Competing against the City:

Entry Deterrence and New Technology Deployment in Local Cable TV Markets

Preliminary and Incomplete – Comments Welcome

September 2008

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* The author thanks David Mowery, Howard Shelanski, Steven Tadelis, Oliver Williamson and Catherine Wolfram for helpful comments, as well as participants in seminars at the University of California. The author is grateful to Shane Greenstein and Michael Mazzeo for sharing data. All errors are the responsibility of the author.

Abstract

How do incumbent firms respond to potential entrants that may not try to maximize profits? The majority of the economics and management literatures focus on interactions between two or more profit-maximizing firms. Yet in many countries for-profit firms interact with public owned enterprises and in many sectors in the US economy for-profit firms interact with non-profit firms or public enterprises. The literature is largely silent on how these interactions play out. This paper demonstrates that incumbent US cable TV firms engage in behavior to prevent potential entry by public enterprises. From the late 1990s to the mid 2000s, incumbent US cable TV firms invested billions of dollars in new technology to upgrade their systems from one-way to two-way capability. This paper shows that incumbent systems timed their upgrades so as to deter potential entry by cities with municipal electric utilities. From 2001 to 2007, incumbent firms upgraded their systems nine months earlier on average when the system was located in a city that owned a municipal electric utility. The result is robust to a number of alternative explanations; in particular, the effect disappears when a state passes a law restricting the city's ability to build and operate a cable TV system. The paper also shows that the incumbent firm's response to potential entry by the city was greater than the response to potential entry by a private firm. The results suggest that incumbent firms engage in stronger *ex ante* deterring responses when the potential entrant is asymmetric. In the context of this study, the asymmetry arises from the different cost profiles of and different objectives pursued by private and public enterprises.

1 Introduction

There exist many industries in which potential and actual entrants may not attempt to maximize profits, but instead maximize different objectives. In many countries private profit-maximizing firms interact with public owned enterprises which may pursue social welfare goals. For example, BBC, which is funded by the UK government and has an educational mission, competes against private channels. In many sectors in the US, including education and health care, private profit maximizing firms compete against non-profit firms and government entities. As another example, open source software projects rely on volunteer users instead of paid employees (Shah, 2006). A large game theory literature provides theory on how incumbent firms respond to potential entrants, but most models assume either that the entrant and incumbent are identical, or that they both maximize profits (Wilson, 1992). The small literature on mixed duopolies is an exception, a recent example of which is Casadesus-Masanell and Ghemawat (2006) who model the interactions between two software firms with different objective functions. Management literature also provides little guidance for how managers should react to potential entrants who may not maximize profits. Chen (1996) highlights the idea that while two firms may exist in the same market, they may have different resource capability profiles. To the extent that these resource endowments are fixed in the short term, they will constrain a firm's strategic choices (Teece, Pisano, Shuen, 1997). Chen suggests that rather than treat all firms in the market as the same, the entrants' market and resource profiles should be taken into consideration. Yet the settings Chen and others study primarily include those in which a rival has already entered. How should managers of incumbent, profit maximizing firms respond to threats of entry from firms that may care more about welfare than profits? One goal of this paper is to demonstrate empirically that incumbent firms actually engage in entry deterrence strategies when faced with potential entry by an entity that may care less about profit and more about welfare.

Empirical studies of entry deterrence are complicated by the difficulty of identifying potential entrants. Prior studies have accomplished this by assuming potential entry in one market segment increases with the number of competitors in adjacent segments. Goolsbee and Syverson (2008) find that incumbent airlines lower prices for a given route when Southwest begins service using the airports at either end of the given route. Dafny (2005) shows that incumbent hospitals increase surgical procedure volume to move further down the surgical procedure learning curve, thereby creating a barrier to entry into the surgical market by adjacent hospitals. Dafny uses a non-monotonicity test developed by Ellison and Ellison (2007) to show that this result is most pronounced for incumbents that face a moderate threat of entry, instead of those that expect no entry or those that expect entry with a high probability. Empirical studies of entry deterrence are further complicated by the difficulty of showing that the incumbent's actions affect the profits and hence incentives of the entrants. For example, it is unclear that an incumbent airline's low prices will affect Southwest's profitability enough to change its incentives.

This paper attempts to overcome these identification problems by studying entry deterrence in the context of the US cable TV industry. The US cable TV industry is comprised of multiple, geographically separate, city-specific systems. These characteristics allow for precise identification of the incumbent and its response to potential entrants. Deregulation of the US cable TV industry following the Telecom Act of 1996 created an opportunity for cities with municipal electric utilities to enter the local cable TV market and provide service in competition with the incumbent. About 15% of US cities operate municipal electric utilities, most of which were established by the early 20th century and hence predates the cable TV industry. Cities that enter the cable TV market justify their entry as a way to bridge the digital divide and provide service to as many residents as possible. This setting, where the potential entrant is not necessarily trying to maximize profit, but is instead trying to provide high quality service to as many residents as possible, provides an opportunity to build our understanding of how managers address non-standard threats of entry.

This paper focuses on the use of cable system technology upgrades as a mechanism used by incumbent cable TV firms to prevent entry by the city's municipal electric utility. Once an incumbent has upgraded to a state of the art system, there is no further incentive for the city to use the municipal electric utility to enter. As highlighted above, the more commonly studied entry deterring mechanisms are price and capacity. The use of technology as an entry deterring mechanism has received less attention, but is related to prior studies on investment in R&D and patents as a way to deter entry. For example, Gilbert and Newbery (1982) model how patent thickets created by incumbents can deter potential entrants. Within the management literature, new technology is often seen as a force that can be used by entrants to unseat incumbents (Christensen and Bower, 1996; Henderson and Clark, 1990). Tripsas (1997) finds that while incumbents have inferior technology to entrants in the typesetting industry, incumbents are displaced in only one of three cases. The incumbent's advantage in two of three cases arises from complementary assets. The analysis below highlights that incumbent firms use technology upgrades to deter entry, and the presence or absence of complementary assets play little to no role.

The analysis uses a dataset of over 4000 cable TV systems over seven years. Data on each cable TV system has been matched with local market information that includes information on the presence of actual and potential competitors. This study first investigates incumbent deterrence of public entrants by focusing on how the timing of system upgrades by an incumbent cable TV firm relates to the city's cost of entering the local market. Variations in entry costs within and across cities over time are used to identify potential entry by public agencies. The existing municipal utility infrastructure in 15% of cities results in lower entry costs. State laws which restrict the city's ability to use municipal electric utility assets and infrastructure result in higher costs of entry for the city. Empirical results show that incumbent firms upgrade their systems about nine months earlier when the city has a municipal utility.[1] In contrast, the incumbent shows a comparatively weak response to potential private firm entry. The results are statistically significant and robust to a number of specifications controlling for alternative explanations. In particular, once a state passes a law restricting municipal entry then incumbents no longer treat cities with municipal utilities any different from other cities.

The next section provides information about the US cable TV industry and argues that city owned cable TV enterprises pose a threat to incumbent firms. Section 3 reviews economics and strategy literature on entry deterrence and states the paper's testable hypotheses. Section 4 describes the data and methodology used to test the hypotheses. Section 5 reports the results of the main empirical tests that show incumbent firms use technology upgrades to deter city entry. Section 6 uses temporal variation in state laws to address possible threats to identification. Section 7 explores some extensions to the basic result. Section 8 investigates the extent to which incumbent firms use upgrades to deter private firm entry. Section 9 discusses the results and concludes.

2 Industry Background

2.1 Technology Change in the 1990s

Cable TV systems were first installed as one-way systems that transmitted a signal from a central location to customers along a tree and branch network of coaxial cable. Cable systems relied on amplifiers to maintain signal strength throughout the network. Such systems had difficulty handling upstream transmissions from the customer because the large number of amplifiers created points of ingress for signal interference; signal interference from the customer's end added to the difficulty (Ciciora et al, 2004). Advances in fiber optics and optical amplification technology in the 1990s

[1] On average, upgrades take 18 months to complete, and empirical results show that upgrades occur 45% earlier in a city with a municipal electric utility than in a similar city without a municipal electric utility.

helped solve some of these problems. In the late 1990s, cable systems started to upgrade from one-way to two-way capability by installing fiber optic cable and new amplifiers and moving to a distributed network configuration. Two-way capability allows the cable system to transmit and receive a signal from the customer. Such capability is an important pre-cursor to broadband over cable, video on demand, digital video recording, and telephony. Costs for upgrading a system vary by geographic and system characteristics; the average cost to upgrade is about $1500 per customer and can take six to 24 months to complete (Goolsbee, 2006).

