Policy Deterrence: Strategic Investment in U.S. Broadband

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Firms' Policy Influence

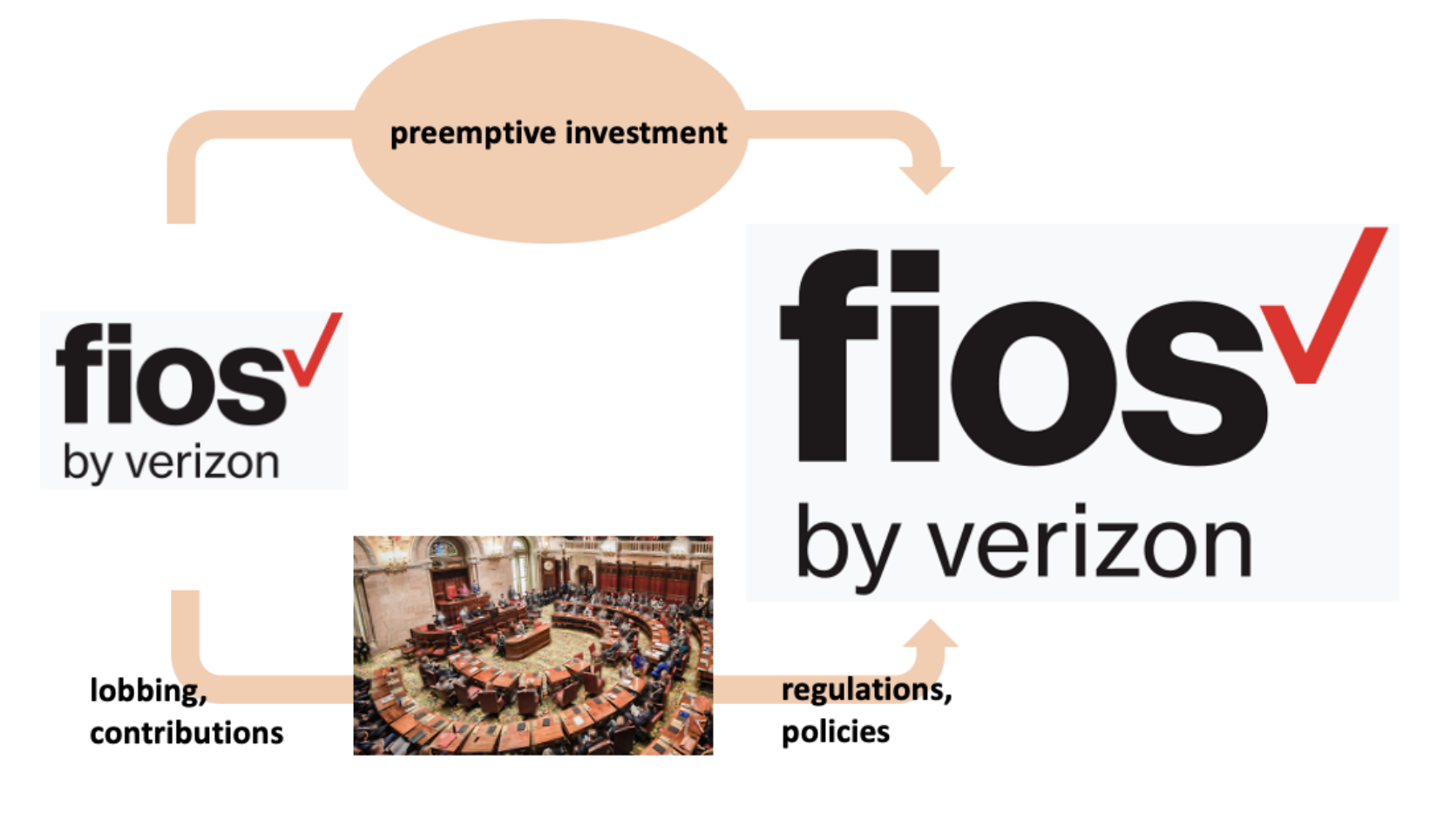
- Firms not only respond to government policies, but also attempt to influence them for better competitive advantage
- Firms may influence policy through their investment (rather than/in addition to contributions or lobbying)
- **This paper**: Provides theory & empirical evidence that firms invest strategically to deter procompetitive government policies in the context of broadband industry

How Do Large Incumbents Reduce Competition?

Thanks to Zhao Li!

