Impact Score: Will climate policy lead to downsizing ?**
- **Innovation Score: Are you doing R&D to develop "clean" products?**

Germany vs France

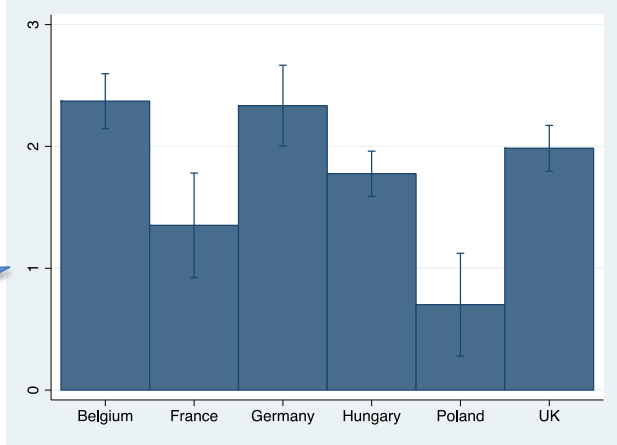
Downsizing, Outsourcing, Exit due to climate change policies
1=no impact
3=about 10% output or employment reduction
5=complete closure very likely





Cost pass trough

Clean Innovation activities:
1= none
5=all R&D is for clean innovation



What do firms actually do?

Some quotes:

Heat recovery

- **Reuse steam** to heat water
- **Recycling of hot water**
- Own power plant, burning in boilers optimized, **heat recovery**, programmes of cleaning system are being checked and water consumption and heat is being checked
- **Biggest impact: Heat recovery**
- **Multiple utilization of waste heat from steam boilers**, reducing temperature of waste heat in chimney/funnel, **waste heat recovery**, controlling of supply and exhaust air
- Optimization of drying processes, **waste heat recovery**
- Optimization of pumps (turning down rotation speed), **waste heat recovery**, heat exchangers
- switch to natural gas, renovation, frequency changers, process heat isolation, steam recovery
- Bought new boilers, **waste heat recovery** installed, more efficient drying methods
- Automatic turning off of air conditioning and infrastructure for production, buying of motors with highest energy efficiency, efficiency of compressed air maximized (i.e. repairing of leakage, etc), **waste heat recovery**
- Optimization of energy mix used (some gases are more efficient than others), **making use of previously escaping vapor heat**
- **Heat recovery in low temperature parts**
- Insulation, **heat recovery**
- **Waste heat recovery,** exhaust heat from facilities (heated air is being blown back into the building in order to save heating – it's not a heat pump, but a direct redirection of the exhaust heat)

Conclusion

- Evidence that ETS reduced emissions (10 to 20% on average)
- Most gains come from increased carbon efficiency
- No evidence of within firm leakage
- Could be indication that there is no between firm/international leakage
- However: some evidence of negative employment effects

The road ahead

More outcomes

- Output, intermediates, profits, prices, productivity, entry, exit, restructuring, etc.)
- Type of employment

➔Will help to clarify mechanisms

Heterogeneity?