2.2 Viability of City Provision of Cable Services

An explicit intention of the Telecommunications Act of 1996 was to encourage use of electric utility infrastructure to increase competition in telecommunications and video programming services. Electric utilities, including city-owned municipal electric utilities, own infrastructure that can be used to build out cable TV and other telecommunications services. There are several reasons city governments in particular are able to enter at low cost. First, cities with municipal utilities may be able to take advantage of economies of scope. Service trucks and customer service representatives can be used to serve the same customers; existing fiber optic networks can be used for the cable TV network. Many local governments operate public telecommunications infrastructure (often called i-Nets) that connects city departments; Gillet, Lehr and Osorio (2006) have suggested that existence of these i-Nets leads to economies of scope and learning effects that drop the cost to the city of installing and operating its own cable TV system. Local governments may be able to use tax-free financing in the form of municipal bonds to build out cable TV networks. As a result of the foregoing, following full implementation of TA96, a number of cities have entered and started to provide cable TV service; by 2002, close to 100 cities provided cable TV service (Gillett, Lehr, Osorio, 2004). For example, Alameda Power & Telecom, a municipal electric utility in Alameda, California, used its existing utility infrastructure to build a cable system in 2001. In order to build the system, the utility floated a bond for $40M with a 4% interest rate. The system also received a $4M loan from the city with a 0% interest rate [need citation].

In many cases cities need voter or state approval before offering their own telecommunications system and the presence of laws regarding these legal requirements add to the fixed cost of setting up a system. A number of states have proposed and passed legislation that limits a city's ability to provide its own cable TV service (see Table 1 for detail on which states have such laws). Some states prohibit the city from using the municipal utility to cross subsidize new businesses such as telecom or cable. Other states allow cities to offer telecom or cable services after receiving voter approval. These types of laws first came into existence in 1996 when the state of Missouri passed a law prohibiting municipalities from offering telecom services and gained wide acceptance with a US Supreme Court decision in March 2004.[2] After such a law is passed, cities with municipal utilities may no longer have a low cost advantage; while in some cases they may still be able to use the municipal utility infrastructure, they may need to incur additional costs to satisfy state legislation.

Upon entry, it appears that incumbent firms pursue a policy of welfare maximization. In fact, a number of cities have suggested that municipal entry is a way to solve the growing digital divide between high income residents that receive advanced services and low income residents that do not. Emmons and Prager (1997) show that municipal cable TV systems are able to set prices below those of private operators in similar cities, and suggest that cheap financing may be one reason cities are able to do this. Emmons and Prager (1997) shows that duopoly markets with a private firm and public firm have prices 30% below duopoly markets with two private firms. Their finding matches a FCC study (FCC, 1994) showing public-private duopoly prices are 20% lower than

[2] On March 24, 2004, the US Supreme Court ruled on the consolidated cases *Nixon v. Missouri Municipal League*, *FCC v. Missouri Municipal League*, *Southwestern Bell Telephone v. Missouri Municipal League*.

private-private duopolies. The forgoing suggests two main reasons private firms may be particularly concerned about public entry. Public providers may be low cost (relative to other potential entrants) or they may pursue different objectives than private firms. Either of these conditions may result in lower prices and possibly less profitability for the incumbent private firm.

2.3 Private Entrants

In most cities, there exists one incumbent cable TV provider. However, in the late 1990s, several private companies were formed with the explicit purpose of entering and competing with incumbent cable TV firms. Companies such as RCN and Knology built their own cable networks; companies such as Qwest and Verizon created subsidiaries to use existing telephone infrastructure to offer video. Collectively, these private entrants are called "overbuilders". Typically, overbuilders will focus on a specific geographic area. For example, in its 2005 Annual Report, RCN notes 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."[3] Building off of the existing footprint allows the private overbuilder to take advantage of economies of scale in customer service and maintenance and repair.

3 Theoretical Background and Related Literature

The relationship between an incumbent cable TV system and the city in which it operates has been studied in prior empirical research. In his case study of cable TV in Oakland, California, Williamson (1976) described how the relationship between the city and firm evolved over time from one characterized by competition between potential franchisors bidding to serve the city to one characterized by opportunism on the part of the firm after the franchise was awarded. Prager (1990) suggests that firm reputation may constrain opportunistic behavior. In a study of cable

[3] RCN SEC Form 10-K, page six. Available for download here: http://investor.rcn.com/downloads/4-10-06_10KA.pdf

contracts in Massachusetts, Zupan (1989) finds that cases of operator reneging are infrequent, and when reneging occurs, it is often due to unforeseen changes in market information. In a study closely related to this one, Savage and Wirth (2005) study the effect of potential entry by private firms on incumbent cable TV operators. They find that the potential entrants have no effect on incumbent prices, but they may have a positive effect on the number of channels offered by the incumbent. It should be noted that Savage and Wirth use cross sectional data as opposed to panel data which is used by this study; also Savage and Wirth do not consider system upgrades as a way to deter entry, nor do they consider the role cities may play as potential entrants.

There has been a large amount of theoretical work on the use of preemptive investment in capacity or capital to deter entry (see Wilson (1992) for an overview). The standard preemption model follows a Stackelberg framework whereby an incumbent in the first period adjusts capacity in anticipation of an entrant's behavior in the second period. In certain cases the incumbent can adjust capacity in such a way to entirely foreclose future entry. Standard preemption models such as those of Spence (1977) and Dixit (1980) assume capital is durable. Eaton and Lipsey (1980) relax this assumption and allow capital to depreciate. Absent potential competition, the incumbent will let capital fully expire before reinvesting. In the presence of potential competition, the incumbent will renew capital early (before it has fully depreciated) in order to avoid preemptive investment by an entrant. By renewing early, the incumbent signals to potential entrants that it will stay in the market long enough such that any entry will be unprofitable. Such a model seems well suited for industries characterized by non-trivial technological change such as the cable TV industry where capital may be non-durable or technological improvements require periodic upgrades.

There have been comparatively fewer empirical demonstrations of entry deterrence. No doubt the difficulty of identifying potential as opposed to actual entrants has contributed to the paucity of research in this area. The focus of this study is on an *ex-ante* mechanism: the use of system upgrades to deter entry into cable TV markets. *Ex-ante* entry deterrence mechanisms require overinvestment in some specific asset that is difficult to redeploy. For example, Dafny (2005) shows that hospitals overinvest in surgical procedures when entry is probable. In general, empirical results have been mixed: there is little empirical support for the idea that capacity deters entry. For example, Lieberman (1987) and Masson and Shaanan (1986) find little empirical support of incumbent use of excess capacity as a way to deter entry. There is more support for the idea that incumbents use limit pricing as a strategy to deter entry. Goolsbee and Syverson (2005) show incumbent airlines use limit pricing strategies in an attempt to deter Southwest Airlines from entering certain city-pair markets. Simon (2005) finds that newer incumbents in the magazine industry cut prices in response to entry more aggressively than older incumbents. There appear to be no studies on entry deterrence that consider an incumbent firm's response to potential entry by public firms.

One place to start to understand how private incumbents may respond to public entrants is with the theoretical literature on mixed duopolies in which competitors have different objective functions. Casadesus-Masanell and Ghemawat (2006) provide a theoretical model of a mixed duopoly competition between two software firms with different objective functions. One result shows that when the incumbent firm attempts to maximize profits and the potential entrant attempts to maximize revenue (by setting prices at marginal cost) the response of the incumbent will increase in aggressiveness as the discount rate of the installed capital increases. In other words, the faster the barrier to entry erodes, the more quickly will the incumbent respond to potential entry. This situation corresponds well to the cable TV industry: as the value of the current system depreciates (due to technological advances), the more likely it will be that the incumbent responds to a potential entrant by upgrading the system, especially when that entrant is a public entity that may not be maximizing profit.

Researchers have suggested that cities may be able to provide cable TV at a lower cost than private companies because of access to tax free financing and to learning-by-doing effects associated with owning and operating a municipal utility and/or a municipal i-Net. Actual entry and statements in annual reports support the idea that incumbent cable TV firms view cities as competitive threats.[4] Theoretical research suggests that one way an incumbent can deter a competitor's entry is by renewing capital quicker. In the cable TV industry, the largest capital outlays over the past decade have been to upgrade systems from one way to two way capability. To the extent that incumbent cable TV firms want to deter entry by a city, upgrade will occur earlier in those cities that have a lower fixed cost of entry or a lower marginal cost of production. These ideas are formally stated in the following hypothesis:

> *Hypothesis 1: Incumbent cable TV firms time their system upgrades to deter entry by cities with municipal utilities.*

Incumbent firms also face entry by private providers. Private providers are known to selectively enter markets by expanding their footprint. We expect incumbents will also use system upgrades to deter entry by private providers.

