Virtual Seminar on Climate Economics

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Banking on Carbon: Corporate Lending and Cap-and-Trade Policy

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Views expressed in this presentation are those of the speaker and not necessarily of the Federal Reserve Board of Governors.

Outline

Motivation

- Debate on climate change and financial stability
  - E.g., Sudden repricing of salient risk, unmonitored concentrated exposures

- Discussion centers around physical and transition risks
  - *"... transition risks: the financial risks which could result from the process of adjustment towards a lower-carbon economy"* (Carney, 2015).
  - Tradeoff between physical and transition risks
  - Concerns about transition risks could prevent climate change regulation

- Banks are among the largest stakeholders in the transition:
  - Mandatory emissions reductions could adversely affect borrowers
  - Climate change regulation could affect bank health

- Question: How do banks react to transition risks?
  - Challenge: Identify effects solely due to risks of adjustment towards a lower-carbon economy

Our paper

- Focus on a prominent policy tool in climate change regulation:
  cap-and-trade programs
- Study cap-and-trade bills as they move through the legislative process
  - Isolate period of high transition risk
  - Heterogeneous treatment of firms
- Analyze how banks manage exposure to affected private and public firms
  - Assess bank expectations of program impact on firms
  - Important evidence for architects of cap-and-trade programs
- Examine the California and Waxman-Markey cap-and-trade bills
  - Different time periods and treatment dimensions help assess external validity

The California cap-and-trade bill

Passed in 2011 and implemented in 2013

The Waxman-Markey cap-and-trade bill

Passed the House in June 2009 and, after high probability of passing the Senate, ultimately failed in July 2010

What do we find?

- Banks gain flexibility to revoke credit in response to cap-and-trade regulation. Covered firms have:
  - Shorter loan maturity
  - Decrease in share of term loans
  - Interest rates increase
  - Total loan commitments and utilization unchanged

- Results concentrated within private firms
  - Banks expect private firms to face greater challenges

- Banks also appear to reduce transition risks exposure by:
  - Selling loans to shadow banks
  - Monitoring firms more closely

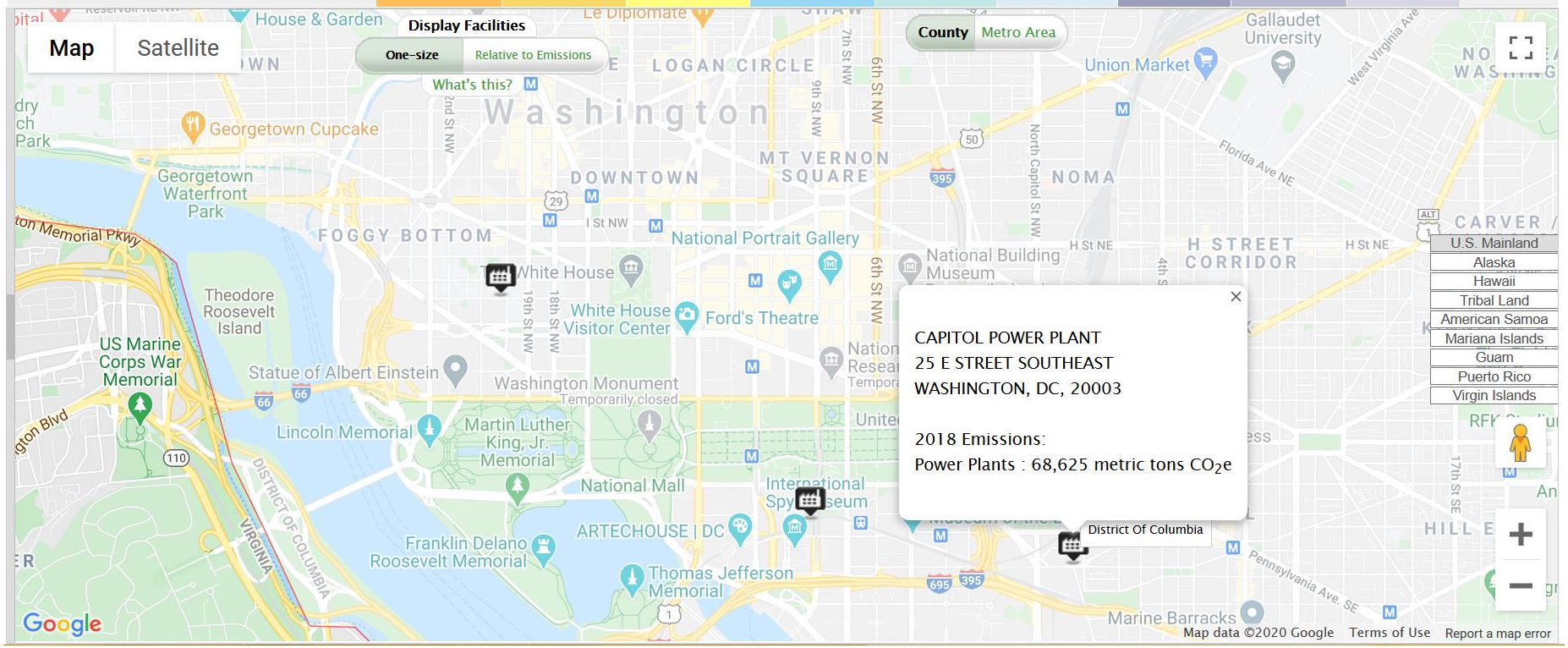
Outline

Data

- California analysis
  - Federal Reserve's Y-14 Collection
    - Covers both syndicated and bilateral loans $>$\$1 million since 2011
    - Has interest rate data and includes smaller private firms
  - Emissions data from the EPA
    - Mandatory reporting by facilities emitting $\geq$25,000MT/yr CO_2 equiv
    - Covers both direct and indirect emissions $\rightarrow$ facilities that produce material that emit $\geq$25,000MT when combusted
    - Aggregate firms to the parent level and map to credit data
- Waxman-Markey analysis
  - Shared National Credit (SNC) Program
    - Covers virtually entire syndicated loan market, including private firms
    - Provides a complete view of lending syndicate, including non-bank participants

