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Fighting City Hall: Entry Deterrence and Technology Upgrades in Cable TV Markets

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This article investigates how private firms respond to potential entry from public firms. This paper uses a data set of over 3,000 U.S. cable TV systems to present evidence consistent with entry deterrence. Incumbent cable TV firms upgrade faster when located in markets with a potential municipal entrant. However, the same systems are then slower to offer new products enabled by the upgrade, suggesting upgrades in these markets occur for strategic reasons. Incumbent cable systems also upgrade faster in response to municipal entry threats than to private entry threats. Understanding how private firms respond to potential entry from public firms is especially important in light of recent U.S. government entry into several industries.

Key words: entry; entry deterrence; technology; public–private interaction
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1. Introduction

Following passage of the Telecommunications Act of 1996, numerous municipal electric utilities entered the cable TV business. In many cases the municipal electric utility entered into direct competition with an incumbent private cable TV firm, resulting in a mixed duopoly. Prior research indicates that municipal providers set prices low (Emmons and Prager 1997, FCC 1994) in an effort to pursue public welfare instead of profit (Hauge et al. 2008). Incumbent firms facing threat of entry from public firms realize that profits in the market will be much lower if public firm entry is successful, and therefore have incentives to deter entry ex ante.[1] Anecdotal evidence suggests that system upgrades by incumbent cable TV firms act to delay or deter municipal entry (Anderson 2009), but no systematic analysis has been conducted. This paper examines the extent to which incumbent cable TV firms use system upgrades in response to threat of municipal entry and compares the response to potential private firm entry.

This paper uses hazard models to study the upgrade timing of 3,000 geographically separate U.S. cable TV systems between 2001 and 2009. The results indicate that incumbents in cities with municipal electric utilities upgrade their cable systems *earlier* than incumbents in cities without municipal electric utilities. Additional results using cross-sectional variation of state laws that prohibit cross-subsidization of municipal entry helps rule out alternative explanations. The results also indicate that, conditional on an upgrade, incumbents in cities with municipal electric utilities offer new services enabled by the upgrade *later* than incumbents in cities without municipal electric utilities. The systematic difference between upgraded systems located in cities with and without municipal electric utilities suggests that strategic motives play a large role in upgrade timing when municipal entry threatens incumbents. A final set of results indicates that incumbent cable systems upgrade earlier when facing threat of municipal entry but not threat of private entry.

This paper contributes to three literatures. First, this paper provides empirical evidence consistent with entry deterrence. As highlighted by Wilson's (1992) review of entry deterrence literature, empirical evidence of entry deterrence is sparse. This article, similar to Dafny (2005) and Hamilton and McManus (2010), provides evidence of incumbents investing resources to raise barriers to entry. In contrast, Lieberman (1987) found no evidence that incumbents act to deter entry. Similar to this paper, Savage and Wirth (2005) found no evidence that incumbent cable TV firms respond to potential private firm entry. However, this paper differs by focusing on potential municipal entry and provides evidence that incumbents respond by upgrading their systems. To the best of my knowledge, this is the first paper to study entry deterrence in the face of potential public firm entry.

In highlighting the role of municipal entrants, this paper also contributes to a stream of literature that seeks to understand the complex relationship

[1] For evidence that incumbent cable firms recognize the threat posed by municipal entry, see Charter Communications' (2005, p. 26) SEC Form 10-K.

between private providers and municipalities or other public agencies. Municipalities contract with private providers for many services (Levin and Tadelis 2010), but in some cases municipal provision is a viable substitute for private provision. Hence, private providers offering goods or services that are deemed to be in the public interest operate not only in the shadow of a government regulator (Short and Toffel 2007, Holburn and Vanden Burgh 2008), but also in the shadow of a potential competitor. A rich theoretical literature in economics studies the interaction between private providers and public regulators (e.g., Cremer et al. 1989, De Donder and Roemer 2009).[2] This paper builds on existing literature by showing how a public firm can improve public welfare by seeking market entry.

Finally, the paper adds to literature studying the effects of various regulatory policies. In allowing competitive entry through the Telecommunications Act of 1996, the federal government hoped that actions by private firms would lead to beneficial public welfare outcomes, an area of growing interest in the management literature (e.g., Mahoney et al. 2009). Much of the existing research studies how the Telecommunication Act of 1996 affected telecommunications firms (e.g., Greenstein and Mazzeo 2006, de Figueiredo and Edwards 2007). This paper focuses on the cable TV industry to show that threat of entry from municipal electric utilities leads to an improvement in incumbent service quality. The results also show that state laws restricting municipal entry reduce incumbent incentives to improve service quality. This complements a study by Wallsten (2005) that studies the effect of state policies on broadband penetration.

The next section provides industry background. Section 3 describes the data. Section 4 describes the empirical methodology. Section 5 presents the results in four subsections. The first subsection provides the main result that incumbent firms upgrade earlier when based in a city with a municipal electric utility. The second subsection uses variation in state laws restricting municipal entry to help rule out alternative explanations. The third subsection investigates post-upgrade behavior of the incumbent cable system to provide evidence that the upgrades are strategic. The fourth subsection then contrasts incumbent responses to potential entry by public and private firms. A final section concludes.

2. Industry Background

The Telecommunications Act of 1996 implemented a set of deregulatory policies aimed at increasing competition faced by incumbent telecommunications firms, including cable TV firms. The increase in competition raised incentives for innovation and delivery of new services (Shelanski 2007). To this end, private investor-owned electric utilities and municipal electric utilities were encouraged to offer telecommunications services in competition with incumbent providers (Eger and Becker 2000). By 2001 close to 100 cities used municipal electric utility infrastructure to build and subsequently provide cable TV service (Gillett et al. 2006).[3] Anecdotal evidence suggests that municipalities enter the cable TV business in an effort to address the incumbent's poor quality or high prices (Anderson 2009, Hauge et al. 2008). Studies of cable TV industry pricing show that prices in mixed duopolies are substantially lower than private–private duopolies (Emmons and Prager 1997, FCC 1994), suggesting that public welfare and not profit maximization motivates municipal entrants. Hauge et al. (2008) reached a similar conclusion in their study of municipal telecom providers.

Municipal electric utilities are city-owned power providers. Most municipal electric utilities were established in the early 20th century. Since 1948, the start of the cable TV industry in the United States, there has been little entry or exit of municipal electric utilities.[4] Municipal electric utilities own infrastructure that can be used to build out cable TV and other telecommunications services. For example, some municipal electric utilities own private networks to communicate with other city agencies or fiber-optic networks that monitor electricity load throughout the municipal electric utility system.[5] The use and servicing of these networks involves skills that are redeployable in the operation of a cable TV network. These networks can also be used as part of the physical infrastructure of a city-owned cable TV system. Other assets from the municipal electric utility such as service vans, customer service representatives, billing systems, and buildings can be used to serve cable TV customers. Ownership of these assets and infrastructure reduces both setup and operating costs for a municipal cable TV system relative to cities that have no municipal electric utility.

Aside from these economies of scope, local governments can use tax-free financing in the form of municipal bonds to build a cable TV system and can also

[2] Interactions between public and private firms can be construed more broadly as interactions between organizations with different objective functions, an area of growing research interest (e.g., Casadesus-Masanell and Ghemawat 2006).

[3] Note that the municipal entrant is not privatized upon entry.

[4] Using data from the Federal Power Commission (1948) and the American Public Power Association (2001), the pairwise correlation between cities with municipal electric utilities in 1948 and cities with municipal electric utilities in 2001 is 0.88.

