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The Consumer Welfare Cost of Cable "Build-out" Rules

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The Consumer Welfare Cost of Cable "Build-out" Rules (Third Release)

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Abstract: Firms that wish to offer wireline, multichannel video programming services in direct competition with cable incumbents are being faced with calls by those incumbents and policymakers to "build-out" to entire communities as a pre-condition of receiving a franchise. This "build-out" requirement is often incorporated into the local cable franchising process, which the FCC over a decade ago called "the most important policy-relevant barrier to competitive entry in local cable markets." In this POLICY PAPER, we show that build-out mandates are actually counter-productive and serve primarily to deter new entry, increase the profits of incumbents, and harm consumers. With both a theoretical model and an empirical simulation, we show that build-out rules cause new video entrants to bypass certain communities entirely and sharply lower the number of communities in which new network construction would be profitable. We show that consumer welfare is likely to be higher with "free entry" policies that impose no build-out requirement.

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I. Introduction

With the marginal cost of providing a telephone call in a free-fall, video is now the key driver for new fiber deployment in the residential market.[1] Yet, in

[1] According to a 2002 Pew Internet & American Life Project survey, the average household spends $51 per month on multichannel video programming services, which represents a significant portion of their total communications (voice, video, Internet, wireless) spending (which averages about $122 per month per household). J. B. Horrigan, *Consumption of Information Goods and Services in the United States*, Pew Internet & American Life Project (2003), http://www.pewinternet.org/pdfs/PIP_Info_Consumption.pdf at 28. If a new entrant cannot readily provide consumers multichannel video over an advanced network, then the prospects for success will be diminished substantially due to a reduction in the entrant's potential revenues. Quite simply, the ability to sell video services over these fiber networks may be a crucial factor in getting those fiber networks deployed.

Regulators are not always sensitive to the importance video availability has on deployment. For example, the New York Public Service Commission issued an order recently that failed to resolve the question as to whether Verizon could sell video services over its new, all-fiber FiOS network, stating that it would resolve that question only *after* Verizon had constructed the fiber network and stood ready to sell video service. Declaratory Ruling on Verizon Communications, Inc.'s Build-Out of its Fiber to the Premises Network, *Joint Petition of the Town of Babylon, et al.*, Case Nos. 05-M-0250 and 05-M-0247 (rel. June 15, 2005).

order to provide multichannel delivered video programming, a new entrant must first obtain a franchise from the local and county government in every market it wishes to serve. Very often, the franchise contract requires that the new entrant agree to geographic build-out requirements as a pre-condition to receiving a franchise, and this process results in a form of creeping governmental control.[2] As we show in this POLICY PAPER, while these build-out requirements may have altruistic intentions behind them (*e.g.,* preventing a "digital divide"[3] or promoting local economic development), *ex ante* build-out requirements are, on average, counterproductive and serve to *slow down* deployment of communications networks.[4] As a result, these build-out mandates actually *reduce* consumer welfare and increase the profits of incumbent providers in many communities. *Build-out requirements are, therefore, a self-defeating exercise*.[5] For this reason, it should come as no surprise that the FCC found over ten years ago that

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[2] *See* Frank Easterbrook, *The Court and the Economic System,* 98 HARV. L. REV. 4, 39 (1984) (emphasis supplied).

> Often an agency with the power to deny an application . . . or to delay the grant of the application will grant approval only if the regulated firm agrees to conditions. . . . The firm will accept the conditions only when they make both it and the agency (representing the public or some other constituency) better off. *Still, though, the agency's options often are potent, and the grant of an application on condition may greatly increase the span of the agency's control.*

[3] D. McCullagh, *Bells' Fiber Plans Spark Political Flame War*, CNET News (20 April 2005) (quoting Ranking House Energy and Commerce Committee Member Ed Markey as complaining that "When a cable company wires a community, it must offer service to all households, so why should [new MVPD entrants] be permitted to select which neighborhoods are wired with fiber first?"). However, numerous studies reveal there is little correlation between income and cable penetration. For a review of this literature, *see* R. Kieschnick and B. D. McCullough, *Why Do People not Subscribe to Cable Television? A Review of the Evidence*, Unpublished Manuscript (1998) at 7-8 and Appendix A (available at http://www.tprc.org/abstracts98/kieschnick.pdf).

[4] Significantly, the FCC has explicitly preempted state laws that require new telephone entrants from any "build-out" requirements. *See In the Matter of The Public Utility Commission of Texas,* CC Policy Docket Nos, 96-13, 96-14, 96-16 and 96-19, *Memorandum Opinion and Order,* FCC No. 97-346 (rel. Oct. 1, 1997) ("*Texas Build-Out Preemption Order*").

[5] While consumers do have satellite as a possible substitute to the incumbent cable operator, the U.S. General Accounting Office found that the price cuts for video services from wireline competition are approximately three times larger than those from satellite competition. *See Direct Broadcast Satellite Subscribership Has Grown Rapidly, but Varies across Different Types of Markets, Report to the Subcommittee on Antitrust, Competition Policy and Consumer Rights,* Committee on the Judiciary, U.S. Senate, US Government Accountability Office, GAO-05-257 (2005). As such, consumers clearly benefit significantly from terrestrial MVPD overbuild entry.

the "*local franchise process is, perhaps, the most important policy-relevant barrier to competitive entry in local cable markets*."[6]

While it may seem to be a counter-intuitive conclusion, it is important that policymakers understand the consequences that a build-out requirement will have on the ability of a firm to enter the market. This POLICY PAPER first presents in Section II a simple conceptual framework to evaluate build-out requirements in video markets. As we show, for a policymaker, a build-out requirement is a risky gamble, because while ubiquitous 100% overlap entry is possible on one hand (clearly a good result for consumers), there still exists the very real possibility that a new entrant will stay out of the market and bypass the community altogether (thus leaving consumers with the status quo). Moreover, our theoretical framework shows that incumbents and consumers cannot both benefit from a build-out rule, which leaves open the question of why both incumbents and policymakers advocate such rules.

To generate plausible estimates of the likely effects of build-out requirements on consumers and firms, Section III sets forth a computer-based simulation based on the conceptual framework outlined in Section II. This simulation answers the important empirical questions asked by the conceptual model. Our simulation reveals, under plausible circumstances, that a build-out rule results in a different form of "economic redlining"—*i.e.,* the build-out rule has less effect on the incentives of a firm to serve the most-profitable communities, but a large effect on deployment in more marginal communities. As such, the simulation leads to the inexorable conclusion that build-out requirements are, on average, more likely to benefit incumbent firms than to increase the welfare of consumers, since such rules deter entry. In short, build-out rules conflict with the stated goals of federal, state, and local governments regarding the desire to see the construction of advanced communications networks as quickly as possible.[7]

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[6] *In re Implementation of Section 19 of the Cable Television Consumer Protection and Competition Act of 1992, Annual Assessment of the Status of Competition in the Market for Delivery of Video Programming*, 9 FCC Rcd 7442, Appendix H at ¶ 375 (1994) (hereinafter "Appendix H")(emphasis supplied); *see also* Richard Posner, *The Appropriate Scope of Regulation in the Cable Television Industry*, 3 BELL JOURNAL OF ECONOMICS 98-129 (1972).

