

Regulatory Perspectives on Investment and Innovation in U.S. Telecommunications

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This article reports some results of a broader review and analysis of the impact of regulation on investment and innovation in the telecommunications sector. It focuses on ways in which traditional and reformed common carrier regulation of telecommunications firms might:

- Influence the level and composition of their expenditures for new capital formation.
- Impact their incentives to undertake risky innovation in a technologically dynamic and uncertain environment.

The discussion builds on and extends the analysis of two earlier articles in *NTQ*.¹

We begin with a discussion of the historic importance of infrastructure development as a goal of telecom policy. Then, we will turn to Congress' recent enlargement of that goal in the Telecommunications Act of 1996. We briefly review the tools available to the Federal Communications Commission (FCC) for encouraging infrastructure and innovation and what the theoretical and empirical literature has to say about the impact of various forms of regulation on innovation and capital formation. The article concludes with some observations about the implications of our overview for development of a comprehensive and coherent policy to encourage innovation and investment in infrastructure.

Infrastructure Growth Has Long Been a Telecom Policy Goal

Making telecommunications policy is about making choices—choices among goals and choices among means. Telecommunications policy in the United States has gradually, but unmistakably, transformed both its goals and the means for achieving them.

For about four decades, the aim of telecom policy, for all practical purposes, had a single dimension. In a remarkable display of consistency, almost every rule and regulation put in place by regulators over that time period took into consideration “universal service” and was rationalized in part as a means of bringing it about. As a practical matter, the universal service goal was transformed into efforts to keep basic residential exchange rates low, despite the fact that lowering rates—and keeping them low—had only modest effects on the rate of household penetration.²

Rate structures were designed without regard to the true structure of underlying costs as a way to assure cheap access to and use of local exchange networks for local calling. Imaginative cost accounting rules consistent with the goal of low basic exchange rates—long plant lives and slow depreciation rates, capitalization of station connection expenses, and creative allocations of common costs among jurisdictions, services, and users—were adopted. Capital formation by regulated carriers was rationed and technology constrained through facilities authorization processes, but it was always

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directed toward assuring extension of basic local service to all households—rural and urban, rich and poor. Entry was foreclosed, earnings were constrained to assure investment sufficient to extend the network to all households, and services were homogenized by regulatory fiat. (Remember the ubiquitous black telephone?) The entire regulatory apparatus was driven by the universal service goal—a goal named and supported by carriers in the old Bell system and their independent telco partners large and small.

Thus, for over 40 years, rules and regulations of the FCC and their colleagues in 50 state capitals were focused on encouraging investment in infrastructure. To be sure, we did not call it that, even though it was clearly the goal of both the private and public principals to the common carrier social contract. The goal served regulators' interests by giving them a major role in the management of telephone companies, while providing a metric—the level of basic exchange rates and the number of households connected to the network—that the public could use to evaluate whether they were doing their jobs. The goal served the interests of the management and shareholders of regulated firms in several ways. Universal service (infrastructure investment policies) assured a large and growing capital stock (the rate base) from which growing and relatively secure cash flows could be generated in a market environment largely insulated by regulators from risks emanating from technological, market, or regulatory sources.

A few critics expressed token concern with regulatory neglect of efficiency and progress during the days of pursuit of universal service. Except for a few disgruntled academic economists, the waste and inefficiencies associated with the regulated and protected monopoly were accepted as the modest cost of the larger socio-economic benefits attributable to the pursuit and achievement of universal service.

The policy worked, but it had both unintended and undesired side effects that expanded over time.

Competition Introduced into the Policy Mix

After having practically accomplished the goal of building local infrastructure sufficient to achieve the goal of universal service, the FCC shifted gears. In a series of controversial and widely-opposed decisions beginning in the late 1960s and early 1970s, the agency began to introduce other goals into the policy mix.

The new goals were multidimensional and involved consideration of various types of economic efficiency, economic progress, productive process and service innovation, diversification of output, improvement of service quality, and the vector of performance variables associated more generally with the operation of competitive markets. The goals were changed and enlarged.