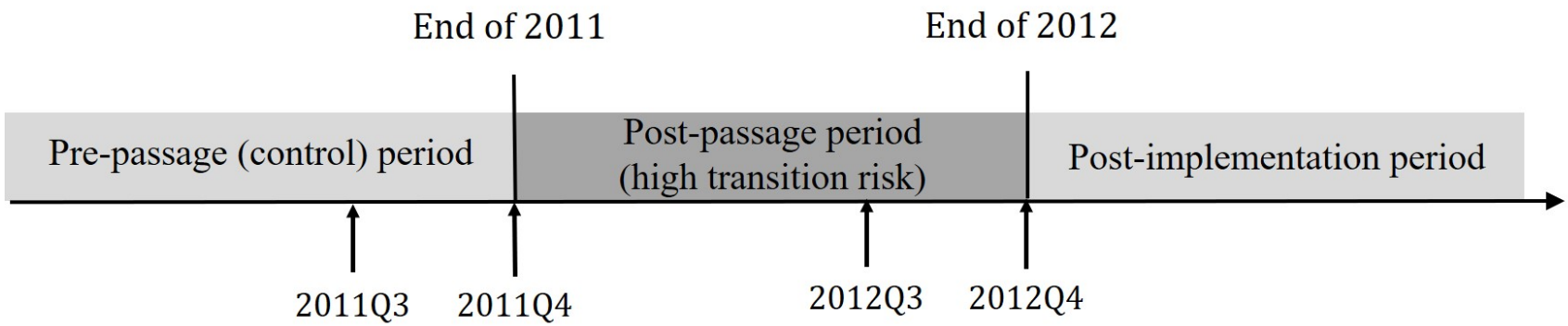
Emissions data

2018 GHG Emissions (Metric Tons CO_2e)	213,947	0	0	0	58,289	0	0	0	0	272,235
# of Reporting Facilities	2	4	0	0	2	0	0	0	0	4



Outline

Identification strategy: California cap-and-trade bill



- First difference: Compare lending in Q3-4 2011 (pre) to Q3-4 2012 (post)
- Second difference: Use EPA data to determine firms with large share of high emission facilities in California (Bartram, Hou, and Kim, 2021)
  - Threshold 1: Firm's CA emission $> 25\%$
  - Threshold 2: Firm's CA emission $> 50\%$

California regression specification

- Baseline regression specification:

$$y_{i,q} = \lambda I_{CA\_Emissions_i > 50\%} \times I_{\text{Post CA bill}} + Controls_{i,q} + \psi_i + \phi_{q,ind} + \epsilon_{i,q}.$$

- $I_{CA\_Emissions_i > 50\%}$ is 1 if firm i has a CA emission share of $> 50\%$, 0 otherwise
- Dependent variables are equilibrium outcomes of the loan contracting process between banks and firms:
  - Credit commitment
  - Maturity (Diamond, 1991)
  - Fraction of term loans (vs. credit lines) (Sufi, 2009)
- Changes can come through both new credit and renegotiation
  - Renegotiation occurs frequently (Roberts and Sufi, 2009)
  - Around once a quarter for small, private firms

$\Rightarrow$ λ is negative if banks cut credit commitment or seek higher contract flexibility

California analysis

	Log committed credit		Maturity (in months)		Term loans share (0 to 1)	
	(1)	(2)	(3)	(4)	(5)	(6)
$I_{CA\_Emissions_i>25\%} \times I_{\text{Post CA bill}}$	0.015		-3.905**		-0.245***	
	(0.061)		(1.670)		(0.034)	
$I_{CA\_Emissions_i>50\%} \times I_{\text{Post CA bill}}$		0.030		-4.946***		-0.262***
		(0.072)		(1.633)		(0.043)
Observations	2,717	2,717	2,717	2,717	2,717	2,717
R2	0.965	0.965	0.807	0.808	0.717	0.719
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes

