POLICY DETERRENCE: STRATEGIC INVESTMENT IN U.S. BROADBAND

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Abstract. This paper provides both theory and empirical evidence that firms act strategically to preempt government policies that promote entry and competition in the context of U.S. broadband investment. In our model, a leading firm's investments can reduce the political appeal of procompetitive policies, which then thwarts a following firm's investment. We show the relevance of this model using data on local broadband investment and the political environment, as well as state-level financial and regulatory broadband policies. We first document a robust empirical pattern that leading firms' investments are politically motivated: they tend to invest more in electorally competitive counties, all else equal. This pattern is not observed for small firms, who tend to benefit from procompetitive policies. We also document that fewer state broadband policies are enacted in response to an increase in broadband capacity, especially in electorally competitive counties. We then discuss the implications of leading firms' investment to reduce competition, both directly and indirectly through policy deterrence.

1. Introduction

Many government policies are intended to affect market structure and industry performance, which often prompts firms to attempt to influence policies. The existing literature has focused on firms' political behavior, such as lobbying and campaign contributions to the political candidates or political action committees. One aspect that has received relatively less attention is the possibility that firms can influence policies through their business investment. To the extent that firm investment can alter market conditions and policymaking responds to these conditions—via voter pressure, ideological considerations, or other political reasons—firm investment can

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potentially influence policies. Importantly, such policy influences may propel rival firms to adjust their strategies and policy responses. This paper provides both theory and empirical evidence that firms invest strategically in order to preempt procompetitive government policies, which, in turn, discourage competitors from investment, in the context of the local broadband investment by Internet service providers (ISPs) and the state-level broadband policies in the United States.

We consider a prototypical model of a policymaker choosing policies and firms, a leader and a follower, making investment decisions in anticipation of its impact on policy choices. We present the key insight in the simplest setup: a Stackelberg capacity game with policymaking in the middle. The policy here is intended to reduce the marginal investment costs of both firms—thus promoting a larger capacity in the market—but it also levels the playing ground for the firms or is *procompetitive*, by reducing the marginal cost of the follower more than that of the leader. The model retains the traditional preemptive motive for the leader to increase capacity in a Stackelberg game, but the main twist is that the leader can also reduce the extent to which the policy is procompetitive by its investment. This new channel of preemptive investment, which we call "policy deterrence" motive, stems from the policymaker's preferences: the political appeal of procompetitive policies diminishes as the market capacity is sufficiently large. One potential explanation is that the constituents' demand for such policies may wane as they are more satisfied about the goods and services provided in the market and that policymakers are electorally accountable as they respond to such demand, in line with the existing studies (Besley and Case, 1995, 2003; List and Sturm, 2006). Another explanation is quid-pro-quo, where politicians may give policy rewards to firms that help their elections through making investments.

We show the relevance of this model in the context of the wireline investment for residential broadband Internet services in the U.S., which involves substantial cost and determines the service quality (e.g. Internet speed and reliability) that consumers receive. This empirical context is ideal for three reasons. First, the Internet Service Providers (ISPs) are highly oligopolistic, predicated by the substantial return to scale of network investment and reinforced by a long and deeply-rooted tradition of government-condoned local monopoly in the U.S. telecommunications industries. Heterogeneous firms with respect to their existing network and relationships with local governments breed mixed strategies and incentives to fend off competition. Second, although the ground rules for the industry are set by federal-level policies, state-level policies affect entry and operating costs and, in general, directly affect providers' profitability.[1] In particular, broadband policies are often considered bi-partisan policy tools that can enter campaign platforms by local politicians to win the favors of local residents, without bending the politicians' innate ideology and preferences. This allows us to exploit panel variation in studying the strategic interaction among (heterogenous) firms and policymakers for a given industry. This feature contrasts to existing literature that exploits variation across industry. Third, there has been a recent stride in introducing and implementing government policies to promote broadband investment, partially driven by the public attention to "digital divide," i.e., unequal access to Internet across geographical areas and socioeconomic groups. These accommodation policies encourage entry and investment by small, local ISPs with limited geographic scope of services, generating credible threat to erode large ISPs' profitability.

We assemble data on firm investment, state policies, and local political environment that span the recent decade, 2010–2019. Our data have three main components. First, we observe each ISP's services provided for a given Census Block, as bi-annually reported by the provider to government agencies, based on which we measure firm entry and investment. Second, we manually compile all states' financial and regulatory policies on broadband investment from state legislation and other official documents. This addresses one of the main challenges to studying state policies and their effects, the lack of systematic data. Third, we measure the local political environment by looking at the county-level election outcomes for state-wide or national elections such as presidential, senatorial, and gubernatorial elections. In addition, we obtain various county attributes to capture the demographic and socioeconomic variations of local population that are relevant to broadband demand and costs, as well as state government attributes such as the party and term structure of a governor and the comoposition of the state government.

Using the data, we document that local political environment, measured by the county-level vote share for a Democratic candidate in recent state-wide or national elections, matters for broadband investment. Specifically, we find that both broadband capacity and investment increase as the Democratic vote share gets closer to

[1] State governments issue certificates for a new ISP to enter and operate in the state, provide financial incentives through tax or subsidy policies, allocate federal funds, involve in siting decisions, and regulate ISPs. In addition, they have jurisdiction to allow the use of a public rights of way (at some compensation to be negotiated), to manage how timely they review applications and mediate ISPs' conflicts with municipalities and private landowners. See Section 2.2.

50%; put differently, more investments have occurred in electorally competitive or *swing* locations. These results are robust to different measures of investment and alternative specifications. More importantly, we find that the inverted U-shaped relationship between the Democratic vote share in a county and the broadband capacity or investment in the county is mostly driven by large firms, even after we control for county fixed effects, state-time period fixed effects, and various other (time-varying) county attributes that may affect investment, such as population density and overall level of education of the county residents. Put differently, large firms invest more in electorally competitive areas while such patterns are not present for small firms.

We then connect this empirical finding to our theory of policy deterrence. The theory is centered on the idea that a leading firm has an incentive to over-invest in order to negatively influence a policy that helps a follower firm's investment. With that, we show that the local political environment provides variation in the extent to which firm capacity affects policymaking. Specifically, we find evidence that better broadband capacity in electorally competitive areas leads to a smaller chance of having pro-investment policies in place, while such patterns are not present for broadband capacity in other areas. This empirical pattern can be explained by governors being electorally accountable even for secondary issues like broadband or environmental policy (List and Sturm, 2006), who especially care about swing voters to maximize vote share (Krasa and Polborn, 2010, 2014) or the number of same-party seats in the state legislature.

An important condition for the policy deterrence motive to translate into over-investment by leading firms is that the pro-investment policies by the state governments are procompetitive, i.e., they disproportionately benefit the following firms (typically small ones) than the leading firms (large ones). Our evidence is consistent: small firms tend to increase investment in response to the policies, while large firms do not. It is notable that broadband policies in our data typically do not target certain firms, but our findings suggest that they tend to be more effective in getting small firms to make investments, rather than large firms which often have advantages in leveraging returns to scale, financing ability, and relationship with governments.

We also document pieces of further supporting evidence, consistent with our theory of policy deterrence. We find that the aforementioned inverted U-shaped relationship is prominent in states where the average number of active large firms is small. The benefits from preempting followers' investment may be dissipated as the number of leading firms increases, explaining this pattern. Furthermore, we find that the pattern that more investment by large firms in swing locations in more pronounced for states without super-majority in either chamber of the state legislature. Again, this pattern is consistent with our theory because firms' incentives to invest in swing locations to influence policies diminish as the value of swing voters to the governor decreases.

Our research lies in the intersection of political economy and industrial organization. We introduce a new channel through which firms and policymakers interact. In doing so, we combine the two strands of studies: the political economy literature on firms' influence in policymaking and the IO literature on strategic investment for entry deterrence. This feature is, in part and spirit, similar to a recent theoretical paper by Callander, Foarta, and Sugaya (2022). While their emphasis is on the market distortions due to a politician's (dynamic) incentive to extract rent, our paper focuses on how firms leverage their policy influence through their investment in order to increase rivals' costs and reduce market competition. Another closely related paper, Cowgill, Prat, and Valletti (2022), looks at the relationship between political influence and market concentration. Our approach is unique in that we focus on a single industry and provides evidence in the two-way relationship, where the politicians respond to the market capacity by state policy instruments, including regulations as well as financial incentives, and firms respond to politicians' incentives by their investments.

In addition, we bring new dimensions to the literature on entry threat and entry deterrence. The theoretical literature points out that a firm's ability to preempt potential rivals hinges on its ability to enhance own competitive strength or burden entrants by costly irreversible investments (Wilson, 1992). The empirical evidence of preemptive behaviors is sparse in part because it is difficult to distinguish between strategic entry deterrence and nonstrategic investment decisions. One approach looks at a non-monotonic relationship between investment and market size or attractiveness (Ellison and Ellison, 2011; Gil, Houde, Sun, and Takahashi, 2021). Another approach focuses on how firm behavior changes upon a threat of potential entry (Goolsbee and Syverson, 2008; Seamans, 2012; Wilson, Xiao, and Orazem, 2021). We differ from these two approaches by exploiting the variation in political environments that firms face, conditional on other observed local attributes that affect the benefits and costs of investment. In our study, the traditional toolkit at a firm's disposal, such as predatory pricing or commitment to capacity is expanded; we rationalize firms' politically-driven investment patterns as means to deter future competition. This channel may heighten the possibility of "power begetting power" (Zingales, 2017).