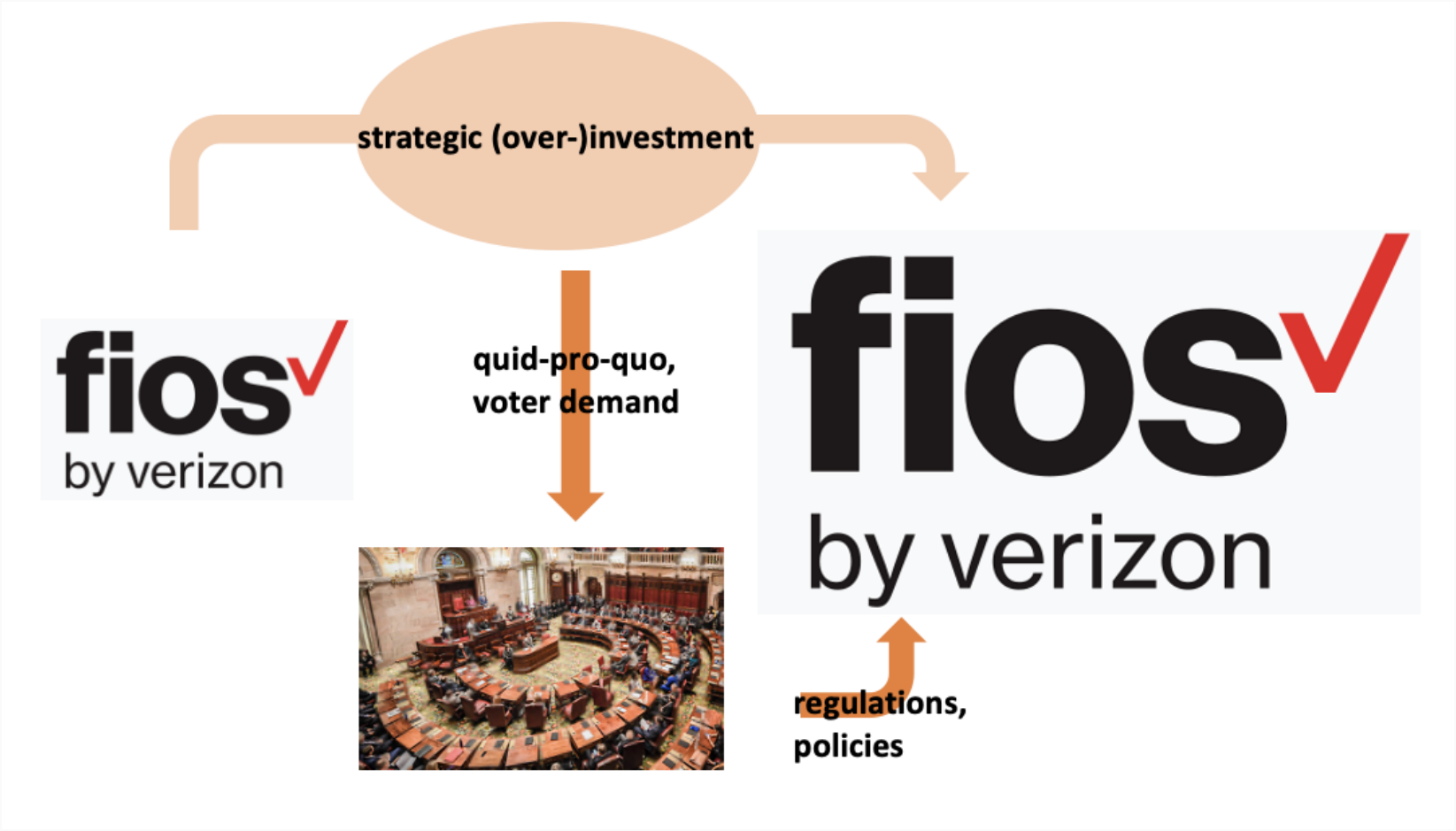
How Do Large Incumbents Reduce Competition?

One-way interactions: Imperfect competition or political influence



How Do Large Incumbents Reduce Competition?

Our paper: Strategic interactions with the govt & competitors



What The Paper Finds

- Robust evidence of politically-motivated investment
  - More broadband investment in electorally competitive counties
- Stackelberg model of two firms (leader & follower) choosing capacity and politician choosing a procompetitive policy
  - Establish conditions under which the leader invests more in order to deter policy
- Multiple pieces of evidence suggesting that policy-deterrence motive explains this empirical pattern

Intersection of Political Economy and IO

- Interaction btw market power and political power: Callander, Foarta & Sugaya, 2022; Cowgill, Prat & Valletti, 2022
- Empirical studies on entry deterrence: Ellison & Ellison, 2011; Goolsbee & Syverson, 2008; Seamans, 2012; Gil et al, 2021; Wilson et al, 2021
    - We exploit variation in political environments to detect strategic investment motive
- Firms' political influence by business activities: Carvalho, 2014; Bertrand et al, 2018; Delatte et al, 2022; Bisbee & You, 2022
    - We emphasize that firm benefits from policy influence are driven by raising rivals' costs

Institutional Background and Data

Context: U.S. Broadband Internet Services

1. Substantive sunk cost of wireline investment
    - Average cost of laying fiber optic cable: $27K per mile (DoT)
2. Recent strides in state policy initiatives ("digital divide")
    - 31 states enacted new pro-broadband legislation in 2020
3. Heterogeneous providers by existing investment and network

    $\rightarrow$ Heterogeneous firm incentives to influence policy
4. Firm investment and government policies are location-specific

    $\rightarrow$ Cross-sectional variation (in addition to variation over time)

State Policies to Encourage Broadband Investment

- Provide funding and tax incentives for private firms
  - $20–500M grants, tax refund/credit/exemptions
- Amend right-of-way laws and help infrastructure access
  - "Dig-once" to streamline fiber deployment in road projects
  - "One touch" make-ready, to relocate all existing attachments
  - Regulations on pole attachment fees, legal disputes with a property owner, etc.
- Strategic plans, broadband offices, publicly-owned broadband
- Promote broadband adoption and address affordability

Heterogeneous Firm Interests on Policies

Small firms tend to benefit more than large ones

- More flexible to work with local communities
  - 90% of Connect Illinois grants awarded to local firms
  - Large firms challenged rural grants to competitors in LA
- Disadvantaged in navigating regulatory hurdles
  - "Dig once" policy is stalled in Congress, in part due to large companies' opposition
- Less likely own dark fiber ("potential" capacity, unused but available for use)
  - Large firms tend not to lease out dark fiber to competitors