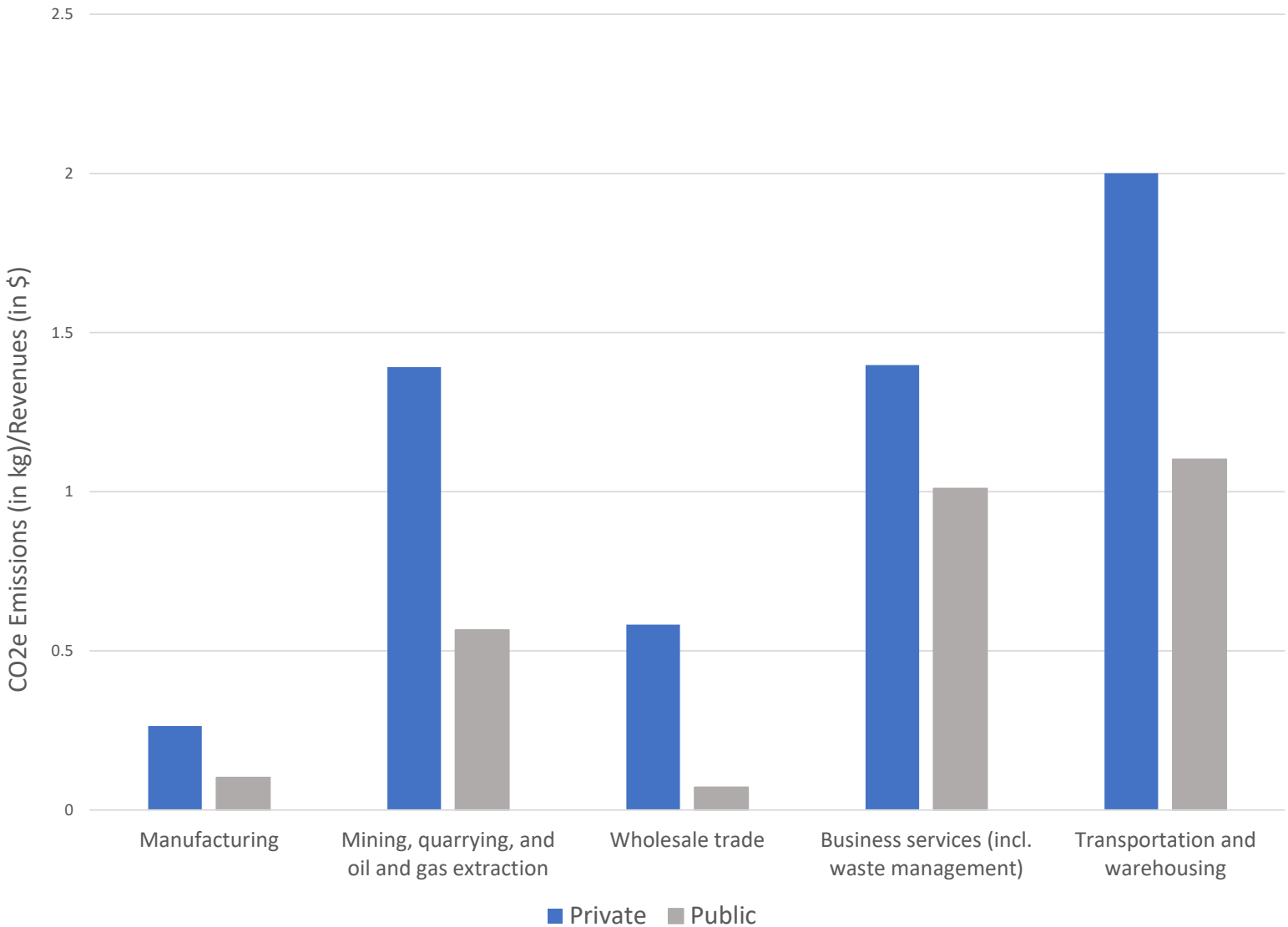
Firms with large CA emissions have:

- 4-5 months shorter maturity
- 0.25 lower term loan share

Private vs. public firms

- Results so far consistent with banks paying attention to transition risks
- Explore heterogeneity in the effect of cap-and-trade programs on firms:
  - Important knowledge for the design of cap-and-trade policies
- Different effects for public versus private firms?
  - Private (smaller) firms tend to be more financially constrained (Hadlock and Pierce, 2010)
  - Economies of scale in regulation compliance
  - Private firms tend to use older equipment and are likely less efficient

Emissions inefficiency higher for private firms



California analysis - private firms only

	Log committed credit		Maturity (in months)		Term loans share (0 to 1)	
	(1)	(2)	(3)	(4)	(5)	(6)
$I_{CA\_Emissions_i>25\%} \times I_{\text{Post CA bill}}$	0.028		-6.318**		-0.535***	
	(0.146)		(2.431)		(0.078)	
$I_{CA\_Emissions_i>50\%} \times I_{\text{Post CA bill}}$		0.031		-5.539*		-0.498***
		(0.160)		(2.875)		(0.103)
Observations	1,546	1,546	1,546	1,546	1,546	1,546
R2	0.956	0.956	0.861	0.861	0.776	0.776
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes

Effects for private firms are substantially larger

California analysis - public firms only

	Log committed credit		Maturity (in months)		Term loans share (0 to 1)	
	(1)	(2)	(3)	(4)	(5)	(6)
$I_{CA\_Emissions_i>25\%} \times I_{\text{Post CA bill}}$	0.223**		1.617		0.011	
	(0.086)		(3.160)		(0.040)	
$I_{CA\_Emissions_i>50\%} \times I_{\text{Post CA bill}}$		0.058		-1.788		0.001
		(0.113)		(4.234)		(0.043)
Observations	822	822	822	822	822	822
R2	0.977	0.978	0.810	0.811	0.829	0.829
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes

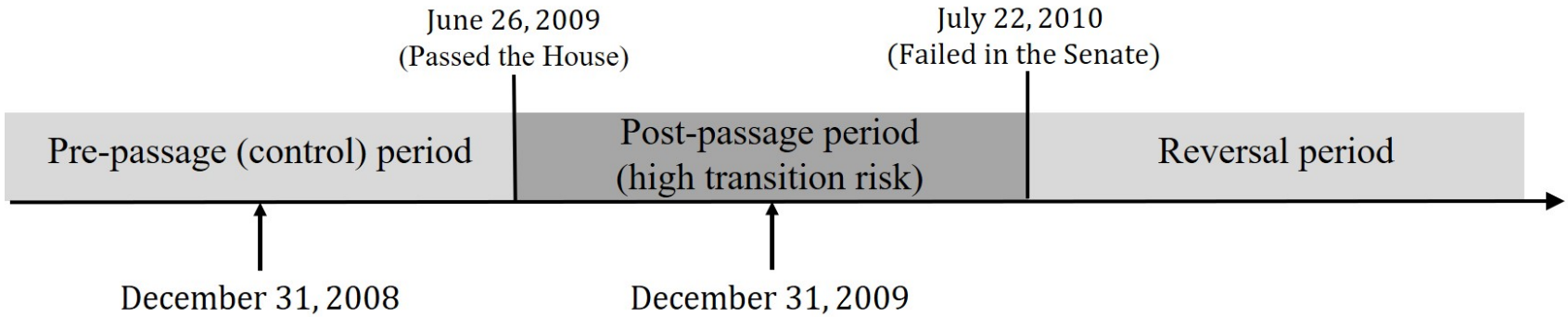
No effects for public firms

California analysis - impact on interest rates

	Full sample				Private firms				Public firms			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$I_{CA\_Emissions_i>25\%} \times I_{\text{Post CA bill}}$	0.667*		0.538*		1.748**		1.013*		0.175		0.082	
	(0.395)		(0.270)		(0.719)		(0.552)		(0.458)		(0.474)	
$I_{CA\_Emissions_i>50\%} \times I_{\text{Post CA bill}}$		0.294		0.137		2.299**		1.356		-0.967*		-0.958*
		(0.662)		(0.523)		(1.031)		(0.889)		(0.480)		(0.508)
Observations	1,191	1,191	1,191	1,191	610	610	609	609	390	390	384	384
R2	0.911	0.910	0.919	0.918	0.953	0.954	0.959	0.959	0.916	0.917	0.925	0.927
Controls	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Banks require compensation from private firms for bearing transition risks

Identification strategy: Waxman-Markey bill



- First difference: Compare lending in 2008 (pre) to 2009 (post)
- Second difference: Exploit difference in how high-emission manufacturing firms would be impacted by the law (Meng, 2017)
  - Manufacturing firms from sectors (6-digit NAICS) with an energy intensity of above 5% get allocated "free permits" for emissions
  - Firms *below* the threshold are *treated*. Firms *above* the threshold are *controls*
- Examine manufacturing firms close to the 5% threshold

Waxman-Markey regression specification

- Regression specification:

$$y_{i,t} = \lambda I_{i \in Treated} \times I_{t=2009} + \gamma Controls_{i,t} + \psi_i + \phi_t,$$

- $I_{i \in Treated}$ is 1 if firm i would not receive a free permit, 0 otherwise
- Same dependent variables as for California analysis:
  - Credit commitment
  - Maturity
  - Fraction of term loans (vs. credit lines)

$\Rightarrow$ λ is negative if banks cut credit commitment or seek higher contract flexibility

Waxman-Markey analysis: private firms

	Log committed credit		Maturity (in months)		Term loans share (0 to 1)	
	(1)	(2)	(3)	(4)	(5)	(6)
$I_{i \in Treated} \times I_{t=2009}$	-0.049		-10.317*		-0.240***	
	(0.059)		(5.181)		(0.068)	
$I_{i \in TreatedWide} \times I_{t=2009}$		0.053		-8.354*		-0.214***
		(0.071)		(4.573)		(0.052)
Observations	170	276	170	276	170	276
R2	0.965	0.954	0.820	0.852	0.868	0.842
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Lead bank FE	Yes	Yes	Yes	Yes	Yes	Yes

Again, strong effects for private firms:

- 9 months shorter maturity
- 0.20 lower term loan share

Waxman-Markey analysis: public firms

	Log committed credit		Maturity (in months)		Term loans share (0 to 1)	
	(1)	(2)	(3)	(4)	(5)	(6)
$I_{i \in Treated} \times I_{t=2009}$	0.108		-0.532		0.060	
	(0.088)		(2.304)		(0.056)	
$I_{i \in TreatedWide} \times I_{t=2009}$		0.066		1.969		0.041
		(0.062)		(2.368)		(0.051)
Observations	172	348	172	348	172	348
R2	0.945	0.963	0.926	0.858	0.876	0.858
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Lead bank FE	Yes	Yes	Yes	Yes	Yes	Yes

No effects for public firms

Outline

Banks manage transition risks in alternative ways

- So far, results consistent with banks managing transition risk by increasing contract flexibility

- Banks have alternative ways to mitigate exposure to covered firms

- Sell syndicated loans on the secondary loan market
  - SNC comprehensively covers lending syndicate participants over loan lifetime
  - Observe dynamics for both banks and non-bank financial intermediaries (shadow banks)

- Increase monitoring or make loan covenants more stringent

- Unlike equilibrium outcomes of the loan contracting process, banks can decide to sell loans or increase monitoring
  - Isolate banks expectations for firm outcomes

(1) Sales of loans made to covered firms

	All firms		Private firms		Public firms	
	(1)	(2)	(3)	(4)	(5)	(6)
$I_{i \in Treated} \times I_{t=2009}$	0.054**		0.071*		0.026	
	(0.026)		(0.037)		(0.029)	
$I_{i \in TreatedWide} \times I_{t=2009}$		0.067***		0.107***		0.019
		(0.022)		(0.026)		(0.027)
Observations	342	624	170	276	172	348
R2	0.877	0.883	0.841	0.844	0.928	0.927
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Lead bank FE	Yes	Yes	Yes	Yes	Yes	Yes