> *Hypothesis 2: Incumbent cable TV firms time their system upgrades to deter entry by private overbuilders.*

4 Data and Methodology

4.1 Variables

[4] For examples see Charter Communications' 2005 Annual Report (p. 19), Comcast's 2005 Annual Report (pp. 7-8) or Verizon's 2005 Annual Report (p. 10).

The focus of this analysis is the window 2001 to 2007. Analysis begins in 2001 because it is after the change in legislation that allowed digital broadcast satellite (DBS) to compete with cable TV firms, but early enough so as to measure changes to two way upgrades and to take advantage of variation in state level restrictions. Information on applicable state laws passed is presented in Table 1; more detail on how these laws are used is discussed in Section 5.2 below. Information on state laws comes from Balhoff, Rowe and Williams, LLC. Summary statistics for variables used are broken out by year and presented in Table 2.[5] The source of cable system data is Warren Communications' *Television and Cable Factbook* (*Factbook*) for October 2001, October 2003, January 2006 and October 2007. January 2006 data is used in place of October 2005 data because of data availability. The *Factbook* data is the main source of cable TV system level characteristics used in most empirical studies of the industry.[6] All cable variables are measured at the system level. *Twoway Capable* indicates whether or not a system has upgraded from one-way to two-way. *Twoway Capable* is the main dependent variable used in all regressions. Other cable characteristics described below are included because of the potential for them to influence the upgrade decision. Older and less technologically advanced systems may be among the first to be upgraded and hence it is important to control for these effects. *Year System Built* is used to create indicator variables for the decade in which the system was built. The expectation is that more recently built systems will be upgraded slower; the capital invested in these systems will not yet have fully depreciated and some of these systems may already incorporate features that would be included in an upgrade. While larger systems take longer to upgrade, they may be upgraded before smaller systems if larger systems are more profitable. For example, upgraded larger systems may attract higher paying advertisers, and so upgrading these systems may be a priority. Log of *homes passed*, a count of the number of potential hookups that the incumbent cable system passes, is included to account for

[5] Correlations between variables are available from the author upon request.
[6] For recent examples, see Goolsbee and Petrin (2004) and Della Vigna and Kaplan (2007).

system size. A *duopoly* dummy indicates if the system competes directly with another system in the same city.

For 2003-2007 the data includes information on which firms own which systems. Using this information, two additional variables are created. The log of *number of systems 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 public market financing that enable them to more quickly upgrade their systems. In addition, as larger firms upgrade more and 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 which may act to slow the upgrade of systems. Regional ownership may also be important. *Share of systems owned* by the firm within each Designated Market Area (DMA) are calculated. The DMA assigns each city in the US to an area that is believed to receive the same media offerings. In most cases there is only one cable system per city, so cable systems do not compete with each other for residential customers. However, a portion of cable system revenue is in the form of advertising revenue. For example, in 2006, $1.5B of Comcast's $24.1B in revenue came from advertising.[7] If a cable firm controls many systems in a DMA it may be able to exercise market power over local and regional businesses that want to advertise on a cable network. DMA level *Share* is included to capture any such effects.

Municipal utility indicates if a system is in a city that has a municipal utility provider. There are no changes in municipal utility status over the relevant time frame (most municipal utilities were established in the late 19th and early 20th centuries). Data on municipal utilities was collected from the American Public Power Association. Assets from the municipal utility, such as service vans, customer service representatives, billing systems and buildings can be used to serve cable TV

[7] Comcast Annual Report for 2006, p. 28. Available here: http://media.corporate-ir.net/media_files/irol/11/118591/financialreport06.pdf

customers. These assets should reduce operating costs for a city cable TV system relative to cities that have no municipal utility. The variable *internal communications*$_i$ indicates municipal utilities that have some form of communications infrastructure. Cities with municipal electric utilities are expected to be able to provide cable at lower cost than cities without; cities with municipal electric utilities that also have internal communication capabilities should be able to provide cable at even lower cost. Such cities own private networks to communicate with other city agencies or fiber optic networks to monitor electricity load throughout the system. The use and servicing of these networks involves skills that should be re-deployable in the use and operation of a cable TV network. These networks could also be used as part of the physical infrastructure of a city cable TV system.

By 2001, the start of the data, digital broadcast satellite (DBS) availability was more or less ubiquitous. Other researchers have accounted for competition from DBS indirectly using demographic control variables.[8] Using a similar approach, DBS is accounted for using various demographic controls at the county level. The controls used are log of median *household income*, percent of population living in a *rural* area, and *population per square mile*.[9] The demographic data are from the *City and County Databook*. Also included are number of *digital subscriber line* (DSL) providers at the city level, weighted by population per square mile. DSL data is from June 2003 and is available from the FCC.

[8] For example, Savage and Wirth (2005) account for DBS using the percentage of the population living in a rural area, the percentage of households living in multiple dwelling units, and the cable system operator's share of national systems.

[9] Other variables were considered such as population, number of households, and percentage of households living in multiple dwelling units but these variables were found to be highly correlated with *income*, *rural* and *population per square mile*. The rural variable is important to include as prior studies have demonstrated that cable service is highly inelastic in rural areas (Mayo and Otsuka, 1991).

4.2 Econometric Model

The analysis focuses on the timing of incumbent cable TV firm system upgrades from 2001-2007. The dataset includes approximately 16,000 system years and approximately 3500 system upgrades. Changes to system technology are observed in two year intervals and so a discrete hazard model is used. We define a discrete time hazard rate:

$$P_{it} = \Pr[T_i = t \mid T_i \geq t, \mathbf{X_{it}}]$$

Where P_{it} is the probability that a system i will upgrade at time t given that it has not already upgraded. A logit function[10] can then be used to specify how the hazard rate depends on time and the explanatory variables:

$$\ln[P_{it} /(1 - P_{it})] = \alpha_t + \boldsymbol{\beta}\mathbf{X}_{itm}$$

where α_t is a set of constants and $\mathbf{X}_{itm}$ represents a set of observed characteristics for system i at time t in market m. In most cases the market will be defined at the county or designated market area (DMA). The municipal utility variable does not vary with time, so a city fixed effects specification would wipe out any municipal utility effect. The DMA assignment is at a high enough level that the city level and county level variables will not be washed out, but low enough to still control for local demographic and market characteristics not already included in the specifications. There are 210 DMAs in the US. Within the dataset, there are approximately 20 systems per DMA, of which approximately three are located in a city with a municipal electric utility.

5 Results

Figure 1 uses raw data on the probability that a system is upgraded in year t to plot the difference in upgrades between systems located in a city with a municipal electric utility and systems located in

[10] The use of the logit model constrains P_{it} to lie in the unit interval and is computationally convenient (Allison, 1982; Effron, 1988). The results are robust to other specifications including those using OLS, exponential hazard and Cox proportional hazard models.

cities without municipal electric utilities. The raw data shows 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 purpose of the following sections is to show that this basic result is robust to the inclusion of a number of control variables and alternative explanations.

Baseline hazard results are presented in Table 3. Standard errors are robust and clustered at the state level. The main variable of interest is *municipal utility*$_i$ which is a dummy variable, and so for ease of interpretation results are presented as odds ratios. The specification in Column I includes only *municipal utility*$_i$ and year fixed effects. The odds ratio on *municipal utility*$_i$ is greater than 1 and significant at the 1% level. The odds ratio confirms hypothesis 1: incumbent firms upgrade systems faster in the presence of a municipal utility. The specification in Column II adds in DMA level fixed effects. The DMA level fixed effects controls for local institutions and market conditions. The coefficient on municipal utility remains significant at the 1% level. In Columns III and IV cable system characteristics and demographic controls are introduced, respectively. The odds ratio on *municipal utility*$_i$ drops in overall magnitude as more of the variation is explained by other factors such as system size and system age, but remains significant at the 1% level. The odds ratio on *municipal utility*$_i$ in Column IV, the full model, is approximately 1.46, indicating that cable systems in cities with municipal utilities are upgraded about 46% faster than in cities with no municipal utilities.[11] Column V of Table 3 repeats the analysis in Column IV but includes the *internal communications*$_i$ variable. Both *municipal utility*$_i$ and *internal communications*$_i$ have odds ratios greater than one and are significant at the 5% level. This indicates that incumbent cable systems in cities with municipal utilities that have internal communications upgrade to two-way

[11] More detailed results are presented in an appendix. In those results notice that, while not significant in all cases, the odds ratios on the dummies for year system built appear to monotonically decrease in magnitude. The pattern of these odds ratios corroborate the general intuition: more recently built systems are less likely to undergo upgrades as their capital has not yet fully depreciated. The appendix also contains results when dropping the *municipal utility*$_i$ variable.

capability even faster than those with only municipal utilities. Columns VI to VIII restrict the dataset to 2003-2007, the years in which the dataset has information on system ownership. Column VI repeats the analysis in Column IV (the full model) to verify that the result on *municipal utility*$_i$ still holds in the sub-sample. Column VII adds in the two variables that account for firm ownership; neither variable is significant and the odds ratio on *municipal utility*$_i$ is unchanged. Column VIII repeats the analysis in Column V and while the magnitude and direction of the results are unchanged the coefficient on *internal communications*$_i$ is no longer significant.