In summary, a reasonable, if simplified, characterization of the goals/means of telecommunications policy before 1996 would include:

- An infrastructure or capital formation goal called universal service.
- Adoption of an “uneconomic” social rate structure as a means for achieving that goal.
- Protection of the monopoly and control of earnings as enabling devices.

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Investment and Innovation Is a Key Goal of the New Act

The Telecommunications Act of 1996 retained both competition and universal service as goals of policy, but added two new ones. Actually, it added one—deregulation—and modified the infrastructure and investment admonitions embodied in the universal service goal so as to encourage investment and innovation in advanced digital, broadband telecommunications facilities. However, by expanding the

number of goals, without changing available policy instruments, Congress laid the groundwork for confusion, delay, and uncertainty.

Most of the day-to-day focus of telecom regulation at the FCC in the United States, and in the courts, has been on matters related to:

- Removing barriers and otherwise promoting competition.
- Rationalizing rate structures.
- Ensuring the preservation and extension of universal service.

However, the act expects and commands more—much more—for its successful implementation. Notwithstanding the narrow regulatory focus to date, much of the promise of the act—reflected in the debate preceding its passage and the publicity and rhetoric thereafter—relates to capital formation and innovation in telecommunications network systems. This sentiment is captured in political statements and in the popular press by terms like “information superhighway,” the “National Information Infrastructure,” and the “Networked Nation.”

The act contains several references to investment and innovation. But, the keystone in this respect is contained in Section 706. It charges the FCC with:

[E]ncouraging the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans by utilizing, in a manner consistent with the public interest, convenience, and necessity, price cap regulation, regulatory forbearance, measures that promote competition in the local telecommunications market, or other regulating methods that remove barriers to infrastructure investment.³

The debate preceding the act’s passage was marked by clear expressions of congressional intention to stimulate investment and

innovation, as is suggested by the following language:

The goal is to accelerate deployment of an advanced capability that will enable subscribers in all parts of the United States to send and receive information in all its forms...over a high-speed switched, interactive, broadband transmission capability.⁴

President Clinton, on signing the new bill into law, observed that his administration had promoted the bill as a means, among other things, of stimulating investment and providing access to the “information superhighway,” a term whose popularity has been, in considerable measure, the result of several speeches by Vice President Gore.

Thus, there is wide recognition and support among the country’s political leadership for telecom policy that promotes investment and establishes a regulatory and market environment which encourages risk taking and innovation. Lamentably, much less clear is the extent to which the FCC and state regulatory agencies have been responsive to the call for putting in place a coherent set of policies clearly designed to foster innovation and investment.⁵

There Are Different Theories of Investment and Innovation

Given the commission’s statutory obligation to encourage “deployment...of advanced telecommunications capability...,” it is reasonable to ask how it might, or should, do so.

The deployment of advanced telecommunications capability requires both investment and innovation from the private sector. A reasonable starting point is to explore the determinants of the level and composition of investment in the telecom sector, and what determines the rate and direction of innovation. While they are clearly related and frequently treated as synonymous, these are two very different questions.⁶

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The literature on the influences and causes of investment and innovation is too broad and diverse to summarize here. Indeed, even a review of the literature would be voluminous. The following simplifies without further apology.

Investment Determinants

Explanations of the cause of investment are difficult to summarize and even more difficult to comprehend in their full breadth and depth. Dozens of theoretical investment models have been devised and many more have been tested. But, neither models nor empirical explanations have won much consensus, never mind universal acclaim.

An eminent academic investment analyst, Harvard economist Dale Jorgenson, wrote some years ago:

There is no greater gap between economic theory and econometric practice than that which characterizes the literature on business investment in fixed capital.⁷

While the gap has been closed somewhat in recent years, due to the efforts of Jorgenson and others, it is still true that a bewildering array of forces have important and differential effects—depending on circumstances—on the rate and composition of investment.

Earnings matter, but are not dispositive. So do interest rates, risk, and prospects for growth. Capital budgeting models built on these variables are instructive, but do not have great predictive power. It seems that other variables—cost of capital goods, market structure, general business conditions and outlooks, marginal capital to output ratios, durability and replacement cycles, the rate of change of demand, and the state of technology, to name a few from a survey of the models—are often dominant. In the world of investment models, everything seems to depend on everything else.