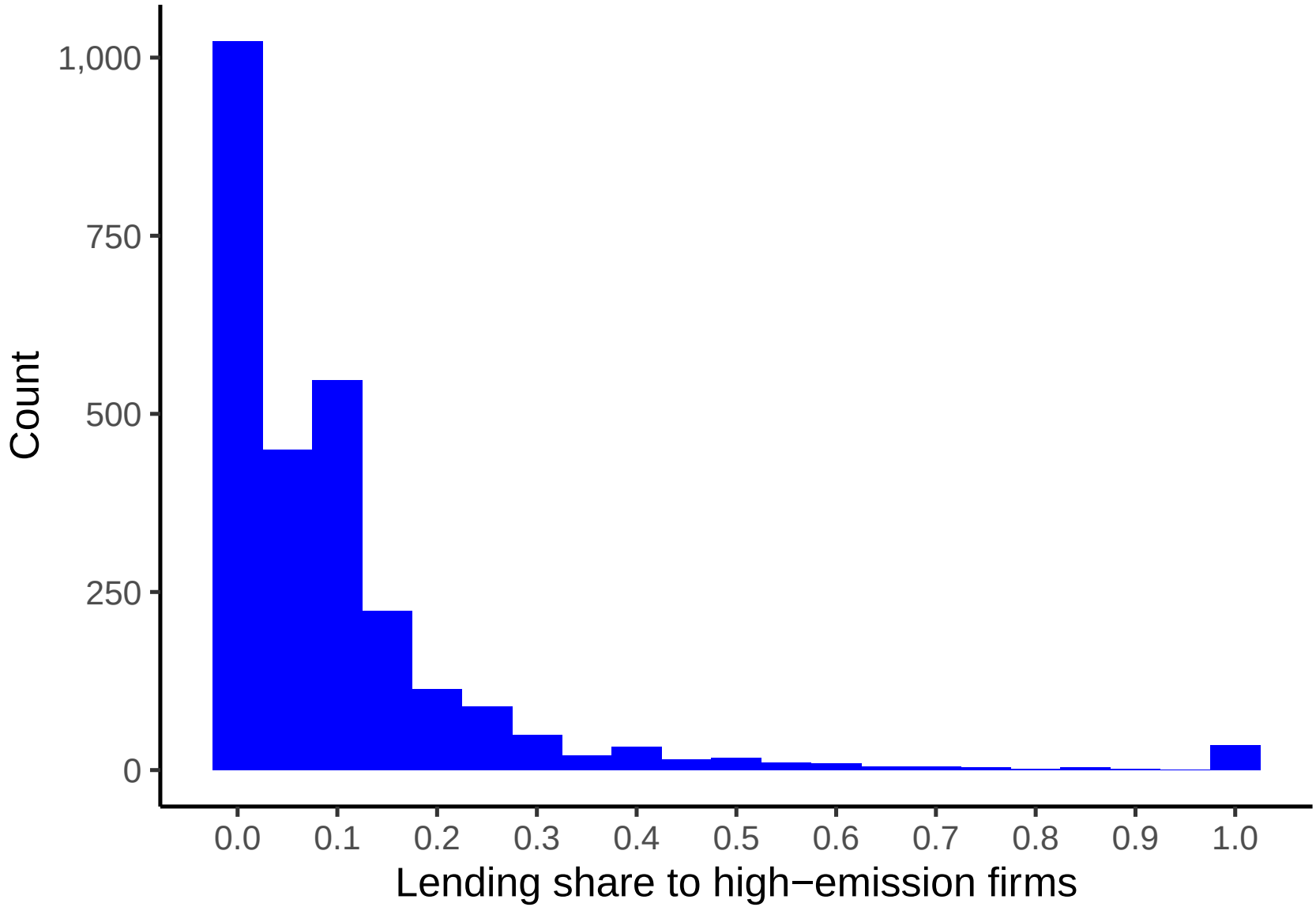
Shadow bank share increase by about 0.07 (avg. 0.15)

Transfer of transition risk from banks to shadow banks?

- Previous result shows that banks disproportionately offload covered firms' loans to shadow banks
  - Reduces transition risk exposure in the traditional banking sector
- Could enhance systemic stability. But,
  - Could lead to concentration of transition risk exposure in shadow banks
- Do (both bank and shadow bank) lenders factor in their ex ante exposure to high-emission firms?
- Analyze impact of heterogeneity in lender exposure,

$$LenderFirmExposure_{i,l,t} = \frac{FirmLending_{i,l,t}}{TotalLending_{l,t}},$$

Lenders' ex ante exposure to high-emission firms



Lenders' ex ante exposure to high-emission firms

- Regression specification:

$$\begin{aligned} LenderFirmExposure_{i,l,t} = & \lambda_1 I_{l \in HighEmissionLender} \times I_{i \in Treated} \times I_{t=2009} \\ & + \lambda_2 I_{i \in Treated} \times I_{t=2009} + Controls_{i,t} + \omega_{i,l} + \phi_t + \epsilon_{i,l,t} \end{aligned}$$

- $I_{l \in HighEmissionLender}$ takes the value 1 if lender l had an above median exposure to high emission firms
- Includes firm-lender fixed effects ($\omega_{i,l}$)

$\Rightarrow$ λ is negative if existing exposure to high-emission firms matters for decision to sell loans of covered firms.

(2) Sales of loans made to covered firms

	(1)	(2)	(3)	(4)
$I_{i \in Treated} \times I_{t=2009}$	-0.006		-0.003	
	(0.007)		(0.007)	
$I_{i \in TreatedWide} \times I_{t=2009}$		-0.010		-0.009
		(0.008)		(0.008)
$I_{i \in Treated} \times I_{t=2009}$	-0.016***		-0.017***	
$\times I_{l \in AboveMedianHighEmissionLender}$	(0.003)		(0.003)	
$I_{i \in TreatedWide} \times I_{t=2009}$		-0.010**		-0.010**
$\times I_{l \in AboveMedianHighEmissionLender}$		(0.004)		(0.004)
Observations	18,043	34,103	18,043	34,103
R2	0.845	0.812	0.846	0.813
Controls	No	No	Yes	Yes
Firm-Lender FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Lenders with higher ex ante exposure to GHG-emitting firms participate less in covered firms' syndicates and more likely to sell loans