Lastly, this paper belongs to a recent, burgeoning empirical literature on how firms attempt to influence government policies by their own business activities—as opposed to political activities such as campaign contributions—such as expanding employment (Carvalho, 2014; Bertrand, Kramarz, Schoar, and Thesmar, 2018), increasing bank credits (Delatte, Matray, and Pinardon-Touati, 2022), and opening subsidiaries (Bisbee and You, 2022). One potential mechanism through which these activities influence politicians is through electoral pressure, to the extent that voters care about job creation and economic development (Nordhaus, 1975), which can be affected by firm behavior. Our paper contributes to the literature by emphasizing a specific route through which firms' policy influence benefits them: maintaining or improving their competitive advantage over (potential) rivals.

2. Internet Service Providers and State Broadband Policies

An Internet Service Provider (ISP) provides Internet access to consumers, offering varied speed, reliability, and customer support at different subscription rates. In general, a U.S. household spends $20 to $100 on Internet services.[2] To deliver Internet services, ISPs build a network infrastructure that connects to Internet backbone through various technologies such as fiber optic cables, satellite links, or cellular networks. In this paper, we focus on wireline ISPs, the most common type of ISPs, which offer Internet services through cable, Digital Subscriber Lines (DSL), or fiber-optic lines. Because these technologies enable data transmission at a higher speed than the traditional narrowband, dial-up services, this industry is often referred as the "broadband" industry.

This industry is highly oligopolistic, with a handful large firms dominating the market and a large set of fringe firms with limited geographic scope of services. In the United States, the dominant players include Comcast Xfinity, AT&T, Charter Spectrum, Verizon Fios, and Cox Communications. They typically span several telecommunications areas; for example, Comcast Xfinity and Charter Spectrum provide cable TV, Internet, telephone and wireless services. These mega businesses often originated from a cable TV provider or an incumbent telephone provider, which was traditionally considered a local monopoly with substantial return to scale.

The industry is regulated by both the federal and state governments. The Federal Communications Commission (FCC) is the main regulator of this industry, while

[2]According to a 2021 Broadband Pricing Index report, the average monthly cost of internet service is $36.33 for basic internet with download speeds of at least 25 Mbps.

the Department of Justice (DOJ) and the Federal Trade Commission (FTC) share the responsibility for evaluating anti-competitive conduct in this industry. While the federal government deals with big picture issues, such as net neutrality and internet privacy (Greenstein, Peitz, and Valletti, 2016), the state governments implement federal policies, allocate federal funds, and, most importantly, impose their own policies to directly affect ISP's behaviors.[3]

2.1. **Broadband Investment.** The term broadband refers to all technologies which transmit data using a wide band of frequencies, and stands in contrast to narrowband technologies (colloquially, dialup) which transmit data using one channel. While multiple channels are capable of transmitting data at faster speeds, this definition of broadband does not imply any particular speed. There are three major groups of technologies to deliver broadband: 1) Cable Modem-DOCSIS (Data Over Cable Service Interface Specifications); 2) DSL (Digital Subscriber Line), and 3) Optical Carrier/Fiber to the End User.[4] The FCC has since 2015 required speeds to meet a benchmark of 25 megabits per second (Mbps) of download speed and 3 Mbps of upload speed in order to qualify as "high-speed internet."[5]

Internet is structured like highways, with infrastructure organized into three levels: the backbone, middle mile and last mile. The backbone (a.k.a., Tier 1 networks) consists of mostly fiber-optic cables that span cross continents and oceans. During Clinton administration, the backbone Internet, initially a government-funded project, was taken over by commercial firms. The largest backbone providers nowadays include Verizon, AT&T, CenturyLink, Level 3, etc., which provide free interconnection to lower level networks (tier 2 and tier 3 networks). The "middle mile" connects the backbone network to various local aggregation points. Internet traffic is then dispensed at different aggregation points before it goes on the "last mile" to arrive at the end user (the local retail customer). In the U.S. most of the middle mile is

[3]Within-state data transmission is considered a part of intrastate commerce and a state is the relevant regulatory body.

[4]The FCC further divide these three groups into 13 types of technologies depending on the versions of these technologies.

[5]According to the Commission (FCC (2021)), "We find that the current speed benchmark of 25/3 Mbps remains an appropriate measure by which to assess whether a fixed service is providing advanced telecommunications capability. We conclude that fixed services with speeds of 25/3 Mbps continue to meet the statutory definition of advanced telecommunications capability..." Industry advocates have debated whether a download speed of 100 Mbps is a better benchmark for the modern economy.

privately owned, and owners charge fees for the usage of the part of infrastructure.[6] Typically, tier 1 providers build an entire network from the backbone to the last mile, tier 2 providers invest in both the middle mile and last mile, and tier 3 providers only invest in the last mile.[7]

The last mile is typically the speed bottleneck; its bandwidth effectively limits the amount of data that can be delivered to the customer. The cost of building up the last-mile broadband infrastructure is substantial. For an industry example, it costs $20,000 for fiber infrastructure per mile and $600 per home to install service from the street, in addition to $32 average monthly cost for service delivery after installation. If there are 13 homes per mile and the monthly subscription fee is $65, it would take 5.4 years to break even on the investment in the best scenario that all 13 homes subscribe to the service. This calculation varies significantly across geographies and terrains, as the cost of laying out the network is much higher in rural, remote, sparsely-populated areas. The lack of the middle mile compounds this problem. To start serving a new market, a firm with some middle-mile infrastructure may only need to build the last mile in urban areas, but may need to build its own middle mile or pay for wholesale middle-mile access in rural areas.

2.2. **State Policies and Regulatory Matters.** Beyond federal regulations, state governments have important jurisdiction over this industry. State policies and regulation, broadly speaking, include four categories: state grants and subsidies, tax incentives, right of way accommodations, and municipality provision restrictions. The last category concerns whether municipal governments are allowed to provide public Internet services, but such restrictions had little variations in our study period so we do not include it in our analysis.[8]

Grants and Subsidies. Many states started an active grant or loan programs during our data period and often set up an office to management funds. States including

[6]There have been policy initiatives recently to build open-access middle mile by governments and non-profit agencies. Two examples are the Network New Hampshire Now and Maine Fiber Company, both funded largely by the U.S. National Broadband Plan to connect all community anchor institutions.

[7]Tier 2 and 3 providers are difficult to distinguish because ISPs are reluctant to admit that they do not have control over parts of their network and, therefore, their ability to improve services may be limited.

[8]Currently, 21 states restrict electric cooperatives and municipalities from providing broadband services. For example, North Carolina requires a city to hold a special election on the question of whether it can provide a communications service before the city can incur debt for building such a system. Wilson (2021) evaluates a ban on municipality provision by estimating a structural model of consumer demand and a dynamic oligopoly model of investment by public and private ISPs.

New York, Massachusetts, Indiana and California provided between \$20m to \$500m grant programs. Such programs were often targeted toward unserved or underserved areas; for example, Vermont established a Connectivity Initiative in 2015 to deploy high-speed Internet to all service locations, and as a part of the initiative, the Public Service Department was required to publish a list of census blocks eligible for funding on an annual basis and to solicit proposals from providers.

Tax Incentives. An example of tax incentives is the 2014 policy in Colorado, allowing broadband providers to get a refund on state sales/use taxes paid for broadband equipment. Another example is the 6-percent excise tax credit for broadband providers purchasing new equipment, which was enacted in 2017 in Tennessee. Tax incentives often are not targeted, not discriminating one provider or location over another, but with some exceptions. In 2017, Indiana enacted a policy to allow local governments to adopt an ordinance designating an area as an "infrastructure development zone" and to provide eligible infrastructure in the zone with an exemption from property tax.

Rights of Way Accommodation. When it comes to poles, conduits and rights of way, state and local governments go beyond just issuing certificate for a new ISP to operate.[9] Section 253(c) of the Telecommunication Act of 1996 states: "Nothing in this section affects the authority of a State or local government to manage the rights of way or to require fair and reasonable compensation from telecommunication providers, on a competitively neutral and non-discriminatory basis."

The rights of way authority governs issues, big and small, about public infrastructure access for Internet deployment. Major issues include permission to build, compensation in return for granting permission (in the form of cost recovery, rental fee, or a flat tax), and the management of a public rights of way, e.g., streets and roads.[10] Somewhat mundane, minor issues include mediation when an ISP conflicts with municipalities and private landowners, and even the time frame within which an ISP application gets reviewed.[11] In addition, remediation and maintenance laws, as determined by state or local governments, dictate issues such as in what state of

[9]Poles and conduits regulation refer to procedures, guidelines and requirements for communications attachments under high voltage power lines and access to underground pipes and tubes for protective electric wiring. Rights of way is a term applied to pathways or corridors of access that ISPs need to secure for installing their facilities and delivering their services.

[10]In some states, an ISP is supposed to get permission to build on a public rights of way from every single municipality that the project crosses, whereas in other states, this is handled by a centralized authority.

[11]In Vermont, landowner complaints can be heard on a wide range of issues including aesthetics, and decisions can be appealed to the Vermont Supreme Court. On the other extreme is Texas, where

repair ISPs must maintain their facilities. For example, if a sidewalk is torn in order to lay cables, these laws determine to what extent the sidewalk would need to be restored to its original state and under what time frame.

Over time in our data period, states have eased regulations on permitting, access, pole attachments, and construction. Some accommodations were big strides, for example, California in 2016 required the Department of Transportation to notify ISPs during the planning phase of department-led highway construction projects suitable for broadband conduit installation. This is called "dig-once" policy, currently in place in eight states including Minnesota, Iowa, and Colorado. Some accommodations clearly tilt the playground toward the ISPs. For example, Alabama in 2019 specified the terms under which a property owner can sue a broadband provider for damages when the provider is using an existing electric easement for broadband. It stipulates that property owners cannot receive more in damages than the amount that their property lost in value because broadband facilities were installed.

