

Municipal Electric Utilities' Role in Telecommunications Services

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August, 2004

Prepared for the Telecommunications Policy Research Conference

September 2004

Abstract

Municipal Electric Utilities (MEUs) are increasingly expanding into telecommunications services. Such entry is interesting in several respects. First, MEUs marry two interesting potential pathways for the growth of telecommunications access infrastructure and services: public ownership of last-mile facilities *and* electric power company expansion into telecommunications. Second, municipalities are key early adopters of next generation access technology in the form of both Fiber-to-the-home (FTTH) and broadband wireless (*e.g.*, WiMax) systems. Third, MEUs are at the nexus of the debate over the proper role for local government in promoting broadband Internet access. Most homes in the United States are served by investor-owned local telephone and cable television providers, using company-owned wireline infrastructure. These providers have generally opposed municipal entry, arguing that it will crowd out private investment and represents an unfair and less efficient form of competition. A number of states have acted to limit – or in some cases – to promote such entry. Before engaging in this debate, it is necessary to have a clearer picture of the current state of municipal entry and the local demographic, cost, industry, and policy factors that influence its evolution. To address this need, this paper reports the results of an empirical analysis of MEUs that provide communications services to the public. This analysis shows that MEUs are more likely to offer such services if they also provide internal communication services to support their electric utility operations (scope economies); are relatively close to metropolitan areas (lower backhaul costs); are in markets with fewer competitive alternatives (cable modem and DSL service availability limited); and which are less encumbered by regulatory barriers to entry (in communities in states which do not restrict municipal entry into telecommunication

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services). Of these results, the competitive impacts are the least straightforward to interpret, suggesting richer dynamics and avenues for further research.²

I. Introduction

Thirty years ago, last-mile telecommunications infrastructure was widely regarded as a natural monopoly that could best be provided by a public utility. Since then, an international trend toward liberalization, privatization, and increased reliance on market forces has sought to reduce a direct government role in managing and operating communications infrastructure. The intent of such policies is to transition toward a service provisioning model based on competition among investor-owned facilities-based providers. A similar trend has occurred over the last decade in the United States with respect to other heavily regulated sectors such as electric power generation and distribution.

This policy trend has been justified in part by changing technology and industry economics. In telecommunications, the emergence of the Internet has helped drive convergence of communications infrastructure toward digital broadband platform services, wherein comparable portfolios of telephony, data, and video services may be offered over diverse physical infrastructure (local telephone, cable television, or terrestrial or satellite-based wireless networks). Technical progress and mass-market acceptance of the Internet has caused overall market demand for last-mile access services to grow and the costs of deploying infrastructure to fall such that many believe that effective facilities-based competition is now possible in most markets in the United States. Indeed, belief in such a future motivated support for passage of the Telecommunications Act of 1996 ("TA96") which was intended to facilitate the emergence of local telephone competition.

Investor-owned telephone companies and cable television companies remain likely providers of wired-access facilities in most markets. However, there are questions as to whether additional wired-facilities providers may also be viable. In this vein, there has long been a hope that local electric power distribution companies might expand into telecommunication services to tap an additional revenue source and to exploit scale and scope economies associated with their local power distribution network operations (Falch, 1999). So far, there has been only very limited entry into last-mile telecommunications by power companies; however, MEUs which represent a minority of power companies have shown a much higher propensity to expand into last-mile telecommunication services than investor-owned electric companies.

Moreover, in light of the limited success under the TA96 of establishing facilities-based competitive local exchange carriers (CLECs) and concerns over the intensity of future competition between incumbent cable television and local exchange carriers (ILECs), the proper role for government regulation of last-mile infrastructure remains highly contentious. Finally, the economics of certain likely-candidate next generation infrastructure technologies like Fiber-to-the-Home (FTTH) raise new questions regarding the sustainability of facilities-based

² This paper complements related work, including Sirbu, Lehr, and Gillett (2004); Lehr, Sirbu, and Gillett (2004); and Gillett, Lehr and Osorio (2004)

competition. If facilities-based competition is either inadequate or unsustainable, then it seems likely that ongoing government regulation of communications access infrastructure will remain necessary.

With very high-bandwidth next generation platform services (*i.e.*, capable of supporting connection speeds in excess of 100Mbps and an integrated bundle of video, data, and telephony services) based on long-lived technologies like FTTH, there is the potential that competitive market pricing may fail to allow adequate recovery of non-traffic-sensitive carrier costs (*i.e.*, fixed and sunk costs). In such a situation, one obvious alternative is for end-users to directly own the dedicated infrastructure, at least up to a point where sufficient demand aggregation once again can support viable facilities-based competition.

With the evolution of distributed computing and the Internet, end-user-owned and controlled equipment at the edges of the network have played an increasingly important role. Recent developments in wireless networking, including WiFi, ad-hoc mesh networks, and cognitive radio, have raised hopes for edge-based, bottom-up "viral" networking as an alternative to traditional service provider models for supporting data communication connectivity. In this newer business model, network services are supported directly by end-user equipment, with only a limited or backbone need for traditional service providers to provide wider-area connectivity. This suggests that local governments may have a role in promoting the evolution of community-owned infrastructure based on these emerging end-user-equipment-centric networking models.

In all cases, Municipally-Owned Electric Utilities (MEUs) are at the center of the debate. They are relevant if one is interested in the role of electric power entry into telecommunications as a source of "third wire" competition which will make government interference in last-mile services less necessary. Indeed, as already noted, MEUs have been entering last-mile telecommunication services at a faster rate than investor-owned electric utilities. Alternatively, MEUs provide insight into the potential role of municipal-ownership in solving market failure problems and in supporting the evolution of end-user centric networking models. While the number of communities that are being served by municipally-owned telecommunication service providers remains small, it has been growing rapidly, and in almost all of these, the provider is the municipally-owned electric utility (MEU).³

Finally, MEUs are critical early adopters of likely candidates for next generation broadband access infrastructure. For example, municipalities are a more significant driver of growth in the U.S. Fiber to the Home (FTTH) market than they may appear at first glance. While they represent about a tenth of the 128 communities served with FTTH as of May 2004, they serve nearly a third of the homes passed, and this fraction has grown even as more types of players participate in the market (Figure 1).⁴ Similarly, municipalities are important customers for emerging broadband and mesh wireless technologies from vendors like Alvarion and Tropos Networks.