[7] FCC Chairman Kevin J. Martin has called "the deployment of new packetized networks throughout the nation" to be "one of the Commission's core priorities". Statement of Chairman Kevin J. Martin, *In the Matter of Petition of SBC Communications Inc. for Forbearance from the Application of Title II Common Carrier Regulation to IP Platform Services,* WC Docket No. 04-29 (May 5,

(Footnote Continued. . . .)

II. An Economic Analysis of Build-out Requirements

To study the impact a "build-out" rule has on the deployment decisions of a new entrant seeking to deploy an advanced fiber network, we first outline a simple, stylized economic model of sequential entry. This theoretical approach builds on the analysis of entry that we describe in detail in PHOENIX CENTER POLICY PAPER NO. 21[8], and it shows that build-out requirements are unambiguously bad for entrants and will make entry more costly and therefore less likely. However, theory alone cannot determine what impact a build-out requirement will have on consumers and incumbents. But this theoretical model does provide guidance on what factors and relationships are important. We provide a more detailed theoretical analysis of build-out requirements in Appendix A, but we limit our attention in this text to the simpler conceptual framework.

A. *The Entry Model*

In PHOENIX CENTER POLICY PAPER NO. 21, we show that a firm's decision to enter a market is essentially a function of the *potential profits from serving* the market and the *costs of entering* the market. Quite simply, entry will be more widespread if profits are higher and the costs of entering are lower. We now extend the analysis in POLICY PAPER NO. 21 to evaluate build-out requirements.

Say there is a market of H homes served by an incumbent monopolist.[9] The incumbent's network passes all H homes, but not all homes subscribe to the

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2005). Section 706 of the Communications Act of 1934, as amended, 47 U.S.C. § 11157 nt. directs the Commission to encourage the deployment of advanced telecommunications capability to all Americans. President George W. Bush has established a 2007 goal of "universal, affordable access to broadband technology." *See, generally, Availability of Advanced Telecommunications Capability in the United States*, GN Docket No. 04-54, Fourth Report to Congress, 19 FCC Rcd 20540, 20578 (2004). The White House, *A New Generation of American Innovation* (April 2004), http://www.whitehouse.gov/infocus/technology/economic_policy200404/innovation.pdf at 11. On June 24, 2004, President Bush said: "What we're interested in is to make sure broadband technology is available in every corner of America by 2007." THE WHITE HOUSE, *President Bush: High Tech Improving Economy, Health Care, Education*, (June 24, 2004), http://www.whitehouse.gov/news/releases/2004/06/20040624-7.html.

8 G. S. Ford, T. M. Koutsky and L. J. Spiwak, *Competition after Unbundling: Entry, Industry Structure and Convergence,* PHOENIX CENTER POLICY PAPER NO. 21 (July 2005).

9 The monopoly assumption is for convenience. There could be more than one incumbent, or an incumbent facing limited competition from a highly differentiated product.

service. The monopolist earns profit m. Costs to construct the incumbents network are sunk, and thus do not affect the marginal decisions of the incumbent. For simplicity, assume the marginal cost of a subscriber is zero and a uniform price is charged across the entire market (*i.e.,* there is no price discrimination in the market).[10]

Now, let there be a firm contemplating entry into this market. The entrant knows that the market price declines as the overlap of the entrant's and incumbent's networks rises, and it knows the cost of serving each of the homes.[11] This price will be uniform across the entire market, even if the entrant only serves a part of the market, although the degree of that price competition will, of course, be related to how much overlap there is between the two networks.[12] Post-entry profit (the duopoly profit) of the entrant is $d(h)$, where the entrant passes h of the H homes. Entry requires the entrant to pay entry costs e, where entry costs rise with the number of homes passed. We assume the entrant will enter only if net profits are non-negative: $d(h) - e(h) \geq 0$. As the number of homes passed rises, profits fall and entry costs rise, and eventually the cost of adding another home reduces net profits $[d(h^*) - e(h^*) > d(h^* + 1) - e(h^* + 1)]$. At this point, the entrant stops expanding its network and serves h^* homes, where h^* is the number of homes passed that maximizes the entrant's net profits.

10 The assumption of zero marginal cost is for convenience. This assumption is equivalent to one where we describe "prices" or "revenues" as being net of variable costs. With zero marginal cost for the incumbent and positive entry cost for the entrant, our simulated markets are natural monopolies (it is always cheaper for the incumbent to provide the service than the entrant). Thus, we do not make total welfare calculations, since total welfare under such circumstances will be lower with entry. Even with these assumptions, the calculation of profits and consumer welfare are legitimate. Eliminating the natural monopoly problem provides nearly no benefit, yet would make the simulation much more complicated.

11 T. R. Beard, G. S. Ford, R. C. Hill, and R. P. Saba, *Fragmented Duopoly: A Conceptual and Empirical Investigation*, JOURNAL OF BUSINESS (Forthcoming 2005) (download draft at www.aestudies.com) ("Beard, Ford, Hill and Saba"); K. Basu and C. Bell, *Fragmented Duopoly: Theory and Applications to Backward Agriculture,* 36 JOURNAL OF DEVELOPMENT ECONOMICS 145-165 (1991); and A. K. Smiley, *Direct Competition among Cable Television Systems*, U.S. Department of Justice, Antitrust Division, EAG paper #86-9 (June 5, 1986).

12 *See* Beard, Ford, Hill and Saba, *id.*

B. *Free Entry versus Build-Out Requirements*

In the absence of a build-out rule (free entry), the entrant will choose to serve h^* homes and will therefore earn gross profits of $d(h^*)$. Consumer surplus rises and incumbent profits fall with entry (since price falls for all subscribers and the entrant acquires market share). Let us assume that in the absence of a build-out rule, the entrant will only serve part of the market ($h^* < H$).[13]

Because of the build-out rule, the entrant must construct a larger network to serve all H homes, instead of the h^* homes it otherwise would have chosen. Making the entrant build a larger network will reduce its gross profits and raise entry costs.[14] The result is that net will profits unambiguously decline in the presence of this mandate, (that is, $d(H) - e(H) < d(h^*) - e(h^*)$), since the addition of homes above h^* adds more to costs than to gross profits. Thus, at the margin, build-out rules reduce the prospects for entry. The extent of this deterrence will depend on aggregate profits, which we discuss in detail in Appendix A. Thus, the firm enters only if $d(H) - e(H) \geq 0$, which is not guaranteed (even though we assume it is profitable for the monopolist to have done so).