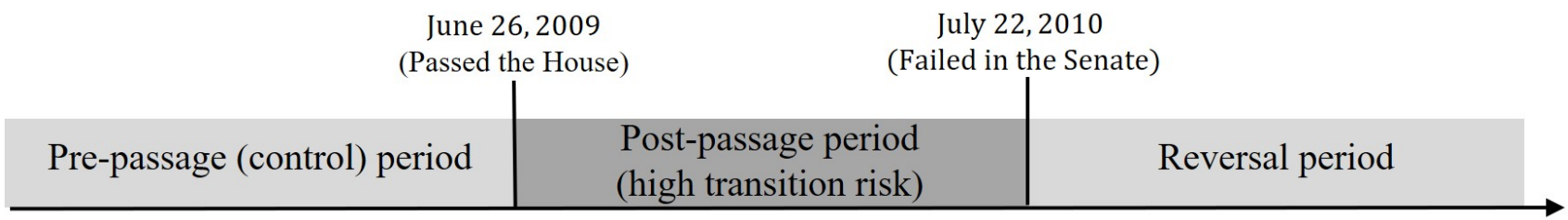
Monitoring

	Cash flow covenants			
	(1)	(2)	(3)	(4)
$I_{i \in Treated} \times I_{t=2009}$	0.277*		0.180	
	(0.149)		(0.127)	
$I_{i \in TreatedWide} \times I_{t=2009}$		0.188*		0.193*
		(0.095)		(0.110)
Observations	114	198	114	198
R2	0.904	0.909	0.929	0.914
Controls	No	No	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes

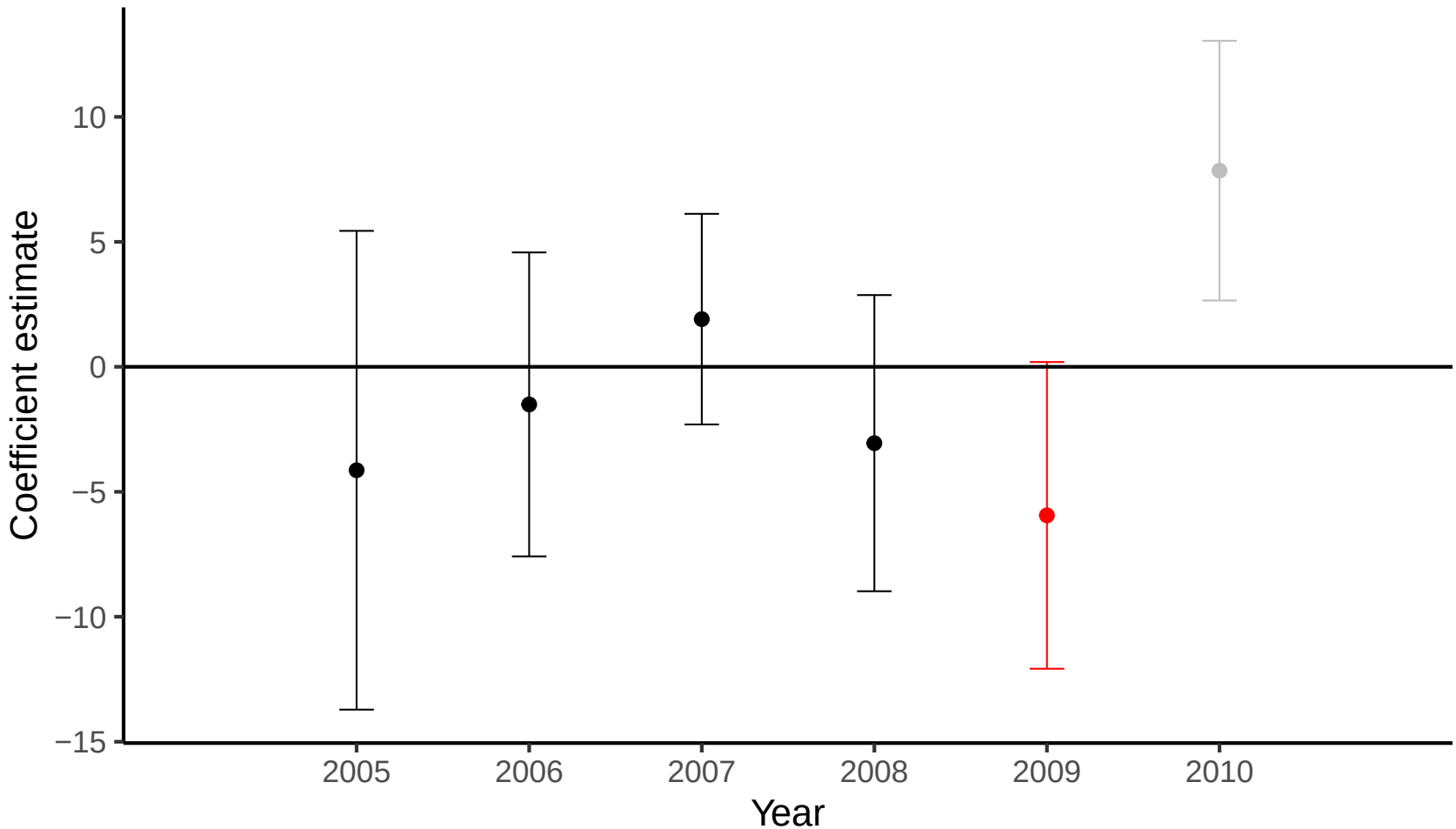
Banks increase their monitoring efforts and introduce cash flow covenants