[5] Many municipal electric utilities laid fiber-optic cables in the 1980s and 1990s to monitor electricity load throughout the system. Typically less than 10% of the fiber was used for monitoring (Eger and Becker 2000).

use projected future revenue from the city's municipal electric utility to cross-subsidize entry into cable TV. For example, Alameda Power, a municipal electric utility in Alameda, California, used its existing fiber-optic infrastructure to build a cable system in 2001. In order to build the system, Alameda issued bonds on the anticipated revenue from the cable system and also received cross-subsidies from its residential electricity business. A number of states have proposed and passed legislation limiting a municipal electric utility's ability to cross-subsidize entry into cable (see Table 1). In other states, the municipal electric utility may be allowed to enter the cable TV business, but only after incurring additional costs to satisfy state legislation or obtain voter approval. These laws effectively raise entry barriers to municipal entry, reducing the advantage that municipal electric utilities gain from economies of scope. Laws restricting municipal entry are highly controversial (Bailey et al. 2006, Gillett et al. 2006) and continue to be debated in states.[6]

Incumbent cable TV firms also face potential competition from several private companies. Companies such as RCN and Knology build their own cable networks to compete with incumbents; companies such as Qwest and Verizon have subsidiaries that use existing telephone infrastructure to offer video. Collectively, these private entrants are called "overbuilders." Typically, overbuilders focus their entry decisions on a specific geographic area. For example, in its 2005 annual report, RCN (2005, p. 6) noted that its strategy is to selectively expand its footprint: "RCN will continue to seek opportunities to increase its network footprint within and adjacent to its existing market clusters." Building off of the existing footprint allows the private overbuilder to take advantage of economies of scale in customer service, maintenance and repair.

In the cable TV industry, the largest capital outlays over the past decade have been to upgrade systems from one-way to two-way. For most of cable TV's history, cable systems have been one-way, in which the cable firm sends video content signals through the system to the customer. One-way systems have difficulty handling upstream transmissions from the customer because the large number of amplifiers creates points of ingress for signal interference (Ciciora et al. 2004). Changes to cable system technology in the mid-1990s allowed cable firms to upgrade their systems to two-way, in which the customer not only receives a signal but can also send a signal back through the system. Two-way systems provide better signal quality

[6] For example, in March 2011, North Carolina passed a law prohibiting cross-subsidies to a municipal telecommunications provider (see Lasar 2011).

Table 1 Information on State Laws and Affected Cities

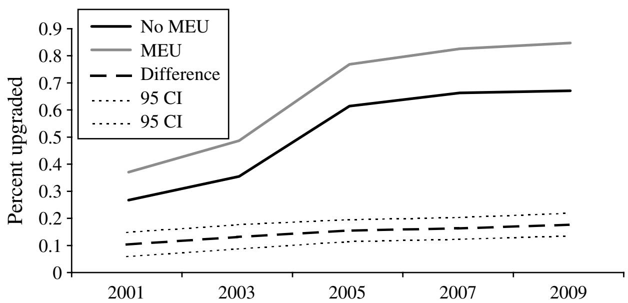
State	No cross-subsidy	Any restriction	Ever considered	Systems	Systems w/MEU
Alabama[f]	2006		Yes	76	18
Alaska				12	5
Arizona				37	6
Arkansas[a]		pre-2001	Yes	77	8
California				117	21
Colorado[e]		2005	Yes	79	18
Connecticut				17	1
Delaware				3	1
DC				1	0
Florida[b]	2001	2001	Yes	60	10
Georgia				90	16
Hawaii				2	0
Idaho				24	2
Illinios			Yes	36	6
Indiana			Yes	121	23
Iowa[c]	2003	2003	Yes	173	37
Kansas				178	61
Kentucky				85	23
Louisiana[e]		2005	Yes	56	7
Maine				42	1
Maryland				18	2
Massachusetts				42	6
Michigan[e]		2005	Yes	145	19
Minnesota[b]		2001	Yes	164	48
Mississippi				50	11
Missouri[a]		pre-2001	Yes	158	46
Montana				62	0
Nebraska[b]		2001	Yes	101	44
Nevada[a]		pre-2001	Yes	14	1
New Hampshire				19	1
New Jersey				25	0
New Mexico				35	5
New York				58	5
North Carolina				85	26
North Dakota				52	5
Ohio[e]		2005	Yes	120	17
Oklahoma				187	32
Oregon			Yes	64	6
Pennsylvania[d]		2004	Yes	77	3
Rhode Island				2	0
South Carolina[d]	2003	2003	Yes	45	12
South Dakota				60	11
Tennessee[a]	pre-2001	pre-2001	Yes	61	25
Texas[b]		pre-2001	Yes	309	37
Utah[b]	2001	2001	Yes	48	14
Vermont				11	2
Virginia[a]	pre-2001	pre-2001	Yes	54	9
Washington[d]		2003	Yes	69	12
West Virginia			Yes	62	2
Wisconsin[d]	2004	2004	Yes	76	9
Wyoming				42	8

Sources. Sources include information from Balhoff and Rowe (2005, pp. 104–108) for details on each state law and Baller Herbst Law Group for timing of the laws' passage.

Notes. This table shows the date when each state passed legislation prohibiting cross-subsidies between the city's municipal electric utility (MEU) and municipal cable TV system (No cross-subsidy), when each state passed legislation in any way restricting or prohibiting the city's ability to offer municipal cable TV (Any restriction), or if the state has ever considered passing such legislation (Ever considered). No cross-subsidy is a subset of Any restriction, which in turn is a subset of Ever considered. The table also counts the number of systems and number of systems based in a city with an MEU in the data sample used in this paper.

[a] Baller and Stokes (1999).
[b] Baller (2001).
[c] http://www.legis.state.ia.us/IACODE/2003/388/10.html.
[d] Baller (2006).
[e] Baller (2005).
[f] Baller (2011).

Figure 1 **Cumulative System Upgrades**



Notes. This figure plots the cumulative percentage of cable TV systems that have been upgraded to two-way for each year in the data set. The systems have been divided into two groups, those that are based in a city with a municipal electric utility (MEU) and those that are based in a city with no municipal electric utility (No MEU). The difference in the probability of upgrade between these groups is also shown, along with a 95% confidence interval band.

than one-way systems. Two-way systems also allow the cable firm to offer advanced services such as telephony and broadband Internet access that are increasingly demanded by residential customers (Crandall 2005). However, upgrading from one-way to two-way is costly because it involves laying new fiber-optic wire and installing new system amplifiers and other equipment.[7] In 2001, about 25% of systems had been upgraded; by 2009, about 75% of systems had been upgraded (see Figure 1).

Although incumbent cable TV firms upgrade their systems in response to customer demand in most cases, anecdotal evidence also indicates that incumbents strategically use system upgrades to deter entry (Anderson 2009). Upgrades raise the fixed cost for a rival to enter, making upgrades effective at deterring both municipal and private entry. In addition, the better signal quality afforded by the upgrade and the prospect of advanced services such as telephony and broadband improve the cable firm's service, obviating the incentives for the municipality to enter for public welfare reasons. A brief description of the experience in Cleveland, Tennessee, provides an example. The city of Cleveland, Tennessee, established a municipal electric utility in 1939. The incumbent cable TV system in Cleveland was originally built in 1977 and had not been upgraded by 2001, at which time the city considered using its municipal electric utility infrastructure to enter the cable TV business (de Medici 2001). In response to the threat of municipal entry, Charter started to upgrade its system in 2002 and completed the upgrade in 2003 (de Medici 2003). The city subsequently shelved its plan to use the municipal electric utility to enter the cable business (Bowers 2007). Charter offered broadband over the upgraded system by 2005 and telephony over the upgraded system by 2009.