³ Recently, a wider selection of communities have begun offering various telecommunication services using wireless technologies (see Lehr, Sirbu, Gillett, 2004). At the time of writing, however, the authors are aware of very few municipal deployments of wired infrastructure in communities without an MEU.

⁴ The FTTH Council's May 2004 list of communities served by FTTH can be found at <http://www.ftthcouncil.org/dbfiles/techexchange/2004%20-05-19%20OptFiberCommunList.pdf>.

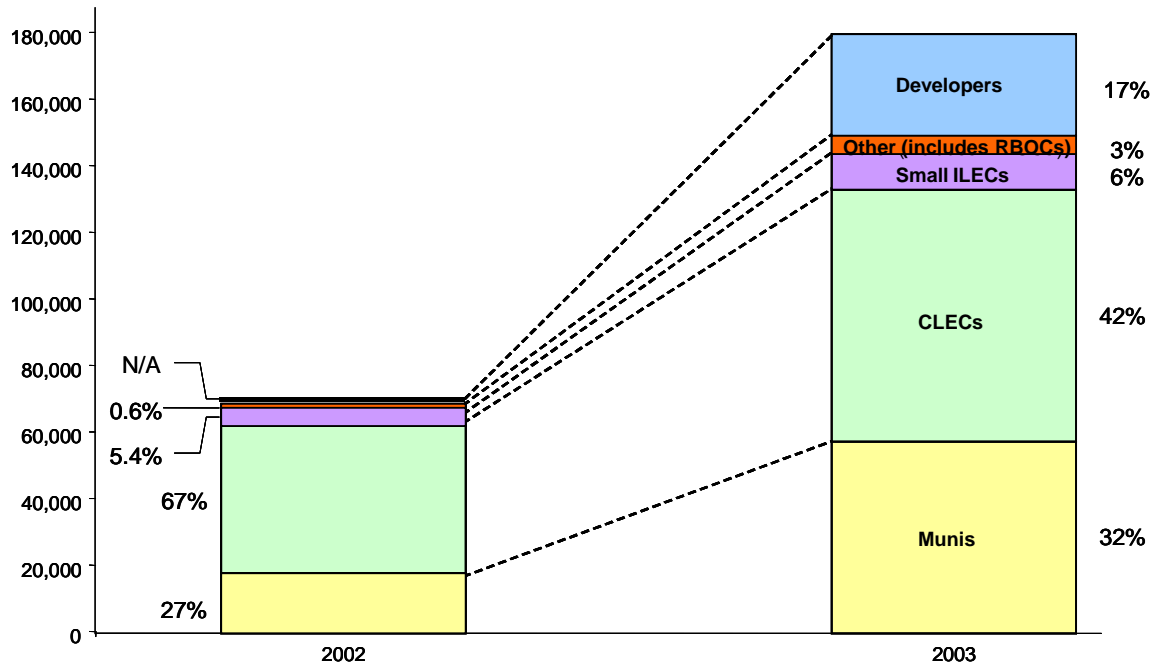


Figure 1: FTTN Homes Passed in U.S.⁵

Sources: FCC Triennial Review report, August 2003; Render, Vanderslice & Associates

This paper presents results from an econometric analysis of a data set of MEU communities in the United States that identifies whether the MEU offers telecommunication services, and if so, which services are offered. The analysis of MEUs that offer telecommunication services provides support for the following findings:

- Communities that have already deployed their own communications infrastructure for internal purposes are much more likely to offer service to the public as well, suggesting that experience effects and scope economies are important factors in inducing MEUs to expand into offering telecommunication services more generally;
- State laws that burden municipal entry into communications are effective at discouraging it, suggesting that the March 2004 Supreme Court ruling⁶ may constrain the growth of municipally-owned telecommunication services;

⁵ Based on data compiled from Render, Vanderslice & Associates, and p. 166 of the FCC's August 21, 2003 Triennial Review report, FCC-03-36, http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-03-36A1.pdf, In the Matter of Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers CC Docket No. 01-338, Implementation of the Local Competition Provisions of the Telecommunications Act of 1996 CC Docket No. 96-98, Deployment of Wireline Services Offering Advanced Telecommunications Capability CC Docket No. 98-147, *Report and Order and Order on Remand and Further Notice of Proposed Rulemaking*.

⁶ *Nixon vs. Missouri Municipal League*, which ruled that the Telecommunications Act of 1996 did not pre-empt state laws of this kind.

- Communities that are more remote from urban areas are less likely to offer communications, suggesting that backhaul costs are an important constraining factor, and that development of regional transport networks is a necessary complementary factor driving municipal entry;
- Municipalities are less likely to offer communications in the presence of competition from investor-owned cable modem operators, suggesting that MEU entry is a substitute for private-sector provisioning;
- Municipalities that do not already run their own utilities (particularly, electric utilities) are much less likely to offer telecommunication services based on municipally-owned wired infrastructure.

The next sections of this paper explain the data, hypotheses, and statistical methods used in the analysis, and present the empirical results. We conclude by considering the implications of these results for the prospects that municipally and investor-owned utilities would grow to provide “third-wire” broadband competition.

II. What Factors Drive or Constrain Municipal Broadband?

We addressed this question by analyzing a data set of Municipal Electric Utilities (MEUs) that offer communications, which was provided to us by the American Public Power Association (APPA) based on their annual survey of public power companies.⁷ As Figure 2 shows, the number of MEUs offering communications services has been growing rapidly.