This complexity in investment models makes it clear that it is nearly impossible for federal and state regulators to find specific, unambiguous, and incontestable support in

the investment literature for any particular approach. The situation is further complicated by the obvious fact that many of the variables important to investment are beyond the control of any regulatory agency. These include:

- Interest rates.
- Health of the economy.
- Expectations about future conditions.
- Growth and composition of future demand.
- Supply of complementary goods and services.
- Costs and quality of capital goods.

Does this mean there is no guidance for the FCC in the investment literature? No, not at all. There is no disputing that risk and uncertainty—of the kind that regulators either can create or control—are deterrents to investment. It is indisputable that efforts to divide the market among competitors, to handicap or favor particular groups, will be recognized by managers and financial investors alike. The literature makes clear that regulation does matter. Rules influence outcomes and payoffs and, thereby, influence investment incentives. The biggest barrier of all may be regulatory indifference and lack of appreciation of the enormous impact of such decisions on management practices that strive to be sensitive to maximizing profit and shareholder value.

The complexity of investment determinants implies that considerably more analysis of the structure of specific market opportunities and constraints in the telecom sector must be undertaken. Only then can we begin to determine how the commission can use its limited policy toolkit to encourage investment in the sector.

Innovation Determinants

We have found no good theory of innovation. No surprise here. The very neoclassical microeconomics that has developed such powerful and policy-robust theorems about decision making within firms and the operation of markets does not

help us to understand with any certainty or specificity:

- What “causes” firms to innovate?
- How can public policy be applied to assist in the process?

Much of what we regard as innovation and technical advance is purely serendipitous. Numerous key innovations—penicillin, cellophane, current electricity, vulcanized rubber, x-rays, radioactivity, practical photography, fire, and the wheel come to mind—were not the result of a purposeful activity that was subject to pace and direction.⁸

Several theories have been developed and tested, but the findings are not especially robust and are almost always expressed in tentative terms. One scholar informs us that: “The astonishing diversity of the processes and phenomena associated with innovation suggest that the idea of a unified theory to explain it may be a pipedream.”⁹

While innovation studies can have policy implications, they do not generally yield specific and clear-cut policy guidance, particularly in a sector as complex and dynamic as markets for telecommunications.

A recent comprehensive review of innovation concluded:¹⁰

- (1) Innovation is costly.
- (2) Innovation involves significant sunk costs.
- (3) Innovation influences costs and revenues in vastly different ways.
- (4) Firms vary widely, but not predictably, in their “innovativeness.”
- (5) Knowledge is cumulative; success breeds success.
- (6) “Spill-over” effects undermine “first mover” advantages.
- (7) Feedback from market conditions, innovation strategies, and performance shapes industry evolution.
- (8) Innovation may be a means to create barriers to entry and thereby diminish price competition.

(9) The employment impacts of innovation are ambiguous.

(10) Innovation is the ultimate force for reshaping economic structures of all kinds.

While these related findings from the literature are indispensable to informing and providing a foundation for regulatory policies, they do not provide much in the way of specific guidance. Regulators need more than this, however. More detail and specificity are required about the relationships between:

- Innovation and market structure.
- Innovation and firm size.
- Innovation and the degree of competition.
- Innovation and a host of other structural conditions.

Currently, there simply is not enough known with sufficient precision to support a broad-scale regulatory effort to encourage innovation.¹¹ We need to know more—much more—about key linkages. First, however, we must ask the right questions and insist on reliable analytical approaches.

Regulatory Commissions Have Several Very Powerful Policy Tools

Regulatory agencies exercise broad and deep powers over the conduct of carrier businesses. They can control:

- Organizational structures.
- Means of cost and revenue accounting.
- The types of services that may or may not be offered, and under what conditions.
- The structure of rates and the overall level of revenue.