2.3. **Heterogeneous Firm Interests on Policies.** Some state policies were written with potential entrants' interests in mind. For example, Missouri in 2014 required pole attachment fees charged by local authorities to be nondiscriminatory and reasonable. For another example, Tennessee in 2017 required electric cooperatives to allow other providers nondiscriminatory access to poles and other infrastructure. These "nondiscriminatory" statutes favored new entrants that have no established relationships with local governments.

Even when state policies do not adopt an explicit language of being pro-competitive, small firms do seem to have more to gain from these policies than their large rivals. Small firms, lacking political capital and a history of interacting with state officials, are disadvantaged in navigating regulatory hurdles without the help of formal polices. Small firms are also less like to own dark fiber,[12] thus facing a higher barrier to entry and needing jump-starting financial incentives. Furthermore, small firms, perhaps because they are disadvantaged in many ways, are usually more flexible to work with local communities; as an example, 90% of Connect Illinois grants were awarded to local firms. Overall, state broadband policies tend to facilitate entry and competition,

most factors cannot be appealed and landowners must pay the ISPs legal expenses if the landowners lose in court.

[12]Dark fiber refers to unused or underutilized fiber-optic cables that have not been activated, considered as potential capacity by the industry. Telecommunications giants such as Comcast, AT&T, and Century Link owns a considerable amount of dark fiber, but they typically choose not to lease them out to competitors in order to avoid cannibalization risks.

to the point that large firms often put on battles against such policies. For example, Cable one, a large ISP, challenged rural grants to competitors in northeast Louisiana, citing that existing infrastructure in an area rendered broadband expansion grants unnecessary. For another example, "dig once" policy has been stalled in the Congress, in part due to large companies' opposition.

3. Data on Broadband Investment and Policymaking

We combine multiple data sources to construct the data for the analyses. First, data on each ISP's entry, technology, and Internet speed at the Census Block level are collected and reported bi-annually by federal agencies, first by the National Telecommunications and Information Administration (NTIA) for the period of 2010 to the first half of 2014, and then by the Federal Communications Commission (FCC) since the second semester of 2014. Second, all state-level statutes related to broadband are compiled by the PEW Charitable Trust's state broadband policy explorer.[13] Starting with the list of statutes from this source, we look at the state broadband program office websites, budget and tax expenditure documents, state laws, public statements, and news articles to construct a comprehensive and consistent dataset of broadband policies. Third, gubernatorial election results are based on CQ Press Voting and Elections Collection; information on governor term limits is sourced from Klarner (2013). We then add to these datasets with our web search for the recent election results. To complement these data, we obtain various demographic information from the American Community Survey.

3.1. Broadband Deployment.

Table 1 provides how the broadband coverage and speed geographically vary during 2010–2019 by rural vs. other counties, focusing on residential services.[14] We divide counties into two groups, rural vs. rest, based on the Census definition of urban areas: if no census blocks in a county are designated as urban, we define that the county is rural. Given this definition, 702 counties are rural, and the rest are not. During the ten years, the average fraction of population with any service availability in rural counties is 81%, the fraction with service availability by at least two providers is 24%, and the fraction with download speed greater than 25 Mbps is 44%. These statistics contrast with those of urban counties, 91%, 65%,

[13]The Pew Charitable Trust's state broadband policy explorer, available at https://www.pewtrusts.org, provides the list of state laws related to access to broadband, dating back to 1991 to 2021.

[14]The FCC data distinguish residential and business services, while the NTIA data do not. To focus on residential services, we exclude the observations by business-only ISPs from the NITA data.

Table 1. Broadband Coverage and Speed: Rural vs. Urban

Variable	Rural Mean	Rural SD	Urban Mean	Urban 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 the rest counties (2,439 counties $\times$ 20). † : We take the average of the maximum download speed of the residential broadband services offered in a given county over provider-technology-block observations.

and 68%, respectively, illustrating the persistence of the digital divide in the recent decade.

3.2. **State Broadband Policies.** Panel A of Table 2 presents some summary statistics regarding various policies that were intended to encourage broadband investment. The most frequently implemented policies were rights of way accommodations, which set rules for ISPs to use public infrastructure and facilities for broadband deployment.

On average, each state adopted more than one pro-investment policy during our data span. There were substantial variations across state and over time.[15] Some states, such as Alaska, adopted none, while others, such as Colorado, adopted such policies frequently and eventually had eleven such policies in place. There had been an increasing effort adopting such policies in the later half of our data span. Out of our data span, the pace is accelerating: by 2020, all fifty states have created a task force, commission, or authority to promote broadband; during the 2020 legislative session: 31 states adopted pro-broadband legislation or resolutions.

[15]Some states place restrictions or bans for public entities like municipalities or electric cooperatives from providing broadband Internet services. During our period, the average number of restrictions or bans in place for a given state is 0.51, but most of these restrictions were placed before 2010 so we do not have much variation during our data span.

Table 2. State Broadband Policies and Politics

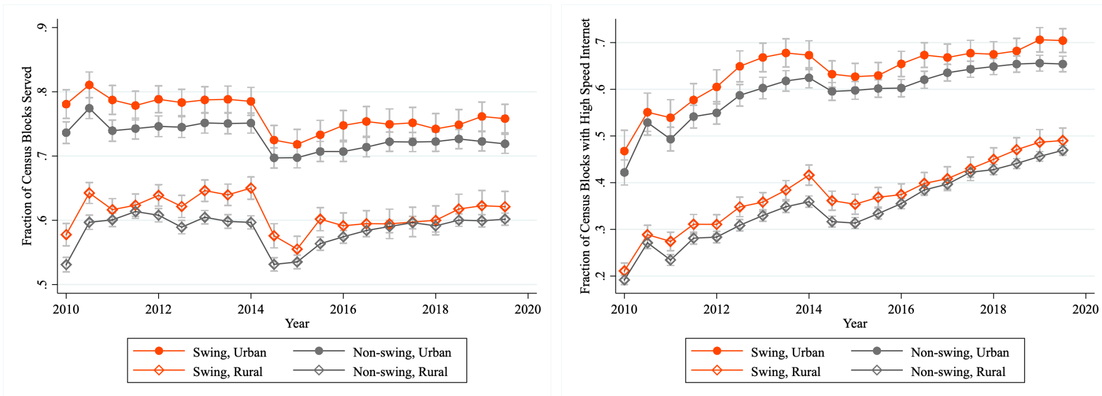
Variable	Mean	SD	Min	Max
Panel A: Broadband investment policies				
rights of way accommodations	0.851	1.381	0	8
Tax incentives	0.204	0.481	0	2
Grant/loan programs	0.491	0.671	0	3
Office for broadband investment	0.210	0.408	0	1
Any pro-investment policy	1.545	1.810	0	11
Panel B: Term limits, elections and politics				
Democrat governor	0.415	0.493	0	1
Lame-duck governor†	0.303	0.460	0	1
Governor's vote margin (%, most recent)	16.404	13.728	0.218	57.973
Governor's vote margin $\geq$ 10%	0.578	0.494	0	1
Divided branch	0.224	0.417	0	1
Split state legislature	0.093	0.290	0	1
Competitive state House or Senate	0.475	0.500	0	1

Notes: 550 observations (50 state $\times$ 11 years, 2009–2019, except that Broadband office data is not available for 2019). † : 1 if the sitting governor is serving his/her last term given the term limit law.

3.3. **Governors and elections.** There is a large heterogeneity across states regarding the term limits and the electoral support of a governor. During 2008–2018, 14 states did not have a term limit for governors (Connecticut, Iowa, Indiana, Illinois, Massachusetts, Minnesota, North Dakota, New Hampshire, New York, Texas, Utah, Washington, Wisconsin); Wyoming used to have a two-term limit but the state Supreme Court invalidated it in 2014; and the remaining 35 states had a term limit (for two terms, except Virginia which allows for one term). Panel B of Table 2 shows that the probability that the sitting governor is serving his/her last term given the state term limit law (or he/she is a "lame-duck" governor) is 0.3.

The table shows that gubernatorial elections are typically not very competitive: the average vote margins, defined as the vote share difference between the winner and his/her runner-up, are 16.4% and the majority of the governors (57.8%) won the election with at least 10% margins. However, some gubernatorial elections can be a toss-up: for example, the vote margin in the 2006 North Carolina election is 0.2, and there are four other elections with less than 1% margins during the period of study: Connecticut (2010, 0.5%), Florida (2010, 0.4%), Illinois (2010, 0.9%), and Minnesota (2010, 0.4%).

Figure 1. Better Broadband in Electorally Competitive Areas



(A) Coverage

(B) Speed

Notes: We group counties into four groups based on (i) whether the fraction of population living in urban area is above 2/3 ("urban," in diamond) or not ("rural," in circle), and (ii) whether the average Democratic vote share in recent state or national elections is 45–55% ("swing," in orange) or not ("non-swing," in grey). The left panel shows the fraction of the census blocks with any residential broadband Internet service, averaged across the counties in each of the four different groups. The right panel presents the fraction of the census blocks with residential broadband Internet services featuring at least 25 Mbps maximum download speed. The error bars represent 95% confidence intervals. Note that the drop in broadband capacity in 2014 is due to the change of the data collection and reporting authorities (from NTIA to FCC).

4. Politically-Motivated Firm Investment

This section documents that local political environment matters for broadband investment, even after we control for a multitude of demographic and socioeconomic factors, as well as a rich set of fixed effects, that may also affect investment. We find a striking and robust pattern that broadband investment increases as the vote share for a Democratic candidate gets closer to 50%; put differently, more investments have occurred in electorally competitive or *swing* locations. In particular, we find that leading firms in a state drive this politically-charged investment pattern.