An entrant faced with a legally-mandated build-out requirement thus faces a tradeoff —i.e., it is forced to decide whether to enter an entire community by balancing the profits earned serving the h homes versus the losses incurred from serving the remainder of the market* (homes h^* to H). This tradeoff is illustrated in Figure 1.

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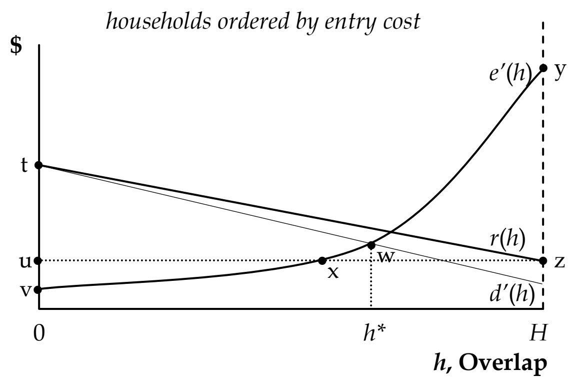
13 This assumption keeps the analysis interesting. If $h^* = H$, then the build-out constraint is non-binding (has no effect). However, even if the entrant desires to the serve the entire market today, the build-out rule is undesirable, since it always forecloses the opportunity to serve less than the entire market.

14 First, if the entrant prefers partial entry ($h^* < H$), then the build-out requirement reduces gross profits (by definition). Second, build-out requirements increase entry costs since they require the entrant to build to more homes than the entrant would willingly choose [$e(h^*) < e(H)$]. Thus, the build-out rule reduces the prospects for entry by attacking the entrant from all sides, cutting gross profits and raising entry costs.

Figure 1. The Entry Decision under a Buildout Rule



In the figure, the vertical axis is price and the horizontal axis is the number of homes the entrant will choose to pass with its new network. In this table, we rank homes by (marginal) entry costs (e') (that is, the cost of constructing to a home increases along the horizontal axis). Since the costs of homes are ranked and the demand for the service is randomly distributed, the horizontal axis also measures the degree of system overlap. There are three curves in the figure, average gross profit per homes passed $r(h)$, marginal gross profit per home passed $d'(h)$, and marginal entry costs $e'(h)$.[15] Without a build-out rule, the entrant will service h^* homes (the intersection of the marginal profit and cost curves). Serving h^* homes—the number of homes it would serve without a build-out requirement—the entrant will have a net profit equal to the area bounded by points **twv**, which is clearly positive.[16] Under a build-out rule, the entrant's net profit is the difference **uxv** - **xyz**, which in this case is plainly negative.[17] The area **uxv** is positive net profit ($r > e$) and the area **xyz** is the negative net profits ($r < e$). Since **uxv** > **xyz**, the entrant would not enter under a

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15 Note that $r(h) \cdot h = d(h)$.

16 Net profits are calculated as: **tw**h^*0 – **vw**h^*0.

17 Net profits are calculated as: **uz**$H0$ – **vy**$H0$.

build-out rule. Note that whether or not a build-out rule deters entry depends on the shapes of the *r*, *d'* and *e'* curves.[18]

C. *Summary of Build-out Effects*

At this point, the consequences of the build-out rule are readily assessed. Without the build-out rule, there may be partial entry. With partial entry, the entrant will make a positive profit, the incumbent's profits will be reduced due to competition, and consumers will benefit from lower prices and higher output. The partial entry case is unambiguously better for consumers and unambiguously worse for incumbents.[19]

But with a build-out rule, entry may still happen, or it may not occur at all. If entry occurs, then consumers will reap the full benefit of the price reduction available from 100% overlap of the networks. The price reduction with complete overlap will be larger than the price reduction consumers would see if the entrant had passed only 50% of the market. But while full entry will provide the greatest benefit to consumers, *consumers will benefit only if entry occurs*. Indeed, *there is a very real risk that the entrant may choose to stay out of the market altogether under a build-out rule.* If the entrant stays out, then the entrant obviously gets no profit, then the incumbent's profits are unchanged, and consumer surplus remains at the monopoly level. A build-out rule that deters entry provides the least benefit to consumers (none), but the most benefit to the incumbent (retention of monopoly profits).[20]

For a policymaker, a build-out requirement is a risky gamble. The policymaker may be fortunate to be in a community in which certain neighborhoods are so profitable that a new, prospective entrant will build even if a build-out requirement is imposed. In that situation, our model shows that an incumbent cable operator facing a complete "over-build" in its community will

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18 We can easily concoct examples where the build-out rule does not deter entry, which is why theory alone cannot resolve this issue.

19 We have assumed a uniform price, so all customers in the market will benefit from partial entry, no matter how partial it is.

20 For this reason, the FCC determined that competitive local telephone build-out requirements constituted an unlawful barrier to entry. *Texas Build-Out Preemption Order*, *supra* n. 4 at ¶ 13 ("build-out requirements are of central importance to competitive entry because these requirements impact the threshold question of whether a potential competitor will enter the local exchange market at all").

face a significant reduction in profits. But what if the policymaker is wrong in this assumption? In that situation, the prospective entrant will bypass the *entire* community if a build-out requirement is imposed. In that latter situation, the only entity that benefits is the incumbent cable operator. Simply given the shape of the debate on this topic, in which incumbent cable operators are steadfast proponents of build-out requirements for new entrants, we are inclined to believe that the latter scenario—*entry deterrence*—is the far more likely in most communities.[21] As a result, *build-out rules, while well-intentioned when proposed by city officials and consumers, may in the end do more harm than good.*

An alternative summary of the effects of the build-out requirements on the participants is provided by a matrix of preference outcomes. In Table 1, preferences are rated 1, 2, and 3, with 1 being the most and 3 the least preferred outcome. We rank the preferences of consumers, incumbents, and entrants.

Table 1. Preferred Outcomes
(1 is most, 3 is least preferred)

Participant	Free Entry	Build-out Rule	
		Entry	No Entry
Consumer	2	1	3
Incumbent	2	3	1

Consumers of course would prefer a build-out rule, but only if entry still occurs. If entry is not assured, then consumers would then clearly prefer free entry to a build-out rule that would deter entry entirely. The worst-case scenario for the consumer is a build-out rule that deters entry. In contrast, the incumbent most prefers a build-out rule with deterred entry, but prefers partial entry to a build-out rule with entry. Free entry is more desirable than a build-out rule with entry, but less desirable than a build-out rule that effectively deters entry.

The conflict between the desires of the cable incumbents and the consumers is again as apparent as it is interesting. Many policymakers and incumbent cable operators advocate build-out rules, but the effect of the rule is to harm one party and help the other, depending on whether entry occurs. *Both groups are taking a*

[21] Cable operators, alternately, are profit maximizers and should be expected to support only those regulations that increase their profits. Since higher profits for firms means lower consumer surplus (absent quality increases), the build-out rule from the view of the cable firms cannot be welfare improving. Thus, from the perspective of the incumbent cable operators, build-out rules are advocated as a means with which to protect profits from competition.

gamble with this position—policymakers are gambling that entry *will occur* even with a build-out rule, but the incumbents are gambling that entry *will not occur* with a build-out rule.