$\Rightarrow$ Broadband policies tend to be procompetitive

Data

- Broadband deployment: Every service provider's entry, technology, and (advertised) maximum speed
  - Collected bi-annually, Census Block level
  - NTIA 2010–2014; FCC 2014–2019
- State broadband policies
  - Pew Charitable Trusts: State Broadband Policy Explorer
  - State government websites (by state broadband program offices), budget and tax expenditure documents, state laws and legislation, public statements, news articles
- State politics: Gubernatorial election results and term limits, state legislature party composition

Broadband Deployment: Stats

Variable	Rural Only		Urban or Mixed	
	Mean	SD	Mean	SD
Coverage				
% Census blocks with any service	54.1	26.5	65.3	20.5
% Census blocks with 2+ ISP's	9.9	12.9	35.3	21.5
% Population with any service	81.4	20.7	90.1	11.5
% Population with 2+ ISP's	24.1	20.7	64.6	25.2
Speed				
% Census blocks with $\geq$ 25 Mbps	27.3	27.7	45.6	27.1
% Census blocks with fiber	15.5	25.8	10.2	18.3
% Population with $\geq$ 25 Mbps	44.4	34.0	68.4	29.6
% Population with fiber	20.3	30.5	14.7	24.2
Average max download speed (Mbps)	146.8	190.0	206.9	198.1

Notes: 14,040 observations from rural counties (702 counties $\times$ 20 semi-annual periods, 2010-2019) and 48,780 observations from urban or mixed counties (2,439 counties $\times$ 20).

State Broadband Policies and Politics: Stats

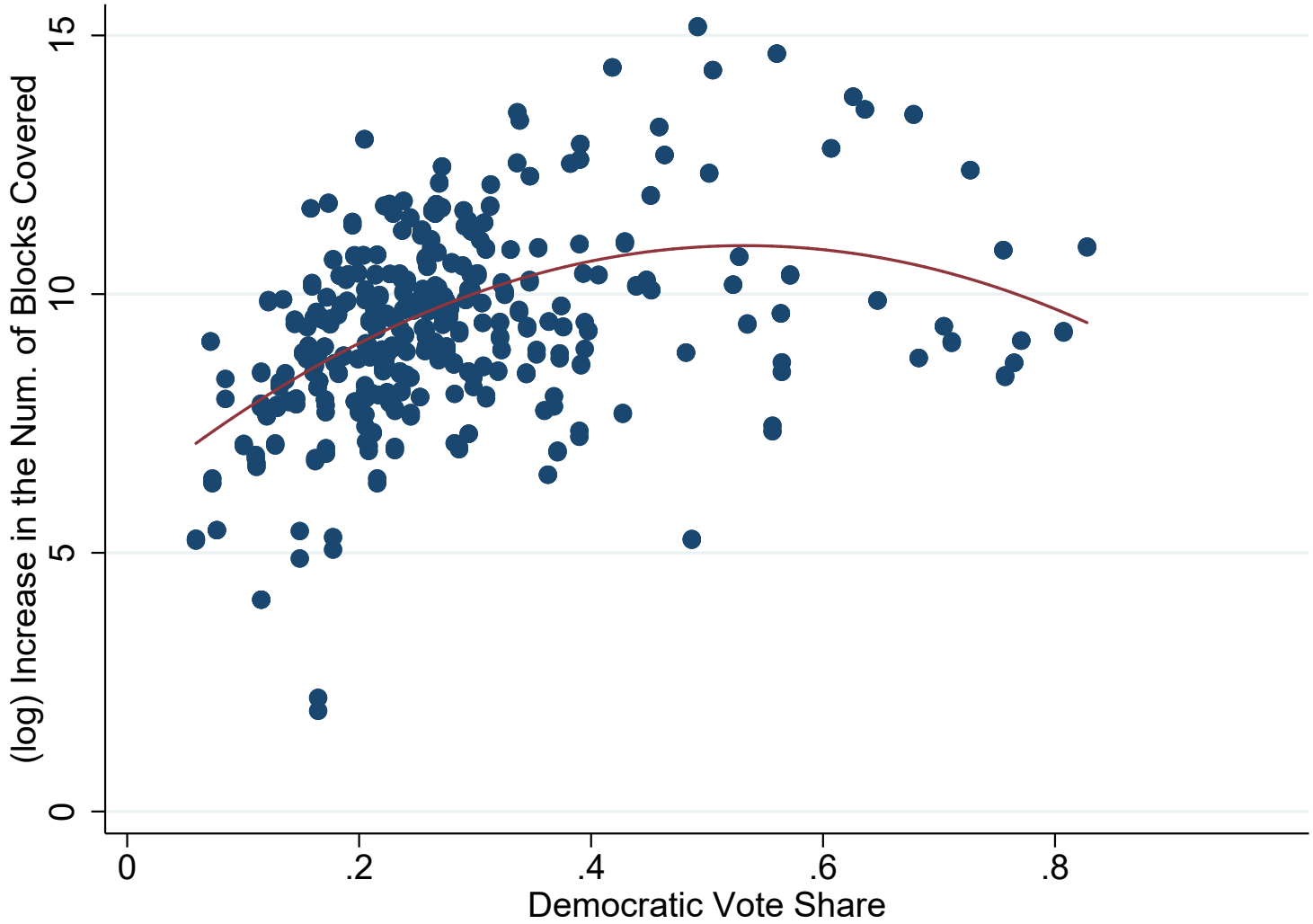
Variable	Mean	SD	Min	Max
Panel A: Broadband investment policies				
Tax incentives	0.204	0.481	0	2
Grant/loan programs	0.491	0.671	0	3
Right-of-way accommodations	0.851	1.381	0	8
Any pro-investment policy	1.545	1.810	0	11
Panel B: Term limits, elections and politics				
Democratic Governor	0.415	0.493	0	1
Lame duck	0.303	0.460	0	1
Vote margins, most recent election (%)	16.404	13.728	0.218	57.973
Vote margins, most recent election $\geq 10\%$	0.578	0.494	0	1
Divided Branch or split Legislature	0.316	0.465	0	1