4.1. **County-level Analysis.** Figure 1 shows the average local broadband capacity, measured by the fraction of census blocks with any residential broadband Internet service (Panel (A)) and with high-speed service ($\geq$ 25 Mbps, Panel (B)), for four different groups of counties based on (i) whether the fraction of population living in urban area is above 2/3 ("urban," in diamond) or not ("rural," in circle), and (ii) whether the average Democratic vote share in recent state or national elections is 45–55% ("swing," in orange) or not ("non-swing," in grey).

There are two notable trends in the figure. First, the gap between rural and urban counties in broadband coverage and speed is persistent. This is the well noted "digital divide" problem.[16] Second, electorally competitive counties consistently have much better broadband capacity than non-swing counties (in other words, partisan counties), regardless of the urban/rural delineation. This is a curious pattern, suggesting the relevance of local political environment to broadband investment. The overall political viewpoints in a local area, however, may also be correlated with demographic or socioeconomic factors that are relevant to broadband investment.

To control for potential confounding factors, we consider the following specification:

$$Y_{ct} = \beta_1 DemShare_{ct} + \beta_2 (DemShare_{ct})^2 + \mathbf{X}_{ct}\beta_{\mathbf{x}} + \mu_{s(c),t} + \epsilon_{ct}, \tag{1}$$

where Y_{ct} measures broadband investment at country c in each semi-annual period t;[17] and $DemShare_{ct}$ is the average vote share for a Democratic candidate in state-level or nation-wide elections in recent eight years for county c.[18] The vector X_{ct} consists of time-varying county attributes, including population density and size, their respective squared terms, and resident attributes listed in Table A1 in the Appendix, such as demographics (age, gender, and racial composition), income, work, and education. This specification includes state-time fixed effects, denoted by $\mu_{s(c),t}$, to account for, among other things, various state-level government policies.

Table 3 reports the OLS results based on Equation (1). We focus on one outcome measure in this baseline table for Columns (1)–(3): we use the log number of census blocks that were newly covered with any services (number of census blocks plus a small positive number, 0.001, so that we include observations with no investment) to measure the investment at the extensive margin. In the last column, we instead look at the (log) number of census blocks with high download speed new services (at least 25

[16]The urban-rural disparity can be attributed to both demand- and supply-side economics in broadband deployment. In rural counties, residents tend to have lower income and are less educated than those in urban counties (Table A1 in Appendix), resulting in lower willingness to pay for broadband services. At the same time, rural counties often have difficulty terrains and low population density, increasing the cost of deploying broadband networks.

[17]To consider the investment in the t^{th} period, we assume that the amount of the "time to build" is one year. In the infrequent occasions of negative deployment growth, we code investment as zero.

[18]By taking the average vote share across multiple elections, we intend to capture the local voters' political preferences, as opposed to the popularity of particular candidates.

Table 3. Politically Driven Investment

	Investment in (log) number of blocks[a]			
	Any			$\geq$ 25 Mbps
	(1)	(2)	(3)	(4)
Democratic vote share	9.895***	8.017***	5.145***	2.601**
	(1.011)	(1.143)	(1.215)	(1.271)
(Democratic vote share)^2	-9.478***	-8.651***	-5.321***	-2.806**
	(1.118)	(1.190)	(1.304)	(1.410)
Time-varying county attributes[b]	N	N	Y	Y
State-period FE	N	Y	Y	Y
Dem. vote share that maximizes investment	0.522	0.463	0.483	0.463
	(0.015)	(0.015)	(0.038)	(0.075)
Number of observations	49,784	49,784	49,661	49,661
Adjusted R^2	0.004	0.280	0.286	0.191

Notes: This table is based on 3,140 county $\times$ 16 semi-annual periods. We cut 4 periods from the 20 periods in the time span of our data: we do not use NITA to FCC transitional periods, December 2013 and June 2014, due to inconsistent reporting; we lose June 2019 and December 2019 data due to 2-period forward calculation of investment. The number of observations slightly changes across the columns because time-varying county attributes based on the American Community Survey are not always available. Standard errors are adjusted for clustering within counties, and are provided in parentheses. Asterisks indicate the statistical significance at the 1% (***), 5% (**), and 10% (*) levels.
On variable construction: a. The outcome variable is the logarithm of the number of census blocks with broadband investment by a given firm plus 0.001, so that we include observations with no investment. b. The time-varying county attributes include population size and density, their respective squared terms, as well as population characteristics on age, gender and race compositions, income, work, education and more, as listed in Table A1 in the Appendix.

Mbps) to measure investment in the intensive margin.[19] In all four columns, there is an astonishing symmetry between the coefficients for the Democratic vote share ($\hat{\beta}_1$) and its squared term ($\hat{\beta}_2$): they are almost equal, with the former positive and the latter negative. Based on $\hat{\beta}_1$ and $\hat{\beta}_2$, all columns present a clear inverted U-shaped relation between the electorally competitiveness of a county and broadband investment to the county. Using these estimates, we calculate the Democratic vote share that maximizes investment, which equals $-\hat{\beta}_1/2\hat{\beta}_2$, and the respective standard errors. As reported by the table, across the columns, broadband investment is maximized in counties with roughly 50% Demographic vote share. In short, everything else equal, there has been more investment in electorally competitive counties. In the Appendix, we document that these patterns are robust to using capacity, as opposed to investment,

[19]Table A2 (left panel) reports summary statistics on the investment variable. There seemed to be more investment in the intensive margin than in the extensive margin.

or measuring capacity or investment by the size of population residing in census blocks with service, as opposed to the number of census blocks (Tables A3 and A4).

4.2. **Firm-level Analysis: Large vs. Small Providers.** With Table 3 as a county-level overview, in this subsection we focus on the decision makers behind the striking investment pattern we discover. The broadband industry features (hugely) heterogeneous providers by existing investment and network presence, with dozens of mega businesses and thousands of fringe players making location-specific investment. We divide these firms into two groups based on their market presence in a state. Specifically, some ISPs have footprint across a state, while others are dedicated to serve a few local markets. We classify an ISP as a "large" firm if the ISP provided broadband services for at least 5% of the census blocks within a state, averaged across the time span of this study, and a "small" firm otherwise. Given this definition, a state typically has about five ISPs that are considered as large, with the minimum two (Alaska, Hawaii, Maryland, New Mexico, and Rhode Island) and the maximum eleven (Indiana).

In this analysis, we build a balanced panel, where a large firm is considered as a potential entrant to every county in the state and a small firm is considered as a potential entrant to a subset of counties in the state where it was ever present during the period of our study. With that, the average number of counties for which a large firm is a (potential) entrant is 277.4 and the counterpart for a small firm is 10.6; the fraction of firm-county-period observations with any nonzero investment is 0.397 for large firms and 0.390 for small firms.[20]

We then consider the following specification:

$$Y_{fct} = \beta_1^{\tau(f)} DemShare_{ct} + \beta_2^{\tau(f)} (DemShare_{ct})^2 + \mathbf{X}_{ct}\beta_{\mathbf{x}}^{\tau(f)} + \xi_{fst}^{\tau(f)} + \mu_c^{\tau(f)} + \epsilon_{fct}, \quad (2)$$

where $\tau(f)$ represents the type of the firm, either large or small, and Y_{fct} measures the investment of firm f in county c during the period of t. Here we control for time-varying county attributes (the same as those used in Equation (1)), firm-state-period fixed effects, and county fixed effects.

Table 4 shows a clear difference between large and small firms: large firms' investment responds to Democratic vote share in the same fashion as shown in Table 3,

[20]A firm may occasionally miss reporting its presence; in this situation, we impute an interpolated value using reported data in adjacent years.

Table 4. Politically Driven Investment by Firm Size

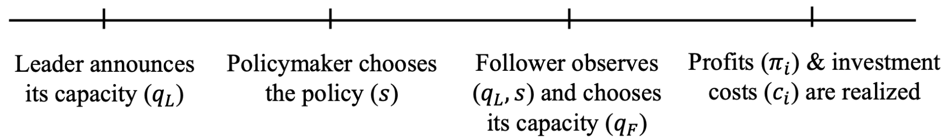
	Investment in (log) number of blocks[a]			
	(1) Large	(2) Small	(3) Large	(4) Small
Democratic vote share	4.373***	0.292	3.431***	0.498
	(0.789)	(0.896)	(1.130)	(1.563)
(Democratic vote share)^2	-4.057***	-0.912	-3.781***	-1.178
	(0.862)	(0.954)	(1.269)	(1.754)
Time-varying county attributes[b]	Y	Y	Y	Y
Firm-state-period FE	Y	Y	Y	Y
County FE	N	N	Y	Y
Dem. vote share that maximizes investment	0.539	0.160	0.454	0.211
	(0.038)	(0.337)	(0.077)	(0.434)
Number of firms	97	1,932	97	1,932
Average (potential) counties per firm	277.39	10.58	277.39	10.58
Number of observations	248,227	196,943	248,227	196,943
Adjusted R^2	0.350	0.366	0.386	0.407

Notes: This table presents the OLS results based on a constructed balanced firm-county-time period panel. Standard errors are adjusted for clustering within counties, and are provided in parentheses. Asterisks indicate the statistical significance at the 1% (***), 5% (**) and 10% (*) levels.
On variable construction: a. The outcome variable is the logarithm of the number of census blocks with broadband investment by a given firm plus 0.001, so that we include observations with no investment. b. The (time-varying) county attributes are listed in Table A1 in the Appendix.

while there is no evidence that small firms do so at all.[21] In other words, the inverted "U" pattern of investment, indicating that investment is maximized in swing counties, is driven by the large firms, not by the small firms. These results are robust to whether or not we include county fixed effects (Columns (1)–(2) vs. (3)–(4)). County fixed effects account for time-invariant county attributes that are associated with demand for broadband Internet services and cost of broadband investment. Table A5 in the Appendix shows that the patterns here are robust to using alternative measures of investment, either by weighing blocks using population size or by focusing on high-speed Internet only.