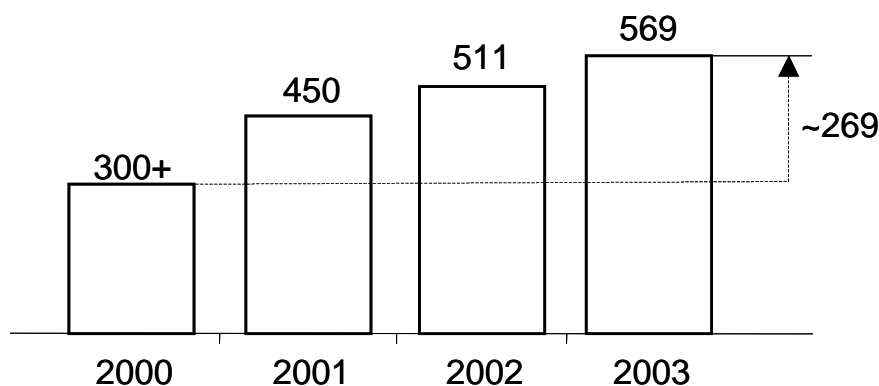


Figure 2: Number of MEUs doing Communications (Source: APPA)

As of 2003, about a quarter of the 2,000 or so U.S. communities with publicly owned electric utilities now provide some type of communications service. We examined whether MEU communities that offer communications are systematically different from MEU communities that offer only electric power, or from communities not served by MEUs at all. Our analysis focuses on four types of factors likely to distinguish MEUs offering communications:

⁷ We acknowledge the invaluable assistance of Ron Lunt of the APPA in obtaining and interpreting this data. We sought, but did not find, a database of municipalities in general (i.e. beyond MEUs) that offer communications.

1. **Geo-demographics.** A number of empirical studies, focusing on deployments by investor-owned telephone and cable television service providers, have demonstrated the importance of local demographic and cost factors in influencing where DSL or cable modem services are available.⁸ Collectively, we refer to these factors as “geo-demographics.” They include indicators that characterize the level of demand in the community (*e.g.*, Internet adoption has been shown to be higher among homes with higher incomes and education⁹) and the costs of meeting that demand (*e.g.*, costs of installing outside plant facilities which are typically higher in lower density rural communities). Not surprisingly, these earlier studies found that broadband access is more often found in communities with higher potential demand and lower cost, or equivalently, communities that offer higher expected profitability. It is less obvious, however, whether municipal deployments should follow a similar pattern since they may be less profit-motivated. Although municipal operators typically operate as non-profits, they are expected to recover their costs. If municipal operators weigh cost-recovery in their decision-making to the same degree that private-sector operators weigh profitability, then we would expect high costs and low demand to constrain deployments, just as in the private sector. On the other hand, the public sector may be *more* likely to build out in areas where costs are higher or demand lower, precisely because the private sector is less likely to serve such areas.
2. **Regulatory framework.** As with geo-demographics, previous empirical studies have confirmed the expected impact of state-level regulatory frameworks that are more or less encouraging to private sector deployments.¹⁰ We therefore hypothesize that state-level differences in regulatory treatment of localities – which are legally creations of the states they reside in – may be an important factor driving or constraining municipal entry into communications. Specifically, we hypothesize that state legal frameworks that give municipalities more discretionary authority are conducive to communications infrastructure deployment, while state laws that burden municipal entry effectively discourage it.
3. **Competition.** Regardless of whether competition actually spurs or deters private-sector investment in broadband facilities,¹¹ we hypothesize that competition from private-sector broadband (*e.g.* cable modem and DSL) operators is likely to inhibit public sector entry. We

⁸ Grubestic (2004) finds explanatory power in the combination of housing density with higher income and educational levels. Prieger (2003) finds that the urban/rural dimension and market size variables for households and businesses present a significant relationship with broadband availability, when controlling by other factors. Also, he finds no statistically significant evidence of the effect of income on differences on broadband access. Gabel and Kwan (2001) also emphasize the importance of business demand for broadband services, in special in terms of number of employees and size of companies and their differences services demanded. Gillett & Lehr (1999) examine how income, education, population levels and density affect demand for broadband services, finding that – as of 1999- availability was scarce and “concentrated in higher income, higher density markets”.

⁹ See for example Hampton (2003) and NTIA (2000).

¹⁰ For a study focused on broadband deployments specifically, see Gabel and Huang (2003). More generally, there is ample evidence that regulatory liberalization and the increased competition associated with it encourage more rapid telecommunications infrastructure modernization. See, for example, Greenstein, McMaster and Spiller (1995), Taylor, Zarkadas, and Zona (1992), and Sappington and Ai (2001). For similar results based on cross-national studies, see for example Boyland and Nicoletti, (2000), Ros (1999) or Walsten (1999).

¹¹ See Gabel and Huang (2003) for a summary of conflicting study results on this hotly contested topic. Prieger (2003), finds that competition raises the “probability of broadband access raises by 26.7 percentage points”

observe that municipal broadband is often accompanied by rhetoric related to economic development, a justification more likely to win local support when the need for broadband infrastructure is either totally unmet, or poorly met by an unpopular monopoly provider. This hypothesis was further suggested by our previous finding that residential broadband services are more commonly offered by municipal operators in very small communities (Gillett, Lehr & Osorio, 2004).

4. **Internal infrastructure.** Finally, we hypothesize that municipalities are more likely to serve the public with communications services when there is an economy of scope with portions of the necessary infrastructure. In the particular case of MEUs, some utilities have deployed their own networks as part of so-called Energy Management Systems (EMS). These systems, which typically involve fiber rings linking substations, enable more automated monitoring and management of electricity distribution.¹² Some MEUs as well as non-MEU municipalities have also deployed fiber to support data and/or voice networking among municipal buildings, including schools. We expect to see more municipally provided broadband when some of the needed infrastructure either already exists, or if it is to be built, can be used to support multiple municipal purposes (*e.g.*, e-government).