Notes: 550 observations (50 state $\times$ 11 years, 2009–2019).

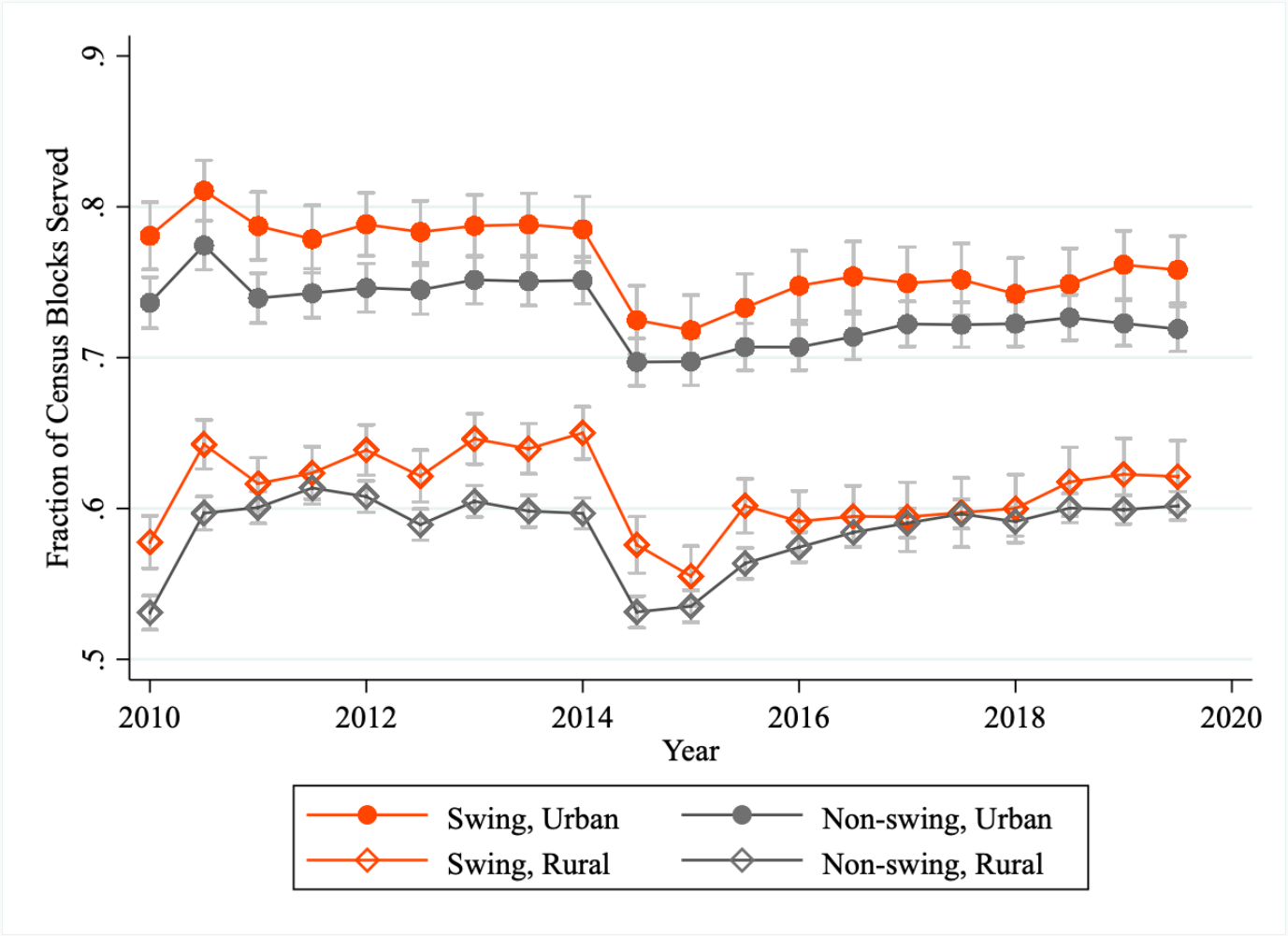
Empirical Evidence: Politically-motivated Investment