6 Addressing Threats to Identification

The results presented in Table 3 show a significant positive correlation between *two-way upgrade* and the presence of *municipal utility*$_i$. The findings are robust to the inclusion of a number of control variables and to multiple specifications. This suggests that incumbent cable TV firms use system upgrades as a way to deter city entry. Whereas prior empirical tests of entry deterrence focus on private incumbent response to a private entrant, here we see a private incumbent respond to potential entry by a public agency, which has hitherto been unexamined. The biggest threat to identification is the possibility of unobserved variation at the system level *i* that is correlated with the presence of a municipal electric utility. For example, there could be other types of potential entrants located adjacent to the municipal electric utility or there could be city specific demographics that increase the probability of early upgrade. A city level or system level fixed effect would ease such concerns, but recall such fixed effects would wash out the municipal electric utility variable.

The approach to dealing with these threats to identification is by using variation in state laws that restrict a city's use of municipal electric utility assets or infrastructure. Once a state passes such a law, the cost of city entry rises, so the probability of entry decreases. We should see a corresponding decrease in the probability of early upgrade in systems located in a city with a municipal electric utility following passage of such a law. Table 4 reports initial results of such a test. Columns I and II restrict the data set to smaller subsamples that only include municipal utilities (Column I) and only those municipal utilities that have internal communications (Column II) to test for the effect of the state regulation on the use of cross subsidies. In Column II, the odds ratio on $\textit{no cross subsidies}_{it}$ is less than one and significant at the 5% level. This indicates that incumbents in cities with municipal utilities upgrade their cable systems slower once such regulation is passed. A similar result is found in Column II, indicating that incumbents in cities with municipal utilities that have internal communications upgrade their cable systems slower once such regulation is passed. Column III replicates the full model (Table 3a, Column IV) but also includes an indicator for whether or not the state has passed no cross subsidies regulation as well as an interaction between $\textit{municipal utility}_i$ and $\textit{no cross subsidies}_{it}$. The variable of interest is the interaction term, the odds ratio of which is expected to be less than one, indicating that cities with municipal utilities but that are located in regulated states pose less of a threat to the incumbent cable system than a city with a municipal utility in an unrestricted state. In Column III, the odds ratio on the interaction term is less than one and significant at the 10% level. Column IV performs the same analysis on municipal utilities with internal communications. Here, the odds ratio on the interaction term is less than one and significant at the 5% level. Column V tests whether this effect remains when jointly tested on both $\textit{municipal utility}_i$ and $\textit{internal communication}_{\text{i}}$. The direction of the interaction terms remain the same, but the significance has dropped below the 10% level. Columns I to V provide further evidence that incumbent cable TV firms use system upgrades to deter entry by the city.[12]

In Table 4, the passage of no cross subsidy legislation is treated as an exogenous event. However, the passage of such laws may be the result of cable firm lobbying or selection effects. Two

[12] Table 4 results are replicated in an appendix using an OLS specification to insure that the results are not affected by use of the interaction term in a logit setting (Hoetker, 2007). Results are also replicated using a larger, less stringent set of state laws that in any way restrict municipal electric utility activity.

approaches are used to correct for any such effects. Recall from Table 1 that there are three types of states: those that never tried to pass a law restricting the city, those that tried to pass restrictions but have so far failed, and those that passed restrictions. The analysis in Table 4 compares cities in states that passed restrictions to cities in all other states. However, an alternative approach would be to constrain our analysis to only those states that tried to pass restrictions, and then compare the results between cities located in states that tried and failed to pass restrictions to cities located in states that successfully passed restrictions. The assumption is that states that considered passing but did not pass (or have not yet passed) such laws are a better control group than the entire population of states that never considered passing such laws. Table 5a focuses on this subsample of states and redoes the analysis from Table 4. The results of Table 5a are similar to Table 4 [need F-tests]: the odds ratios on the interaction terms are less than one.

A second approach, presented in Table 5b, uses a two-stage Heckman correction. The first stage uses all the independent variables as before, but includes an instrument to help predict which states will pass a no cross subsidies law. The instrument is log number of years a state has specified homerule in its constitution (*ln home rule years*). Homerule charter states are those that have passed a constitutional amendment that grants "homerule" status to municipal governments. Homerule is a legislative tool that places more regulatory and financial control with local municipalities rather than with the state. As an example, Massachusetts passed legislation adding homerule to the state charter in 1966, and in the process removed the county layer of government in over half of the state. The logic behind using homerule years to instrument for the presence of a state restriction is that homerule states value placing authority with cities and hence would be less likely to enact state level legislation that reduces a city's choice set. The t-statistic on *ln home rule years* is 20.84 and the F-statistic on the first stage regression is 64.83; both these statistics indicate *ln home rule years* is a good instrument. The first stage results are then used to create Mills Ratios which are included in second stage regressions. Column IIa presents the second stage results in the case where the system is located in a state that passed a no cross subsidies regulation; Column IIb presents the second stage results in the case where the system is located in a state that has not passed a no cross subsidies regulation. The odds ratio on *municipal utility*$_i$ is less than one in the former case and greater than one in the latter case, as expected. In neither case are the Mills ratios significant, indicating that selection may not be a concern. Column IIc pools all states together; the odds ratio on the interaction between *municipal utility*$_i$ and *no cross subsidies*$_{it}$ is less than one and significant at the 10% level. The coefficient on the Mills ratio is not significant, indicating that selection may be less of a concern than originally anticipated.

We next consider the actions of incumbent firms after completing a system upgrade. To do this, we look at the probability that an incumbent system has introduced new services, given that the system has upgraded to two way capability. As discussed above, the benefit of an upgraded system is its ability to offer advanced services such as telephony over cable and broadband over cable, as well as the ability to add more satellite channels. Table 6 considers whether incumbent systems offer services any different when they are based in cities with municipal electric utilities. Data on telephony, broadband and satellite channels are only available for select years, as indicated in the Table. Columns I and II investigate the effect of *municipal utility*$_i$ on the probability of offering telephony, conditional on two way upgrade. The odds ratio on *municipal utility*$_i$ in Column I is less than one and statistically significant, indicating that incumbents have a lower probability of offering telephony in systems based in a city with a municipal electric utility. Because of the small number of observations, DMA fixed effects are not used in this model, and so the analysis is repeated using an OLS specification in Column II; the results are qualitatively similar. Columns III and IV perform a similar analysis on the probability of offering broadband. The results are similar to those in Columns I and II but not statistically significant at conventional levels (p-value = 15% in both cases). Column V performs a similar analysis on the number of satellite channels offered. The coefficient on *municipal utility*$_i$ suggests that systems located in cities with a municipal utility receive one less satellite channel on average, but this result is not statistically significant. In general, the results of Table 6 suggest that incumbent firms are less likely to offer new services after upgrading in cities with municipal electric utilities. This result corresponds well with standard entry deterrence theory: the incumbent firm builds excess capacity to deter entry. Absent entry, the capacity sits idle. In the cable TV context, it appears incumbent firms upgrade systems to deter municipal entry, and absent that entry the benefits of the upgrade remain unused.

7 Extensions

Extensions to the main result are presented in Table 7. Here we address the possibility that system upgrades may be influenced by the presence of a firm's complementary assets or political considerations on the part of the city. The most important complementary asset for a cable TV firm is access to video content, which comes through vertical integration with programming networks. 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 by subscribers. 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. The *top 20* $network_i$ variable is then introduced into the hazard model in Column I of Table 7 and interacted with *municipal* $utility_i$ in Column II. The odds ratio on the *top 20* $network_i$ variable is greater than one, indicating that owning complementary assets may increase the speed of upgrade, but not in a statistically significant way. Political considerations may also play a role in upgrades. Cities with elected mayors may have political incentives to pressure the incumbent cable firm to increase the speed of upgrade. Columns III and IV check for such an effect on a subsample of the dataset. The results suggest that the presence of a mayor increases the speed of system upgrades, but not in a statistically significant way. Ideological considerations about the proper role of government may play a role in determining how much pressure to upgrade to apply to an incumbent firm in the private sector and may play a role in determining the likelihood of the city using its infrastructure to compete with a firm in the private sector. Such ideological concerns are captured using percent of population that voted Republican in 2000. The odds ratio on the variable is less than one in Columns V and VI, indicating that as *percent voted Republican*$_i$ increases, the incumbent cable system will slow the speed of upgrade. It is interesting to note that while the odds ratios on *percent voted Republican*$_i$ are not significant, the presence of the interaction term has the effect of dropping the significance of the odds ratio on *municipal utility*$_i$ below the 10% level (p-value = 0.14). This result suggests that a large population of Republican voters may have a dampening effect on the city's ability to enter and compete with an incumbent cable TV firm.[13]