Agencies have the ability to impose costly service requirements, including carrier of last resort obligations. They may prescribe the terms and conditions of service to end-users and, very importantly, to competitors. They may, and do, prescribe the content of marketing materials and communications with customers. They charge for radio licenses and impose a variety of other

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hidden, but no less substantial, costs on companies under their purviews.

These and numerous other expressions of regulatory control over business operations influence the payoff from investing and innovating and thereby the incentives for doing so. That we are unable to determine specific and quantifiable one-to-one relationships between government rules and private market behavior does not negate the power of the influence.

The Telecommunications Act in Section 706 sets forth some suggestions for tools the commission might use:

[P]rice cap regulation, regulatory forbearance, measures that promote competition in the local telecommunications market, or other regulating methods that remove barriers to infrastructure investment.

While the commission is not limited to these tools, they are so broad as to be virtually all-encompassing of the FCC's options.

While competition is an important tool for stimulating investment and may be an important impetus to innovation as well, we want to emphasize that competition policy alone is not sufficient to ensure high levels or an acceptable composition of either. Moreover, given that there are countless specific manifestations of "competition policy," it follows that there is no assurance that the complex vector of federal and state rules constituting current "competition policy" will in fact stimulate total investment (entrant plus incumbent) in the sector. The investment that is stimulated will be "efficient" investment consistent with the requirement that traffic will be awarded by users to the low-cost carrier.

Competition is no doubt necessary to ensure the public interest. However, the commission's competition policies—embodied in the orders issued to date—are by no means sufficient to meet the requirements of Section 706 or the needs of the economy for high levels of both investment and innovation in this sector.

Studies of Regulatory Links to Investment/Innovation Inconclusive

We have reviewed the available literature on the relationships between various forms of regulation and firm/industry performance related to investment and innovation. The preceding discussion suggests the difficulty of establishing empirically clearcut bridges linking government constraints on market structure and behavior on the one hand and "dynamic" firm or industry performance on the other.

In principle, there are countless ways in which regulation might influence investment and innovation through their impact, for example, on their neoclassical determinants—expected earnings or cash flow, risk, and growth expectations—and more specific incentives that operate through these. Regulations and regulatory processes influence private sector expectations about the present value of potential capital formation programs.

Much of the literature on incentive regulation focuses on modifications to the form of the rate-of-return constraint—the limitation on earnings. Traditionally, earnings of telecom common carriers have been determined by the classical method of setting allowed earnings as a function of the used and useful rate base—capital stock—multiplied by a fair rate of return (based on the weighted average cost of capital).

Several variations on this basic monopoly earnings control scheme have been tried. The most common variations can be grouped into three categories: rate change moratoria or freezes, "profit" sharing, and "price caps." Under a pure *rate moratorium*, the firm agrees to freeze rates for a specific time period in exchange for lessened restrictions on earnings. This gives firms the incentive to become more efficient, since the cost savings can be realized by shareholders. Consumers gain because nominal rates are constant and declining in real terms.

The *profit sharing* plan allows the firm and the consumer to divide profits earned by the firm in excess of the baseline "allowed" rate. In principle, this opportunity will also induce the regulated firm to be

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more efficient by permitting it to flow realized cost efficiencies to shareholders, while consumers gain in proportion to their share of the reduced costs that would not otherwise have materialized.

Pure *price cap* regulatory schemes have similar salutary incentive effects, in principle, since they too permit carrier management to pass cost savings to owners, instead of being obliged to return them to consumers.

Other plans mix the basic features of these, but all are designed to give the firm positive economic incentives to behave in ways they would not under traditional rate-base, rate-of-return earnings regulation. As they say, "The devil is in the details." Thus, to understand the incentives for the firm to invest more or to become more innovative under these plans, it is necessary to understand the specific construction of the plans and the incentives embodied therein.

Efforts to measure the impact of incentive plans addressing carrier earnings prospects have found generally positive impacts. However, existing empirical work does not support the conclusion that incentive regulation plans have produced dramatic changes in key performance indices across the board in the telecom industry. In general, the studies indicate improvements in productivity, quality of infrastructure, level of investment, returns to shareholders, telephone penetration, and the rate of introduction of new services offerings. Prices have been stable or decreasing, and quality of service has not decreased.¹² But, the effects are seldom dramatic and almost always contestable, owing either to flaws in study design, inadequate specification of the models, ambiguous data, or other difficulties that plague efforts to measure regulatory impacts.