III. Empirical Analysis

The empirical analysis was conducted on a data set we constructed by matching the APPA data, which identifies which (if any) communications services are offered by U.S. MEUs, against multiple sources of data we selected to proxy for the four factors discussed above.¹³ We first tested the hypotheses using Probit estimation of the probability that an MEU offers any communications service to the public (dependent variable) as a function of a collection of regressors (independent variables) representing these four types of factors.¹⁴

Table 1 summarizes our categorization of the communications services listed in the APPA data and the distinction between internal and external services. The services listed as internal are for use by the utility in its internal operations. The dependent variable in the probit analysis is whether the MEU offers any *external* communications service; it is coded as 1 if the MEU offers one or more of the 9 communications services possibly offered to residential or business customers.

¹² For example, the ability to read electric meters remotely, turn service on or off without a truck roll when customers move, detect service outages or theft, and monitor variations in load. These systems go by many names depending on the vendors involved. Two common acronyms are SCADA (Supervisory (or System) Control and Data Acquisition) and AMR (Automatic Meter Reading). See Osorio (2004, pp. 29-31) for more details.

¹³ The analysis reported here was conducted using data collected in the APPA's December, 2002 survey of 2,000+ U.S. public power companies, and validated by the APPA for its Annual Directory & Statistical Report. This research could be extended to test the APPA's December, 2003 data and to look for dynamic effects across years.

¹⁴ Our econometric analysis was conducted in Stata using the standard Probit estimation routine. In addition to the results reported in Table 2, sensitivity runs were conducted with different variable choices. The results from these analyses were substantively the same as presented here. Additionally, we controlled for outliers by excluding very large communities like Los Angeles that might be thought to be anomalous, as well as very small communities for which measurement errors might be more likely. The results were similar with and without the outliers included, so the analysis reported here includes all communities in our sample.

Table 1: Categorization of Services Offered in APPA Data

Internal Services	External Services	
	Primarily Residential/Consumer	Primarily Business/Commercial
Internal telephone service	Cable Television	Leased (Private) Lines
Automated meter reading	Local Telephone	Fiber Leasing
System control & data acquisition	Long Distance Telephone	
	Video on Demand	
	Wireless services ¹⁵	
	ISP ¹⁶	
	Broadband Modem	

Table 2 summarizes the numeric results of the probit analysis, while Tables 3-6 summarize the data used and present the same results in non-econometric form, grouped by the four types of factors (geo-demographics, regulatory framework, internal infrastructure, and competition). The focus of our analysis is on the sign and level of statistical significance of the coefficients for the various independent variables; because of limitations in the available data, coefficient magnitudes are much more susceptible to measurement error and difficult to interpret. When the sign of the coefficient is positive and significant (at the 90% confidence level or higher) for an independent variable, we conclude that that variable increases the probability that the MEU will offer at least one external communication service.

¹⁵ Utility provides a radio frequency based commercial service (*e.g.*, PCS Service). Wireless and telephone services may also be provided to business customers.

¹⁶ This includes dial-up access.

Table 2: Econometric Results from Probit Model

	Variables	Model 1	Model 2	Description
	Dep.: External			= 1 if MEU offers any external telecommunication service, 0 otherwise
Internal Infrastructure	Internal	1.29027*** (.0969657)	1.291951*** (.09707)	= 1 if MEU offers internal services of voice and data (internal voice, AMR, and SCADA), 0 otherwise
Competition	Cable Modem Competition	-.2890704*** (.0969215)	-.274023*** (.0967253)	= 1 if there is at least one private provider of Cable Modem broadband services, 0 otherwise
	DSL Competition	.2915961*** (.1214732)	.312027*** (.1208535)	= 1 if there is at least one private provider of DSL broadband, 0 otherwise
Regulatory framework	Regulate	-.3422064*** (.095802)	-.3513576*** (.0959344)	= 1 if State regulations difficult or explicitly prohibit MEUs for offering telecommunication services, 0 otherwise
	NotDillon	.1651156 (.1072134)	.154468 (.1073175)	= 1 if place is <u>not</u> subject to Dillon’s Rule, 0 otherwise
	City	.7631923*** (.1301235)	.7652744*** (.131993)	= 1 if MEU is located in a city, 0 otherwise
Geo-demographics	Metro_County	.2323209** (.0939599)	.2281651** (.0944135)	= 1 if RUCC equals 1, 2 or 3 (Place located in a metro county) ; 0 otherwise
	Ed_Attain	1.616987* (1.007527)	.7240682 (1.100392)	% Population with bachelors degree
	Inc_Cap	-.0220581 (.0153691)	-.0162077 (.014791)	Average Income per capita (in \$1000)
	Hous_dens	.0577286 (.1241977)	.0553292 (.1236062)	Housing density (1000 units/sq. mile)
	Pop	4.84e-07 (3.77e-07)	4.81e-07 (3.75e-07)	Population (people)
	FIRE		1.17389* (.6835656)	% workers in financial, information, retail and education, health and social services industries
	Constant	-2.090772*** (.2707124)	-2.593577*** (.3830089)	Constant
	N	1801	1801	No. observations
	Pseudo R ²	0.2265	0.2289	

Note: * Significant at 90% confidence level, **: significant at 95%, ***: significant at 99%. Robust standard errors are in parenthesis.

Table 2 presents two models. Their difference resides on the inclusion of a variable controlling for the percentage of “white-collar” workers on the city (FIRE) in model 2, which lessens the statistical significance of educational attainment in model 1 below 90%.

Geo-Demographic Variables

To control for geo-demographic effects, we include indicators of local characteristics that influence the magnitude of potential demand and the costs of supplying infrastructure to meet it (Table 3). As suggested above, while we would expect that indicators of higher demand/lower cost would have positive signs if the analysis focused on private-sector provider behavior, the prospects for public sector actors such as MEUs are more ambiguous.