More Investment for Swing Counties

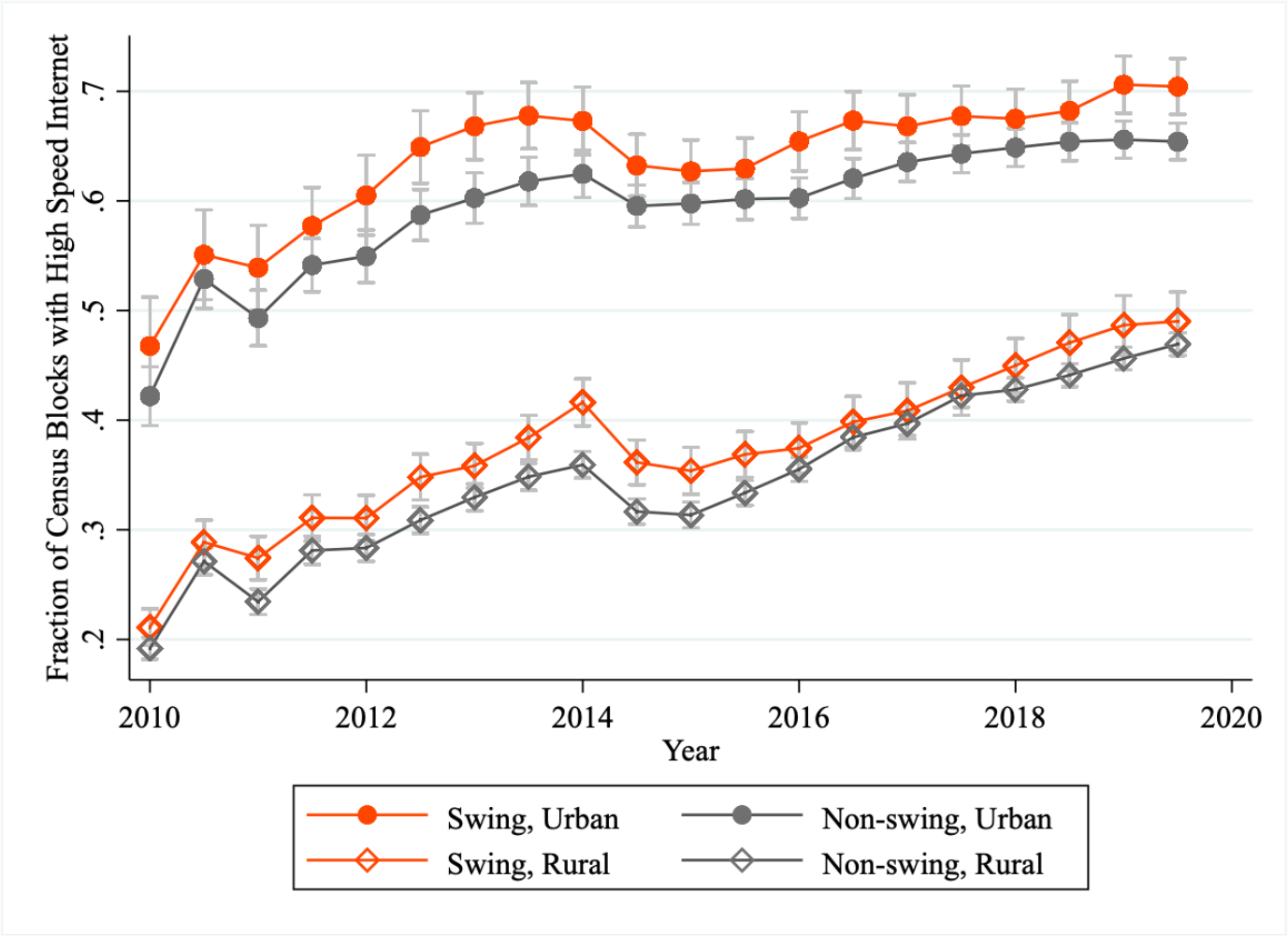
Texas, 2015



More Investment for Swing Counties: Revisited



More Investment for Swing Counties: Speed



Do Firms Strategically Invest for Political Reasons?

- Specifically: "All else equal, do firms invest more on locations that are electorally competitive?"
- For each county c and semi-annual period t:

$$\begin{aligned} Y_{ct} &= \beta_1 DemShare_{ct} + \beta_2 (DemShare_{ct})^2 \\ &\quad + X_{ct}\beta_x + \rho_{ct} + \varepsilon_{ct} \end{aligned}$$

  - Y_{ct}: County-level broadband investment, measured by the (log) number of Census blocks
  - $DemShare_{ct}$: Average vote share for a Democratic candidate in the state-wide elections in the past 8 years
  - X_{ct}: Population size and density, their respective squared terms, age, gender and race compositions, income, work, education, ...

Politically Motivated Investment

$$Y_{ct} = \beta_1 Dem_{ct} + \beta_2 (Dem_{ct})^2 + X_{ct}\beta_x + \rho_{st} + \varepsilon_{ct}$$

	Investment in (log) number of blocks		
	(1)	(2)	(3)
Democratic vote share	9.895***	8.017***	5.145***
	(1.011)	(1.143)	(1.215)
(Democratic vote share)^2	-9.478***	-8.651***	-5.321***
	(1.118)	(1.190)	(1.304)
Time-varying county attributes	N	N	Y
State-period FE	N	Y	Y
Maximized at Democratic vote share	0.522	0.463	0.483
	(0.015)	(0.015)	(0.038)
Fraction of counties with any investment	0.692	0.692	0.692
Median number of blocks invested (if invested)	46	46	46
Number of observations	49,784	49,784	49,661
Adjusted R^2	0.004	0.280	0.286

Notes: 3,140 counties $\times$ 16 semi-annual periods (2010–2019). SEs are adjusted for clustering within counties; $^{***}p < 0.01$.

Which Firms Strategically Invest for Political Reasons?