[21]Table A2 (right panel) reports summary statistics on the investment variable for large and small firms respectively. Large firms invested more within a county conditioning on non-zero investment in a county.

Figure 1. Timeline of the Model



5. Model

This section presents a model that explains why large broadband providers may invest more in electorally competitive locations, while small firms do not. This model introduces a new channel of preemptive investment, that is, a large firm can directly influence government policies by its own investment. To describe the key insight in a simple setup, we consider a Stackelberg game with policymaking in the middle, and provide comparative statics consistent with our empirical findings in Section 4.

5.1. Setup.

5.1. Setup. There are two firms in a market, a leader (L) and a follower (F), denoted by $i \in \{L, F\}$. These two firms make capacity choices, q_L, which is costly but is necessary for making profit. There is an additional actor, the policymaker, whose policies reduce followers' investment costs only.[22] Government policies, such as implementing an investment subsidy or easing the rights of way regulations, can reduce the investment costs, especially for followers. We represent such policies in one dimension, $s \in [0, 1]$, to measure the extent to which policies reduce the marginal investment costs of the follower and thus help increase competition.

The timeline is depicted in Figure 1. The leader announces its planned capacity q_L, and observing the announcement, the policymaker determines policy s.[23] Observing both the leader's capacity and the policy, the follower chooses q_F and both firms pay the corresponding investment costs. Both firms' capacities of the period determines each firm's operational profits.

5.1.1. *Firm Competition and Profits.* The operational profit of each firm is determined by the capacity levels of both firms, and is denoted by $\pi_i(q_L, q_F)$ for $i \in \{L, F\}$.

[22]This assumption is motivated by our discussion in Section 2.3 and simplifies our argument. It is also confirmed in Section 6.2, if we consider large firms as a leader and small firms as a follower. Large broadband providers' services tend to receive more public scrutiny and media attention than those of small firms, making it easier to influence other firms' decisions, public opinion, and policy-making.
[23]Because the policy affects the leader's investment cost, as well as the follower's, the leader may have an incentive to make a false announcement, and we assume that the cost of making a false announcement is high enough to deter such a behavior.

This function applies to a case of monopoly ($q_F = 0$), as well as duopoly ($q_F > 0$). A firm's profit is increasing in its own capacity, but is decreasing in the competitor's capacity. In addition, a firm's profit is concave in its own capacity while convex in the competitor's capacity, and an increase in the competitor's capacity reduces the firm's marginal profit gain from increases in its own capacity. We further assume that the extent of such a reduction for the leader, i.e., $|\partial^2 \pi_L(q_L, q_F)/\partial q_L \partial q_F|$, is smaller than the extent to which the follower's capacity decreases its own marginal profit gain from its capacity increase.

ASSUMPTION 1 (**Firm Profits and Competition**). *(i) For the leader, we have*

$$\frac{\partial}{\partial q_L}\pi_L(q_L, q_F) \geq 0, \quad \frac{\partial}{\partial q_F}\pi_L(q_L, q_F) \leq 0.$$

Similar inequalities hold for the follower. (ii) The following inequalities hold for the leader and similar ones hold for the follower:

$$\frac{\partial^2}{\partial q_L^2}\pi_L(q_L, q_F) < 0, \quad \frac{\partial^2}{\partial q_F^2}\pi_L(q_L, q_F) \geq 0, \quad \frac{\partial^2}{\partial q_L \partial q_F}\pi_L(q_L, q_F) \leq 0.$$

(iii) We assume that

$$\frac{\partial^2}{\partial q_F^2}\pi_F(q_L, q_F) \leq \frac{\partial^2}{\partial q_L \partial q_F}\pi_L(q_L, q_F).$$

The assumptions above are satisfied for a large class of firm competition. An example is when the operational profit is determined by a linear demand for homogeneous goods (for example, $d(q_L + q_F) = A - b(q_L + q_F)$ and $\pi_L(q_L, q_F) = q_L d(q_L + q_F)$). For an instance, $\partial^2 \pi_F/\partial q_F^2 = -2b$ and $\partial^2 \pi_L/\partial q_L \partial q_F = -b$, satisfying Assumption 1(iii).

5.1.2. *Investment Costs.* Increasing capacity requires costly investment, and we denote the cost by $c_i(q_i, s)$ for each firm $i \in \{L, F\}$.[24] We assume that the cost is convex in the firm's own capacity. In addition, government policies reduce the marginal cost of investment.

ASSUMPTION 2 (**Investment Costs**). *(i) The cost of investment is increasing and convex for both firms. For $i \in \{L, F\}$, $q_i \geq 0$ and any s,*

$$\frac{\partial}{\partial q_i}c_i(q_i, s) \geq 0, \quad \frac{\partial^2}{\partial q_i^2}c_L(q_i, s) \geq 0,$$

[24]Given that our model is one-period, the capacity choice is essentially equivalent to an investment decision, especially when the capacity function is firm-specific and thus incorporates the initial capacity level differences, among others.

with strict inequality holding for some values of q_i. (ii) The higher the value of s, the lower the the marginal cost of investment for the follower, while the policy has no impact on the leader's marginal investment costs.

$$\frac{\partial^2}{\partial q_F \partial s} c_F(q_F, s) < \frac{\partial^2}{\partial q_L \partial s} c_L(q_L, s) = 0.$$

5.1.3. *Policymaker Preferences.* The policymaker values a high broadband capacity, representing her constituents' preferences (under electoral pressure), and perhaps she may or may not view that policies that reduce broadband investment costs are desirable, based on her ideology, career concerns, or relationships with local industries. Note that these policies are not without costs; for example, negative consequences may include a higher expenditure to pay for subsidies and more complaints from pedestrians and property owners by relaxing the rights of way regulations and proceedings. Furthermore, there is a political cost of enacting a policy, in terms of time and energy to reach to a consensus in the legislature, which may increase with the extent to which the policy reduces investment costs. We represent the payoff of the policymaker, reflecting all these considerations, as a function of the total broadband capacity, $q \equiv q_L + q_F$, and the policy, by $u(q, s)$.

Assumption 3 (**Policymaker's Payoff**). *(i) The policymaker's payoff function satisfies the following standard conditions:*

$$\frac{\partial}{\partial q} u(q, s) \geq 0, \quad \frac{\partial^2}{\partial q^2} u(q, s) \leq 0, \quad \frac{\partial^2}{\partial s^2} u(q, s) \leq 0.$$

(ii) The appeal for the policy decreases as the capacity increases:

$$\frac{\partial^2}{\partial s \partial q} u(q, s) < 0.$$

The first set of the assumptions are standard: the policymaker prefers better broadband capacity for her constituents, all else equal, but its marginal value is not increasing. Although we do not place a restriction on the sign of the marginal value of a policy, the third inequality in the above assumption implies that the payoff is concave in the extent to which the policy promotes investment.

Assumption 3(ii) implies that the marginal increase in the politician's payoff from enacting a more pro-investment policy reduces as the capacity increases. One potential explanation or justification is that the constituents' demand for policies to reduce investment costs may wane as the broadband infrastructure gets more satisfactory.

Of all the assumptions we have made so far, this is perhaps the most important assumption as it enables a channel through which the leading firm can exercise influence on policymaking by building its own capacity.

5.2. **Follower's Response.** Given that players in the model move sequentially, we solve the model backwards, starting with the follower's problem.

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

By Assumptions 1(ii) and 2(i), it can be seen that an increase in the leader's capacity deters the follower's investment:

$$\frac{dq_F}{dq_L} = -\left\{\frac{\partial^2}{\partial q_F^2}\pi_F(q_L, q_F) - \frac{\partial^2}{\partial q_F^2}c_F(q_F, s)\right\}^{-1} \frac{\partial^2}{\partial q_L \partial q_F}\pi_L(q_L, q_F) \leq 0. \tag{3}$$

Similarly, it is straightforward to see that, by Assumptions 1(ii) and 2, as the policy promotes investment, the follower responds accordingly:

$$\frac{dq_F}{ds} = \left\{\frac{\partial^2}{\partial q_F^2}\pi_F(q_L, q_F) - \frac{\partial^2}{\partial q_F^2}c_F(q_F, s)\right\}^{-1} \frac{\partial^2}{\partial q_F \partial s}c_F(q_F, s) \geq 0. \tag{4}$$

5.3. **Policymaking.** The policymaker maximizes her payoff given the leader's capacity (announcement):

$$\max_{s} u(q_L + q_F(q_L, s), s)$$

Taking the first order condition:

$$\frac{\partial}{\partial s}u(q, s) + \frac{\partial}{\partial q}u(q, s)\frac{\partial}{\partial s}q_F(q_L, s) = 0. \tag{5}$$

This equation represents that the policymaker considers the policy's direct impact on her payoff, as well as its indirect impact through the follower's investment.

How does the leader's capacity influence policymaking? To see this, denoting the left-hand side of the policymaker's first order condition by $P(q_L, s)$ and applying the Implicit Function Theorem to (5), it can be seen that

$$\frac{ds}{dq_L} = \left(1 + \frac{dq_F}{dq_L}\right)\left(\frac{\partial^2 u}{\partial q^2}\frac{dq_F}{ds} + \frac{\partial^2 u}{\partial q \partial s}\right) \Big/ \left(-\frac{\partial}{\partial s}P(q_L, s)\right) \leq 0. \tag{6}$$

In short, the policymaker enacts a less pro-investment policy as the leader's broadband capacity increases. The right-hand side of (6) provides the intuition for this prediction. The first term represents how the leader's capacity affects the total equilibrium capacity. Although an increase in the leader's capacity leads to a decrease in the follower's capacity, the effects on the total capacity are positive by Assumptions

1(iii) and 2. The second term represents how the total capacity increase affects the marginal benefit of the policy, which is negative because the policymaker's payoff is concave in capacity and she finds the benefit of the policy wanes with the capacity level (Assumption 3). Noting that the denominator is positive (the negative value of the policymaker's second order condition), we conclude that the leader's capacity increase lowers the strength of the policy in promoting investment.