III. Simulation of Entry under a Build-out Rule

Our entry model reveals that the key question for a policymaker is straight forward: *is the entry-deterring effect of a build-out mandate sufficient to deter entry altogether?* The simulation described in this Section III provides evidence on the entry deterring effects of build-out rules. Thankfully, the simulation is not the only evidence regarding the entry-deterring effects of build-out rules. Hazlett and Ford (2001) show, using economic theory and a statistical test, that build-out rules significantly reduce entry in cable television markets.[22] Thus, the ability of such rules to deter entry has been plainly demonstrated.

This simulation of sequential entry is based on the entry game from the previous section. We stress to the reader that this is only a simulation, and we adopt a number of simplifying assumptions to ease the implementation and evaluation of the simulation. All the markets evaluated are hypothetical, as are the costs and demand relationships. We do our best, however, to avoid any assumption that will render (or tend to render) misleading inferences, and we try to calibrate the model to known values and relationships in the cable and telecommunications industries. The purpose of the simulation is merely to provide an informed guess of the effects of build-out requirements, and to illustrate clearly the tradeoff between incumbents and consumers. We focus our attention here on the main findings of the simulation, and refer the reader to Appendix B for the details on the simulation.

We are not the first to construct a simulation to evaluate entry and build-out requirements in local communications markets. Faulhaber and Hogendorn (1999) construct a simulation similar to ours, though their approach is more technical. While the focus of that study is on the prospects for a multi-firm equilibrium, the authors did simulate the effect of build-out requirements. They conclude, "[a build-out rule] delays entry, delays competition, [and] actually

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[22] T. W. Hazlett and G. S. Ford, *The Fallacy of Regulatory Symmetry: An Economic Analysis of the Level Playing Field in Cable TV Franchising Statutes*, 3 BUSINESS & POLITICS 21-46 (2001); *see also* Appendix H, *supra* n. 6.

creates a unnatural (as opposed to natural) monopoly."[23] Our findings are generally consistent with this earlier research.

A. *Simulation Summary*

In the simulation, we have 100 markets with 1000 homes each.[24] The incumbent has constructed network to pass all 1000 homes in all markets. We assume that 50% of households subscribe to the monopolist's service (a 50% penetration rate).[25] Each home has its own unique capital costs; we calibrate the simulation for an average capital cost of $600, which is consistent with capital costs for a traditional cable network per home passed.[26] These capital costs vary by home, and entry costs are lognormally distributed (similar to the shape in Figure 1).[27] Marginal costs are assumed to be zero for both the entrant and incumbent. The incumbent has already built its network and the costs are sunk.

Now we assume that a prospective entrant is deciding whether to enter this community. In the absence of a build-out requirement, the entrant will build a network to a home as long as its net profits will increase with that construction. We assume that the entrant will take a market share of 35% of the homes it passes that subscribe to the service, which is substantially above the analysts'

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23 G. R. Faulhaber and C. Hogendorn, *The Market Structure of Broadband Communications*, Unpublished Manuscript, Research Center: Public Policy and Management Department (1999), http://knowledge.wharton.upenn.edu/papers/701.pdf at 23.

24 The simulation is flexible enough to evaluate different values for both the number of markets and the homes in each. All markets, however, must be of the same size. Changing the number of markets or their size does not affect the results in any meaningful way.

25 The simulation is calibrated so that the incumbent will serve the entire market under a build-out rule, even if the incumbent prefers not to build out (which is typically the case). The 50% penetration is consistent with a major cable provider's current penetration, but the assumption is primary one of convenience. *See* Comcast Corporation, 2004 Form 10-K at 3 (Feb. 23, 2005) (noting 52.8% penetration in 2004).

26 T. W. Hazlett and G. Bittlingmayer, *The Political Economy of Cable "Open Access"* 2003 STANFORD TECHNOLOGY LAW REVIEW 4 (2003); M. Shapiro and D. Gall, *The New Economics of Overbuilds*, BROADBAND NETWORKS (2000). We recognize that these costs may be lower than current technology, but higher costs only make the deterrent effect stronger, so our assumption is conservative.

27 In effect, our cost function is driven by population density, which is known to be approximately lognormal. J. B. Parr and G. J. O'neill, *Aspects of the Lognormal Function in the Analysis of Regional Population Distribution*, 21 ENVIRONMENT AND PLANNING at 961-73 (1989). Appendix B contains a detailed description of the cost function.

estimates of entrant penetration in video markets.[28] (In additional simulations, we contemplate both lower and higher penetrations rates. If the aggregate market penetration is 60%, then the entrant serves 21% of homes if it passes all homes.) As we discuss in POLICY PAPER NO. 21, profits are impacted also by the degree of price competition and network overlap. As the overlap of rival networks rises, the market price will decline. Our benchmark assumption is that the full overlap price is 20% lower than the monopoly price. We also assume that as level of overlap between incumbent and entrant decreases, this price decline also will decrease in a linear fashion. It should be noted that in situations where an incumbent cable firm only sees a partial geographic entry in a market, prices are reduced throughout the market, even in areas where the entrant has not built a network. This price reduction is consistent with research of pricing behavior in the few markets that have seen cable overbuilding.[29] Alternate assumptions on the expected price decrease are also considered. As prices fall due to competition, market penetration will rise.[30]

With zero marginal cost, we can interpret "price" to mean the stream of gross profits from the customer (and not the monthly price). In effect, "price" is the (present value) sum of the monthly payments of the subscriber over the life of the network.[31] Consumer reservation prices (required for consumer surplus calculations) are set so that at the monopoly price, the penetration rate is 50%. Prices are calibrated so the value of the incumbent's cable system is $1200 per home passed (consistent with cable industry statistics).[32]

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28 Bank of America Securities, *Bell Video – IPTV is Not Yet the Answer*, Research Brief (June 2, 2005) ("BOA Bell Video Research Brief") at 1 ("History has shown on numerous occasions, with limited exceptions, that new entrant linear TV competitors usually reach only 15% market share after 10 years.").

29 *See* Beard, Ford, Hill and Saba, *supra* n. 11.

30 The demand curve is linear, with an elasticity of -1 at the monopoly price. The change in penetration for a price reduction is measured using the slope of the demand curve. Aggregate penetration at the 20% price reduction is 60%.

31 The assumption is $2400 per subscriber at the monopoly price. The assumption of zero marginal cost is equivalent to an assumption of net price, where net price is the actual price minus variable cost.