Placebo tests

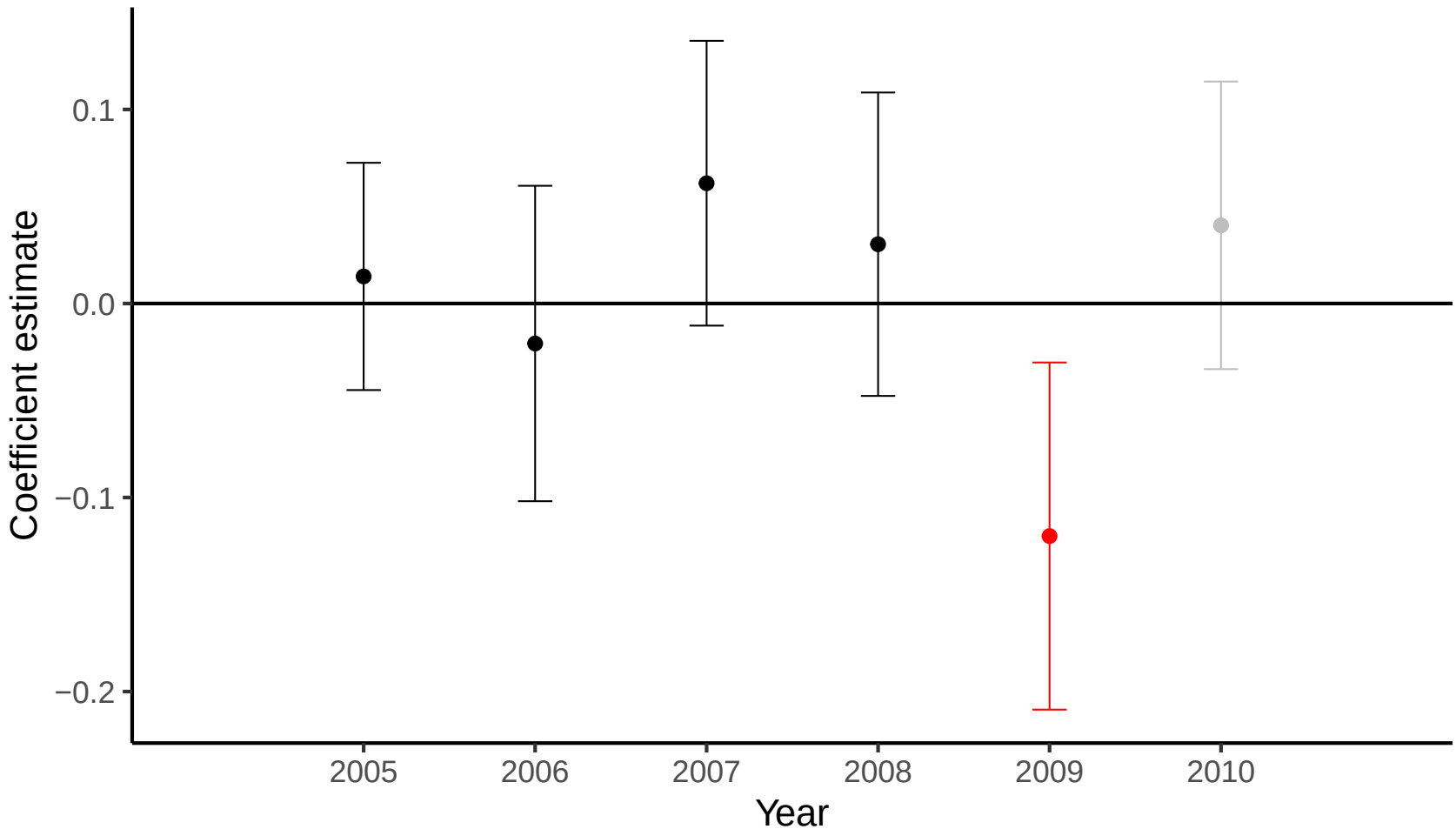
- Do treated and control groups exhibit similar trends before treatment occurred?
- Using two different natural experiments with similar findings alleviates this concern
- Placebo regressions for Waxman-Markey analysis
  - "Falsify" treatment in the years before the bill's passage
  - We should see reversal of effects in 2010 when the bill fails the Senate