The empirical sections that follow use a data set of over 3,000 cable TV systems to systematically examine the idea that incumbents time system upgrades to deter municipal entry and also contrast this response to the incumbent's response to potential private firm entry.

3. Data and Variables

The empirical analyses use an unbalanced panel of cable TV system data from 2001 to 2009. As shown in Figure 1, over 50% of cable systems were upgraded during this time period.[8] The source of cable system data is Warren Communications' *Television and Cable Factbooks* for October 2001, October 2003, January 2006, October 2007, and October 2009. January 2006 data are used in place of October 2005 data because of data availability. The *Factbook* data are the main source of cable TV system-level characteristics used in most empirical studies of the industry (e.g., Rubinovitz 1993, Goolsbee and Petrin 2004, Della Vigna and Kaplan 2007). All cable variables are measured at the system level i for the year t. The cable system data are matched to other data as described below.

3.1. Dependent Variables

Two-way upgrade$_{it}$, the dependent variable used in most regressions, is a dummy variable that equals one when a system has upgraded from one-way to two-way. *Telephony available*$_{it}$ and *broadband available*$_{it}$ are two other dependent variables used in regressions. These variables are equal to one when the incumbent system offers telephony over cable or broadband over cable, respectively.

3.2. Municipal Utility

The main independent variable of interest is *municipal utility*$_i$, a dummy variable that indicates whether system i is located in a city that has a municipal electric utility as of 2001. The variable municipal utility with *internal communications*$_i$ indicates municipal utilities that have some form of communications or fiber optic infrastructure. The median municipal electric utility in the sample was established in 1917, and none entered

[7] Several authors have estimated the costs of establishing and upgrading systems in the late 1990s/early 2000s. Estimates of fixed costs range from \$10 million to \$23 million, depending on expected population growth in the market (estimated from figures provided by Goolsbee 2006). Estimates of annual costs per subscriber range from low \$100s in high-density areas to \$600+ in less dense areas (Crandall 2005).

[8] It would be difficult to use an earlier time period because of a potential confound with digital broadcast satellite (DBS) entry. A 1999 change in regulation allowed for DBS firms to compete more aggressively with cable TV firms for customers, and as a result, from 1999 to 2001, DBS penetration increased. However, since 2001, DBS penetration has been more or less flat (Crawford 2012).

or exited the panel during the time period under study. Data on municipal utilities were collected from the American Public Power Association (2001).

3.3. Cable System Controls

Various cable system and cable firm controls are included because of their potential to influence the upgrade decision. *System age*$_{it}$ counts the number of years from when the system was first built to the current year. Older and less technologically advanced systems may be among the first to be upgraded, and hence it is important to control for these effects, whereas the capital invested in newer systems will not yet have fully depreciated. Log of *homes passed*$_{it}$, a count of the number of potential hookups that the incumbent cable system passes, is included to account for system size. Larger systems take longer to upgrade, but may be upgraded before smaller systems if larger systems are more profitable. For example, larger systems may attract higher advertising revenue, and so upgrading these systems may be a priority. A *duopoly*$_{it}$ dummy indicates whether the system competes directly with another system in the same city, and a *public*$_{it}$ dummy indicates whether the system is owned by a municipality. There are no public systems owned by a city without a municipal electric utility, and the results are robust to the exclusion of these systems.

3.4. Cable Firm Controls

Data from 2003 to 2009 include information on which firms own which systems.[9] The log of *number of systems*$_{it}$ owned by the firm is included to control for firm size (as distinct from system size). Larger firms may have access to more resources, such as bank loans or equity financing, which enables them to more quickly upgrade their technology. In addition, as larger firms upgrade more of their systems, they may move down a learning curve and be able to upgrade faster. On the other hand, larger firms may have more layers of bureaucracy that may slow the upgrading of systems. A *top* 20 *network*$_i$ indicator variable is constructed by identifying all the cable TV systems that own one or more of the top 20 programming networks. It is important to consider the effect that vertical integration may have on the upgrade decision, because vertical integration has been shown to influence other incumbent system behavior such as pricing and marketing (Waterman and Weiss 1996). An incumbent system that owns video programming content may be less threatened by a potential entrant, because the incumbent may be able to adversely influence the entrant's access to content. Fear of foreclosure from content may be enough of a deterrent to a potential entrant that an incumbent system need not upgrade early to deter entry. Several cable TV firms are vertically integrated in this way. For example, Time Warner owns 100% of CNN, TBS, and TNT, three of the top programming networks.[10]

3.5. Overbuilder Threat Measure

As discussed above, private overbuilders are more likely to enter other cities in close proximity to their existing systems. The distances between each incumbent and the closest overbuilder were calculated to create the variable *distance_to_overbuilder*$_{it}$.[11] The variable is truncated at 1,500 miles to avoid problems with extreme values. As the distance increases, it becomes less likely that the overbuilder is about to enter the incumbent's market. The distance variable will be used to investigate how the incumbent firm responds to threat of entry from private entrants.

3.6. Demographic Controls

Several demographic variables are included to control for variation across markets that might affect the incumbent's decision to upgrade its system. All demographic variables are measured at the county level and are from the 2000 U.S. Census *City and County Data Book* (Haines 2010). Demographic variables include *population density*, *percent high school graduates*, *median household income*, and *percent rural*. Population density is included to control for differences in costs of serving a market (Crandall 2005, Goolsbee 2006). Education and income variables are included to control for demand-side effects that determine early adoption of advanced telecommunication services (Greenstein and Mazzeo 2006, Xiao and Orazem 2009). The percentage of the population living in a rural area is included because prior studies have demonstrated that cable service is highly inelastic in rural areas (Mayo and Otsuka 1991).

3.7. Other Market Controls

The log of the *city elevation*$_i$ is included to control for quality of the digital broadcast satellite signal

[9] Data from 2003 and later were available in digital format from Warren Communications. Data from 2001 were only available in hard copy. The digitization process for 2001 data did not allow for capture of the "ownership" field.

[10] Chipty (2001) provides evidence that vertically integrated cable TV firms foreclose rival content providers from access to the cable system. The suggestion here is that vertically integrated cable TV firms may foreclose rival cable systems from access to content. Furthermore, it is important to note that vertical integration has been treated as an exogenous variable in this analysis, when in fact it is a strategic choice made by the firm (Williamson 1975). However, results in §5 suggest firm characteristics are not important determinants of upgrade.

[11] Distances between the incumbent's zip code and the zip code of the closest potential entrant were calculated using Spheresoft Zip Code Tools in Microsoft Excel.