5.4. **Leader's Incentive to Deter Policy.** The leader's problem is:

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

The above problem makes it clear that the leader does not take q_F or s as given because the leader moves before policy-making and the follower's move.

The first order condition is:

$$\frac{\partial}{\partial q_L}\pi_L(q_L, q_F) + \frac{\partial}{\partial q_F}\pi_L(q_L, q_F)\left\{\frac{dq_F}{dq_L} + \frac{dq_F}{ds}\frac{ds}{dq_L}\right\} = \frac{\partial}{\partial q_L}c_L(q_L, s) \tag{7}$$

The left-hand side of (7) represents the marginal benefit of investment, and the right-hand side represents the marginal cost. The leader's marginal benefit includes two strategic components, deriving from the investment's impact on the follower's action. First, the leader's capacity directly crowds out the follower's investment, following (3). Second, by (6), as the leader builds up its capacity, the policy intervention is reduced, which indirectly reduces the follower's investment, as shown in (4).

While the first component has been studied in the existing literature, the second one is new. If the leader's capacity does not directly affect the government policy, i.e., $ds \,/\, dq_L = 0$, then this second component is zero. The firm capacity's negative influence on policies that invite more competition increases the marginal benefit of investment.

5.5. **Policymaker's Preferences and Firm Behavior.** Given our discussions, we then study the role of political environment or policymaker preferences in shaping the firm capacity choices and the market competition. For a start, we introduce a parameter, $\gamma > 0$, which represents the extent to which the policymaker values the broadband capacity, and assume that for any (q, s, γ),

$$\frac{\partial^2}{\partial q \partial \gamma} u(q, s; \gamma) > 0. \tag{8}$$

By taking the derivative of (7) with respect to γ, we can write the leader's response to an increase in the policymaker's preference for broadband as follows:

$$\frac{dq_L}{d\gamma} = A(q_L,\gamma)\frac{ds}{d\gamma} + B(q_L,\gamma)\frac{\partial \pi_L}{\partial q_F}\frac{\partial q_F}{\partial s}\frac{d^2 s}{dq_L d\gamma},$$

where $A(q_L,\gamma) \leq 0$ and $B(q_L,\gamma) \geq 0$ for all (q_L,γ), given our assumptions on the profit and the cost functions. In determining the sign of $dq_L/d\gamma$, we see that there are two counteracting forces or channels. The first channel concerns the direct impact of the policymaker's preference for broadband on her policy choice ($ds/d\gamma$). The more the policymaker cares about broadband, the more she would promote it (i.e., $ds/d\gamma \geq 0$). To the extent that this policy boost serves as an extra competitive advantage for the follower, this channel lowers the incentive for the leader to increase its capacity. The second channel relates to the impact of the policymaker's preference on the leader's policy influence ($d^2s/dq_L d\gamma$). As the policymaker pays more attention to the broadband capacity, the leader's influence on her policy choice can increase ($d^2s/dq_L d\gamma \leq 0$). The leader then may take advantage of its amplified influence and increase its capacity to deter the follower.

If the second channel prevails over the first one, the leader increases its capacity in response to an increase in γ. The follower, on the other hand, reduces its capacity for two reasons. First, as the leader further increases its capacity, making it less profitable for the follower to make an investment. Second, the ensuing policy is less supportive of new investment in terms of marginal costs, further depressing the follower's incentive to invest.

To connect this comparative statics to the inverted U-shape relationship between the Democratic vote share in a county and broadband investment, documented in Section 4, we argument that the policymaker's γ is higher for electorally competitive locations, relative to other locations, when it comes to determining the level of pro-competitiveness of a policy (s). The next section provides empirical support on this argument.

6. Policy Deterrence as the Rationale

The present section provides evidence that the empirical findings presented in Section 4 can be rationalized by our theory of policy deterrence. The theory posits that a leading firm may invest more in order to influence a pro-competitive policy. A key to this argument is whether policies respond to broadband capacity; Section 6.1

presents empirical evidence of such policy influence through firm investment, especially in the electorally competitive, swing areas. Section 6.2 shows that small firms tend to increase investment in response to pro-investment policies, while large firms don't, representing the incentives for large firms to deter such policies. Next, Section 6.3 provides a set of heterogeneity results consistent with our theory and discusses alternative explanations.

6.1. **Policymaking and Broadband Capacity.** Our theory hinges on the idea that the appeal for policies to promote broadband investment to the policymaker decreases as the voters, especially those located in electorally competitive locations, enjoy better broadband infrastructure. This, in turn, manifests in policymaking, where such broadband policies are less likely enacted and implemented as the broadband capacity (in electorally competitive locations) expands.

We test this idea using our data on state-level policies, as described in Section 3.2. We consider the following specification:

$$\begin{aligned} Y_{s,y} &= \beta_1 SwingCap_{s,y-1} + \beta_2 PartisanCap_{s,y-1} && (9)\\ &\quad + \beta_3 SwingCap_{s,y-1} \times GovVote_{sy} + \mathbf{X}_{sy}\beta_{\mathbf{x}} + \eta_s + \mu_y + \epsilon_{sy}, && (10) \end{aligned}$$

where $Y_{s,y}$ is a variable representing broadband policies in state s and year y. We look at whether there is a financial incentive policy (either grant or tax incentives), a rights of way accommodation policy, or any policy (including these two types of policies) that promote broadband investment. We evaluate the likelihood of whether a pro-broadband policy is in place as a function of state-level attributes lagged by one year, in order to partially rule out the concerns of reverse causality and to reflect the possibility that policymaking is based on past information which is not necessarily fully up-to-date.

Specifically, we look at the effects of the broadband capacity on policies, where we measure the capacity for two disjoint groups of counties: swing or electorally competitive counties (those with the average Democratic vote share in the recent 8 years of state-wide elections lying between 45% and 55%), $SwingCap_{sy}$, and the rest, $PartisanCap_{sy}$. For each county group, we sum the fraction of blocks with any broadband Internet services within a county, multiplied by the ratio of county to state population for each county in this group.[25] Note that the counties with a larger population is weighed more, reflecting that the political representation is by

[25] When either group of counties is an empty set, then we impute the capacity of the other group of counties for the period. The results are robust to excluding such observations.

Table 5. Broadband Policies and Capacity

	Any policy on			Number of
	Tax/Grants (1)	ROW (2)	All (3)	all policies (4)
Pop.-weighted capacity in swing counties (lag)[a]	-0.122	-0.409***	-0.444***	-0.727
	(0.270)	(0.139)	(0.135)	(0.732)
Pop.-weighted capacity in swing counties (lag) × Governor's vote margin (in %)	0.015	0.020***	0.023***	0.056***
	(0.010)	(0.006)	(0.005)	(0.019)
Pop.-weighted in partisan counties (lag)[b]	0.366	-0.192	-0.0680	-0.322
	(0.229)	(0.142)	(0.148)	(0.827)
Governor vote margin (in %)[c]	0.003	-0.001	-0.000	0.003
	(0.003)	(0.002)	(0.002)	(0.010)
Time-varying state attributes[d]	Y	Y	Y	Y
State FE, Year FE	Y	Y	Y	Y
Mean of the dependent variable	0.180	0.462	0.687	1.689
Number of observations	450	450	450	450
Adjusted R^2	0.749	0.819	0.787	0.746

Notes: This table presents the OLS results and the unit of observation is state-year, from 2011 to 2019 (the 2010 policy data are not used because the broadband map data is available from 2010). Standard errors are adjusted for clustering within states. Asterisks indicate the statistical significance at the 1% (***), 5% (**) and 10% (*) levels.
On variable construction: *a.* The sum of the fraction of blocks with any broadband Internet services within a county, multiplied by the ratio of county to state population, over counties with the average Democratic vote share in the recent 8 years of elections lying between 45% and 55%. When there is no such county in a state, then we impute the average capacity in the state for the period. The results are robust to excluding such observations. *b.* A county is labeled as "partisan" when the average Democratic vote share in the recent 8 years of elections in the county is below 45% or above 55%. *c.* We consider the most recent gubernatorial election for a sitting governor at a given year, by calculating the vote share difference with his/her runner-up. *d.* The same time-varying attributes of Table 3 are used, except that these are aggregated at the state-level (as opposed to the county-level). In addition, we also include variables in Panel B in Table 2, which represent the political circumstances for the governor and the state legislature.

popular votes. We allow that the effects of the broadband capacity on policies may vary with the governor's electoral incentives, measured by his/her vote margins in the most recent election in year y, $GovVote_{sy}$.

The time-varying state attributes, $\mathbf{X}_{sy}$, include all variables of $\mathbf{X}_{cy}$ in (1) that are aggregated at the state level, as well as variables representing the political circumstances for the governor and the state legislature, summarized by those in Panel B in Table 2. This specification also includes year fixed effects and state fixed effects.

Table 5 shows the OLS results. We find that an increase in the population-weighted capacity in swing counties is associated with a decrease in the probability that a regulatory policy to help with the rights of way issues for the broadband providers is in place, while such pattern is statistically insignificant for financial policies for broadband investment. We find that these patterns are mitigated as the governor's vote margin increases. Notably, policy does not seem to be responsive to partisan counties' capacity.