8 Effect of Private Overbuilders

The results in Tables 3-6 establish that incumbent cable TV firms act to deter entry by cities through cable system upgrades. Incumbent cable TV firms also face threat of entry from private overbuilders. As discussed above, private overbuilders are more likely to enter other cities in close proximity to their existing systems. Given the risk of private overbuilder entry, do incumbent cable TV firms use system upgrades to deter entry? Table 8a explores this issue using three measures of the threat of overbuilder entry. For ease of interpretation, the various threat measures are categorized into bins as described below. Number of overbuilders in DMA counts the number of private overbuilders in each DMA. This variable captures the idea that an increase in the number of private overbuilders leads to an increase in the probability that there exists one close by to the incumbent cable system. Dummy variables for 0, 1, 2, 3, 4+ overbuilders in the DMA are used in the hazard models (the first category is excluded). We expect the strength of incumbent response to increase as the bin number increases. Distance in miles to the closest overbuilder is calculated using the latitude and longitude of the center of the county in which system *i* is located and the

[13] Additional robustness tests are included in an appendix. One such test uses data supplied by Greenstein & Mazzeo to test for the effect of CLEC change on two way upgrade. Another uses an indicator variable for cities with a high number of DSL entrants. The results are qualitatively unchanged in both cases. The municipal utility variable is not significant at conventional levels in the CLEC sample but this may be due to the small sample size.

corresponding latitude and longitude of the counties in which the overbuilders are located. Dummy variables for 0-49, 50-99, 100-149, 150-199, 200+ miles are used in the hazard models (the first category is excluded). We expect the strength of the incumbent response to decrease as the number of miles to the closes overbuilder decreases. Finally, using observed entry of overbuilders we predict overbuilder entry for each system using all observable cable characteristics. The resulting continuous measure, called PCOM, corresponds to the PCOM measure used by Savage and Wirth (2005). The PCOM measure is broken into five more or less equal sized bins with the first category excluded in the hazard models. Columns I – VI of Table 8a include all system characteristics and controls, including the municipal utility variable, and separately consider the effect of each measure of private overbuilder. Every other model includes suppressed interaction terms between the municipal utility variable and the private overbuilder bins.

Columns I and II of Table 8a report the results using the number of overbuilders in the DMA. The odds ratios on the bins are all less than one, and significant in a couple of places, suggesting that incumbent firms upgrade their systems slower as the number of potential entrants increases. None of the odds ratios for the PCOM bins in Columns III and IV are statistically significant, but the fact that they are greater than one in most cases suggests that as the estimated probability of overbuilder entry increases, the incumbent firm is more likely to upgrade its system. Columns V and VI report results using distance to closest overbuilder. There appears to be an interesting non-monotonic relationship between the probability of upgrade and miles to closest overbuilder. As the number of miles increases, the probability of upgrade first increases (statistically significantly so when the distance is 100-149 miles) and then decreases. [relate this result to Dafny (2004)].

Taken as a whole, the results of Table 8a are mixed; two of the measures suggest that incumbents might upgrade faster when faced with potential overbuilder entry, whereas one measure suggests that incumbents might upgrade slower. The insignificant coefficients may in part be driven by heterogeneity of potential entrant type. Private overbuilders primarily consist of two types of firms: start up cable overbuilders such as RCN that were established in the late 1990s who aggressively pursued expansion programs and incumbent telecom firms such as Verizon which started to create video networks in the early 2000s. Of these two types of firms, it is plausible that the telecom firms pose a larger threat; they own physical infrastructure and may benefit from economies of scope by increasing the number of products available to their established customers. Table 8b repeats the analysis in Table 8a, but restricts the population of private overbuilders to only include those that are telecommunication firms. The three measures are redefined accordingly. The results of Table 8b are mixed as well. Incumbent firms appear to significantly increase speed of upgrade when the number of telecom firms in a DMA increases. Distance to a telecom overbuilder appears to have no effect. The PCOM results suggest that as the estimated probability of telecom overbuilder entry increases, the incumbent firm is less likely to upgrade its system. Taken as a whole, the results presented in Tables 8a and 8b suggest that incumbent cable TV firms probably do not use upgrades as a way to deter entry by private overbuilders. There is little support for hypothesis 2. Of course, this does not preclude incumbents from relying on some other form of entry deterrence.

9 Discussion and Conclusion

In summary, this research makes four contributions. First, it adds to the small but important body of work on empirical demonstrations of entry deterrence. Second, it suggests that technology upgrades may be an effective mechanism used by incumbents to deter entry. This contribution may be of particular interest to researchers focusing on technology and innovation. Third, private incumbents actively engage in behavior designed to deter potential entry by a city. Finally, at least in the case of the cable TV industry, incumbent firms have a stronger response to potential entry by city entrants as opposed to private entrants.

The final result raises the question of why incumbent firms might respond stronger to entrants that attempt to maximize objectives such as welfare instead of profit. The first best solution for the incumbent in all cases is to deter entry altogether. However, conditional on entry having occurred, the second best solution for the incumbent is to arrive at some mutually beneficial choice of price and output. Collusion is illegal, but tacit collusion may be attainable if the two firms are symmetric (Schelling, 1960). As the firms become more asymmetric, the coordination required to sustain a collusive outcome becomes more difficult (Scherer, 1980). Realizing that coordination will be more difficult, the incumbent will work harder to deter potential entry by highly asymmetric firms. The asymmetries between a private and public firm may be greater than the asymmetries between two private firms. For example, while it may be reasonable to assume that private firms attempt to maximize profit, it is not necessarily the case for public firms. Public firms may want to maximize social welfare or revenues; for example, some cities have pointed to a need to reduce the "digital divide" as a reason for entering the cable TV market.

Other than differences in the objective function, another form of asymmetry may be in the degree of efficiency. A preponderance of evidence seems to point to public firms as being less efficient than private firms (Megginson and Netter, 2001). However, contrary views exit. Caves and Christensen (1980) study Canadian railroads and find no difference in the efficiencies between public and private railroads. If public and private firms are no more or less efficient, as suggested by Caves and Christenson, then private incumbents will treat the threat public entrants pose as the same as the threat from a potential private entrant. If, on the other hand, public firms are less efficient, as the bulk of the literature seems to suggest, then this implies public firms tend to enter more often than they should and, conditional on entry, tend to persist in operation longer than they should. This in turn implies private firms will see public entrants as a greater threat because they may enter even when the market can only support one firm. There is some evidence for this in the cable TV industry. Alameda Power and Telecom (APT), the municipal electric utility owned by the city of Alameda, California, started providing its own cable TV service in competition with Comcast in 2001. By 2006, it became clear that the decision to enter was probably a mistake, as APT was reported to have losses of about $80M [need cite]. Hence, one should expect the incumbent to be more aggressive in its attempts to prevent entry by the public agency.

The statistical analyses in the foregoing sections find strong support for hypothesis 1: incumbent cable TV firms use system upgrades to deter entry by cities with municipal electric utilities. Not only is there a strong statistical correlation between the presence of a municipal electric utility and the speed of upgrade, but the fact that state restrictions on city use of the municipal electric utility reverses this effect helps rule out alternative hypotheses. In particular, when a state passes a law that prohibits the city's ability to use the municipal electric utility to cross-subsidize its entry into the cable TV industry, the incumbent system treats the city as if it does not have a municipal electric utility. There is weak evidence for the hypothesis that incumbent firms use system upgrades to deter entry by private firms. It is also possible that incumbent firms use other mechanisms such a limit pricing and reputation to deter entry by private firms, and one goal of future research is to further investigate this possibility.

The results of this paper add to existing empirical work on entry deterrence by demonstrating that private incumbent firms attempt to deter entry by public entities. This finding may aid our understanding of when firms use entry deterrence mechanisms. Some prior studies find no evidence of entry deterrence in an industry (Lieberman (1987) and Masson and Shaanan (1986)) whereas others do (Dafny (2005), Goolsbee and Syverson (2008) and Simon (2005)). This study suggests that in some cases the entry deterrence response may be more a function of the type of entrant. Expanding the set of potential entrants may broaden the situations in which we observe managers using entry deterring strategies. There are a number of situations outside of the cable TV industry in which these results may apply including other regulated industries and industries in which non-profit firms compete with for-profit firms. In addition to broadening the set of potential competitors faced by incumbents, this research paper also broadens the set of entry deterring mechanisms to include investment in new technology.