Table 2 Summary Statistics and Pairwise Correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 *Two-way upgrade*	1.00																	
2 *Municipal electric utility*	0.10	1.00																
3 *MEU w/internal comm. feature*	0.15	0.49	1.00															
4 *System age*	0.16	0.09	0.10	1.00														
5 Ln *homes passed*	0.36	0.15	0.25	0.41	1.00													
6 *Duopoly*	0.07	0.05	0.09	−0.01	0.09	1.00												
7 *Public*	−0.02	0.05	0.02	−0.04	−0.02	0.12	1.00											
8 *Population density*	0.22	0.00	0.12	−0.04	0.53	0.07	−0.04	1.00										
9 *Percent HS graduates*	0.10	0.03	0.02	−0.11	0.02	0.03	0.04	0.11	1.00									
10 *Median HH income*	0.17	0.03	0.08	−0.13	0.24	0.03	−0.01	0.46	0.71	1.00								
11 *Percent rural*	−0.12	0.07	−0.08	−0.19	−0.44	−0.03	0.06	−0.51	0.00	−0.17	1.00							
12 Ln *elevation*	0.06	−0.03	0.04	−0.03	0.22	0.02	−0.06	0.42	−0.20	0.05	−0.28	1.00						
13 *Number DSL providers*	0.16	0.02	0.08	0.21	0.33	0.04	0.00	0.29	0.07	0.19	−0.20	0.12	1.00					
14 Ln *number systems owned by firm*	0.10	0.00	0.06	0.15	0.35	−0.02	−0.14	0.22	−0.12	−0.01	−0.26	0.20	0.11	1.00				
15 *Top 20 network owner*	0.10	0.03	0.03	0.10	0.23	0.02	−0.03	0.18	−0.01	0.04	−0.13	0.10	0.10	0.16	1.00			
16 *Telephony*	0.17	0.03	0.08	0.05	0.22	0.06	−0.01	0.13	0.04	0.08	−0.07	0.01	0.16	0.01	0.16	1.00		
17 *Broadband over cable*	0.96	0.10	0.14	0.17	0.36	0.07	−0.03	0.22	0.07	0.15	−0.12	0.06	0.18	0.11	0.08	0.15	1.00	
18 *Distance to overbuilder*	−0.04	−0.04	−0.05	0.02	−0.13	−0.05	0.05	−0.34	0.04	−0.18	0.02	−0.12	−0.07	−0.02	−0.04	−0.04	−0.03	1.00
Mean	0.27	0.16	0.04	27.04	7.26	0.00	0.01	3.60	70.90	10.35	6.89	3.55	4.28	4.38	0.07	0.05	0.25	131
Std. dev.	0.44	0.37	0.20	10.40	1.74	0.07	0.09	1.45	9.58	0.22	7.06	2.59	3.11	2.10	0.25	0.21	0.43	92
Min	0.00	0.00	0.00	3.00	2.77	0.00	0.00	0.10	35.70	9.61	0.00	0.00	0.00	0.69	0.00	0.00	0.00	0.00
Max	1.00	1.00	1.00	60.00	14.61	1.00	1.00	11.11	95.50	11.22	47.30	8.38	30.00	7.04	1.00	1.00	1.00	1,499

Note. MEU, municipal electric utility; HS, high school; HH, household.

(Goolsbee and Petrin 2004).[12] The elevation was obtained from each city's Wikipedia webpage. The average number of *digital subscriber line* (*DSL*) *providers* in the city at time *t* is included to control for competition from DSL providers given that broadband over cable and telephony over cable are services enabled by the upgrade to two-way. Information on DSL providers is available by zip code from the Federal Communications Commission (FCC).[13] I averaged this information across all zip codes in the city.

3.8. Designated Market Areas

Over 200 regional dummy variables are included in most regressions. These regions, called designated market areas (DMAs), are mutually exclusive and together account for all areas in the United States. Each region, which may cross state boundaries, is an area in which the population receives similar television and radio station content. The regional dummies are included to control for regional differences in demand for cable and cable-related services, regional variation in cost of implementing a two-way upgrade, and any other regional variation not already accounted for with other demographic variables (Crawford 2000).

3.9. State Laws

Robustness checks rely on variation across state laws. Information on state laws, including sources, is presented in Table 1.[14] Table 1 also lists for each state the total number of systems and the number of systems based in a city with a municipal electric utility.

Summary statistics and correlations between variables are presented in Table 2. Table 3 presents summary statistics broken out by whether the system is based in a city with a municipal electric utility or not as of 2001 (or 2003 in some cases). The *t*-tests show that systems based in a city with a municipal electric utility are significantly more likely to be upgraded to two-way as of 2001. The *t*-tests also indicate that although systems vary across some dimensions, demographic characteristics measuring population density, education, and income are similar across the two city types. The last four rows provide comparisons of telephony and broadband across the two city types. Unconditional means show that broadband over cable is more likely to be offered by systems in cities with municipal electric utilities, but no statistical difference across city type for telephony over cable. Conditional on an upgrade to two-way, the probability of a system offering broadband over cable

[12] It is worth pointing out that by 2001, the start of the period studied in this paper, DBS availability was more or less ubiquitous, and prices were uniform across markets (Crawford 2012). Other researchers have indirectly accounted for variation in demand for DBS using demographic control variables (e.g., Savage and Wirth 2005). The empirical approach used in this paper also accounts for variation in DBS demand using several demographic variables.

[13] This information is available for download from the FCC at http://www.fcc.gov/wcb/iatd/comp.html.

[14] Information on state laws comes from the consulting firm Balhoff & Williams and the law firm Baller Herbst. Table 1 includes additional details on these sources.

Table 3 Summary Statistics by Municipal Electric Utility Status

	(1) Without a municipal electric utility (2001: $N = 2{,}136$)				(2) With a municipal electric utility (2001: $N = 468$)				(3) Comparison
Systems in cities	Mean	SD	Min	Max	Mean	SD	Min	Max	t-statistic
1 *Two-way upgrade*	0.26	0.44	0.00	1.00	0.37	0.48	0.00	1.00	−4.45
2 *System age*	24.23	10.40	3.00	53.00	26.86	9.58	5.00	50.00	−5.06
3 Ln *homes passed*	7.39	1.88	2.77	14.46	7.98	1.67	4.58	12.85	−6.30
4 *Duopoly*	0.00	0.04	0.00	1.00	0.01	0.09	0.00	1.00	−2.36
5 *Public*	0.00	0.06	0.00	1.00	0.01	0.11	0.00	1.00	−2.43
6 *Population density*	3.73	1.55	0.26	11.11	3.70	1.41	0.10	8.12	0.24
7 *Percent HS graduates*	71.33	9.49	39.80	95.50	72.15	8.99	44.60	94.70	−1.57
8 *Median HH income*	10.37	0.22	9.61	11.22	10.39	0.20	9.86	11.22	−1.32
9 *Percent rural*	6.31	6.81	0.00	47.30	7.85	7.12	0.00	38.80	−4.23
10 Ln *elevation*	3.64	2.59	0.00	6.91	3.35	2.69	0.00	6.91	2.20
11 *Number DSL providers*	2.57	1.84	0.00	30.00	2.67	1.74	0.00	12.00	−1.11
12 Ln *no. systems owned by firm*	4.76	2.17	0.69	7.04	4.80	2.25	0.69	7.04	−0.24
13 *Top 20 network owner*	0.08	0.27	0.00	1.00	0.11	0.31	0.00	1.00	−1.78
14 *Distance to overbuilder*	100.38	76.59	0.00	1,499.46	91.40	59.99	0.00	632.34	2.11
15 *Broadband over cable*	0.33	0.47	0.00	1.00	0.43	0.50	0.00	1.00	−4.50
16 *Broadband* | *system upgraded*	0.92	0.27	0.00	1.00	0.88	0.32	0.00	1.00	1.85
17 *Telephony*	0.07	0.26	0.00	1.00	0.06	0.23	0.00	1.00	1.15
18 *Telephony* | *system upgraded*	0.11	0.32	0.00	1.00	0.07	0.26	0.00	1.00	2.38

Notes. The table presents summary statistics of variables separately by whether the system is based in a city (1) without a municipal electric utility or (2) with a municipal electric utility. A statistical comparison of variables across the two city types is presented in column (3). Data are from 2001 for variables 1–11, data are from 2003, for variables 12–16, and data are from 2005 for variables 17–18. Numbers of observations vary by year. Variables 16 and 18 are conditional on the system having upgraded from one-way to two-way. HS, high school; HH, household.

or telephony over cable increases (comparing means from row 15 to row 16 and means from row 17 to row 18). However, relative to their counterparts in cities without municipal electric utilities, upgraded systems based in cities with municipal electric utilities are less likely to offer either telephony or broadband over cable in 2003.