Why are pro-investment policies less likely to be enacted as the broadband capacity, especially in electorally competitive locations, improves? One potential channel is that politicians respond to voter demand. Although broadband investment may be a secondary policy issue for voters, unlike "frontline" policy issues such as the level of government spending or the degree of income and wealth redistribution, there is empirical evidence that secondary policy issues are influenced by electoral incentives (List and Sturm, 2006). With that, politicians may care more about swing voters than others for two reasons. When there is uncertainty over the distribution of voter preferences, catering to swing voters (as opposed to say, median voters) can help a politician win an election (for example, see Krasa and Polborn (2010, 2014)). Alternatively, perhaps more seats occupied by the same-party politicians in the state legislature can be valuable for the governor to push her agenda, which explains her attention to swing locations.

An alternative channel is that broadband investment is a *quid pro quo* to politicians. Broadband investment can benefit the voters by better and cheaper Internet service availability and an inflow of money to the local economy. This can turn into a higher chance of winning for the sitting politicians, and this can be more effective for electorally competitive locations. A similar argument is made for the case of French financial markets in Delatte, Matray, and Pinardon-Touati (2022).

Given this suggestive empirical evidence of and potential mechanism for the notion that better broadband capacities in electorally competitive locations reduce the chance that a pro-investment policy for broadband Internet services is enacted, we may interpret that the value of γ, as defined in (8), is higher for electorally competitive counties than for other counties.

6.2. **Small Firms Responds to Policies, Not to Politics.** Another important assumption for policy deterrence is that the benefits of a pro-investment policy are more pronounced for followers (or small firms in our empirical context) than for leaders (or large firms). Without observing the investment costs of firms, we infer these heterogeneous effects by looking at how firms respond to a pro-investment policy.

We consider the following specification for firm f:

$$Y_{fct} = \gamma^{\tau(f)} Policy_{s(c),t} + \mathbf{X}_{ct}\gamma_{\mathbf{x}}^{\tau(f)} + \eta_{ft}^{\tau(f)} + \xi_c^{\tau(f)} + \epsilon_{fct}, \tag{11}$$

where Y_{fct} is the investment size of firm f in county c during period t and $\tau(f)$ represents the type of the firm, either large or small. This specification differs from (2) in that it explicitly control for the state-level (time-varying) policies (as opposed to including firm-state-year fixed effects). The time-varying county attributes, $\mathbf{X}_{ct}$, include time-varying state attributes, such as the party of the sitting governor and the legislature.

Table 6 reports the OLS results. We find that pro-investment policies do increase the investment of small firms (the even-numbered columns in the table), while there's a notable contrast for large firms. Large firms positively respond to tax incentives or grants (Column (1)),[26] but they negatively respond to accommodations for the rights of way issues (Column (3)); put them all together, the overall response of large firms to these policies is statistically insignificant (Column (5)). This heterogeneity could be partially driven by the leader's advantage in leveraging the existing infrastructure and relationships (Section 2.3), and also by potential frictions in the financial market that disproportionately increase financial costs to followers, as opposed to leaders. In this regard, the pro-investment policies seem to be procompetitive, in the sense that it levels the playing field by helping small firms more than large ones.

To the extent that state policies take into account unobserved factors that are correlated with broadband investment, the correlations between state policies and investment outcomes are not causal. One important such channel might be an unobserved shock for Internet demand at the state level, which affects both investment and policy in the same direction. In that case, our policy effect parameters may be over-estimated. Our main focus, however, is the difference in policy effects among large vs. small firms. Therefore, the standing of our results on heterogeneous policy effects relies on whether the estimation bias is disproportionately distributed between these two types of firms.

Notably, the inverted U-shape relationship between Democratic vote share and broadband investment in a county holds for large firms but not for small firms, echoing the results of Table 4. In addition, large firms' investment tends to be more responsive to the state political environment than small firms. The odd columns in Table 6 show that investment by large firms is negatively associated with a Republican

[26]Note that large firms still respond less than small firms do in this dimension.

Table 6. Heterogeneous Response to Policy vs. Politics by Firm Size

	Investment in (log) number of blocks					
	(1) Large	(2) Small	(3) Large	(4) Small	(5) Large	(6) Small
Broadband policy:						
Any tax incentives/grants	0.399***	0.421***				
	(0.0456)	(0.0689)				
Any ROW accommodation			-0.293***	0.152*		
			(0.0503)	(0.0874)		
Number of all policies					-0.010	0.049**
					(0.0136)	(0.0233)
Local political environment:						
Democratic vote share	4.414***	2.418*	4.091***	1.933	3.900***	1.927
	(1.010)	(1.398)	(1.014)	(1.410)	(1.018)	(1.408)
(Democratic vote share)^2	-4.233***	-2.577	-3.714***	-1.894	-3.491***	-1.838
	(1.131)	(1.588)	(1.138)	(1.594)	(1.140)	(1.594)
State politics:						
Democrat governor	0.192***	0.0922	0.153***	0.063	0.162***	0.060
	(0.044)	(0.074)	(0.043)	(0.073)	(0.043)	(0.073)
Lame-duck governor	0.050	-0.073	0.052	-0.089*	0.041	-0.083*
	(0.032)	(0.049)	(0.032)	(0.049)	(0.032)	(0.049)
Governor's vote margin	-0.003*	-0.001	0.001	0.004*	0.001	0.003
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
Divided branch/legislature	-0.250***	-0.013	-0.212***	0.014	-0.226***	-0.005
	(0.034)	(0.067)	(0.034)	(0.067)	(0.034)	(0.067)
Competitive legislature	-0.126***	0.062	-0.083**	0.104*	-0.071**	0.084
	(0.036)	(0.062)	(0.035)	(0.062)	(0.036)	(0.063)
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: This table presents the OLS results. See the notes of Table 4 for the definition of small and large firms, the sample selection criteria, and the description of the outcome variable. Standard errors are adjusted for clustering within counties, and are provided in parentheses. Asterisks indicate the statistical significance at the 1% (***), 5% (**) and 10% (*) levels. † : The (time-varying) county attributes are listed in Table A1.

governor, divided state government, and state legislature with a slim majority. On the other hand, the even columns presents no statistically significant correlations between investment by small firms and variables representing state political environment.

6.3. **Heterogeneity Analyses and Alternative Explanations.** The extent to which large firms' investment is driven by a policy deterrence motive may depend on the market structure and political environment. First, as there are many large firms operating in a state, the benefits of policy-motivated investments are dissipated among the firms, prompting them to free-ride on one another. To see this, using the data of first semester in 2010, we count the number of large firms operating in a county and then take the average at the state level. The median value is 2.34, based on which we divide the states into two groups. Columns (1) and (2) in Table 7 present the OLS results based on the specification of (2), using large firms only, for states with a fewer vs. more number of large firms, respectively.[27] We find that the inverse U-relationship documented in Table 7 is driven by the states with a fewer number of large firms.

Second, as the value of swing voters to the governor or the state legislature decreases, firms' incentives to invest in swing locations to influence policies may also diminish. One source of variation in the swing voters' value is the strength of a majority party's hold on the state legislature. Column (3) in Table 7 shows the OLS results of (2) for large firms, focusing on the states without super-majority (2/3 of the seats) in either chamber of the state legislature; Column (4) shows the counterpart for the remaining states. The results reveal that the pattern of more investment by large firms in swing locations is more pronounced for the former set of states. A similar conclusion is drawn by comparing the OLS results for two groups of states (Columns (5) and (6)): the states where the majority party of a chamber in the state legislature has a slim advantage in the number of seats (5%) vs. the rest.

Although these results are consistent with our theory, it is important to acknowledge that the voting behavior of residents in a county is not random. Specifically, there may be unobserved time-varying county-firm attributes, represented as ϵ_{fct} in (2), that are correlated with both the Democratic vote share and the broadband investment.[28] Note that state-level broadband policies tend not to be location-specific, and if anything, they target rural areas, which are often not electorally competitive

[27]Because the market structure can be influenced by government policies and firm investments, we use the 2010 market structure and do not employ the data from 2010 in the regression.

[28]Recall that for the results in Tables 4 and 7, unobserved time-invariant county attributes and time-varying firm-state attributes are controlled for through respective fixed effects.

Table 7. Heterogeneity in Politically Motivated Investment

	Investment in (log) number of blocks[a]					
	Num. of Large Firms[b]		Competitive Legislature[c]			
			Super majority		Slim majority	
	(1) Few	(2) Many	(3) No	(4) Yes	(5) Yes	(6) No
Democratic vote share	4.039***	4.693**	5.177***	1.369	6.707***	2.023
	(1.421)	(2.221)	(1.482)	(1.762)	(1.869)	(1.420)
(Democratic vote share)^2	-3.877**	-2.467	-6.488***	0.972	-8.852***	-1.002
	(1.724)	(2.141)	(1.691)	(1.771)	(2.195)	(1.518)
Time-varying county attributes[d]	Y	Y	Y	Y	Y	Y
Firm-state-period FE	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y
Maximized at Dem. vote share	0.521	0.951	0.399	-0.704	0.379	1.009
	(0.116)	(0.495)	(0.048)	(2.056)	(0.046)	(1.007)
Number of observations	115,609	101,643	190,895	57,332	121,823	126,404
Adjusted R^2	0.345	0.395	0.374	0.425	0.382	0.389

Notes: This table presents the OLS results, focusing on large firms' investment only (see the notes of Table 4 for the definition of large firms). The unit of observation is at the firm-county-period level, for the period of 2010–2019 (except for Columns (1) and (2), where we omit data from 2010). Standard errors are adjusted for clustering within counties, and are provided in parentheses. Asterisks indicate the statistical significance at the 1% (***), 5% (**) and 10% (*) levels.
On variable construction: *a.* The outcome variable is the logarithm of the number of census blocks with broadband investment (any technology or that with at least 25 Mbps maximum download speed) by a given firm plus 0.001, so that we include observations with no investment. *b.* We calculate the average number of large firms operating in a county at the state level using the data of the first semester of 2010. The states with the average number less than or equal to the median (2.34) are used in Column (1), and the rest are used in Column (2). *c.* We look at the party composition of both state House and Senate during a given period. We define that there is a super majority in the state legislature if the majority party of a chamber holds at least 2/3 of the seats; a slim majority if the majority party holds less than or equal to 5% more seats in both chambers. *d.* The (time-varying) county attributes are listed in Table A1.