32 *In the Matter of Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming,* MB Docket No. 04-227, Eleventh Annual Report (Feb. 4, 2005) at Table 5 ("*Eleventh Annual Cable Competition Report*").

Household demand for cable service is a function of price alone. Thus, all variations in penetration across markets are based on cost, not demand factors. Therefore, we assume that the entrant will not exclude markets based on household demographics (*e.g.*, income, race, *etc.*).

B. *Results of the Simulation*

Table 2 summarizes the results of the benchmark simulation. Prior to entry, the monopolist passes all homes (100·1000 = 100,000) and serves all markets.[33] Consumer surplus is $60 million and the incumbent's profits are $120 million.[34]

In the free entry equilibrium (*i.e.,* no build-out rule), the entrant will partially enter all 100 markets and pass approximately 60% of all homes at a cost of $18 million. Consumer surplus rises to $75 million and the incumbent's profits fall to $94 million. Unsurprisingly, entry is good for consumers (+$26M) and bad for the incumbent (-$15M).

Table 2. Results of Benchmark Simulation

	Entrant's Homes Passed	Markets Entered	Entrant's Investment	Consumer Surplus	Incumbent's Profits
Monopoly	…	…	...	$60M	$120M
Free Entry	60,000	100	$18M	$75M	$94M
Build-out Rule	15,000	15	$6M	$64M	$113M

Notes: Reported results are based on an average of 10 runs of the simulation. Results are rounded.

With a build-out rule, however, entry is substantially curtailed. The entrant no longer enters all markets and instead now chooses to serve only 15 of the 100 markets, with total homes passed of only 15,000. Thus, *85 of the 100 markets are bypassed entirely by the new entrant, and consumers in those markets see no benefit from competition whatsoever*. Consumer welfare is $64 million, down from $75 million in the free entry case.[35] This decline in consumer surplus indicates that

[33] The simulation is calibrated to ensure that it is profitable for the monopolist to wire the entire market under a build-out rule.

[34] Consumer surplus the difference between what consumers are willing to pay for a service (*i.e.,* reservation prices) and the market price.

[35] The maximum consumer welfare is about $86M (at 100% overlap).

consumers in the 85 markets "left behind" are harmed by the build-out rule far more than consumers in the other 15 markets benefit from the build-out requirement. As expected, the incumbent cable company's profits are higher in the presence of a build-out rule than free entry ($113 million to $94 million).

From our benchmark simulation, we see that build-out rules are bad for consumers and good for incumbents. Moreover, this simulation shows that a build-out rule results in a different form of "economic redlining"—*i.e., the build-out rule has little effect on the incentives of a firm to serve the most-profitable communities but instead causes more marginal communities to be bypassed entirely*.[36] In our simulation, the build-out rule caused the entrant to build a network that passed only 25% of the homes than it would have built in the absence of such a rule.

C. *Sensitivity to Market Share Assumption*

In Table 3, we evaluate the simulation results across a range of market shares for the entrant (the benchmark being 35%). Table 3 shows that the entry-deterring effect of a build-out rule is strong even with less-optimistic and more-optimistic market share assumptions. At a 15% market share, the entrant enters all 100 markets and passes 10% of the homes with free entry, on average. If the entrant's market share rises to 50%, then the entrant passes 79% of homes, on average, in the 100 markets.

Likewise, with higher market shares, the entrant will pass more homes under a build-out rule, though the entrant always passes fewer homes under a build-out rule than under a policy of free entry. Even if the entrant achieves a 50% market share, then the entrant will serve only 65 of the 100 markets. Note that *if the entrant only achieves a market share of less than 35%, then the entrant will fail to enter any market if a build-out rule is imposed*. One recent analyst report predicts that the telecommunications carriers' market share of video services will be 15%, so the prospect that entry will not occur because of build-out rules—even for large, well-financed firms like the Bells—is genuine.[37]

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36 Red-lining is typically associated with the treatment of different income groups. But, as we illustrate here, partial entry can also be motivated by cost differences even if households do not vary in demand characteristics.

37 *See* BOA Bell Video Research Brief, *supra* n. 28.

Table 3. Effects of the Entrant's Market Share

Entrant Market Share	Entrant's Share Homes Passed to Total Homes (100,000)		Entrant's Markets Served		Entrant's Investment $Mil		Consumer Surplus $Mil		Incumbent's Profits $Mil	
	Free Entry	Build-out Rule	Free Entry	Build-out Rule	Free Entry	Build-out Rule	Free Entry	Build-out Rule	Free Entry	Build-out Rule
0.20	0.10	0.00	100	0	2	0	63	60	117	120
0.25	0.26	0.00	100	0	7	0	67	60	112	120
0.30	0.43	0.00	100	0	12	0	71	60	104	120
0.35	0.60	0.15	100	15	18	6	75	64	94	113
0.40	0.69	0.36	100	36	22	15	78	69	85	102
0.45	0.75	0.54	100	54	26	23	80	74	76	90
0.50	0.79	0.65	100	65	28	30	81	77	71	79

Notes: Reported results are based on an average of 10 runs of the simulation. Results are rounded.

The entrant's investment is likewise positively related to its market share. What is interesting about the statistics on investment is the relationship between investment in the free entry and build-out scenarios. If the entrant has only a small market share, then investment is higher with free entry. As the entrant's share rises, investment becomes higher in the build-out case. Note, however, that in every case the number of homes passed falls with the build-out rule. Thus, even though investment may be higher, even significantly so, the increased investment does not lead to more service being provided. At a 50% market share for the entrant, it costs more to serve 18% fewer homes under a build-out rule. Clearly, *build-out rules lead to excessive and less productive investment, and are thus socially undesirable*.

The final two headings of Table 3 are the most important for deciphering the "consumer welfare" versus the "incumbent profit" justification for a build-out rule. Observe that consumer surplus under the build-out rule is never larger, and typically much smaller, than consumer surplus with free entry.[38] Thus, we

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[38] It is theoretically possible to get higher consumer surplus with build-out rules, but only under some rather extreme assumptions. Even then, the increase in surplus over the free entry case would be rather small.

find no support here for a consumer justification for build-out requirements. Alternately, the incumbent's profits are always larger with a build-out rule than with free entry. So, the best argument for a build-out rule seems to be the profit motive—*i.e., the role of build-out requirements is to protect the profits of the incumbent.*

D. *Sensitivity to Price Competition Assumption*

In the benchmark case, we assumed price was 20% less than the monopoly price if the rival networks completely overlapped (with prices falling linearly between monopoly and 100% overlap). In Table 3, we present the output of the simulation at price cuts ranging from 0% to 50% off monopoly levels at 100% overlap. For all the simulations summarized in Table 4, the entrant is assumed to have a 35% post-entry market share (as in the benchmark case).