4. Empirical Approach

This paper seeks to understand the relationship between an incumbent cable TV system's upgrade decision and the presence of a municipal utility in the local market. Accordingly, the analysis begins by estimating the following latent variable model:

$$y^*_{it} = \delta_1 \mathit{municipal\ utility}_i + \mathbf{X}_{it}\boldsymbol{\beta} + \varepsilon_{it}, \qquad (1)$$

where $y^*_{it} = 1$ indicates the system i has upgraded to two-way by time t, and $y^*_{it} = 0$ indicates the system has not yet upgraded. The dummy variable *municipal utility*$_i$ equals one when system i is located in a city with a municipal electric utility. The vector $\mathbf{X}_{it}$ is a vector of controls for system i and the market in which system i is located. Each system in the study is specific to a city. Hence, the subscript i refers to both system-level characteristics and city-level characteristics. The upgrade to two-way is an absorbing state, so (1) is modeled as a discrete hazard probability that a system i will upgrade at time t given that it has not already upgraded: $\Pr(y^*_{it} > 0 \mid y^*_{it-k} < 0)$ for $k > 0$. In practice this amounts to dropping system i from the sample in years after it has upgraded. I expect $\delta_1 > 0$, which would indicate that when the market contains a potential municipal entrant, the incumbent system will upgrade earlier, all else equal. In some models, the variable municipal utility with *internal communications*$_i$ is used instead of *municipal utility*$_i$. The results of Equation (1) are presented in §5.1.

The empirical approach assumes *municipal utility*$_i$ is an exogenous variable. This assumption would be correct if municipal electric utility status were randomly assigned across the cable systems in the study. If this assumption is violated, the empirical relationship between *municipal utility*$_i$ and the incumbent system's decision to upgrade may be endogenous to other factors. For example, the incumbent system may upgrade with higher probability in the presence of substitutes, such as DSL service. In that case, a positive correlation between *municipal utility*$_i$ and the incumbent's decision to upgrade could result if cities with municipal electric utilities also happen to have more DSL providers. However, t-tests presented in Table 3 reveal no significant difference in the number of DSL providers across the two city types. In addition, demographic characteristics measuring population density, education, and income, which are correlated with advanced services take-up rates (Goolsbee 2006, Greenstein and Mazzeo 2006), are similar across the two types of cities. To help rule out such alternative explanations, all models include a large number of control variables. Three additional steps described below are also taken.

First, §5.2 uses variation in state laws that prohibit the municipal electric utility from cross-subsidizing its entry into the cable business. The analyses in §5.2 estimate models of the following type:

$$\begin{aligned} y_{it}^* = {} & \delta_1 \mathit{municipal\ utility}_i \\ & + \delta_2 \mathit{municipal\ utility}_i * \mathit{no\ cross\text{-}subsidy}_{it} \\ & + \delta_3 \mathit{no\ cross\text{-}subsidy}_{it} + \mathbf{X}_{it}\boldsymbol{\beta} + \eta_{it}, \end{aligned} \tag{2}$$

where the dummy variable *no cross-subsidy*$_{it}$ is set equal to one if the state in which system i is located has passed a law prohibiting the municipal electric utility from cross-subsidizing its entry into the cable TV business, and the other variables are as described in (1) above. If a municipal utility is located in a state with a "no cross-subsidy" law, the cost of city entry will be higher than without the law, thereby decreasing the probability of entry. I therefore expect $\delta_1 > 0$, $\delta_2 < 0$, and $\delta_1 + \delta_2 = 0$, which would indicate a corresponding decrease in the probability of early upgrade in systems located in a city with a municipal electric utility when based in a state with a "no cross-subsidy" law.

Next, §5.3 provides evidence consistent with the idea that the upgrade decision occurs for strategic reasons. There should be no systematic delay between the upgrade and the offering of advanced services such as telephony or broadband over cable if the incumbent upgrades to meet consumer demand for advanced services. On the other hand, if the incumbent upgrades for strategic reasons, there may be a delay between when the upgrade occurs and when telephony and broadband are offered. The following models are presented in §5.3:

$$w_{it}^* = \delta_4 \mathit{municipal\_utility}_i + \mathbf{X}_{it}\boldsymbol{\beta} + \gamma_{it}, \tag{3}$$

where w_{it}^* is the latent continuous value of system i offering telephony over cable or broadband over cable, conditional on having upgraded to two-way. The data show that once a system offers either telephony over cable or broadband over cable, it always offers that service, and hence (3) is modeled as a discrete hazard. As when estimating (1), this amounts to dropping system i from the sample in years after it offers the particular service. A value of $\delta_4 < 0$ would indicate that there is a systematic delay in the offering of such services by upgraded systems in cities with municipal electric utilities, which would be consistent with the incumbent system upgrading for strategic considerations.

Evidence of delay is not necessarily evidence of strategic behavior. Customers of an upgraded system receive a better quality cable signal than before the upgrade. Hence, it is possible that the incumbent upgrades in response to customer demand for improved signal quality, and those customers only demand advanced services at a later date. However, it is unlikely that customer preferences for signal quality differ between cities with municipal electric utilities and those without given that demographic characteristics including population density, education, and income are statistically similar across the two city types. Emmons and Prager (1997) find no quality differences between municipal and private cable TV systems, which provides additional evidence that customer preferences do not vary across city type.

Finally, §5.4 uses various measures of distance to the closest overbuilder to rule out the possibility that the presence of a municipal electric utility is systematically correlated with greater threat of entry from a private potential entrant. This approach has the added benefit of contrasting the incumbent's response between potential public firm entry and potential private firm entry. This is accomplished by estimating models of the following type:

$$\begin{aligned} y_{it}^* = {} & \delta_1 \mathit{municipal\ utility}_i \\ & + \delta_5 \mathit{overbuilder\ threat\ measure}_{it} + \mathbf{X}_{it}\boldsymbol{\beta} + \varepsilon_{it}, \end{aligned} \tag{4}$$

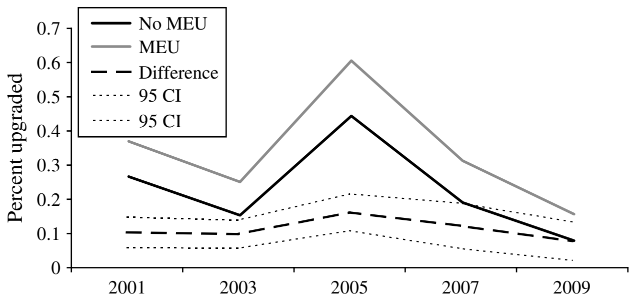
where y_{it}^*, *municipal utility*$_i$ and $\mathbf{X}_{it}$ are as described above. The variable *overbuilder threat measure*$_{it}$ will be a continuous variable, the log of distance to the closest overbuilder, or a series of dummy variables for 10 mile intervals of distance to the closest overbuilder. Because overbuilders enter new markets by expanding off their existing footprint, the distance to the closest overbuilder is a reasonable measure of the threat of entry from an overbuilder; $\delta_5 > 0$ would be evidence in support of the idea that the incumbent system is upgrading in response to potential entry from an overbuilder.