- Large firms: Broadband providers (ISPs) with services for at least 5% of the Census Blocks within a state, averaged across the time span of the study
    - Typically 5 large firms, with minimum 2 (AK, HI, MD, NM, RI) and maximum 11 (IN)
- Large firms (e.g., Comcast and AT&T) receive more public scrutiny and media attention
    - More influence on other firms' decisions and policymaking
    - Tend to be more politically active

Politically Motivated Investment by Large Firms

$$Y_{fct} = \beta_1 Dem_{ct} + \beta_2 (Dem_{ct})^2 + X_{ct}\beta_x + \mu_{fst} + \xi_c + \varepsilon_{fct}$$

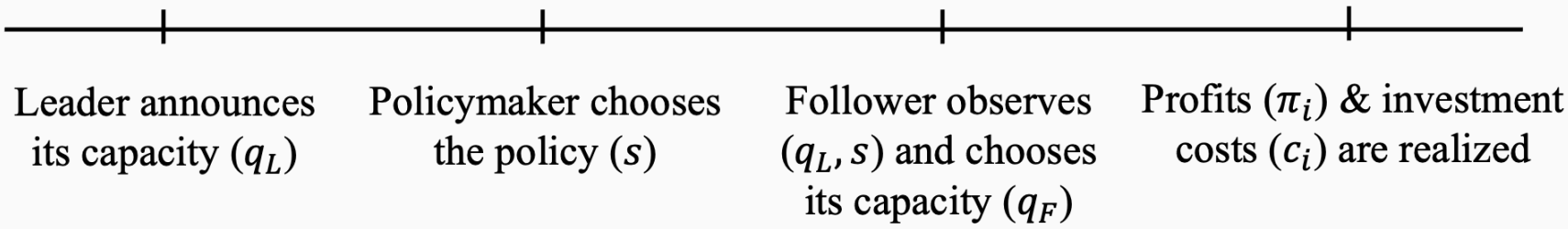
	Investment in (log) number of blocks	
	(1) Large	(2) Small
Democratic vote share	3.431***	0.498
	(1.130)	(1.563)
(Democratic vote share)^2	-3.781***	-1.178
	(1.269)	(1.754)
Time-varying county att.	Y	Y
Firm-state-period FE & County FE	Y	Y
Maximized at Dem. vote share	0.454	0.211
	(0.077)	(0.434)
Number of firms	97	1,932
Number of observations	248,227	196,943
Adjusted R^2	0.350	0.366

Notes: SEs are adjusted for clustering within counties; $^{***}p < 0.01$.

Theoretical Framework

Government Policymaking and Firm Investment

- Players: Two firms (Leader L and Follower F) and a politician
- Firms choose capacity (q_i for $i \in \{L, F\}$) at a cost
- Politician chooses government policy $s \in \mathbb{R}_+$



Payoff and Preferences

- Firms: $\underbrace{\pi_i(q_L, q_F)}_{\text{operational profit}} - \underbrace{c_i(q_i, s)}_{\text{investment cost}}$
  - Capacity decisions are strategic substitutes
  - Government policy reduces marginal investment cost for the follower (s measures the level of pro-competitiveness)
- Politician: $u(q_L, q_F, s)$
  - Increasing and concave in capacities, q_L and q_F
  - Not necessarily increasing in policy s
  - Appeal for policy diminishes as q_L increases: $\frac{\partial^2 u}{\partial s \partial q_L} < 0$

Follower's Response

- Follower takes (q_L, s) as given and chooses its capacity:

$$\max_{q_F} \pi_F(q_L, q_F) - c_F(q_F, s)$$

- An increase in the leader's capacity deters the follower's investment: $\frac{dq_F}{dq_L} \leq 0$
- Policy encourages the follower's investment: $\frac{dq_F}{ds} \geq 0$

Policymaking

- Politician chooses policy s given the leader's capacity, anticipating the follower's response:

$$\max_s u(q_L + q_F(q_L, s), s)$$

- First order condition:

$$\underbrace{\frac{\partial}{\partial s} u(q, s)}_{\text{Direct MB}} + \underbrace{\frac{\partial}{\partial q} u(q, s) \frac{\partial}{\partial s} q_F(q_L, s)}_{\substack{\text{Indirect MB} \\ \text{via follower response}}} = 0$$

Policymaking (Cont'd)

- How does the leader's capacity influence policymaking?
- Less pro-investment policy as the leader's capacity increases:

$$\frac{ds}{dq_L} = \underbrace{\left(1 + \frac{dq_F}{dq_L}\right)}_{(+)} \underbrace{\left(\frac{\partial^2 u}{\partial q^2}\frac{dq_F}{ds} + \frac{\partial^2 u}{\partial q \partial s}\right)}_{(-)} \underbrace{P(q_L, s)}_{(+)} \leq 0$$

Effect of q_L on total capacity (q)

Effect of q on MB of policy (s)

  - Leader's influence can come from politician's preference over (q, s), (partially) representing voter preferences

Leader's Incentive to Deter Policy

- Leader chooses its capacity, anticipating politician and follower:

$$\max_{q_L} \pi_L\left(q_L, q_F\left(q_L, s(q_L)\right)\right) - c_L(q_L, s(q_L))$$

- Leader's policy influence: Politician chooses less pro-competitive policy as q_L increases ($ds/dq_L < 0$)
  - This channel increases the leader's MB of capacity $\Rightarrow$ More investment

$$MB(q_L) = \frac{\partial}{\partial q_L}\pi_L(q_L, q_F) + \left\{\frac{dq_F}{dq_L} + \frac{dq_F}{ds}\frac{ds}{dq_L}\right\}\frac{\partial}{\partial q_F}\pi_L(q_L, q_F)$$