Table 4. Effects of the Intensity of Price Competition

Assumed Price Cut at 100% Overlap	Entrant's Homes Passed to Total Homes (100,000)		Entrant Markets Served		Entrant's Investment $Mil		Consumer Surplus $Mil		Incumbent's Profits $Mil	
	Free Entry	Build-out Rule	Free Entry	Build-out Rule	Free Entry	Build-out Rule	Free Entry	Build-out Rule	Free Entry	Build-out Rule
0.00	0.61	0.23	100	23	19	9	60	60	94	110
0.10	0.60	0.21	100	21	19	8	68	63	94	111
0.20	0.60	0.15	100	15	18	6	75	64	94	113
0.30	0.57	0.04	100	4	18	1	83	62	93	118
0.40	0.56	0.00	100	0	17	0	90	60	92	120
0.50	0.53	0.00	100	0	16	0	96	60	91	120

Notes: Reported results are based on an average of 10 runs of the simulation. Results are rounded.

From the table we see that large changes in the price reduction from competition do not have a particularly strong effect on the free entry equilibrium. The percent of homes passed in the free entry equilibrium fall from 61% to 53% as the price cut rises from 0% to 50%, and the entrant's investment remains relatively stable at just under $20 million. In contrast, the build-out rule is a much more potent deterrent to entry as price competition intensifies. For example, if the price cut rises from 20% to 30% (a plausible scenario given published estimates of the price effects of cable competition), then the entrant's homes passed fall from 15% to 4% of homes (15 markets to 4 markets).[39] The entrant does not enter at all under a build-out rule if the price cut is 40% or larger. The role of the intensity of price competition is detailed in POLICY PAPER NO. 21.

While consumer surplus rises with the intensity of price competition in the free entry case, consumer surplus falls toward the monopoly level under a build-out rule with intense price competition. But observe that consumer surplus has a non-linear relationship with the intensity of price competition. At both a 0% and 50% price cut consumer surplus is $60 million (the monopoly level), and between these two extremes consumer surplus is always larger than $60 million. The explanation is simple. If entry does not reduce prices (0%), then consumers gain nothing from entry; but if the combination of aggressive pricing and build-out rules deter entry (+40%), then consumers gain nothing. Intermediate ranges of price cuts allow for some entry, and consumers always benefit from price-reducing entry. Since perfect collusion is practically impossible and the evidence weighs against collusive outcomes,[40] then this simulation reveals that *the only certain method of increasing consumer welfare in video markets is to have entry without build-out rules*.

The relationship of incumbent profits to price competition is also interesting. With a free entry policy, more intense price competition always reduces the incumbent's profits. With a build-out rule, however, the incumbent's profits will rise even if entry would result in intense price competition. While this may seems a bit paradoxical, this apparent anomaly is explained when one recognizes that the prospects for intense price competition serves to retard and deter entry. Stated another way, both the build-out rule and intense price competition work

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39 A Government Accountability Office study estimates a 16% differential based on the average overlap of cable rivals, where the average is less than 100%. *See* GAO, *Direct Broadcast Satellite Subscribership Has Grown Rapidly, but Varies across Different Types of Markets*, *Report to the Subcommittee on Antitrust, Competition Policy and Consumer Rights, Committee on the Judiciary, U.S. Senate,* US Government Accountability Office, GAO-05-257 (April 2005) ("GAO Report"); Beard, Ford, Hill and Saba, *supra* note 11.

40 *Id.*

together to significantly retard entry. With entry sufficiently deterred, the incumbent will never have to reduce its price significantly.[41]

Like Tables 2 and 3, the simulation results summarized in Table 4 show that the interests of consumers and incumbents are always in conflict. The fact that both policymakers and incumbents are strong advocates of build-out rules is puzzling, particularly if policymakers are viewed as serving the interests of consumers.

IV. Impact of Build-Out Rules with Defection

Our benchmark simulation above shows that a universal build-out rule has the effect of the entrant bypassing entire communities (77% of the communities in particular). In the current U.S. cable franchise system, build-out requirements are not uniform and many communities have no such requirements. But, for the results summarized in Tables 2 through 4, we have assumed that all markets either have a build-out rule or do not. In reality, some markets will impose the build-out requirement while others will allow for free entry. We can consider the effects of a mix of entry constraints by allowing free entry in some markets while imposing a build-out rule in others.

Communities benefit from defecting from a build-out requirement by increasing their relative attractiveness to entrants. If we assume (plausibly) that the entrant has limited deployment resources, then the entrant will direct its limited resources to their highest-value use.[42] *As a result, a community can "leap-frog" other communities and make its locality more profitable to the entrant by not imposing a build-out requirements.* We can evaluate how a community may be affected by defection using the simulation.

[41] Cable operators have already signaled to telecom entrants that competition will be intense. *See, e.g., Comcast to Boost Residential Internet Service Speed*, WALL STREET JOURNAL (July 12, 2005) at D4 (reporting that Comcast, the nation's largest cable operator, will automatically begin to upgrade existing subscribers located in Philadelphia, Baltimore, Detroit, New Jersey and Washington, D.C. to six megabits per second for free (or eight megabits per second for an additional $10) during Summer 2005). Coincidentally, these are the same states where Verizon plans to roll-out its FiOS fiber-to-the home product.

[42] Note that we are not assuming a capital budget constraint, only that deployment resources such as labor and materials are limited and directed to higher valued uses first.

If we assume, for example, that 25% of the markets do not impose a build-out rule (and the other 75% impose such a requirement), then the average increase in the rank of the "defectors" is 38 places. In other words, a market ranked 50th in terms of profitability with a build-out rule ranks 12th in profitability, on average, if it does not impose a build-out rule. Given that it is the high cost markets that are abandoned by the entrant under a build-out rule, it is these markets that may have the most to gain from this "defection."

So, in the presence of widespread application of a build-out rule, policymakers (local and state) can increase the probability of their markets being served sooner rather than later by rejecting the requirement for an entrant to serve the entire market.

V. Conclusion

Policymakers have long wished for the nation's two wireline communications goliaths – the cable and local telephone industries—to compete aggressively for residential consumers over a bundle of voice, video, and data services. The desired outcomes are lower prices that result from head-to-head competition and expanded consumer choice among providers and video line-ups.

That dream is on the brink of becoming a reality. Technological advances and new infrastructure deployment have put the country at the cusp of this inter-modal competition for advanced products and services. Cable companies today are now deploying advanced, Voice over Internet Protocol service that is substantially deregulated and not subject to any build-out commitment. At the same time, telephone companies like Verizon and SBC are aggressively deploying new fiber services, but their ability to sell multichannel video services to residential consumers must pass through a long and torturous local franchise process. There should be no surprise, then, that while cable companies serve over 3.7 million residential consumers with telephone service, incumbent telephone companies only serve a smattering of video customers.[43]

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[43] Industry Analysis and Technology Division, Wireline Competition Bureau, FCC, *Local Telephone Competition: Status as of December 31, 2004* (July 2005) at Table 5. In the *Eleventh Cable Competition Report,* the FCC reported that the majority of cable operators offered some form of voice telephone service – in that same report, the FCC observed that telephone company video entry "remains limited". *Eleventh Annual Cable Competition Report, supra* n. 32 at ¶¶ 12, 125.