5. Results

5.1. Basic Results

Figure 1 uses raw data on the probability that a system is upgraded in year t to plot the cumulative difference in upgrades between systems located in cities with municipal electric utilities and systems located in cities without municipal electric utilities. Figure 2 plots the probability of upgrade in year t given that the system was not upgraded at $t' < t$. As with Figure 1, the raw data show that incumbent systems are more likely to upgrade when located in a city with a municipal electric utility. This difference holds across all years and is statistically significant. The following analyses demonstrate that this basic result is

Figure 2 **Annual Upgrades Given System Not Already Upgraded**



Notes. This figure plots the percentage of cable TV systems that are upgraded to two-way, conditional on not having already been upgraded, for each year in the data set. The systems have been divided into two groups, those that are based in a city with a municipal electric utility (MEU) and those that are based in a city with no municipal electric utility (No MEU). The difference in the probability of upgrade between these groups is also shown, along with a 95% confidence interval band.

robust to the inclusion of a number of control variables and is not likely to be a consequence of alternative explanations.

Linear probability regression models are used to insure that results are not affected by use of interaction terms in a logit setting (Hoetker 2007); results are robust to either type of model, however. Standard errors are robust and clustered at the cable TV system level unless noted otherwise. Baseline results on data from 2001–2009 are presented in Table 4. The main variable of interest is the dummy variable *municipal* $utility_i$, and so for ease of exposition, control variables are suppressed. Columns (1)–(5) use all years of available data and add successively more control variables

Table 4 **Determinants of Two-Way Upgrade, 2001–2009 (Discrete Hazard Model)**

	(1)	(2)	(3)	(4)	(5)
Municipal electric utility	0.062*** [0.015]	0.056*** [0.015]	0.047*** [0.016]	0.045*** [0.015]	
MEU w/internal comm. feature					0.130*** [0.029]
Controls					
Cable system characteristics?	Yes	Yes	Yes	Yes	Yes
City demographics?	—	Yes	Yes	Yes	Yes
Regional dummies?	—	—	Yes	Yes	Yes
Years (2001–2009)?	—	—	—	Yes	Yes
N	9,216	9,216	9,216	9,216	9,216
Adjusted R^2	0.133	0.147	0.184	0.251	0.253

Notes. The dependent variable equals one when the system has been upgraded from one-way to two-way. Two-way capability is an absorbing state, so the system is dropped from the sample in the period after the dependent variable becomes one. The controls include system-, city-, and county-level variables. Dummies for years (2001–2009) and region are included where indicated. Robust standard errors, clustered at the cable system level, are in brackets.

***Significant at 1%.

to show that the coefficient on *municipal* $utility_i$ is stable. The coefficient on *municipal* $utility_i$ in column (4) is 0.046 and significant at the 1% level.[15] Column (5) instead uses an indicator for municipal utility with *internal* $communications_i$, which has a coefficient of 0.133 and is significant at the 1% level. The difference in magnitude is as expected given that municipal utilities with internal communications can enter the cable market at an even lower cost, and hence pose an even greater threat to the incumbent system. Recall that, because *two-way* $upgrade_{it}$ is an absorbing state, the panel drops systems in the period following upgrade and so the results should be interpreted as a hazard. Using the coefficient on *municipal* $utility_i$ in column (4), the results indicate that cable systems in cities with municipal electric utilities that are not already upgraded by time t are 28% more likely to be upgraded by time $t+1$ than cable systems in cities without municipal electric utilities.[16]

Table 5 replicates the results in Table 4 using data from 2003–2009 to take advantage of additional information on firm characteristics. The coefficients on *municipal* $utility_i$ in Table 5 are positive and significant, but slightly lower in magnitude than in Table 4 owing to the different time period studied. The important comparison is between columns (5) and (6) of Table 5, which show that the coefficient on *municipal* $utility_i$ is unchanged by the inclusion of firm characteristic variables. The results presented in Tables 4 and 5 provide evidence that incumbents upgrade their systems earlier when based in a city with a municipal electric utility. The findings are robust to the inclusion of a number of control variables and to multiple specifications.

5.2. Variation in State Laws

State laws prohibiting the municipal electric utility from cross-subsidizing its cable business are another source of variation that can be used to aid identification of the main effect. Table 6 reports results of tests using variation in state laws. Columns (1) and (2) restrict the data set to smaller subsamples that include only municipal electric utilities (1) and only those municipal electric utilities that have internal communications (2) to test for the effect of the "no cross-subsidy" laws. In column (1), the coefficient on *no* $cross\text{-}subsidies_{it}$ is negative and significant at the 10% level, indicating that, among the subsample of systems located in a city with a

[15] Significance results are from two-tailed tests in all cases.

[16] Using the mean for municipal utility found in Table 2, $0.045/0.16 = 0.28$ (approximately). Alternately, one could run a logit on the model presented in column (4) and obtain the odds ratio on *municipal* $utility_i$. Doing so would result in an odds ratio of approximately 1.30.

Table 5 Determinants of Two-Way Upgrade, 2003–2009 (Discrete Hazard Model)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Municipal electric utility	0.059***	0.053***	0.052***	0.040**	0.038**	0.039**	
	[0.016]	[0.016]	[0.016]	[0.017]	[0.016]	[0.016]	
MEU w/internal comm. feature							0.124***
							[0.032]
Controls							
Cable system characteristics?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City demographics?	—	Yes	Yes	Yes	Yes	Yes	Yes
Cable firm characteristics?	—	—	Yes	Yes	Yes	—	Yes
Regional dummies?	—	—	—	Yes	Yes	Yes	Yes
Years (2003–2009)?	—	—	—	—	Yes	Yes	Yes
N	6,598	6,598	6,598	6,598	6,598	6,598	6,598
Adjusted R^2	0.162	0.179	0.179	0.209	0.298	0.298	0.3

Notes. The dependent variable equals one when the system has been upgraded from one-way to two-way. Two-way capability is an absorbing state, so the system is dropped from the sample in the period after the dependent variable becomes one. The controls include firm-, system-, city-, and county-level variables. Dummies for years (2003–2009) and region are included, where indicated. Robust standard errors, clustered at the cable system level, are in brackets.

**Significant at 5%; ***significant at 1%.

municipal electric utility, those systems located in a state that prohibits cross-subsidies upgrade later than those systems located in a state that allows cross-subsidies, as expected. A similar but nonsignificant result is found in column (2) when focusing on the subsample of systems located in a city with a municipal electric utility with internal communications features. Columns (3) and (4) restrict the data set to only those systems located in a state that prohibits cross-subsidies. The coefficient on *municipal utility*$_i$ in column (3) is negative and insignificant. The coefficient on municipal utility with *internal communications*$_i$ in column (4) is also negative and insignificant. The results of columns (3) and (4) show that when the incumbent cable system is located in a state Top 20 that prohibits cross-subsidies, it is no more likely to upgrade when the city has a municipal electric utility than would be other systems located in cities without municipal electric utilities.

Table 6 Effect of No Cross-Subsidies Law on Two-Way Upgrade (Discrete Hazard Model)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample restrictions (if any)	MEUs only	MEUs w/internal only	Only no cross-subsidy states		Full sample		Excludes Florida, Tennessee, Utah, Virginia	
Municipal electric utility			−0.021		0.056***		0.052***	
			[0.035]		[0.017]		[0.017]	
MEU w/internal comm. feature				−0.032		0.156***		0.149***
				[0.062]		[0.033]		[0.033]
No cross-subsidies	−0.089*	−0.155			0.010	0.003	0.013	0.004
	[0.053]	[0.109]			[0.021]	[0.020]	[0.025]	[0.024]
MEU ∗ no cross-subsidies					−0.067*		−0.030	
					[0.035]		[0.050]	
MEU w/internal ∗ no cross-subsidies						−0.139**		0.039
						[0.065]		[0.130]
Controls								
Cable system characteristics?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
City demographics?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Years (2001–2009)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,501	403	1,132	1,132	9,216	9,216	8,619	8,619
Adjusted R^2	0.282	0.405	0.315	0.315	0.251	0.253	0.251	0.254

Notes. The dependent variable equals one when the system has been upgraded from one-way to two-way. Two-way capability is an absorbing state, so the system is dropped from the sample in the period after the dependent variable becomes one. The controls include system-, city-, and county-level variables. Dummies for year and region are included where indicated. Robust standard errors, clustered at the system level, are in brackets.