Table 3: Geo-demographic Variables

Variable	Description	Source	Expected Direction of Impact	Actual Sign	Statistical Significance (Confidence Level)
Ed_Attain	% Population with bachelors degree	(U.S. Census Bureau, 2004)	Positive (?) ¹⁷	Positive	90% in Model 1; Not S.S. in Model 2
Pop	Population (people)	(U.S. Census Bureau, 2004)	Positive (?)	Positive	not S.S.
Hous_dens	Housing density (1000 units/sq. mile)	(U.S. Census Bureau, 2004)	Positive (?)	Positive	Not S.S.
Inc_Cap	Average Income per capita (in \$1000)	(U.S. Census Bureau, 2004)	Positive (?)	Negative	Not S.S.
FIRE	% workers in financial, information, retail and education, health and social services industries	(U.S. Census Bureau, 2004)	Positive (?)	Positive	Not in Model 1; 90% in Model 2
Metro_County	=1 if RUCC equals 1, 2 or 3 (Place located in a metro county) ; 0 otherwise	Computed. (Economic Research Service, 2003)	Positive	Positive	95%

As proxies for the level of local demand for broadband and the cost to supply it, we include data from the U.S. Census Bureau on housing density (Hous_dens), population (Pop), educational attainment (Ed_Attain), income per capita (Inc_Cap), and workforce participation in information intensive sectors (FIRE), as well as an indication of whether the community is located in a metropolitan area (Metro_County). Generally, the higher the population and housing density, the greater is potential demand (measured in homes that might be served) and the lower are expected costs (less outside plant infrastructure is required to serve each customer). The level of educational attainment, per capita income, and workforce participation in information intensive activities complement these variables by providing additional indicators of the type of community it is. Earlier studies have shown higher penetration of IT services among better educated, higher-earning “white-collar” workers.¹⁸ If these variables influence public-sector provisioning in the same way that earlier studies have shown them to affect investment decisions by private-sector operators, then we would expect positive signs for all of these variables, indicating that communications services are more likely to be offered in communities with higher residential and business demand, and lower costs. However, this expected result is tentative because the MEUs are non-profits that may be influenced by different factors than investor-owned providers. Thus, they may be more inclined to offer communication services in

¹⁷ We include a question mark to indicate that this expected result is tentative, as explained in the text.

¹⁸ Intensive use of IT by industry has shown to be associated with high-skilled labor, a more college-educated labor force, and higher salaries (Bresnahan, Brynjolfsson and Hitt, 2002; Autor, Levy and Murnane, 2003).

precisely those markets which are underserved by investor-owned providers (*i.e.*, low demand, high cost markets).

The Metro_County variable is computed from the 9-level rural/urban community classification scheme developed by the U.S. Department of Agriculture's Economic Research Service, and known as the Rural/Urban Continuum Codes (RUCC). This classification scheme "distinguishes metropolitan (metro) counties by the population size of their metro area, and nonmetropolitan (nonmetro) counties by degree of urbanization and adjacency to a metro area or areas. The metro and nonmetro categories have been subdivided into three metro and six nonmetro groupings, resulting in a nine-part county codification."¹⁹ We compute Metro_County as 1 if the community is located in a metropolitan county (*i.e.*, RUCC = 1, 2, or 3). We assume, *ceteris paribus*, that communities closer to metropolitan areas are likely to experience lower backhaul costs, suggesting that this variable should be positively associated with the probability of finding public broadband infrastructure in a community, if the public sector behaves like the private sector in this regard.

As Tables 2 and 3 show, within the group of geo-demographic indicators, the only two variables that turned out to be significant in our regression analysis were closeness to metropolitan areas (positive at 95% significance level), educational attainment (positive at 90% significance level) in model 1, and closeness to metropolitan areas and white-collar workforce (FIRE, positive at 90% significance) in model 2. The signs are consistent with interpreting higher potential demand (more educated workforce) and lower costs (closer to metro area) as increasing the likelihood that an MEU would offer communication services. With the exception of the sign for per capita income (which is negative in both models), the signs on the other variables are also positive, and hence consistent with the normal expectation. We have included Model 1 and 2 here to show that the results are robust to the choice of geo-demographic variables; however, disentangling the separate effects of controls for market demand and cost conditions has proven difficult. A number of other choices for geo-demographic controls which are not reported here yielded analogous results.

The limited significance of the geo-demographic variables and the negative sign for per capita income is consistent with there being a tension between the normal expectation of a positive sign for variables that indicate higher demand and lower costs and the divergent objectives of investor-owned vs. public-owned providers. MEUs may be willing to invest in communities with less obviously proven demand, as part of the community's economic development strategy.

Regulatory Variables

We hypothesize that the likelihood that an MEU decides to offer communications services is influenced by its regulatory environment. Because localities are creations of the states they reside in, and local governments represent areas that are chartered in various ways, communities vary in their level of local discretionary authority. Our model tested three binary variables proxying for different aspects of the regulatory framework applying to municipalities (Table 4).

¹⁹ See Economic Research Service, (2003).

Table 4: Regulatory Variables

Variable	Interpretation	Source	Expected Direction of Impact	Actual Sign	Statistical Significance (Confidence Level)
City	= 1 if MEU is located in a city, 0 otherwise	(U.S. Census Bureau, 2004)	Positive	Positive	99%
NotDillon	= 1 if MEU is located in a state not subject to Dillon's Rule, 0 otherwise	(Richardson, Zimmerman, and Puentes, 2003)	Positive	Positive	Not S.S.
Regulate	= 1 if state regulations hinder or prohibit MEUs from offering communications services, 0 otherwise	(APPA, 2004)	Negative	Negative	99%

The City variable captures the institutional classification of the community. We expected its coefficient to be positive, and found this to be the case. This result was expected because cities are more likely to have the local government resources to support more interventionist policies.

As Richardson, Zimmerman and Puentes (2003) explain, Dillon's Rule is a "judicial doctrine named for a 19th-century Iowa Supreme Court justice...that allows localities to possess only such powers as are specifically delegated to them by state law" (in other words, they can only do what their state expressly permits). Thirty-nine states limit local government power in this way (NotDillon=1), while others follow the "home rule" tradition in which localities can do whatever is not explicitly prohibited. Our hypothesis of a positive sign for this indicator reflects our expectation that communities under home rule might be better able to innovate as needed to support municipal communications. The lack of statistical significance for the result probably reflects the complex reality of how Dillon's Rule is applied in practice, with many years of legal history affecting the actual powers available to any given community.