More countries: UK, Belgium

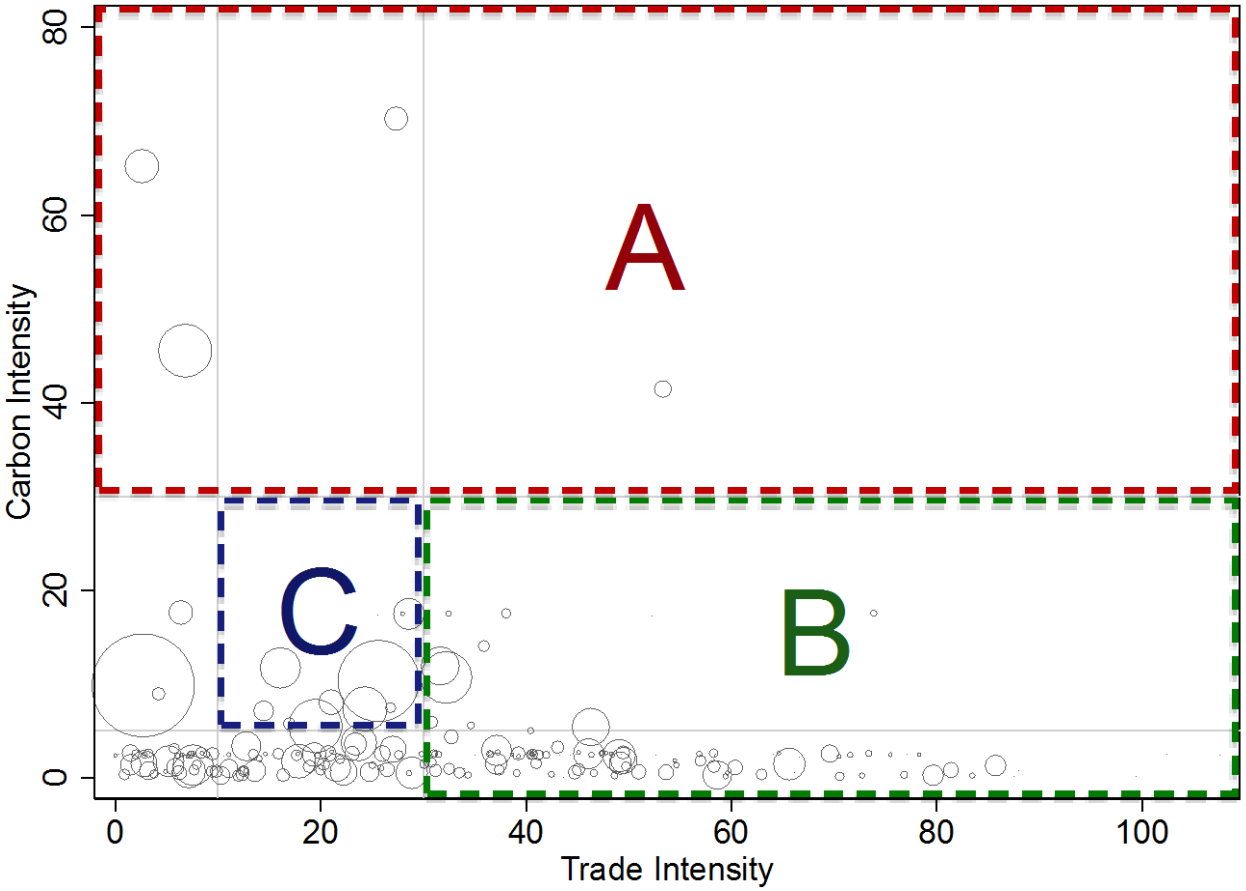

Thanks
r.martin@imperial.ac.uk

Extra slides……

How to Mitigate negative employment effects?

- Main instrument: Free emission permit allocation
- Free emission permit allocation to ETS firms deemed “at risk”
- At risk criteria at hoc: sector exceeds certain thresholds in terms of carbon and/or trade intensity

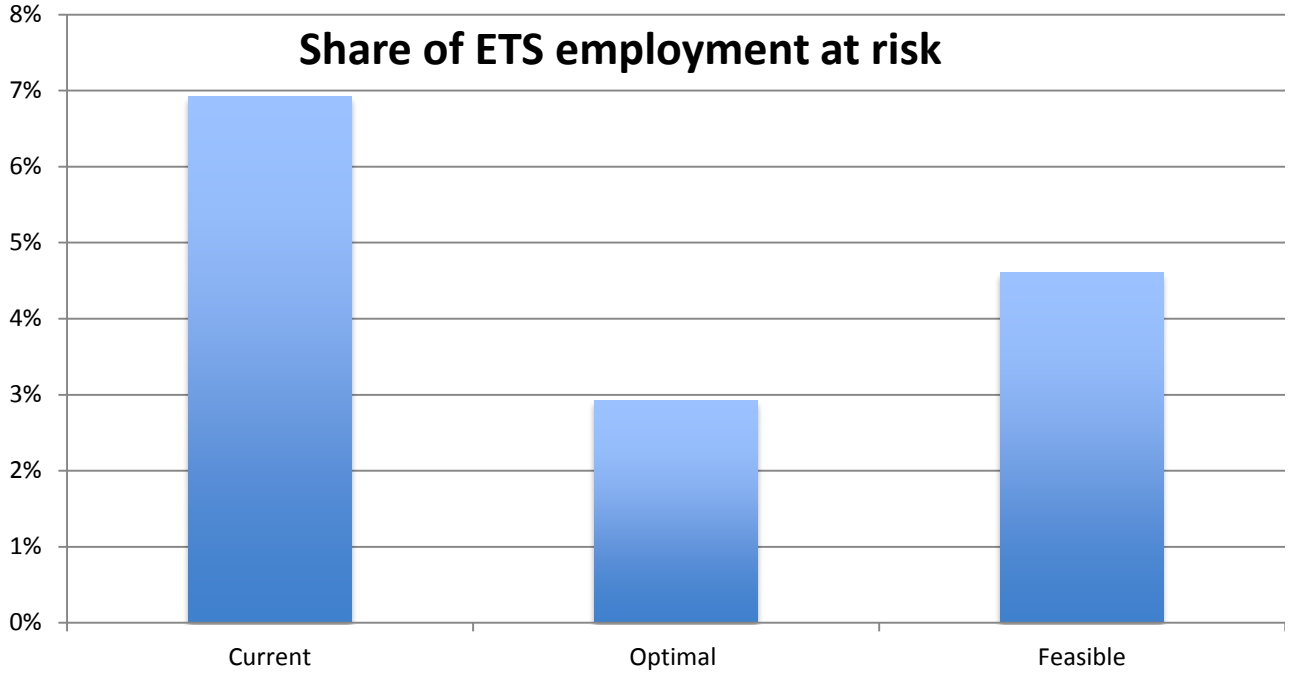
At risk criteria



Interviews with 800 managers

- Martin, Muuls, de Preux & Wagner (2014)
- Open dialogue but scoring in the background (following the method developed by Bloom and van Reenen as well as Propper)
- We derive a firm specific measure of Employment risk due to carbon pricing
- We also derive a measure of marginal impact of free permits

Optimizing permit allocation



- Equalize marginal impacts on government objective (e.g. job risk) across firms