*Significant at 10%; **significant at 5%; ***significant at 1%.

Columns (5) and (6) use the full sample and introduce interactions between *no cross-subsidies*$_{it}$ and *municipal utility*$_i$ or *internal communications*$_i$. The coefficient on *municipal utility*$_i$ in column (5) is 0.056 and significant at the 1% level; the coefficient on *no cross-subsidies*$_{it}$ $*$ *municipal utility*$_i$ is −0.068 and significant at the 10% level. The similarity in the absolute values of these point estimates indicates that a prohibition on cross-subsidies erases the effect on *municipal utility*$_i$, as expected. The coefficient on *internal communications*$_i$ in column (6) is 0.159 and significant at the 1% level; the coefficient on *no cross-subsidies*$_{it}$ $*$ *internal communications*$_i$ is −0.134 and significant at the 5% level. As before, the similarity in the absolute values of these point estimates indicates that a prohibition on cross-subsidies erases the effect on municipal utilities with internal communications. Wald tests of the coefficients in columns (5) and (6) cannot reject that *municipal utility*$_i$ + *no cross-subsidies*$_{it}$ $*$ *municipal utility*$_i = 0$ or that *internal communications*$_i$ + *no cross-subsidies*$_{it}$ $*$ *internal communications*$_i = 0$. Similar results are obtained in unreported models that limit the sample to systems based in states that ever considered restricting municipal entry into cable, which suggests that heterogeneity in a state's willingness to pass such a law does not impact the results.

Columns (7) and (8) repeat the analyses from columns (5) and (6), but exclude states that had already passed laws prohibiting cross-subsidies. The coefficient on *municipal utility*$_i$ in column (7) is 0.052 and significant at the 1% level; the coefficient on *no cross-subsidies*$_{it}$ $*$ *municipal utility*$_i$ is negative but not significant. The coefficient on *internal communications*$_i$ in column (8) is 0.149 and significant at the 1% level; the coefficient on *no cross-subsidies*$_{it}$ $*$ *internal communications*$_i$ is negative but not significant.[17] These last two columns suggest that the states that adopt the prohibitions later contribute little to the analysis. The results in Table 6 provide evidence that incumbents upgrade earlier when threatened by potential entry from a municipal electric utility.

5.3. Post-Upgrade Actions of Incumbents

Table 7 considers the post-upgrade actions of incumbent systems and examines the speed with which incumbents use the two-way-capable platform to offer new services such as telephony over cable or broadband over cable. Data on telephony and broadband are available only for select years, as indicated in the table. Columns (1) and (2) investigate the effect of *municipal utility*$_i$ and municipal utilities with *internal communications*$_i$ on the incumbent's hazard of offering telephony, conditional on previously upgrading to two-way. The coefficient on *municipal utility*$_i$ in column (1) is negative and statistically significant at the 1% level, indicating that upgraded cable systems in cities with municipal electric utilities that have not offered telephony by time t are less likely to offer telephony at time $t+1$ than similarly upgraded cable systems in cities without municipal electric utilities. The coefficient on *internal communications*$_i$ in column (2) is negative, but not statistically significant. Columns (3) and (4) perform similar analyses on the probability of offering broadband, conditional on having upgraded. The coefficient on *municipal utility*$_i$ is negative and statistically significant at the 10% level, and the coefficient *internal communications*$_i$ is negative but only significant at the 15% level. The coefficient on *municipal utility*$_i$ indicates that upgraded cable systems in cities with municipal electric utilities that have not offered broadband by time t are less likely to offer broadband at time $t+1$ than similarly upgraded cable systems in cities without municipal electric utilities. The results presented in Table 7 indicate that, although they eventually do offer such services, incumbents offer advanced services over their upgraded systems with a longer time lag when based in a city with a municipal electric utility. These results suggest that system upgrades occur for strategic reasons in cities with municipal electric utilities.

Table 7 Determinants of Telephony and Broadband, After Upgrade (Discrete Hazard Model)

	(1)	(2)	(3)	(4)
Dependent variable	Telephony available		Broadband available	
Municipal electric utility	−0.029***		−0.043*	
	[0.011]		[0.022]	
MEU w/internal comm. feature		−0.020		−0.045
		[0.016]		[0.033]
Controls				
Cable system characteristics?	Yes	Yes	Yes	Yes
Cable firm characteristics?	Yes	Yes	Yes	Yes
City demographics?	Yes	Yes	Yes	Yes
Regional dummies?	Yes	Yes	Yes	Yes
Years?	Yes	Yes	Yes	Yes
N	5,622	5,622	2,886	2,886
Adjusted R^2	0.312	0.312	0.392	0.391

Notes. The dependent variable in columns (1) and (2) equals one when the system offers telephony over cable; the sample covers years 2005–2009. The dependent variable in columns (3) and (4) equals one when the system offers broadband over cable; the sample covers years 2003–2009. Only systems that have been upgraded from one-way to two-way are used in the sample. The controls include firm-, system-, city-, and county-level variables. Dummies for year and region are included where indicated. Robust standard errors, clustered at the system level, are in brackets.

*Significant at 10%; ***significant at 1%.

[17] Wald tests of the coefficients in columns (7) and (8) cannot reject that *municipal utility*$_i$ + *no cross-subsidies*$_{it}$ $*$ *municipal utility*$_i = 0$, but do reject that *internal communications*$_i$ + *no cross-subsidies*$_{it}$ $*$ *internal communications*$_i = 0$ at the 15% level.

Table 8 Determinants of Two-Way Upgrade with Two Types of Potential Entrants 2003–2009 (Discrete Hazard Model)

	(1)	(2)	(3)	(4)
Municipal electric utility	0.036**	0.036**	0.036**	0.035**
	[0.017]	[0.017]	[0.017]	[0.017]
Log *distance to overbuilder*		−0.002	0.013	
		[0.009]	[0.029]	
Log *distance to overbuilder*^{2}			−0.002	
			[0.004]	
10 *miles* < *distance to overbuilder* ≤ 20 *miles*				0.008
				[0.061]
20 *miles* < *distance to overbuilder* ≤ 30 *miles*				0.013
				[0.055]
30 *miles* < *distance to overbuilder* ≤ 40 *miles*				−0.013
				[0.055]
40 *miles* < *distance to overbuilder* ≤ 50 *miles*				−0.008
				[0.055]
50 *miles* < *distance to overbuilder* ≤ 60 *miles*				0.010
				[0.054]
60 *miles* < *distance to overbuilder* ≤ 70 *miles*				−0.008
				[0.056]
70 *miles* < *distance to overbuilder* ≤ 80 *miles*				−0.008
				[0.057]
80 *miles* < *distance to overbuilder* ≤ 90 *miles*				−0.003
				[0.056]
90 *miles* < *distance to overbuilder* ≤ 100 *miles*				0.048
				[0.057]
100 *miles* < *distance to overbuilder* ≤ 110 *miles*				0.060
				[0.057]
110 *miles* < *distance to overbuilder* ≤ 120 *miles*				0.030
				[0.057]
120 *miles* < *distance to overbuilder* ≤ 130 *miles*				0.057
				[0.058]
130 *miles* < *distance to overbuilder* ≤ 140 *miles*				0.095
				[0.058]
140 *miles* < *distance to overbuilder* ≤ 150 *miles*				0.048
				[0.057]
150 *miles* < *distance to overbuilder* ≤ 1500 *miles*				0.006
				[0.054]
Controls				
Cable system characteristics?	Yes	Yes	Yes	Yes
Cable firm characteristics?	Yes	Yes	Yes	Yes
City demographics?	Yes	Yes	Yes	Yes
Regional dummies?	Yes	Yes	Yes	Yes
Years (2003–2009)?	Yes	Yes	Yes	Yes
Observations	6,362	6,362	6,362	6,362
Adjusted R^2	0.297	0.297	0.297	0.298

Notes. The dependent variable equals one when the system has been upgraded from one-way capability to two-way capability. Two-way capability is an absorbing state, so the system is dropped from the sample in the period after the dependent variable becomes one. The dummy variable for *distance to overbuilder* ≤ *10 miles* is excluded. Systems included in the sample are those with a potential entrant located within 1,500 miles. The controls include firm-, system-, city-, and county-level variables. Dummies for year are included, as are fixed effects at the DMA level. Robust standard errors, clustered at the system level, are in brackets.