A handful of studies have specifically addressed the impact of earnings-based incentive plans on capital formation.¹³ The most comprehensive and rigorous study made to date concludes that incentive regulation, especially price regulation, increases infrastructure investment and innovation.¹⁴ This study examined the propensity of local carriers to invest in

"innovative" technologies under different regulatory schemes and concluded that direct regulation of prices substantially increased (as much as 100%) the rate of deployment of Signalling System 7, fiber links, and ISDN technologies.

An earlier and related study examined the relationship between network modernization and incentive regulation (related to both earnings and pricing flexibility) using industry-wide data for local exchange companies and concluded that infrastructure deployment is substantially enhanced by incentive regulation.¹⁵ A follow-up study indicated that profit incentives alone—without other pricing incentives—did not significantly influence the propensity of regulated carriers to invest. Finally, we are obliged to report that one study concluded that incentive plans have *no* impact on infrastructure investment.¹⁶

Most attempts to measure the effect of incentive regulation have found positive impacts on investment of regulatory efforts to reform traditional rate-of-return regulation. Despite serious problems of identification and measurement problems, the principal studies are united in that conclusion.

More specific linkages between regulatory rules and incentive effects on the conduct and performance of firms are very difficult to identify. For example, if the firm's performance in one time period affects its future regulatory environment, the effects are not at all clear-cut. The basic theory of incentive regulation of earnings is that higher earnings will bring about beneficial firm conduct. However, regulators come under substantial political pressure to renege on the original arrangement and to "recontract" when firms report high profits.¹⁷

Thus, in determining resource allocation in the near term, firms under these kinds of incentive regulation must take into account how committed the regulatory authorities are to the agreed-upon incentive regulation. Also, they must consider the probability that present earnings will adversely effect the future type of regulation. This not only adds uncertainty and risk to the firm, it also

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makes it more difficult to achieve either a market solution or a predictable one. The uncertainty invites gaming.¹⁸

Regulatory Policies to Encourage Investment and Innovation?

There are no silver bullets. It will not be simple or noncontroversial to identify and implement policies that will meet the requirements of the economy for high-speed digital electronic distribution systems. Such policies will have to be woven into a web of existing rules and regulations motivated by entirely different concerns and that developed over a long period of time.

A major challenge, and one that must be met if we are to succeed, will be to overcome the traditional mindset that basically takes technology, technological change, and investment in this sector for granted. It is much too important for that.

Technological change and innovation are indispensable to the economy at large and no less so to telecommunications and the larger information technology sector of which it is a part. Forty years ago, Nobel Laureate Robert M. Solow published research indicating that about 80% of the increase in gross output per worker hour in the United States in the first half of the 20th century was attributable to technological change. While subsequent work has somewhat lowered the estimate, the force of Solow's work is unchanged—technological change is the primary force propelling growth in productivity and our standard of living. The authors of an important review of markets and innovation summed it admirably:

[W]hether technical advance is regarded as a blessing or an evil, we cannot ignore it. Indeed, it is arguably the most important determinant of our past, present, and future.¹⁹

Much of the mindset of the regulatory community seems to be focused on matters involving fair competition and fair interconnection, access by favored groups to ser-

vices, and to the essentially impossible task of “getting prices right.” The focus is on fairness and short-run static efficiency. That focus may well be myopic, and we think it is. A recent review of antitrust policy contained what we regard as an efficient expression of the current gap in regulatory performance:

We know that many discussions of antitrust policy and efficiency have violated the New Testament injunction against beholding the mote and ignoring the beam. X-efficiency is much more important than allocative efficiency, and dynamic efficiency is almost surely even more important.²⁰

Dynamic efficiency is critical, even more so than more conventional static measures if Scherer is right. Kamien and Schwartz expressed the same sentiment in a slightly different way:


Thus, technical advance appears to require the sacrifice of some allocative efficiency at each moment of time for the purpose of greater efficiency in the long run.²¹

Short-run static efficiency is important, as are efforts by regulators to achieve it. The longer run performance of the economy, however, depends on investment and innovation. These are not necessarily, or even probably, optimized by the single-minded pursuit of policies to ensure equity, fairness, and arbitrary costing and pricing standards—especially if they are pursued, as they have been, without regard to dynamic considerations.