Of more significance are state regulations that explicitly address municipal entry into communications. As of 2002, 9 states hindered or prohibited municipal entry, suggesting that the coefficient of Regulate would have the negative sign which we indeed found. Not surprisingly, this result suggests that regulatory policy has an important impact on municipal entry into communications. Since 2002, the number of states with restrictions has grown to 13 (APPA, 2004). Absent such state-level constraints limiting entry, more MEUs might be expected to offer communications services.

Internal Infrastructure Variables

To control for the presence of internal infrastructure, we compute a binary indicator (Internal) of whether the MEU provides communication services for its own use. We view this as a control for potential scope economies and "path dependence" associated with earlier decisions made by the MEU. Because of technical innovations in how electric power networks are managed and operated, and because of ongoing deregulation of the industry, electric power utilities have been deploying increasing amounts of information technology infrastructure to support their power

operations. This infrastructure includes facilities to support automatic meter reading and power management and control systems. While an electric utility (municipal or otherwise) may choose to deploy such infrastructure without any intention of also using it to provide communications services to the public, the fact that such infrastructure exists (as measured by the observation that the MEU provides internal services) indicates the potential for scope economies. The costs of offering communications services to local businesses and residential consumers are lower if an MEU has this internal capability. Additionally, an MEU may initially deploy services for internal use to learn how to manage the facilities before expanding to a wider market. If this capability was put in place earlier, then past decisions by the MEU are likely to be influencing their behavior with respect to entering communications services more generally and suggest a dynamic component to MEU entry that is not otherwise reflected in our analysis. Exploring these dynamic issues (and especially how they interact with competition) are an obvious focus for future research.

Table 6: Internal Infrastructure Variable

Variable	Interpretation	Source	Expected Direction of Impact	Actual Sign	Statistical Significance (Confidence Level)
Internal	= 1 if MEU offers any internal communications service, 0 otherwise	2003 APPA Annual Survey (data for 2002)	Positive	Positive	99%

As Table 6 shows, the coefficient for Internal has the expected sign (positive) and is significant at the 99% level. As noted, we interpret this variable as indicating that the MEU has lower entry costs because it is able to realize scope economies associated with being able to share infrastructure costs across its core business, electric power. Additionally, this variable likely reflects a dynamic component. Early experience with internal services may provide learning experience which makes these MEUs more likely to expand into offering telecommunication services to the general public.

Competition Variables

As a measure of competition, we constructed two binary variables that indicate whether private-sector DSL (DSL competition) or cable modem (Cable Modem Competition) broadband Internet access is available in the community (Table 5). Each of the variables is coded as a 1 if DSL (or cable modem service, respectively) is available anywhere in the community from a non-MEU provider, and 0 otherwise. For example, if both are equal to 1, then broadband services are available from at least two private-sector providers using two separate physical infrastructures, whereas if both are equal to zero, then no private-sector broadband access alternatives are available. Since we know that virtually every home in the U.S. is served by basic telephone service and most are passed by private-sector cable television systems, our competition metrics focus not on whether private-sector communications service providers are present in the community, but rather whether they are actively selling advanced communication services. If they are, then the demand for publicly provided communications services would presumably be lower, as would the motivation for local public sector investment.

Table 5: Competition Variables

Variable	Interpretation	Source	Expected Direction of Impact	Actual Sign	Statistical Significance (Confidence Level)
Cable Modem Competition	= 1 if there is at least one private provider of Cable Modem services in the community, 0 otherwise	Data for 2002 (Warren, 2004)	Negative	Negative	99%
DSL Competition	= 1 if there is at least one private provider of DSL in the community, 0 otherwise	Data used on Gabel and Huang (2003)	Negative	Positive	99%

The measure of cable modem availability is constructed from data in the Television and Cable Factbook, listing which cable franchises supported cable modem services as of 2002 (Warren, 2004). DSL availability is derived from a data set constructed by Gabel and Huang (2003) from data reported by local telephone companies on the services that were available from each local switching center, also in 2002. These indicators are the best we could find,²⁰ but are known to have inaccuracies that overstate the extent of competitive supply. Particularly for DSL, just because the switch in a wire center can support DSL features, does not mean that the outside plant can actually reach the entire community with DSL. Also, a community may be served by more than one wire center or cable franchise, and we code the competitive variables as 1 if service is available anywhere (but not necessarily everywhere) in the community.

As expected, we observe that the coefficient on Cable Modem Competition is negative and significant at the 99% level (Tables 2 and 5). In other words, the existence of private cable-based broadband alternatives is associated with reduced likelihood of MEU entry into telecommunications. Regression analysis alone is not enough to infer the direction of causality associated with this result, which may in any case differ by community based on the timing of local public and private-sector broadband offerings.

There are several possible explanations behind the surprising finding of a positive coefficient for DSL competition, significant at the 99% level. It may simply reflect the noisiness of the underlying indicator. Or it may reflect dynamics that are not captured in our data, namely that DSL probably became available later than cable modems in many communities. An MEU that offered broadband services at the end of 2002 would have had to begin planning their deployment several years before. Quite possibly, the DSL available in 2002 was not available at the time the MEU made its decision to offer broadband, suggesting that the coefficient would actually be negative if this dynamic could be measured. In this scenario, MEU broadband may actually have stimulated deployment of DSL, by proving out demand for broadband services.

²⁰ The FCC zip-code broadband data collected on Form 477 does not, unfortunately, distinguish among private and public providers, and it lumps “1-3” providers into a single category. Therefore it was not possible to remove public providers from this data so as to be left with a measure of private sector competition in the communities of interest.

A third possible explanation for the seemingly contradictory results shown in Table 5 is that MEUs view private sector cable modem competition as a closer substitute (and therefore a more vigorous rival) than DSL. Supporting this possibility is the observation that most MEUs in the 2002 data that did offer residential broadband used cable modem technology and also offered cable television. DSL was at least originally more targeted at business users and may therefore have been viewed as less threatening to an MEU that is also a cable television provider, than a cable company that has upgraded its plant to support broadband and that can be expected to compete aggressively in the residential market.