**Significant at 5%.

5.4. Effect of Private Entrants

Table 8 investigates how distance to the closest private overbuilder affects the incumbent system's upgrade decision. One goal of this analysis is to rule out the alternative explanation that the presence of a municipal electric utility is systematically correlated with greater threat of entry from a private potential entrant. The other goal is to compare incumbent firm response to potential public firm entry and potential private firm entry. The analyses rely on data from 2003 to 2009 because system ownership information, which is necessary to identify overbuilder location, is not available in 2001. The model presented in column (1) replicates that presented in Table 5, column (6) for comparison. Column (2) adds in the log of the distance to the closest overbuilder, the coefficient of which is negative and insignificant. Column (3) then adds in the square of the log distance to closest overbuilder; neither the log distance nor its square is significant. Next, the distances are broken into 16 mutually exclusive bins, indicating the 10-mile segment in which the overbuilder is located. These bins range from a bin for overbuilders located within 10 miles of the incumbent to a bin for overbuilders located over 150 miles from the incumbent. Column (4) presents results from a model using the mutually exclusive bins. The bin indicating that an overbuilder is located within 10 miles of the incumbent is excluded. None of the coefficients on the bins is significant. The coefficient on *municipal utility*$_i$ does not change across the different models presented in columns (1)–(4), and thus there is no evidence that the result on *municipal utility*$_i$ is driven by the proximity of other private entrants to the incumbent system. Moreover, the different responses to potential entry by a city with a municipal electric utility versus potential private firm entry suggest that incumbents are more threatened by potential public firm entry. The finding that incumbent cable TV firms do not respond to potential entry by private firms corroborates a finding by Savage and Wirth (2005). Savage and Wirth (2005) used observed entry patterns of private overbuilders to predict future entry. They showed that incumbent firm prices do not vary significantly with predicted future entry.

6. Conclusion

The statistical analyses in the foregoing section provide evidence consistent with the idea that incumbent cable TV systems use upgrades in an attempt to deter entry by municipal electric utilities. Incumbent cable TV systems based in cities with municipal electric utilities upgrade earlier than similar incumbents in cities without municipal electric utilities. The results are even stronger for municipal electric utilities with internal communications features, which can take advantage of lower fixed costs of entry and greater economies of scope. The analyses use variation in state laws that prohibit the municipal electric utility from cross-subsidizing its entry into the cable TV business as one approach to rule out alternative explanations. Analyses of incumbents' post-upgrade actions suggest that the upgrades are motivated at least in part by strategic reasons. Finally, the results hold even when controlling for threat of entry from private entrants. Using a system upgrade as an entry deterrence mechanism appears to be effective: in the sample used for this study, only nine municipal electric utilities enter after the incumbent system upgrades to two-way.[18]

One of the main contributions of this paper is its focus on incumbent response to potential government firm entry. Recent U.S. government entry into finance and automobile manufacturing industries highlights the salience of this issue. The vast majority of management and economics literature focuses on interactions between private, profit-maximizing firms, whereas in practice many other firm types exist (McGahan 2007a, b).[19] In the setting studied in this paper, the incumbent's strong response to potential public firm entry, especially relative to the lack of response to potential private firm entry, suggests that incumbents view public entrants as *more threatening* than private entrants. This finding makes sense given that public entrants to the cable TV industry are known to set prices low and pursue public welfare objectives (Emmons and Prager 1997, Hauge et al. 2008). Thus, even though public firms may be less efficient than private firms (Megginson and Netter 2001), an incumbent facing threat of entry from a public firm realizes that the ex post profits in the market will be much lower if the public firm's entry is successful, and so the incumbent works harder to deter entry ex ante.

This paper also adds to current policy debate regarding the appropriate role for regulation of telecommunications infrastructure investments. The results show that incumbent cable TV systems based in cities with municipal electric utilities are upgraded move slowly if state laws restrict municipal entry. Moreover, systems in other cities in states with laws restricting municipal entry are not upgraded any faster than counterparts in states without such laws. These results imply that laws restricting municipal entry reduce incumbent infrastructure investments. The findings confirm the basic premise of the Telecommunications Act of 1996 that an increase in competition to incumbent providers spurs infrastructure investment. More broadly, the results provide some empirical justification for the notion in Cremer et al. (1989) that public firms can regulate incumbent private firm behavior. The results also elaborate upon Mahoney et al. (2009) by suggesting that the

[18] From Table 3 there are 468 systems in cities with municipal electric utilities. By 2009, 85%, or about 400 of the 468, had upgraded to two-way. Nine of the 400 upgraded systems subsequently experienced entry by the municipal electric utility.

[19] Notable exceptions in the management literature include recent work on nonmarket strategy (e.g., Henisz and Zelner 2003, Holburn and Vanden Burgh 2008). Notable exceptions in the economics literature include studies of interactions between not-for-profit hospitals (e.g., Duggan 2002, Gertler and Kuan 2009).

set of private firm actions that impact public welfare should include the response to *anticipated* public agency actions. In the case of incumbent cable TV firms, system upgrades achieve a local policy goal and effectively prevent the need for public intervention in the form of municipal entry. Hence, even if the potential public entrant does not gain market access, it may still gain improvement to public welfare at the local level.[20]

There are several limitations to the analysis. Threat of entry is measured differently when considering potential public and private entrants. Variation in the threat posed by public entrants comes from the presence or absence of a municipal electric utility, whereas variation in the threat posed by private firms comes from the distance to other cities that have experienced private overbuilder entry. Also, "entry" involves different trade-offs for the two types of potential entrant. Entry by a municipal electric utility entails an expansion of firm scope within the same geographical market, whereas entry by a private overbuilder entails replication of an existing business model, but within a different geographical market. The two entrant types have different capabilities and different preentry experience, which might affect the timing of entry and likelihood of success (Klepper and Simmons 2000, Helfat and Lieberman 2002, Bayus and Agarwal 2007). Finally, there are a range of entry deterrence mechanisms available to incumbents, so it is possible that incumbents use other mechanisms to deter private entry. Future research needs to be undertaken to determine how an incumbent decides between entry deterring mechanisms.

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[20] Although a full welfare analysis is beyond the scope of this study, one point to consider is the extent to which cities with municipal electric utilities benefit from system upgrades at the expense of cities without municipal electric utilities. For example, a resource-constrained cable firm that is only able to upgrade one of its cable systems in a period could face the trade-off between upgrading a system based in a city with a municipal electric utility that has less demand for advanced services and upgrading a system based in a city without a municipal electric utility but that has more demand for advanced services.

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