An Extension: State-level Policy and Local Investment

- Policies at the state level; two markets in a state, M_1 and M_2
- Governor cares more about M_1's capacity than M_2's
  - Perhaps, wooing voters in M_1 is more beneficial?
- Leader has an incentive to invest more in M_1 than in M_2 if
  1. Governor prefers less policy if capacity, esp. in M_1, is high
  2. Policy is deemed as unfavorable to the leader

$\Rightarrow$ We provide empirical evidence for both conditions

Supporting Evidence for *Policy Deterrence*

Policy Responds to Broadband Status

$$
\begin{aligned}
Y_{s,y} &= \beta_1 SwingCap_{s,y-1} + \beta_2 PartisanCap_{s,y-1} \\
&\quad + \beta_3 SwingCap_{s,y-1} \times GovVote_{sy} + X_{sy}\beta_x + \eta_s + \mu_y + \varepsilon_{sy}
\end{aligned}
$$

- Y_{sy}: State-level pro-investment broadband policies in year y
- Broadband capacity: $SwingCap_{sy}$ and $PartisanCap_{sy}$
  - County-level capacity: Average fraction of population covered with broadband
  - Sum of capacities, multiplied by county-to-state population ratio, across swing counties and others, respectively
  - Lagged by one year (to rule out reverse causality + to reflect information flow in policymaking)
- Effects of broadband capacity may vary with governor's electoral incentives (recent vote margins, $GovVote_{sy}$)

Policy Responds to Broadband in Swing Counties

	Any policy on		
	Tax/Grants	ROW	All
	(1)	(2)	(3)
Pop.-weighted capacity in swing counties (lag)	-0.122	-0.409***	-0.444***
	(0.270)	(0.139)	(0.135)
Pop.-weighted capacity in swing counties (lag)	0.015	0.020***	0.023***
× Governor's vote margin (in %)	(0.010)	(0.006)	(0.005)
Pop.-weighted in partisan counties (lag)	0.366	-0.192	-0.0680
	(0.229)	(0.142)	(0.148)
Time-varying state attributes	Y	Y	Y
State FE, Year FE	Y	Y	Y
Mean of the dependent variable	0.180	0.462	0.687
Number of observations	450	450	450
Adjusted R^2	0.749	0.819	0.787

Notes: Standard errors are adjusted for clustering within states.

Policy Responds to Broadband in Swing Counties: Why?

- Swing voters are more responsive to politicians' performance
- Winning more (swing) votes is valuable:
  - More legislative seats for legislative agenda
  - Preferences of the median voter are uncertain
- Two potential channels: Investment in swing locations can
  1. Help politicians win elections $\rightarrow$ *Policy* rewards (quid-pro-quo)
  2. Affect voter demand $\rightarrow$ Less policy (electoral accountability)

Policy Disproportionately Benefits Small Firms

	Investment in (log) number of blocks					
	(1) Large	(2) Small	(3) Large	(4) Small	(5) Large	(6) Small
Any tax incentives/grants	0.399***	0.421***				
	(0.0456)	(0.0689)				
Any right-of-way accommodation			-0.293***	0.152*		
			(0.0503)	(0.0874)		
Number of all policies					-0.010	0.049**
					(0.0136)	(0.0233)
Time-varying county attributes	Y	Y	Y	Y	Y	Y
Firm-period FE, County FE	Y	Y	Y	Y	Y	Y
Number of observations	248,227	193,916	248,227	193,916	248,227	193,916
Adjusted R^2	0.259	0.352	0.259	0.352	0.259	0.352

Notes: Standard errors are adjusted for clustering within counties.