How can regulatory institutions best contribute to “dynamic” efficiency? Again, there are no silver bullets, and no simple one-shot solutions.

The key is probably found in the complex regulatory behavior that resulted in the successful pursuit of universal service. In retrospect, universal service policy considerations permeated almost every rule-making

for several decades. It is very likely that a similar preoccupation with and commitment to investment and innovation will be required by the regulatory community.

Recognition by the regulatory community of the enormous contribution of telecommunications investment and innovation to our overall economic welfare is a necessary first step. Infrastructure policy is just as important as competition policy to the public's well-being. A good second step is a recognition by regulators of their role in fostering—or discouraging—investment and innovation. A third is a commitment to making the impact on infrastructure a consideration in all regulatory determinations. Call it “universal service” for the 21st century and the digital age. 

¹ L. F. Darby and J. P. Fuhr, Jr., “Impacts of the 1996 Telecom Act on Investment and Innovation,” *New Telecom Quarterly*, Vol. 5, No. 2 (May 1997):21-30. L. F. Darby and J. P. Fuhr, “Telecommunications Capital Formation, Regulation, and Economic Development: A Primer,” *New Telecom Quarterly*, Vol. 2, No. 3 (July 1994):45-52. We hasten to point out that we have not touched on matters related to incentives to invest and innovate in important and closely-related sectors—wireless, satellite, and cable systems. Their exclusion does not indicate a judgment that they are unimportant, but a recognition of the limits of space here.

² The elasticity of demand for local exchange service is quite low. The coefficient has recently been estimated at = -.02 by Crandall and Waverman. It has been consistently found to be less than -.05. R. W. Crandall and L. Waverman, *Talk is Cheap* (Washington, DC: The Brookings Institution, 1995), p. 92. This means that the demand for local service is insensitive to rates and implies, for example, that a doubling of rates (a 100% increase) would suppress demand by only two percentage points.

³ Codified at 47 USC Section 157 note (“Section 706”).

⁴ U.S. Senate, Report 104-23, 104th Congress, 1st Session 50 (1995), p. 51.

⁵ The act sets forth in no uncertain terms in Section 706 (b) a requirement that, within 30 months after the act is enacted, the FCC shall “...initiate a notice of inquiry concerning the availability of advanced telecommunications capability to all Americans...and shall complete the inquiry after 180 days.” Nevertheless, there has been no action on this important Congressional directive, and there is little indication, beyond passing reference in the commission's self-styled trilogy (three proceedings addressing interconnection, universal service, and access charge reform) and rhetorical flourishes in speeches, that the commission is concerned about this critical issue.

⁶ Of the numerous definitions of innovation, our favorite was set out many years ago by Professor Jacob Schmookler who spoke of it as follows: “When an enterprise produces a new good or service or uses a method or input that is new to it, it makes a technical change. The first enterprise to make a given technical change is an innovator. Its action is the innovation.” J. Schmookler, *Invention and Economic Growth* (Cambridge, MA: Harvard University Press, 1966), p. 8. Investment, of course, refers to acquisition and installation of capital goods, an activity that may or may not be innovative, depending on whether the investment is for simple replacement or extension or for modernization and adaptation of new production technologies.

⁷ D. W. Jorgenson, *Investment: Capital Theory and Investment Behavior* (Cambridge, MA: MIT Press, 1994), p. 1.

⁸ M. I. Kamien and N. L. Schwartz, *Market Structure and Innovation* (Cambridge, England: Cambridge University Press, 1985), p. 1.

⁹ P. Hall, *Innovation, Economics, and Evolution: Theoretical Perspectives on Changing Technology in Economic Systems* (New York: Harvester Wheatsheaf, 1994), p. 403.