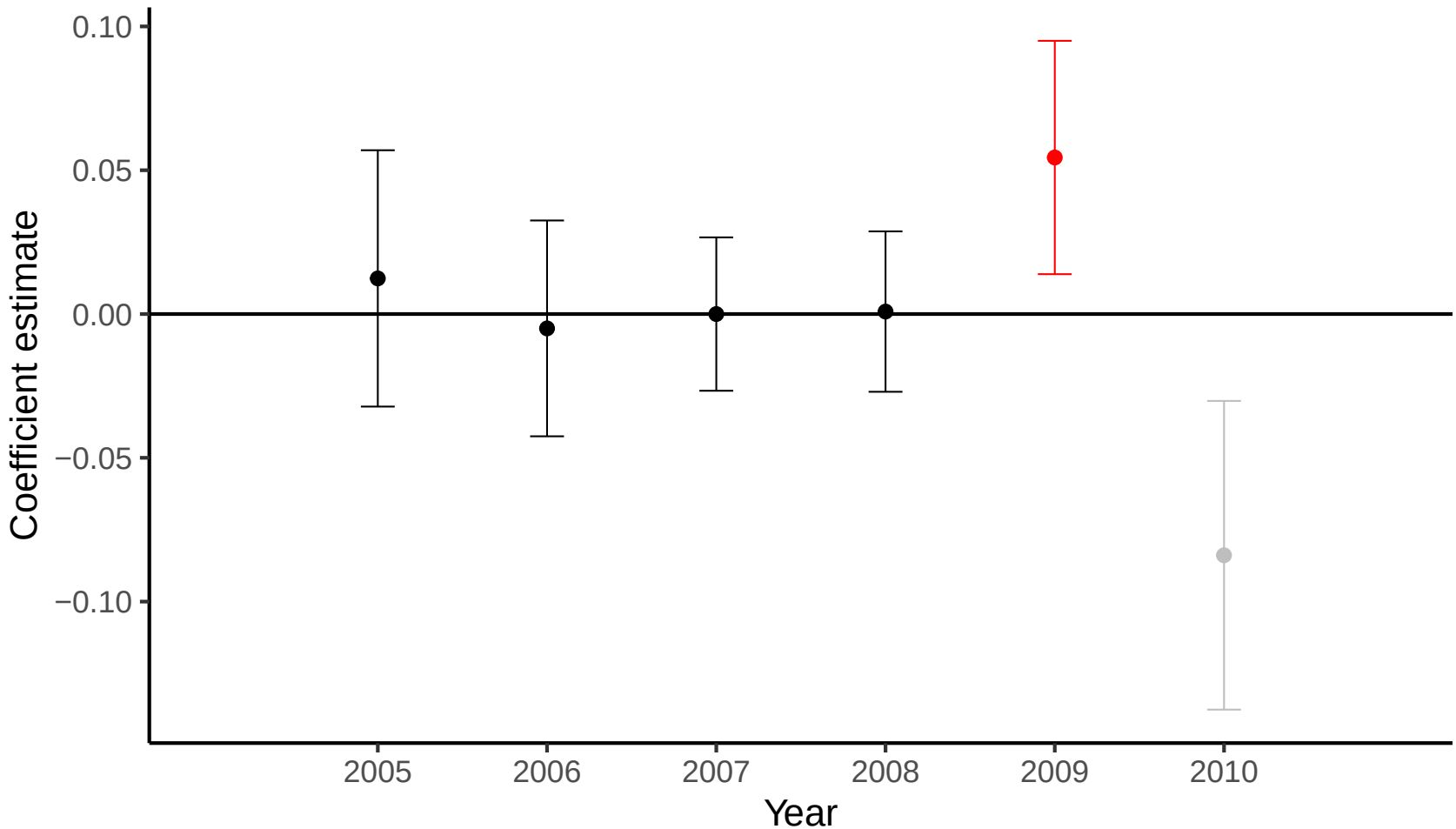
Placebo test: remaining maturity



Placebo test: term loans share

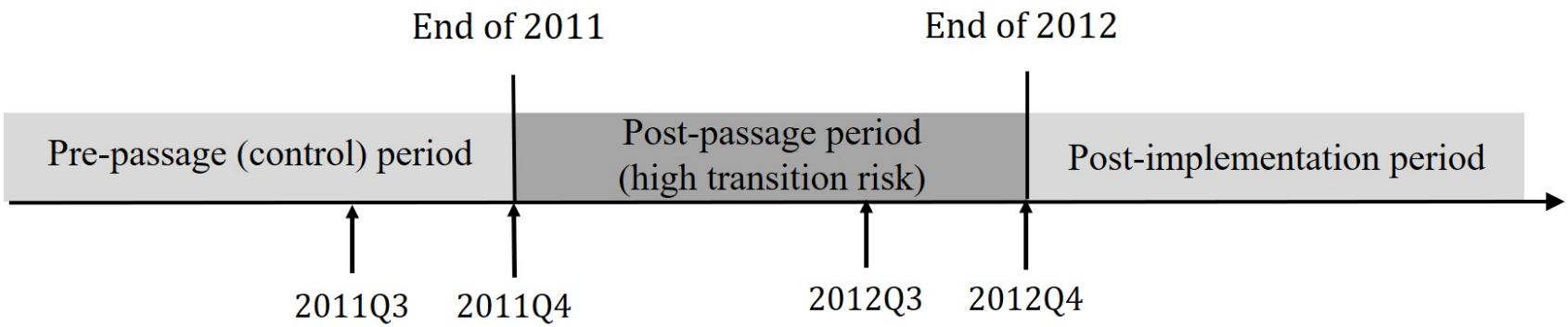


Placebo test: shadow bank share



Firm balance sheet effects

- What is the impact on firms once the CA bill is finalized and implemented?
- Analyze Y-14 balance sheet information for private and public firms



Firm balance sheet effects - following passage

Cash/Assets

	All firms		Private firms	
	(1)	(2)	(3)	(4)
$I_{CA\_Emissions_i > 50\%} \times I_{\text{Post CA bill}}$	0.032***	0.033***	0.026***	0.027***
	(0.005)	(0.005)	(0.005)	(0.005)
Observations	726	726	430	430
R2	0.897	0.899	0.901	0.902

CapEx/Assets

$I_{CA\_Emissions_i > 50\%} \times I_{\text{Post CA bill}}$	0.019*	0.019*	0.036***	0.039***
	(0.011)	(0.010)	(0.013)	(0.014)
Observations	666	666	394	394
R2	0.706	0.706	0.726	0.728
Controls	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes

Firm balance sheet effects - after implementation

Cash/Assets

	All firms		Private firms	
	(1)	(2)	(3)	(4)
$I_{CA\_Emissions_i>50\%} \times I_{\text{Post CA program}}$	-0.038***	-0.037***	-0.027***	-0.024*
	(0.005)	(0.006)	(0.010)	(0.012)
Observations	1,016	1,016	426	426
R2	0.886	0.887	0.911	0.914

CapEx/Assets

$I_{CA\_Emissions_i>50\%} \times I_{\text{Post CA program}}$	-0.026***	-0.025***	-0.033***	-0.031**
	(0.009)	(0.008)	(0.011)	(0.014)
Observations	968	968	404	404
R2	0.680	0.683	0.735	0.737

EBITDA/Assets

$I_{CA\_Emissions_i>50\%} \times I_{\text{Post CA program}}$	-0.001	-0.002	-0.025**	-0.019
	(0.005)	(0.006)	(0.011)	(0.013)
Observations	950	950	402	402
R2	0.843	0.845	0.883	0.887
Controls	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes

Outline

Conclusion

- We isolate high transition risk periods around cap-and-trade bills moving through the legislative process
  - Exploit heterogeneous treatment within sets of high-emission firms
  - Two natural experiments with distinct time periods and treatment dimensions

- We show that banks act swiftly to reduce transition risks
  - Gain flexibility to cut credit exposure
  - Require additional compensation for bearing transition risk
  - Reduce syndicate participation in favor of shadow banks

- Concern about imposing systemic instability for banking sector likely should not prevent climate policies that incentivize low-carbon economy

- Potential adverse effects of cap-and-trade programs on covered private firms:
  - Evidence potentially useful for design of cap-and-trade policies