One aspect of the cable local franchising process is the imposition of "build-out" requirements on new video entrants. Authorities that impose such build-out rules perhaps have the best of intentions, which is to assure that all constituents in their community receive the benefits of competition. But we show in this paper that this is a risky gamble—*i.e., a build-out rule, in fact, creates a tremendous disincentive for a new entrant to invest and is likely to result in entire communities being bypassed*. Our theoretical model shows that a build-out rule will *always* increase costs and reduce profits of the prospective entrant, and our empirical simulations show that the net result is substantially less deployment. In other words, a build-out rule designed to prevent "economic red-lining" *within a community* essentially imposes a different form of "economic red-lining" *between communities*. Further, if entry is deterred by the build-out rule, consumers are denied a price break that they would have otherwise received in the absence of the rule.

APPENDIX A
THEORETICAL ANALYSIS

We begin with a simple scenario. Let there be two firms, A and B, and two markets, 1 and 2. Firm A is the incumbent and already has sunk investments in both markets. Firm B is contemplating entry in the markets with sunk costs of K_1 and K_2 (both positive) to enter market 1 and market 2, respectively. There are three possible structures:

Case 1) Firm A is in both markets 1 and 2 operating as a monopolist charging common price P_A;

Case 2) Firm A is in both markets 1 and 2, Firm B is in market 1 only, and prices are P_A and P_B; and

Case 3) Firms A and B are in markets 1 and 2 and prices are P_A and P_B.

For simplicity, let the prices (P_A, P_B) be net of incremental cost. The demand curves faced by the two firms in each market are:

$$\text{Firm A}: q_1^A(P_A, P_B),\ q_2^A(P_A, P_B), \tag{A-1}$$

$$\text{Firm B}: q_1^B(P_B, P_A),\ q_2^B(P_B, P_A), \tag{A-2}$$

where q_i^j is equal to the subscribers/customers in market i for firm j. Note that each firm charges a uniform price across all markets. For simplicity, let

$$q_2^A(P_A, P_B) = \lambda q_1^A(P_A, P_B), \tag{A-1'}$$

$$q_2^B(P_B, P_A) = \lambda q_1^B(P_B, P_A), \tag{A-2'}$$

where λ is an exogenous, non-negative constant. Numerous factors may determine differences across markets, but those differences are summarized by the parameter λ.

We can now evaluate equilibria under our three possible outcomes. Equilibria are determined under the following assumptions: (a) prices are determined under simultaneous, non-cooperative, one-shot pricing; (b) products are differentiated; (c) firm own-demand elasticities decrease (become more elastic) as own prices rises, and increase (become less elastic) as the rival's price rises; and (d) equilibria exist and are unique.

Case 1 Equilibrium:

For Case 1, Firm A operates alone in both markets 1 and 2; Firm B does not offer services. The profit function for A is

$$\pi^A = P_A(1+\lambda)q_1^A(P_A,\infty), \tag{A-3}$$

where π is profit. The first order condition for firm A is

$$1+\xi^A(P_A,\infty)=0\,, \tag{A-4}$$

where ξ^A is the own price elasticity of demand. Equation (A-4) is the first-order condition for a monopolist. Let $\overline{P}_A$ be the monopoly price.

Case 2 Equilibrium:

For Case 2, Firm A operates alone in market 2, but competes with Firm B for customers in market 1. The profit function for A is

$$\pi^A = P_A q_1^A(P_A,P_B)+\lambda P_A q_1^A(P_A,\infty)\,, \tag{A-5}$$

where π is profit. The first order condition for firm A can be written as

$$\lfloor 1+\xi^A(P_A,P_B)\rfloor+\lambda\lfloor 1+\xi^A(P_A,\infty)\rfloor=0\,. \tag{A-6}$$

From Equation (A-6), the reaction function of firm A is derived. If P_A rises when P_B rises $(\partial P_A^* / \partial P_B > 0)$, which is a sensible expectation and our assumption, then the reaction function is upward sloping. Note that P_A and P_B are strategic complements. Further, $(\partial P_A^* / \partial \lambda > 0)$, which can be shown by calculus.[44]

[44] *See* Beard, *et al.* (2005), *supra* n. 11, for a detailed exposition on this point.

Firm B is now active in market 1, and his first-order condition can be written as

$$1+\xi^{B}(P_{A},P_{B})=0\,. \tag{A-7}$$

As with Firm A, we have $(\partial P_B^* / \partial P_A > 0)$, but note that $(\partial P_B^* / \partial\lambda = 0)$ so that P_B^* depends on λ only indirectly through P_A.

In this case, the equilibrium prices are (P_A^*, P_B^*), and it can be shown that $(\overline{P}_A > P_A^*)$. In other words, Firm A's price falls when B enters market 1. The proof is straightforward. For $P_B < \infty$, we have

$$1+\xi^{A}(P_{A},P_{B})<1+\xi^{A}(P_{A},\infty)\,, \tag{A-8}$$

and we know that

$$1+\xi^{A}(\overline{P}_{A},\infty)=0\,. \tag{A-9}$$

For $\lambda > 0$, we must have

$$1+\xi^{A}(P_{A}^{*},P_{B}^{*})<0<1+\xi^{A}(P_{A}^{*},\infty)\,, \tag{A-10}$$

so we know that $(\overline{P}_A > P_A^*)$, since $\xi^A(\overline{P}_A, \infty)$ is declining in P_A.

Case 3 Equilibrium:

In the final case, Firm B enters both markets. The first order conditions yield

$$1+\xi^{A}(P_{A},P_{B})=0\,, \tag{A-11}$$

for Firm A, and

$$1+\xi^{B}(P_{A},P_{B})=0\,. \tag{A-12}$$

for Firm B.

Lemma #1. When B enters both markets, the equilibrium prices are $(\tilde{P}_A, \tilde{P}_B)$, whereas when B entered only market 1 prices were (P_A^*, P_B^*). Then, $(P_A^*, P_B^*) \neq (\tilde{P}_A, \tilde{P}_B)$.

Proof. Assume that the prices are equal. Then, we have

$$1 + \xi^A(P_A^*, P_B^*) = 1 + \xi^A(\tilde{P}_A, \tilde{P}_B) = 0\,. \tag{A-13}$$

But we also have

$$1 + \xi^A(P_A, \infty) = 0\,, \tag{A-14}$$

which cannot be true since

$$1 + \xi^A(P_A^*, \infty) > 1 + \xi^A(P_A^*, P_B^*)\,. \tag{A-15}$$

QED.