IV. Conclusions and Implications for Last-Mile Competition

Considered as a whole, the results of the analysis suggest that demographic and competitive factors have more ambiguous and less readily interpretable influences on a municipal electric utility's decision to offer telecommunications services to the public, while existing technical capabilities and state-level regulations are stronger influences. These findings have implications for potential growth in broadband competition from municipalities as well as investor-owned utilities, and the role of public policies in shaping the competitive outcome.

The ambiguous demographic results suggest MEU's motivations for telecommunications deployments may differ somewhat from the private sector's. Economic development is often cited as a motivation for MEU involvement in communications, and this explanation is consistent with the negative sign on per-capita income, which would be counter-intuitive *vis a vis* private-sector deployment incentives. Overall, the demographic indicators of demand were weak predictors of MEU entry. The two models reported here show the expected positive sign on educational attainment and workforce participation in information-intensive sectors, but both variables are not significant at the same time; and inclusion of other demographic variables did not materially alter the result.²¹

On the other hand, the geographic location of a community in a metropolitan county showed a consistent and statistically significant positive correlation with the MEU's likelihood of providing external telecommunications, suggesting that lower middle-mile costs are associated with the propensity for municipal action in the last mile. MEUs may be more willing to serve in communities whose demand profiles are less attractive to the private sector, often with the rationale that the services they provide will help improve the profile (e.g. attract information-intensive industries and jobs to the community). However, MEUs located in more remote areas appear to be just as constrained by backhaul costs as the private sector. This finding suggests the importance of state and regional cooperative networks to which municipal networks can connect.

The opposing signs associated with the statistically significant cable modem and DSL competition coefficients suggest competitive dynamics that are more complex than what the

²¹ The lack of significance of housing density and population may reflect the inclusion of overlapping variables included to test other types of effects (City and Metro_county). Alternatively, it may reflect the greater homogeneity of MEU communities relative to the U.S. as a whole. MEUs typically do not serve the endpoints of the community size distribution: the smallest communities are typically served by Rural Electric Cooperatives, and the largest (with the exception of Los Angeles) by investor-owned electric utilities. See Gillett, Lehr & Osorio (2004) for more details.

probit model tested here can capture. They show that competition from cable modems is associated with less MEU entry, but of course regression is insufficient to infer causality (i.e., cannot distinguish between scenarios (a) public broadband “crowds out” private cable modem operators, and (b) the public sector is more likely to enter when the private sector hasn’t). They also show that DSL competition is associated with more MEU entry, which may reflect noisy competition data, and/or DSL’s generally later entry into many U.S. markets (i.e. DSL was available in 2002, but not at the earlier time that the MEU decided to enter the market). Alternatively these results may suggest that cable modem and DSL services are not viewed as economic substitutes, for example if DSL is perceived as a business service while cable modem is targeted mainly at residential customers. Osorio (2004, pp. 73-75) tests a multinomial logit model with MEU offerings segmented by type of customer, and finds support for segmenting competition along business vs. residential lines. Further research in this area, supported by an augmented data set, could reveal interesting competitive dynamics.

The consistently strong positive coefficient for internal infrastructure highlights the importance of scope economies between last-mile telecommunications and the management of local electricity distribution. The strong correlation between communities offering external and internal communications is also consistent with a progression we have observed in interviews with MEUs and Public Utility Districts (PUDs) that have gotten into communications. Namely, their first step is often “insourcing” communications – i.e. building their own infrastructure – to be used for services that will improve the internal operations of their electric utility. The cost of such infrastructure, such as fiber rings connecting substations, is typically justified on the basis of operational cost savings from more automated monitoring and management of electricity distribution; sometimes, the ability to provision voice services to the utility and/or the local government is added to the cost equation as well. However it is justified, once this first step has been taken, the decision to deploy additional infrastructure to end users becomes incremental, i.e. lower cost and risk than it would have been as a starting point, and therefore easier to make. In addition, the experience the utility gains in operating internal infrastructure lowers hurdles to offering communications services to end users.

The importance of scope economies with internal infrastructure suggest that the prospects for growth in municipally and/or utility-driven broadband competition can be segmented as shown in Figure 3.

It is perhaps suggestive that of the municipalities listed by the FTTH Council as having deployed FTTH, about half are in states with laws limiting municipal entry into communications.

It is too early to tell whether the Supreme Court's *Nixon* decision will accelerate state laws, or whether Congress will consider legislation to override it. What is clear, however, is that absent such state laws, more MEUs would be likely to deploy broadband last-mile networks.

Acknowledgments

We would like to thank the following individuals for their contributions to this research: Bob Whitman, Corning; Ron Lunt, APPA; Jim Baller, The Baller Herbst Law Group; David Gabel, Queens College, City University of New York; Scott Kennedy, independent consultant; Michael Render, Render, Vanderslice & Associates; Esme Vos, MuniWireless.com; Kara Callahan, AES; Judi Cardell; Smith College; David Clark, MIT; Joel Cutcher-Gershenfeld, MIT; Paul Morris and Roger Black, Utopia; and Terry McGarty, the Merton Group.

Financial support for this research was provided by the industrial partners of the MIT ITC and CFP research programs (see <http://itc.mit.edu> and <http://cfp.mit.edu>), by the Digital Government Program of the U.S. National Science Foundation, Award #EIA-0306723, and by the Business School at Universidad Adolfo Ibanez, Chile. Views expressed in this article are those of the authors; no endorsement by project sponsors is implied, and any errors of fact or interpretation remain the responsibility of the authors.

References

American Public Power Association, 2004. "Public Power: Powering the 21st Century Through Community Broadband Services" <last visited on August 17th 2004, at url

<http://www.appanet.org/files/PDFs/TelecomFactSheet050104.pdf>>

Autor, D., F. Levy, and R. Murnane, 2003. "The Skill Content of the Technology Change," *Quarterly Journal of Economics*, 118(4), pp. 1279-1333.