¹⁰ *Ibid.*, pp. 407-410.

¹¹ The gap in our knowledge about different characteristics of markets and the prospects for innovation is succinctly summarized in the conclusion of a recent review of the literature. The authors conclude: “Another gap in the empirical literature is the absence of a satisfactory explanation for inter-firm differences in innovative activity.” See W. M. Cohen and R. Levin, “Empirical Studies of Innovation and Market Structure” in R. Schmalensee and R. Willig, Eds., *Handbook of Industrial Organization*, Vol. 1 (North Holland, 1992), p. 1097.

¹² D. J. Kridel, D. M. Sappington, and D. L. Weisman, “The Effects of Incentive Regulation in the Telecommunications Industry: A Survey,” *Journal of Regulatory Economics*, Vol. 9, No. 3 (1996):271.

¹³ These and related studies are addressed in an excellent review by D. M. Sappington and D. L. Weisman, *Designing Incentive Regulation for the Telecommunications Industry* (Cambridge, MA: MIT Press, 1996), pp. 314-324.

¹⁴ S. Greenstein, S. McMaster, and P. Spiller, “The Effect of Incentive Regulation on Local Exchange Companies' Deployment of Digital Infrastructure,” *Journal of Economics and Management Strategy*, Vol. 4 (1995):187-236.

¹⁵ W. E. Taylor, C. J. Zarkadas, and J. D. Zona, “Incentive Regulation and the Diffusion of New Technology in Telecommunications.” Paper presented at the Ninth International Conference of the International Telecommunications Society (June 14-17, 1992).

¹⁶ W. P. Montgomery, “Promise Versus Reality: Telecommunications Infrastructure, LEC Investment, and Regulatory Reforms.” Research paper, MCI Communications Corporation (August 1994). We report this result despite our lack of confidence in the method or the findings. The independent variable used, investment per access line, is widely known to be an exceptionally ambiguous and unreliable measure of the impact of

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regulation on capital formation. This study suggests that incentive regulation leads to less investment and, as such, proves rather too much.

¹⁷ M. Z. Starkey and J. W. Van Pelt, Jr., "Productivity Measurement and Price Cap Regulations," *Telecommunications Policy*, Vol. 19, No. 2, p. 157.

¹⁸ D. Weisman, "Superior Regulatory Refines in Theory and Practice," *Journal of Regulatory Economics*, Vol. 5 (1993):363. Weisman contends that the firm under modified price caps has the incentive to engage in pure waste if it gains more from reducing the probability of recontracting than it loses from engaging in pure waste. T. P. Lyon, "Regulatory Hindsight Review and Innovation by Electric Utilities," *Journal of Regulatory Economics*, Vol. 7 (1995):249. Lyon claims that, if the firm's share of profit is low, then it may overcapitalize so that in the future when its profit share may be higher or it is deregulated, it already has built its plant and its profits will increase. M. A. Crew and P. R. Kleindorfer, "Incentive Regulation in the United Kingdom and the United States: Some Lessons," *Journal of Regulatory Economics*, Vol. 9 (1995):214. Crew and Kleindorfer argue that a pure price cap scheme mimics a competitive market in that the firm can keep all its earnings. However, if a firm thinks that its success will be penalized, then it will game the system and pursue the "optimal" efficiency based on forecasts of future regulatory change. Others note an unintended negative effect of all these incentive plans if they lead to "too much" efficiency that deters future entry and thereby reduces competitive forces downstream. Thus, some have argued that "efficiency-based" entry barriers may have the deleterious effect of sheltering an incumbent from future competition. S. V. Berg and R. D. Foreman, "Incentive Regulation and Telco Performance: A Primer," *Telecommunications Policy*, Vol. 20, No. 9, p. 651. Berg and Foreman purport that erecting barriers to entry dampens incentives to innovate and discover new ways to meet consumer demand.

¹⁹ Kamien and Schwartz, p. 223.

²⁰ F. M. Scherer, "Antitrust, Efficiency, and Progress," *New York University Law Review*, Vol. 62 (November 1987):1018.

²¹ Kamien and Schwartz, p. 217.