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Figure 1:

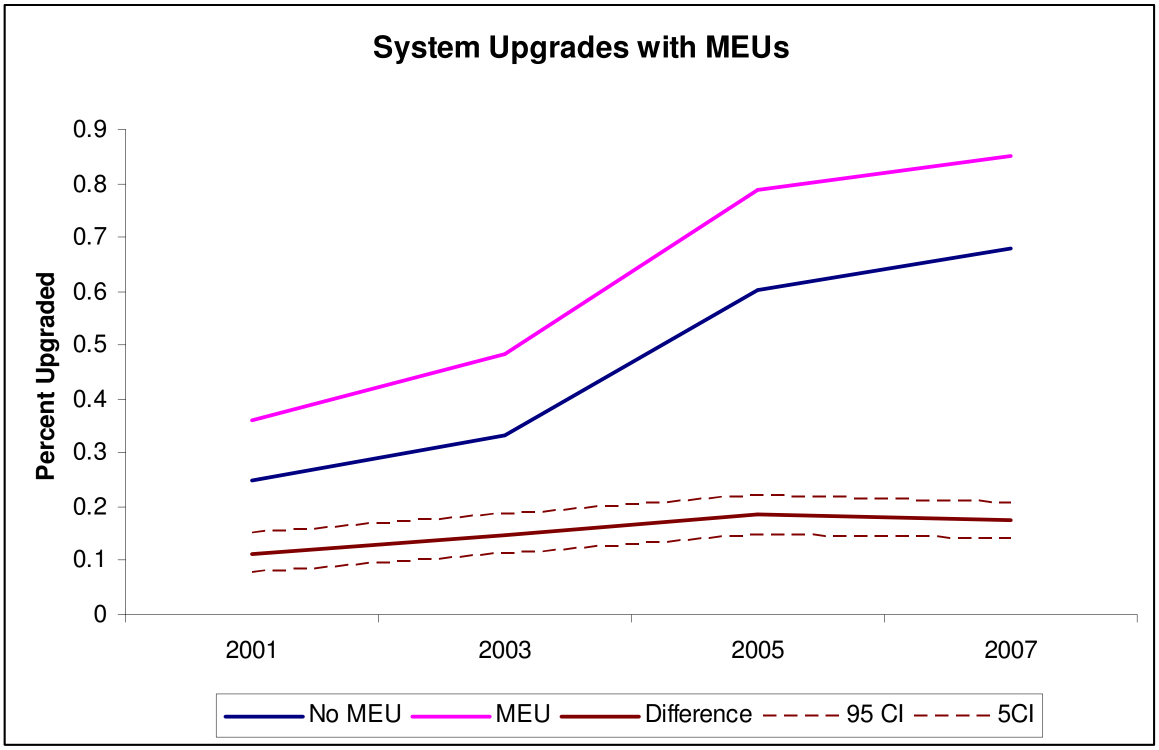
System Upgrades with MEUs
Percent Upgraded
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2001
2003
2005
2007
No MEU
MEU
Difference
95 CI
5CI

Table 1: Information on State Laws

State	No Cross Subsidy	Restricted	Ever Considered
Alabama		pre-2001	
Alaska			
Arizona			
Arkansas			
California			
Colorado			
Connecticut			
Delaware			
DC			
Florida	2001	2001	
Georgia			
Hawaii			
Idaho			
Illinios			X
Indiana			X
Iowa	2003	2003	
Kansas			
Kentucky			
Louisiana			
Maine			
Maryland			
Massachusetts			
Michigan			
Minnesota			
Mississippi			
Missouri		pre-2001	

State	No Cross Subsidy	Restricted	Ever Considered
Montana			
Nebraska		2001	
Nevada		pre-2001	
New Hampshire			
New Jersey			
New Mexico			
New York			
North Carolina			
North Dakota			
Ohio			
Oklahoma			
Oregon			X
Pennsylvania		2004	
Rhode Island			
South Carolina	2003	2003	
South Dakota			
Tennessee	pre-2001	pre-2001	
Texas		pre-2001	
Utah	2001	2001	
Vermont			
Virginia	pre-2001	pre-2001	
Washington		2003	
West Virginia			X
Wisconsin	2004	2004	
Wyoming			

Table 2 (A-D): Summary Statistics by Year

(A) 2001	Obs	Mean	Std. Dev.	Min	Max
Two Way Upgrade	4274	0.2639	0.4408	0.0000	1.0000
Municipal Utility	7269	0.1377	0.3446	0.0000	1.0000
Internal Communications Feature	7269	0.0439	0.2049	0.0000	1.0000
Start Year	5091	1977	10	1948	2002
Ln Homes Passed	7269	7.1461	1.8880	0.0000	14.4574
Ln Pop per Sq Mile	7269	3.8804	1.4778	-2.3026	11.1100
Ln Income	7269	10.3820	0.2177	9.5594	11.2582
Rural	7269	0.0621	0.0664	0.0000	0.5500
DSL Providers / Population	7269	0.1475	0.4270	0.0002	20.0000
Duopoly	7269	0.0155	0.1237	0.0000	1.0000
Ln Number Systems Owned by Firm	-	-	-	-	-
Share of Systems Owned in DMA	-	-	-	-	-

(B) 2003	Obs	Mean	Std. Dev.	Min	Max
Two Way Upgrade	4757	0.3565	0.4790	0.0000	1.0000
Municipal Utility	7254	0.1366	0.3435	0.0000	1.0000
Internal Communications Feature	7254	0.0436	0.2041	0.0000	1.0000
Start Year	5084	1977	10	1948	2002
Ln Homes Passed	7254	7.1994	1.8716	2.0794	14.4574
Ln Pop per Sq Mile	7254	3.8811	1.4774	-2.3026	11.1100
Ln Income	7254	10.3825	0.2184	9.5594	11.2582
Rural	7254	0.0620	0.0663	0.0000	0.5500
DSL Providers / Population	7254	0.1476	0.4274	0.0002	20.0000
Duopoly	7254	0.0149	0.1211	0.0000	1.0000
Ln Number Systems Owned by Firm	7220	4.8708	2.1065	0.6931	7.0440
Share of Systems Owned in DMA	7220	0.2213	0.1926	0.0055	1.0000

(C) 2005	Obs	Mean	Std. Dev.	Min	Max
Two Way Upgrade	4996	0.6319	0.4823	0.0000	1.0000
Municipal Utility	7252	0.1367	0.3435	0.0000	1.0000
Internal Communications Feature	7252	0.0436	0.2042	0.0000	1.0000
Start Year	5084	1977	10	1948	2002
Ln Homes Passed	7252	7.2283	1.8964	2.1972	14.6070
Ln Pop per Sq Mile	7252	3.8811	1.4774	-2.3026	11.1100
Ln Income	7252	10.3825	0.2184	9.5594	11.2582
Rural	7252	0.0620	0.0663	0.0000	0.5500
DSL Providers / Population	7252	0.1476	0.4274	0.0002	20.0000
Duopoly	7252	0.0149	0.1211	0.0000	1.0000
Ln Number Systems Owned by Firm	6007	4.5640	2.1110	0.6931	6.8469
Share of Systems Owned in DMA	6007	0.1932	0.1820	0.0056	1.0000

(D) 2007	Obs	Mean	Std. Dev.	Min	Max
Two Way Upgrade	4937	0.7071	0.4551	0.0000	1.0000
Municipal Utility	7249	0.1367	0.3436	0.0000	1.0000
Internal Communications Feature	7249	0.0436	0.2042	0.0000	1.0000
Start Year	5083	1977	10	1948	2002
Ln Homes Passed	7249	7.2472	1.9220	2.3026	14.7372
Ln Pop per Sq Mile	7249	3.8810	1.4776	-2.3026	11.1100
Ln Income	7249	10.3825	0.2184	9.5594	11.2582
Rural	7249	0.0620	0.0663	0.0000	0.5500
DSL Providers / Population	7249	0.1476	0.4275	0.0002	20.0000
Duopoly	7249	0.0149	0.1212	0.0000	1.0000
Ln Number Systems Owned by Firm	5679	4.3273	2.0385	0.6931	6.5985
Share of Systems Owned in DMA	5679	0.1795	0.1784	0.0056	1.0000

Table 3: Baseline Hazard Results (Dependent Variable: Two Way Upgrade)

	I	II	III	IV	V	VI	VII	VIII
Municipal Utility	2.0627**	2.3164**	1.4392**	1.4554**	1.3082*	1.5265**	1.5238**	1.3796*
	[0.1935]	[0.2265]	[0.1268]	[0.1302]	[0.1438]	[0.1720]	[0.1712]	[0.1803]
Internal Communications					1.4478*			1.4047
					[0.2639]			[0.3178]
Demographic Controls	N	N	N	Y	Y	Y	Y	Y
Cable System Characteristics	N	N	Y	Y	Y	Y	Y	Y
DMA Fixed Effects	N	Y	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Owner Characteristics	N	N	N	N	N	N	Y	Y
Observations	12863	12829	12829	12829	12829	8616	8598	8594
Log pseudolikelihood	-7030.43	-6495.95	-5907.72	-5888.99	-5884.99	-3650.11	-3639.27	-3628.03

Robust standard errors in brackets; clustered at state.