Lemma #2. We have either

$$P_A^* > \tilde{P}_A \quad \text{and} \quad P_B^* > \tilde{P}_B\text{, or} \tag{A-16}$$

$$P_A^* < \tilde{P}_A \quad \text{and} \quad P_B^* < \tilde{P}_B\,. \tag{A-17}$$

Proof. Obvious based on derivatives.

We now turn to the main result on prices. We have

Result:

$$\tilde{P}_A < P_A^*, \tag{A-18}$$

$$\tilde{P}_B < P_B^*. \tag{A-19}$$

Proof. The proof comes from the following: (a) assume equilibria are unique; (b) recall that $(\partial P_A^* / \partial\lambda > 0)$ and the reaction function of B is upward sloping; and (c) notice that $\widetilde{P}_A = P_A^*$ and $\widetilde{P}_B < P_B^*$ when λ = 0. Start at λ = 0 and let λ rise; both (P_A^*, P_B^*) rise above $(\widetilde{P}_A, \widetilde{P}_B)$, which do not depend on λ. Other proofs are possible.

Application:

From the above analysis, we see that

$$\overline{P}_A > P_A^* > \widetilde{P}_A \tag{A-19}$$

and

$$\overline{P}_B = \infty > P_B^* > \widetilde{P}_B\,. \tag{A-20}$$

This ordering of prices implies

$$\pi_B(\overline{P}_A, \infty) > \pi_B(P_A^*, P_B^*) > \pi_B(\widetilde{P}_A, \widetilde{P}_B)\,. \tag{A-21}$$

where π is gross (or variable) profit. In all, for Firm B, the net profit order depends on K_1 and K_2. Firm B will enter both markets if

$$\pi_B(\widetilde{P}_A, \widetilde{P}_B) - K_1 - K_2 > 0\,, \tag{A-22}$$

and will enter only market 1 if

$$\pi_B(P_A^*, P_B^*) - K_1 > 0\,,\text{ and} \tag{A-23}$$

$$\pi_B(\widetilde{P}_A, \widetilde{P}_B) - K_1 - K_2 < 0\,. \tag{A-24}$$

In this latter case, a rule requiring that Firm B enter both markets would lead to no entry, whereas the absence of such a rule results in B's entry to market 1.

APPENDIX B
A SIMULATION OF SEQUENTIAL ENTRY

In this Appendix, we describe the details of the simulation of sequential entry. The simulation is programmed and run using the statistical software package Eviews 5.1 (www.eviews.com). A spreadsheet could be used, but the simulation would be exceedingly slow and clumsy given the large number of calculations and random numbers generated for the simulation.

There are four fundamental components of the simulation: (a) demand; (b) costs; (c) entry decision; and (d) defection. We describe each in turn, though the first three are jointly determined to some extent.

Demand:

The demand curve in all markets is identical. In each market, we have uniformly distributed reservation prices between \$4800 and \$0. Since marginal costs are zero, the monopoly price is \$2400, where the own-price demand elasticity is -1.0 and market penetration (homes buying divided by homes passed) is 50%. The demand curve is

$$p = 4800 - 4800q \qquad \text{(B-1)}$$

where p is price and q is the penetration rate ($0 \le q \le 1$). The demand curve is calibrated so that the average sale price of cable system would be, on average, approximately \$1200 per home-passed, which is consistent with industry statistics.[45]

Prices are uniform across the market and across the incumbent and entrant. Market price falls as the entrant passes more homes (i.e., overlap), and q rises as p falls as indicated by the demand curve. We assume a benchmark price reduction from monopoly to 100% overlap of 20%.[46]

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45 *Eleventh Annual Cable Competition Report*, *supra* n. 32 at Table 5.

46 GAO Report, *supra* n. 39.

Consumer surplus in each market is calculated as (4800 – p^*)q^*/2, where (p^*, q^*) are the relevant equilibrium quantities. Monopoly profits in each market are simply 2400·0.5·1000 = 1.2M, or \$120M across all 100 simulated markets.

Costs:

Entry costs are computed for each home in each market using the function

$$e'_{i,m} = A \exp(1 + r_{i,m} \cdot s_m) \tag{B-2}$$

where $e'_{i,m}$ is the capital entry costs for home i in market m, A is constant, r is a standard normal random variable unique for each home, and s is scale parameter unique to each market. The constant A is set so that the average cost per home passed across all markets is \$600, which is consistent with industry statistics. Equation (B-2) renders variation both within and across markets, with r determining within market variation and s determining across market variation.

The scale parameter s is set such that values of $0.5 \le s \le 1.5$ occur in about two-thirds of the simulated markets, where this range was based on an evaluation of the distribution of loop costs across census block groups using the HAI 5.0 TELRIC cost model. The range for s was determined by estimating the following regression for a number of states:

$$\ln L = \beta_0 + \beta_1 R + \varepsilon \tag{B-3}$$

where L is *ordered* loop costs and R is an *ordered* standard normal random variable. The estimated coefficient β_1 is an estimate of s, and we found that the estimated parameter typically fell between 0.50 and 1.5. We do allow for more extreme values in about one-third of the simulated markets, so costs are allowed to be very low with little variation to favor a finding of pro-consumer build-out mandates.

We can interpret the term [1 + exp($r \cdot s$)] as market density, where costs are a direct function of density. Research shows that population density is approximately lognormal, which explains our choice of functional form.

Entry:

A home is passed if

$$\mathbf{E}(d') > e' \quad \text{(B-4)}$$

where E(d') is the expected marginal gross profit per home passed and e' is the entry costs for the home. Expected gross revenues for the entrant are simply the market price multiplied by the product of the entrant's market share and the aggregate market penetration. With a build-out requirement, the entrant serves the entire market if the entrant's gross profits at 100% overlap exceeds the sum of e' for the market. Investment is simply the sum of per-home capital costs for whatever number of homes the entrant chooses to serve or is forced to serve under the build-out requirement.

Defection:

The change in profit rank from defection is easily computed. First, we assign a rank to the build-out profit for each market. We then select f markets for defection, and replace the build-out profit for each of the f markets with their respective free entry profits. We then re-rank the profits and compute the mean change in rank.

ADDENDUM (July 20, 2005)

This POLICY PAPER was initially released on July 19, 2005. We since found an error in the simulation related to the computation of the value of a monopoly system. Since this value was an important calibration point for the simulation, we re-ran all the simulations using the correct calculation. The changes to the initial document are only in the tables and discussion thereof, and in Appendix B (in the *Demand* section). The error in the simulation produced too much entry in the build-out case, since the error led to an over-valuation of the monopoly system (i.e., a larger demand for service).

ADDENDUM (January 4, 2007)

Figure 1 and the companion text were altered for consistency with the theoretical exposition and simulation calculations. For better exposition, we also changed some text and notation in Appendix B to match the theoretical discussion in the paper and to eliminate some notational and calculation ambiguities.