(see Table A1 in the Appendix). Perhaps, mayors or other (elected) local officials may be eager to help broadband investment through various policies that boost the demand for broadband Internet services or reduce the hurdles of investment especially if they face tough elections. Relatedly, empirical evidence suggests that local politicians actively attract firm investment via tax incentives and subsidies (Jensen, Malesky, and Walsh, 2015; Mast, 2020; Slattery, 2020; Slattery and Zidar, 2020; Jensen, Findley, and Nielson, 2020). If so, firms may be simply responding to these policies, as opposed to making preemptive investment to influence policies. However, this alternative explanation is not consistent with our finding that the inverted U-shaped relationship is not observed for small firms (Tables 4 and 6).

7. Conclusion

This paper provides a new channel through which firms gain competitive advantages by influencing government policies through their investment in local markets. We document a robust empirical pattern that more broadband investments occur in electorally competitive counties, and this pattern is driven by large firms. We connect our theory to this empirical finding by interpreting that local political environment, associated with how electorally competitive a given location is in state-wide elections, affects the extent of such policy influence. We show evidence that state policies promoting broadband investment respond more to the level of broadband in the electorally competitive counties.

Our findings have several welfare implications. First, given that firms' policy deterrence incentives are motivated by the benefits from decreased competition, consumers may be worse off due to higher prices and perhaps lower service quality, which are often-documented outcomes of reduced competition. Second, there can be misallocation of resources, in the sense that there are more investment for electorally competitive locations, at the expense of other locations. Given that urban areas are more likely to be electorally competitive than rural areas (Table A1), the policy deterrence incentive may exacerbate the "digital divide," an uneven access to high-speed Internet across geographical areas and socio-economic groups. For example, the Federal Communications Commission (FCC) estimated that 21 million Americans, 14.5 million of them living in rural areas, still had no access to broadband services in 2019.

Last and most importantly, our findings suggest that there might be weaker government support for broadband investment than, perhaps, the socially desirable level. The effects of this inefficiency can be propagated beyond this single industry, as individuals' and households' ability to access reliable/affordable Internet has increasingly become essential to their well-being in economic, political, and social aspects. The recent COVID-19 pandemic has accelerated this trend and expanded it to remote work, online education, telehealth and telemedicine, and even the ability to self-isolate at home (Chiou and Tucker, 2020). The central issues discussed in this paper—the uneven competition landscape, the mis-allocated resources, and the policymaking in the U.S. broadband investment—may ultimately contribute to frictions and ill-functioning in U.S. labor market, regional growth and macro economy.

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Table A1. County Attributes: Urban vs. Rural

	Urban	Rural	Difference	SE
Average Democratic vote share	0.421	0.363	0.058***	(0.001)
Population size (in millions)	0.127	0.008	0.119***	(0.003)
% Female	0.502	0.493	0.009***	(0.000)
% Kids (aged under 5)	0.061	0.056	0.005***	(0.000)
% Senior (aged over 65)	0.162	0.200	-0.038***	(0.000)
% White	0.827	0.866	-0.039***	(0.002)
% Black	0.097	0.065	0.032***	(0.001)
% Asian	0.015	0.005	0.010***	(0.000)
% Hispanic	0.161	0.138	0.023***	(0.002)
% College-educated	0.199	0.162	0.036***	(0.001)
% In labor force	0.601	0.573	0.027***	(0.001)
% Working at home	0.042	0.070	-0.028***	(0.000)
% Commuting in long distance	0.173	0.188	-0.016***	(0.001)
% Using public transportation	0.011	0.004	0.007***	(0.000)
Average household size	2.643	2.539	0.104***	(0.003)
(log) Median household income	10.763	10.663	0.100***	(0.002)
% In poverty	0.160	0.162	-0.002***	(0.001)
% Living in an old house	0.293	0.358	-0.065***	(0.001)
Median year a house was built	1975.221	1970.175	5.046***	(0.106)
% Living in a rental property	0.291	0.243	0.047***	(0.001)
% Owning a phone	0.971	0.972	-0.001***	(0.000)
Population density	0.000	0.000	0.000***	(0.000)
Population growth rate	0.004	0.001	0.003***	(0.000)
Median household income growth rate	0.002	0.002	-0.000***	(0.000)
% College-educated growth rate	0.070	0.075	-0.005***	(0.002)

Notes: These statistics are based on 62,778 observations. An urban county refers to a county where some area within the county is categorized as urban by the Census criteria, and in a rural county, all areas are rural. The standard errors of mean differences are in parentheses.

TABLE A2. Measuring Investment

	Investment in (log) number of blocks			
	County-level		Firm-level	
	(1) Any	(2) $\geq$ 25 Mbps	(3) Any, Large	(4) Any, Small
Mean of investment	0.117	0.774	1.668	1.351
Fraction of any nonzero investment	0.692	0.727	0.397	0.390
Median number blocks invested (if invested)	46	73	20	9
Number of counties	3,140	3,140		
Number of firms			97	1,932
Number of observations	49,784	49,661	248,227	196,943

Notes: This table reports the extent of investment at the county-time level (left panel) and at the firm-county-time level (right panel).

TABLE A3. Politically Driven Capacity

	Capacity by blocks with any service[a]			
	(log) number		(log) population	
	Any (1)	$\geq$ 25 Mbps (2)	Any (3)	$\geq$ 25 Mbps (4)
Democratic vote share	1.222**	4.387***	2.954***	4.496***
	(0.482)	(1.248)	(0.555)	(1.012)
(Democratic vote share)^2	-1.226**	-4.022***	-2.750***	-4.111***
	(0.518)	(1.333)	(0.602)	(1.115)
Time-varying county attributes[b]	Y	Y	Y	Y
State-period FE	Y	Y	Y	Y
Dem. vote share maximizing investment	0.499	0.545	0.537	0.547
	(0.057)	(0.055)	(0.034)	(0.049)
Number of observations	62,066	62,066	62,066	62,066
Adjusted R^2	0.675	0.391	0.841	0.576

Notes: This table is based on 3,140 county $\times$ 20 semi-annual periods, with some observations dropped due to unavailability of certain variables from the American Community Survey. Standard errors are adjusted for clustering within counties, and are provided in parentheses. Asterisks indicate the statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

On variable construction: a. For Columns (1) and (2), the outcome variable is the logarithm of the number of census blocks with broadband service plus 0.001 for Columns (1) and (2). The difference between (1) and (2) lies in that we consider any broadband service for (1) while we focus on high-speed service (with at least 25 Mbps download speed) for (2). For Columns (3) and (4), we consider the weighted number of blocks, where the weight is population of each block, and add 1 when taking the logarithm to include counties without broadband service. b. The time-varying county attributes are as listed in Table A1.

TABLE A4. Politically Driven Investment: Alternative Measure

	Investment in (log) population of blocks[a]			
	Any			$\geq$ 25 Mbps
	(1)	(2)	(3)	(4)
Democratic vote share	10.45***	7.951***	3.760***	1.694*
	(0.717)	(0.833)	(0.760)	(0.901)
(Democratic vote share)^2	-9.903***	-8.508***	-3.995***	-2.167**
	(0.821)	(0.906)	(0.852)	(1.039)
Time-varying county attributes[b]	N	N	Y	Y
State-period FE	N	Y	Y	Y
Dem. vote share maximizing investment	0.528	0.467	0.471	0.391
	(0.012)	(0.011)	(0.032)	(0.069)
Number of observations	49,784	49,784	49,661	49,661
Adjusted R^2	0.013	0.322	0.352	0.225

Notes: This table is based on 3,140 county $\times$ 16 semi-annual periods. We cut 4 periods from the 20 periods in the time span of our data: we do not use NITA to FCC transitional periods, December 2013 and June 2014, due to inconsistent reporting; we lose June 2019 and December 2019 data due to 2-period forward calculation of investment. The number of observations slightly changes across the columns because time-varying county attributes based on the American Community Survey are not always available. Standard errors are adjusted for clustering within counties, and are provided in parentheses. Asterisks indicate the statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

On variable construction: a. The outcome variable is the logarithm of the population of census blocks with broadband investment plus 1, so that we include observations with no investment. b. The time-varying county attributes are as listed in Table A1.

Table A5. Politically Driven Investment/Capacity: Firm-level

	Investment in (log) population of blocks		Investment in (log) number of blocks, $\geq$ 25Mbps	
	(1) Large	(2) Small	(3) Large	(4) Small
Democratic vote share	1.970***	-0.066	5.138***	0.268
	(0.712)	(0.950)	(1.207)	(1.585)
(Democratic vote share)^2	-2.253***	-0.190	-3.779***	-0.780
	(0.794)	(1.077)	(1.302)	(1.741)
Time-varying county attributes†	Y	Y	Y	Y
Firm-state-period FE	Y	Y	Y	Y
County FE	Y	Y	Y	Y
Dem. vote share maximizing investment	0.437	-0.174	0.680	0.171
	(0.087)	(3.365)	(0.126)	(0.716)
Number of firms	97	1,932	97	1,932
Average (potential) counties per firm	277.39	10.58	277.39	10.58
Number of observations	248,227	196,943	248,227	196,943
Adjusted R^2	0.372	0.373	0.378	0.411

Notes: This table presents the OLS results based on a constructed balanced firm-county-time period panel. Standard errors are adjusted for clustering within counties, and are provided in parentheses. Asterisks indicate the statistical significance at the 1% (***), 5% (**) and 10% (*) levels. † The (time-varying) county attributes are listed in Table A1.