+ significant at 10%; * significant at 5%; ** significant at 1%

Table 4: Hazard Model with Effects of Cross Subsidy Restriction (Dep Var: Two Way Upgrade)

	I	II	III	IV	V
	Municipal Utility Subsample	*Internal Comm Subsample*	*Full Sample*		
Municipal Utility			1.5314**		1.3496*
			[0.1459]		[0.1601]
Internal Communications				2.0318**	1.5805*
				[0.3280]	[0.3343]
No Cross Subsidies	0.6325*	0.4170*	0.9945	0.9619	0.9957
	[0.1410]	[0.1468]	[0.1887]	[0.1742]	[0.1863]
Municipal*NoCross			0.7009+		0.7809
			[0.1362]		[0.1493]
Internal*NoCross				0.5378*	0.6699
				[0.1530]	[0.1883]
Demographic Controls	Y	Y	Y	Y	Y
Cable System Characteristics	Y	Y	Y	Y	Y
DMA Fixed Effects	N	N	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y
Observations	1698	469	12829	12829	12829
Log pseudolikelihood	-971.22	-265.35	-5886.93	-5888.33	-5881.81

Robust standard errors in brackets; clustered at state

+ significant at 10%; * significant at 5%; ** significant at 1%

Table 5a: Effects of Regulation on Similar State Sub-Sample (Dep Var: Two Way Upgrade)

	I	II	III
Municipal Utility	1.6899**		1.5612**
	[0.2404]		[0.2047]
Internal Communications		1.9079*	1.3185
		[0.6143]	[0.4233]
No Cross Subsidies	1.2982	1.2296	1.2996
	[0.3180]	[0.2812]	[0.3165]
Municipal*NoCross	0.6535*		0.6962*
	[0.1378]		[0.1272]
Internal*NoCross		0.5853	0.7954
		[0.2307]	[0.2862]
Demographic Controls	Y	Y	Y
Cable System Characteristics	Y	Y	Y
DMA Fixed Effects	Y	Y	Y
Year Fixed Effects	Y	Y	Y
Observations	6434	6434	6434
Log pseudolikelihood	-2795.86	-2800.63	-2795.1

Robust standard errors in brackets; clustered at state

+ significant at 10%; * significant at 5%; ** significant at 1%

Table 5b: Heckman Selection Correction for State Laws

	I	IIa	IIb	IIc
	1st Stage	2nd Stage		
Dependent Variable:	*No Cross Subsidies*	*Two Way Upgrade*		
ln Home Rule Years	0.8609**			
	[0.0052]			
Municipal Utility	1.2625**	0.8133	1.3904*	1.5572**
	[0.0470]	[0.1664]	[0.1810]	[0.19802]
Municipal Utility*No Cross				0.6975+
				[0.1352]
No Cross Subsidies				0.9667
				[0.1998]
Mills Ratio (Regulation Passed)		1.9398		0.8952
		[1.4395]		[0.3484]
Mills Ratio (Regulation not Passed)			4.8249	
			[4.6961]	
Demographic Controls	Y	Y	Y	Y
Cable System Characteristics	Y	Y	Y	Y
DMA Fixed Effects	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y
1st Stage F-Statistic	64.83			
T-stat on ln Home Rule Years	20.84			
Log pseudolikelihood	-6248.96	-543.16	-5248.9	-5877.99
Observations	14526	1419	11388	12810

Robust standard errors in brackets; clustered at state
+ significant at 10%; * significant at 5%; ** significant at 1%

Table 6: Ex-Post Actions of Incumbent Firm

	I	II	III	IV	V
			Cable Broadband		*No. Satellite*
Dependent Variable:	*Telephony Available*		*Available*		*Channels*
Regression Model:	Probit	OLS	Probit	OLS	OLS
Municipal Utility	0.7031*	-0.0430*	0.7707	-0.0188	-1.1375
	[0.1168]	[0.0189]	[0.1333]	[0.0120]	[0.8216]
Two Way Upgrade Occurred?	Y	Y	Y	Y	Y
Years	2005	2005	2003-2005	2003-2005	2003-2007
Demographic Controls	Y	Y	Y	Y	Y
Cable System Characteristics	Y	Y	Y	Y	Y
DMA Fixed Effects	N	Y	N	Y	Y
Year Fixed Effects	N	N	Y	Y	Y
Observations	2625	2625	4584	4584	7438
Log pseudolikelihood	-993.8		-1038.22		
R-squared		0.2517		0.1574	0.5149

Robust standard errors in brackets; clustered at state
+ significant at 10%; * significant at 5%; ** significant at 1%

Table 7: Baseline Hazard Results - Extensions (Dependent Variable: Two Way Upgrade)

	I	II	III	IV	V	VI
Top 20 Network	1.0233	1.0511				
	[0.1942]	[0.1863]				
Top 20 Network* Municipal Utility		0.8706				
		[0.1673]				
Mayor Indicator			1.102	1.0597		
			[0.1235]	[0.1298]		
Mayor Indicator*Municipal Utility				1.1601		
				[0.2597]		
Percent Voted Republican					0.7625	0.8343
					[0.5073]	[0.5784]
Percent Voted Republican*Municipal Utility						0.6032
						[0.4707]
Municipal Utility	1.4512**	1.4669**	1.6238**	1.5225**	1.4497**	1.9437
	[0.1314]	[0.1353]	[0.1906]	[0.1734]	[0.1316]	[0.8865]
Demographic Controls	Y	Y	Y	Y	Y	Y
Cable System Characteristics	Y	Y	Y	Y	Y	Y
DMA Fixed Effects	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y
Observations	12823	12823	4344	4344	12759	12759
Log pseudolikelihood	-5883.6	-5883.42	-2236.26	-2235.94	-5858.07	-5857.71

Robust standard errors in brackets; clustered at state

+ significant at 10%; * significant at 5%; ** significant at 1%

Table 8A: Hazard Model with Effects of All Private Overbuilders (Dep Var: Two Way Upgrade)

	I	II	III	IV	V	VI
1 Overbuilder in DMA	0.7665	0.738				
	[0.3045]	[0.3017]				
2 Overbuilders in DMA	0.3844+	0.3392+				
	[0.2110]	[0.1913]				
3 Overbuilders in DMA	0.3482	0.2963				
	[0.2964]	[0.2708]				
4+ Overbuilders in DMA	0.2571*	0.2392*				
	[0.1567]	[0.1504]				
PCOM Bin 2			1.1924	1.0824		
			[0.1443]	[0.1462]		
PCOM Bin 3			1.2684+	1.218		
			[0.1773]	[0.1754]		
PCOM Bin 4			1.2158	1.0888		
			[0.1620]	[0.1656]		
PCOM Bin 5			1.0395	0.9931		
			[0.2261]	[0.2437]		
50-99 miles to first Overbuilder					1.2114	1.2132
					[0.1459]	[0.1503]
100-149 miles to first Overbuilder					1.4607*	1.4404+
					[0.2725]	[0.2768]
150-199 miles to first Overbuilder					1.3026	1.3015
					[0.2700]	[0.2800]
200+ miles to first Overbuilder					1.0167	1.0044
					[0.2561]	[0.2547]
Municipal Utility	1.5180**	1.4504**	1.5127**	1.3251*	1.5093**	1.4780+
	[0.1700]	[0.1903]	[0.1701]	[0.1657]	[0.1672]	[0.3162]
Municapal Utility Interactions	N	Y	N	Y	N	Y
Demographic Controls	Y	Y	Y	Y	Y	Y
Cable System Characteristics	Y	Y	Y	Y	Y	Y
DMA Fixed Effects	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y
Observations	8594	8594	8594	8594	8594	8594
Log pseudolikelihood	-3632.96	-3620.75	-3638.84	-3622.83	-3634.55	-3623.44

Robust standard errors in brackets; clustered at state
+ significant at 10%; * significant at 5%; ** significant at 1%

Table 8B: Hazard Model with Effects of Private Telecom Overbuilders (Dep Var: Two Way Upgrade)