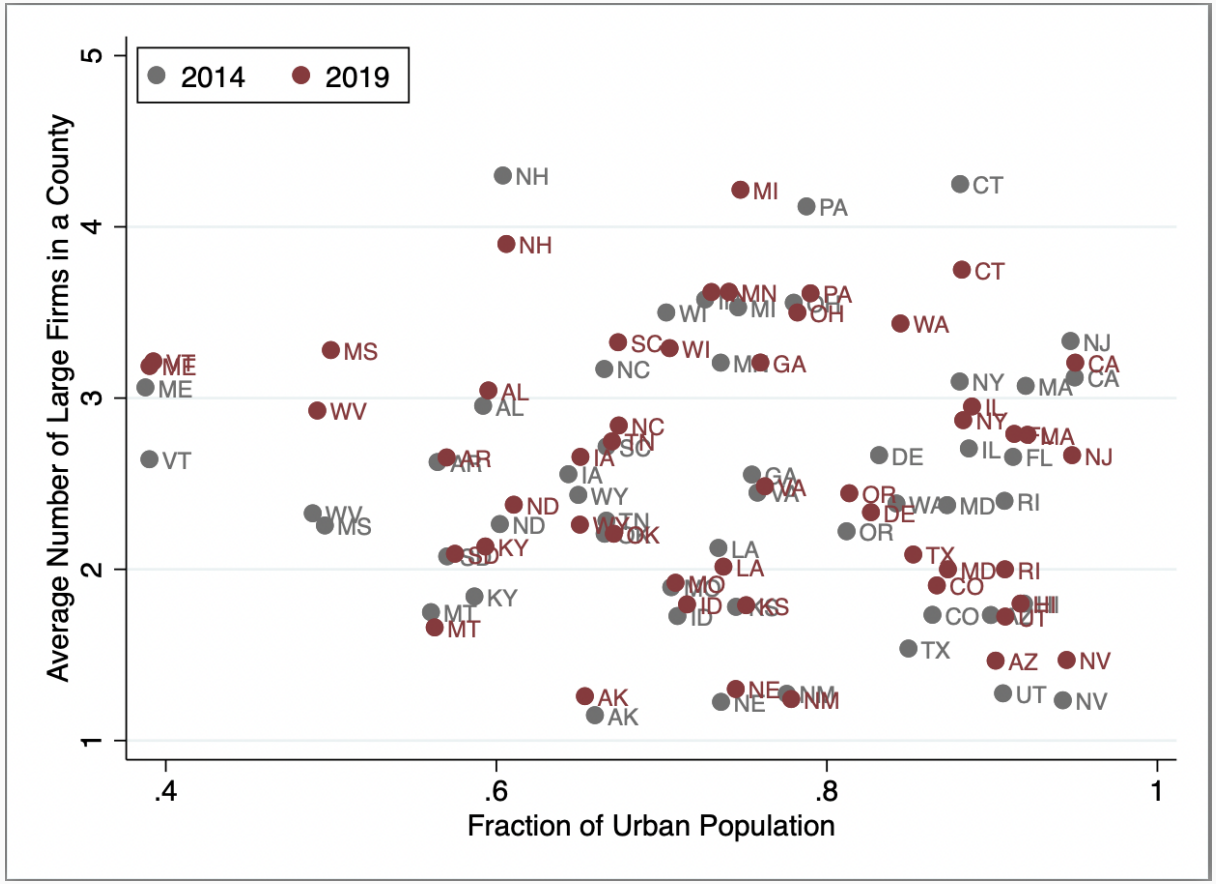
Large Firms Are Responsive to Politics

	Investment in (log) number of blocks					
	(1) Large	(2) Small	(3) Large	(4) Small	(5) Large	(6) Small
Any tax incentives/grants	0.399***	0.421***				
Any right-of-way accommodation			-0.293***	0.152*		
Number of all policies					-0.010	0.049**
Democratic vote share	4.414***	2.418*	4.091***	1.933	3.900***	1.927
(Democratic vote share)^2	-4.233***	-2.577	-3.714***	-1.894	-3.491***	-1.838
Democrat governor	0.192***	0.0922	0.153***	0.063	0.162***	0.060
Lame-duck governor	0.050	-0.073	0.052	-0.089*	0.041	-0.083*
Governor's vote margin	-0.003*	-0.001	0.001	0.004*	0.001	0.003
Divided branch/split legislature	-0.250***	-0.013	-0.212***	0.014	-0.226***	-0.005
Competitive state legislature	-0.126***	0.062	-0.083**	0.104*	-0.071**	0.084
Time-varying county attributes	Y	Y	Y	Y	Y	Y
Firm-period FE, County FE	Y	Y	Y	Y	Y	Y
Number of observations	248,227	193,916	248,227	193,916	248,227	193,916
Adjusted R^2	0.259	0.352	0.259	0.352	0.259	0.352

Notes: Standard errors are adjusted for clustering within counties.

Heterogeneity in Market Structure

- Median number of large firms operating in a county is 2 (typically DSL + cable); maximum is 9



Heterogeneity in Market Structure

Hump-shape more prominent for markets with a few large firms (less free riding)

	Investment in (log) number of Blocks	
	Fewer Firms (≤ 2.5)	More Firms (> 2.5)
	(1)	(2)
Democratic vote share	4.586***	1.679
	(0.962)	(1.137)
(Democratic vote share)^2	-3.987***	-1.319
	(1.113)	(1.169)
Time-varying county attributes	Y	Y
Firm-state-period FE	Y	Y
Number of observations	107,983	109,269
Adjusted R^2	0.294	0.375

Notes: Standard errors are adjusted for clustering within counties.

Heterogeneity in Political Environment

Hump-shape more prominent for states without supermajority

	Investment in (log) number of Blocks	
	Not Supermajority	Supermajority
	(1)	(2)
Democratic vote share	4.164***	3.376**
	(0.908)	(1.506)
(Democratic vote share)^2	-4.007***	-1.187
	(0.991)	(1.711)
Time-varying county attributes	Y	Y
Firm-state-period FE	Y	Y
Number of observations	190,895	57,332
Adjusted R^2	0.340	0.387

Notes: Standard errors are adjusted for clustering within counties.

Alternative Explanations: Omitted Variables

- Unobserved county attributes correlated with both electoral competitiveness and investment
  - State-level broadband policies tend not to be location-specific (perhaps rural areas—often not electorally competitive)
  - Local policies: Officials may be eager to help local investment (Slattery, 2020; Jensen et al, 2020), and perhaps more so in swing counties?
- Firms may be simply responding to these (unobserved) policies
- If so, why do we not observe more investment for swing counties by small firms?

Policy Deterrence: Why Do We Care?

We show firms invest so as to deter procompetitive policies

1. Misallocation? Infrastructure of *certain locations* matters more than others to a policymaker
    - Partially explaining the widening digital divide?
2. Intensified market concentration (and higher price for consumers), strengthened by firms' enhanced ability to influence competitive policy
3. Less provision of public goods: Political inefficiency (e.g., Lizzeri and Persico (2001)) + market inefficiency