Boyland, O. and G. Nicoletti, 2000. "Regulation, Market Structure and Performance in Telecommunications," Economics Department Working Paper No. 237, Organization for Economic Cooperation and Development, Paris. <last visited on August 17th, 2004, at url <http://www.oecd.org/dataoecd/24/33/2736298.pdf> >

Bresnahan, T., E. Brynjolfsson, and L. Hitt, 2002. "Information, Technology, Workplace Organization and the Demand for Skilled Labor: Firm Level Evidence." *Quarterly Journal of Economics*, Vol. 117, Issue 1, February, pp.339-376

Economic Research Service (2003) "Rural Urban Continuum Codes" U.S. Dept. of Agriculture <url <http://www.ers.usda.gov/briefing/Rurality/> last visited on August 23, 2004>

Falch, M. (1999) "Electricity Companies and Railway Networks as Newcomers in Telecommunications," in Welfens, P.J.J., G. Yarrow, R. Grinberg, and C. Graack, eds., *Towards Competition in Network Industries: Telecommunications, Energy and Transportation in Europe and Russia*, Springer.

- Gabel, D. & F. Kwan, 2001. "Accessibility of Broadband Telecommunication Services by Various Segments of the American Population," in B. Compaine and S. Greenstein, eds., *Communications Policy in Transition: The Internet and Beyond*, MIT Press, pp. 295-320.
- Gabel, D. and Huang, G-L, 2003, "Promoting Innovation: Impact of Local Competition and Regulation on Deployment of Advanced Telecommunications Services for Businesses" <url last visited on August 24th, 2004 at http://itc.mit.edu/itel/docs/2003/promo_innov.pdf>
- Gillett, S. & W. Lehr, 1999. "Availability of Broadband Internet Access: Empirical Evidence," Presented at Telecommunications Policy Research Conference, September 25-27, Alexandria VA, <url http://itc.mit.edu/itel/docs/MISC/LehrGillettTPRC99_0523.doc last visited on August 16th, 2004)
- Gillett, S., W. Lehr and C. Osorio, 2004. "Local Government Broadband Initiatives," *Telecommunications Policy*, Volume 28, Issues 7-8, August-September, Pp. 537-558
- Greenstein, S., S. McMaster, and P. Spiller, 1995. "The Effect of Incentive Regulation on Infrastructure Modernization: Local Companies' Deployment of Digital Technology," *Journal of Economics and Management Strategy*, Vol 4, No. 2, pp. 187-236.
- Grubestic, T., 2004. "The geodemographic correlates of broadband access and availability in the United States." *Telematics and Informatics* 21, pp. 335-358.
- Hampton, K., 2003. "Grieving for a Lost Network: collective action in a wired suburb," *The Information Society* 19 (5).
- Lehr, William, Marvin Sirbu, and Sharon Gillett, 2004, "Municipal Wireless Broadband: Policy and Business Implications of Emerging Access Technologies," paper prepared for "Competition in Networking: Wireless and Wireline," London Business School, April 13-14, 2004.
- National Telecommunications and Information Administration (NTIA), 2000. "Advanced Telecommunications in Rural America: the challenge of bringing broadband service to all Americans." <url <http://www.ntia.doc.gov/reports/ruralbb42600.pdf> last visited on August 16th, 2004>
- Osorio Urzúa, C. 2004. *Bits of Power: The Involvement of Municipal Electric Utilities in Broadband Services*, MS Thesis, Technology and Policy, Massachusetts Institute of Technology <url http://itc.mit.edu/itel/students/papers/osorio_thesis.pdf last visited on August 16th, 2004>
- Prieger, J., 2003. "The Supply Side of the Digital Divide: Is There Equal Availability in the Broadband Internet Access Market?" *Economic Inquiry* vol. 41, no. 2, pp. 346-363.
- Richardson, J., M. Zimmerman, and R. Puentes, 2003. *Is Home Rule the Answer? Clarifying the Influence of Dillon's Rule in Growth Management*, Discussion Paper prepared for The Brookings Institution Center on Urban and Metropolitan Policy <last visited on August 16th, 2004 at url <http://www.brookings.edu/dybdocroot/es/urban/publications/dillonsrule.pdf>>

Ros, A., 1999. "Does Ownership or Competition Matter? The Effects of Telecommunications Reform on Network Expansion and Efficiency," *Journal of Regulatory Economics*, 15, pp. 65-92.

Sappington, D., and C. Ai, 2001. "The Impact of State Incentive Regulation On the U. S. Telecommunications Industry," working paper, Department of Economics, University of Florida.

Sirbu, Marvin, William Lehr, and Sharon Gillett, 2004, "Broadband Open Access: Lessons from Municipal Network Case Studies," paper prepared for TPRC, Washington DC, September 2004.

Strover, S. and L. Berquist, 2001. "Developing Telecommunications Infrastructure: State and Local Policy Collisions," in B. Compaine and S. Greenstein, eds., *Communications Policy in Transition: The Internet and Beyond*, MIT Press, Cambridge, MA.

Taylor, W., C. Zarkadas, and J. Zona, 1992. "Incentive Regulation and the Diffusion of New Technology in Telecommunications," presented to the Ninth Biennial Conference of the International Telecommunications Society, Sophia-Antipolis, France.

U.S. Census Bureau (2004) "2000 United States Census" <url last visited on August 23, 2003 at <http://www.census.gov/main/www/cen2000.html>>

Vos, E. 2004. "MuniWireless.com: First anniversary report," <last visited on August 16th, 2004, at url <http://www.muniwireless.com/reports/docs/June2004Report.pdf> >

Walsten, S., 1999. "An Empirical Analysis of Competition, Privatization, and Regulation in Africa and Latin America," World Bank Working Paper #2136 <last visited on August 17th, 2004 at url <http://ideas.repec.org/p/fth/wobaco/2136.html>>

Warren A. (2004) "Television and Cable Factbook 2004" Warren Communication News.