	I	II	III	IV	V	VI
1 Telecom in DMA	1.3463	1.3289				
	[0.4477]	[0.4509]				
2 Telecom in DMA	1.0842	0.4444+				
	[0.3991]	[0.2092]				
3 Telecom in DMA	4.7910**	4.2039**				
	[2.1284]	[2.0235]				
4+ Telecom in DMA	4.5478**	3.8959**				
	[1.9558]	[1.9278]				
PCOM Telco Bin 2			0.8015	0.9543		
			[0.1859]	[0.2249]		
PCOM Telco Bin 3			0.7707	0.77		
			[0.2049]	[0.2035]		
PCOM Telco Bin 4			1.3195	1.4467		
			[0.3500]	[0.3816]		
PCOM Telco Bin 5			0.5323**	0.5418**		
			[0.0881]	[0.0945]		
50-99 miles to first Telecom					1.231	1.3443
					[0.2161]	[0.2693]
100-149 miles to first Telecom					1.2994	1.4295
					[0.2492]	[0.3132]
150-199 miles to first Telecom					1.4257	1.5085
					[0.3459]	[0.4016]
200+ miles to first Telecom					1.1807	1.2474
					[0.3693]	[0.3818]
Municipal Utility	1.5002**	1.4668**	1.4811**	1.5254**	1.5004**	2.0586*
	[0.1678]	[0.1767]	[0.1676]	[0.1848]	[0.1710]	[0.7352]
Municapal Utility Interactions	N	Y	N	Y	N	Y
Demographic Controls	Y	Y	Y	Y	Y	Y
Cable System Characteristics	Y	Y	Y	Y	Y	Y
DMA Fixed Effects	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y
Observations	8594	8594	8594	8594	8594	8594
Log pseudolikelihood	-3628.9	-3616.14	-3631.76	-3620.41	-3638.37	-3626.31

Robust standard errors in brackets; clustered at state

Appendix 1: Extended Baseline Hazard Results (Dependent Variable: Two Way Upgrade)

	I	II	III	IV	V	VI	VII	VIII	IX
Municipal Utility	2.0627**	2.3164**	1.4392**	1.4554**		1.3082*	1.5265**	1.5238**	1.3796*
	[0.1935]	[0.2265]	[0.1268]	[0.1302]		[0.1438]	[0.1720]	[0.1712]	[0.1803]
Internal Communications						1.4478*			1.4047
						[0.2639]			[0.3178]
Start Year 1960s			1.1321	1.2005+	1.2340*	1.195	1.3195*	1.3062*	1.3063*
			[0.1289]	[0.1306]	[0.1320]	[0.1309]	[0.1595]	[0.1589]	[0.1613]
Start Year 1970s			1.1089	1.1314	1.153	1.1348	1.0806	1.07	1.0716
			[0.1393]	[0.1375]	[0.1390]	[0.1377]	[0.1576]	[0.1540]	[0.1555]
Start Year 1980s			0.9413	0.9039	0.9052	0.9071	0.9325	0.9166	0.9266
			[0.1013]	[0.0945]	[0.0936]	[0.0948]	[0.1030]	[0.0999]	[0.1006]
Start Year 1990-2000s			0.6293*	0.5878**	0.5801**	0.5838**	0.7169+	0.6967*	0.7166+
			[0.1285]	[0.1195]	[0.1162]	[0.1183]	[0.1384]	[0.1217]	[0.1248]
Ln Homes Passed			1.6550**	1.5954**	1.6228**	1.5869**	1.7998**	1.8287**	1.8239**
			[0.0569]	[0.0567]	[0.0572]	[0.0566]	[0.0794]	[0.0814]	[0.0821]
Duopoly			1.0564	1.0159	1.0537	1.0063	1.0415	1.0105	0.8208
			[0.1912]	[0.1845]	[0.1966]	[0.1797]	[0.2896]	[0.2921]	[0.2708]
Ln Pop per Sq Mile				1.0677	1.0653	1.0659	1.1099*	1.1064*	1.1033+
				[0.0513]	[0.0518]	[0.0514]	[0.0559]	[0.0560]	[0.0565]
Ln Income				2.0458**	2.0520**	2.0299*	2.0987**	2.0878**	2.0533**
				[0.5644]	[0.5552]	[0.5606]	[0.5821]	[0.5673]	[0.5591]
Rural				1.0073	1.0094	1.0079	1.0089	1.0087	1.0082
				[0.0068]	[0.0069]	[0.0069]	[0.0092]	[0.0094]	[0.0094]
DSL Providers				0.9483	0.95	0.9554	0.9674	0.9646	0.9705
				[0.0710]	[0.0769]	[0.0753]	[0.0814]	[0.0833]	[0.0900]
Ln Number Systems Owned by Firm								0.9502	0.9547
								[0.0379]	[0.0389]
Share of Systems Owned in DMA								1.8026	1.8331
								[0.8287]	[0.8416]
DMA Fixed Effects	N	Y	Y	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	12863	12829	12829	12829	12829	12829	8616	8598	8594
Log pseudolikelihood	-7030.43	-6495.95	-5907.72	-5888.99	-5904.54	-5884.99	-3650.11	-3639.27	-3628.03

Robust standard errors in brackets; clustered at state

+ significant at 10%; * significant at 5%; ** significant at 1%

Appendix 2: Additional Robustness Checks

	I	II	III	IV
Dependent Variable:	*Two Way Upgrade*			
CLEC Change	1.1421	1.105		
	[0.1089]	[0.1087]		
CLEC Change*Municipal Utility		1.1947		
		[0.3633]		
DSL>3 Indicator			0.8785	0.6509
			[0.4752]	[0.4179]
DSL>3 Indicator*Municipal Utility				3.0533*
				[1.7057]
Municipal Utility	1.4842	1.3314	1.4503**	1.4471**
	[0.4439]	[0.4757]	[0.1306]	[0.1303]
Demographic Controls	Y	Y	Y	Y
Cable System Characteristics	Y	Y	Y	Y
DMA Fixed Effects	N	N	Y	Y
State Fixed Effects	Y	Y	N	N
Year Fixed Effects	Y	Y	Y	Y
Observations	761	761	12823	12823
Log pseudolikelihood	-385.97	-385.56	-5883.94	-5883.57

Robust standard errors in brackets, clustered at state
+ significant at 10%; * significant at 5%; ** significant at 1%

Appendix 3: Hazard Model with Effects of Restrictive Regulation

	I	II	III	IV	V	VI	VII	VIII
	Entire Sample					*Restricted Sub Sample*		
Municipal Utility			1.4846**		1.2872+	1.555		1.2899
			[0.1727]		[0.1890]	[0.4781]		[0.4201]
Internal Communications				2.0747**	1.6756*		2.3530+	1.8807
				[0.3600]	[0.4015]		[1.1597]	[0.7436]
Any Restriction	0.6826*	0.4086**	0.8997	0.9047	0.894	1.0498	1.081	1.0484
	[0.1049]	[0.1136]	[0.1183]	[0.1162]	[0.1166]	[0.1994]	[0.1985]	[0.1968]
Municipal*Restriction			0.9542		1.0479	0.9473		1.1331
			[0.1577]		[0.1838]	[0.2923]		[0.3609]
Internal*Restriction				0.728	0.7072		0.5977	0.5508
				[0.2032]	[0.2163]		[0.2921]	[0.2100]
Demographic Controls	Y	Y	Y	Y	Y	Y	Y	Y
Cable System Characteristics	Y	Y	Y	Y	Y	Y	Y	Y
DMA Fixed Effects	N	N	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	1698	469	12829	12829	12829	6434	6434	6434
Log pseudolikelihood	-970.07	-262.4	-5888.06	-5889.03	-5883.01	-2798.43	-2801.55	-2797.02

Robust standard errors in brackets; clustered at state

+ significant at 10%; * significant at 5%; ** significant at 1%

Appendix 4: Linear Model with Effects of Cross Subsidy Restriction

	I	II	III	IV	V	VI
Municipal Utility	0.0406*			0.0737**		0.0465*
	[0.0190]			[0.0166]		[0.0201]
Internal Communications	0.0891*				0.1462**	0.1070*
	[0.0352]				[0.0309]	[0.0401]
No Cross Subsidies		-0.0868*	-0.1682*	0.0017	-0.004	0.0019
		[0.0427]	[0.0627]	[0.0286]	[0.0271]	[0.0281]
Municipal*NoCross				-0.0643+		-0.0455
				[0.0353]		[0.0325]
Internal*NoCross					-0.1218*	-0.0808
					[0.0571]	[0.0541]
Demographic Controls	Y	Y	Y	Y	Y	Y
Cable System Characteristics	Y	Y	Y	Y	Y	Y
DMA Fixed Effects	Y	N	N	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y
Observations	12863	1698	469	12863	12863	12863
R-squared	0.2346	0.1875	0.2111	0.234	0.2344	0.2351

Robust standard errors in brackets; clustered at state

+ significant at 10%; * significant at 5%; ** significant at 1%