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From Open Networks to Open Markets: How Public Policy Affects Infrastructure Investment Decisions

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Executive Summary

This report examines the theoretical underpinnings of the primary current (2000) telecommunications regulatory model, the Open Network Model (ONM), and its application. The report concludes that this policy model has slowed investment in local networks, thereby limiting the spread of facilities-based competition for most local-access telecommunications services. Because open network policies encourage the development of services and service providers that rely unduly on existing local networks, rather than being the solution to engender competition, ONP has become the problem.

Local monopoly or near-monopoly is a legacy of embedded technology, and a review of changes in the economics of transmission, processing, and memory storage indicates that the natural monopoly in telecommunications has largely been eroded. The issue facing government at the start of the twenty-first century is how to generate the large investments needed to deploy the newest capabilities of information infrastructure. To do so, government will need to shift from a policy of preserving efficient monopoly while protecting users to a policy of encouraging economic growth and development by enabling market-based investment in alternative networks so that competition can safeguard users' interests.

This report offers a policy framework, called the Open Market Model (OMM), to replace the ONM. New theoretical underpinnings are needed for the proposed OMM. Neoclassical economic theory needs to be replaced by theory based on evolutionary economics and differentiated competition. The premise for the new theory is that neither the regulator nor the entrepreneur can predict with certainty the outcome of a dynamic competitive process. The competitive market process is, by its nature, a search for unanticipated, innovative solutions.

Similarly, in the OMM neoclassical investment theory is replaced by "real option" investment theory. An investment opportunity is like a perpetual call option created by delaying actual investment. Deciding when to invest is like deciding when to exercise the option. Because such decisions generally are irreversible, regulatory uncertainty creates real options that have financial value. An increase in uncertainty means an increase in the value of future investment opportunities, because increased uncertainty adds to the value of real options while reducing the amount of actual investing in the present. The paradoxical result is that delaying investments under conditions of market or environmental uncertainty can raise a firm's value.

Under OMM, the focus of regulatory intervention is on demonstrated market failures. By distinguishing enduring failures from transitory ones, the model provides a path for regulatory withdrawal in favor of competition law, once appropriate conditions have been met.

Summary of Comparison of Policies

Policy Goal	Open Network Policy	Open Market Policy
Interconnection definition	Access and termination	Termination only
Interconnection pricing	LRIC for both access and termination	LRIC for termination
End-user prices	Rebalance slowly to prevent rate shock	Rebalance quickly to attract investment; wholesale rates for call origination
Market definitions	By technology (local loop, trunk, fixed, mobile)	By service (call origination, call termination)
Universal service	Service X-subsidy; geographic price averaging	Competition; customer-direct subsidy; encourage low-cost technology
Burden of proof for intervention	On market	On regulator
Spectrum management	"Command-and-control" allocation by licensing	Secondary markets

LRIC = long-run incremental cost X-Subsidy = cross-subsidy

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Chapter One

Introduction

Beyond the problems of war and peace, crime and punishment, hunger, health care, and social justice, the most difficult problem facing most nations at the turn of the millennium is the transition from nineteenth-century to twenty-first century telecommunications technology. Innovation, productivity, wealth and job creation, social relationships, even the arrangement of furniture at home, all are being altered in unexpected and unforeseen ways. Many countries have recognized that management of this transition will largely determine their economic development and global competitive position.

The investments required to replace the existing telecommunications infrastructure with networks embodying new technologies will be enormous. Unlike previous waves of infrastructure investments, such as railroads in the nineteenth century and highways in the twentieth, these investments are being made during rapid technological changes arising from hardware and software development. Investments come as much from the community of users as from suppliers. Suppliers range from incumbents through allied or merged recombinations of existing entities to new entrants, some *de novo*, others from the traditional telecom sector, and still others from other industries, such as cable television (TV), electricity, and water distribution.

Policymakers around the world, long accustomed to stable environments and well-defined provider communities, now find themselves in an environment of converging industries, rapidly changing technologies, and financial and market risks that are new to the telecommunications industry and its regulators. Tried and true approaches, those that have had have had relatively predictable outcomes, now ricochet through increasingly complex segments of users, suppliers, and intermediaries.

This report examines the theoretical framework, behavioral assumptions, and regulatory tools that for the most part have driven telecommunications policy around the world up to the end of the twentieth century. One conclusion reached is that that framework is implicitly or explicitly founded on neoclassical economic theory, a theory inadequate to the task of explaining and predicting dynamic market behavior. Policies based on and derived from this theory are therefore inadequate to the task of generating the investments needed to create competitive infrastructure, especially in local telecommunications networks.

The policy framework developed in this report starts from the recognition that the pace of technological change has been accelerating and developing down paths that cannot easily be foreseen. Rapid change alters the nature of business investment decisions and suggests the need for a different model of the investment decision, one based on the approach known as "real options." The real option approach puts a premium on flexibility of outcomes and resilience to change, rather than trying to forecast and minimize risk factors.[1] On the basis of this approach, key variables can be identified that affect decisions on whether and how to invest, and the impact of public policy on investment decisions can then be evaluated within the real option framework.

Policy decisions and changes are a significant source of uncertainty, and policy decisions strongly affect investors and the level and direction of investment flows. For example, "Mobilcom, the small German operator, grew dramatically last year by exploiting a regulatory regime which enabled it to undercut Deutsche Telekom handsomely. This year [1999], its shares lost 22 percent...as regulatory changes allowed its bigger rival to cut its prices."[2] Government policy affects the products that can be sold, the market prices to be charged, the geography to be served, the network technology to be used, a large proportion of the operating costs incurred, and the nature of competition. Taken together, these variables constitute a business case. Investment decisions are based on business cases. Policymakers need a sophisticated understanding of the links between their proposals and actions and the investment decisions on which they themselves rely for fruition of their policies.

This report examines the main features of alternative telecommunications policies through the eyes of potential investors. This perspective allows an assessment of the effects of government telecommunications policy on relative risk and returns in the various segments of the telecommunications industry and, therefore, also of the direction of investment decisions. For example, does policy deliberately or unintentionally encourage a "one-wire" approach to local infrastructure, encouraging resale but discouraging investment in competing infrastructure? Or does policy encourage investment in competitive long distance networks but discourage local competition? Or does policy, based on protectionism or belief in natural monopoly, discourage any competition? Different countries have made or are making policy choices that will affect the direction of investment.

In the last quarter of the twentieth century, two schools of thought developed on how public policy can best encourage the necessary investment. The first, here called the Open Network Model (ONM), believes that investors will follow a multistage strategy, beginning with resale and proceeding to infrastructure investment. According to this view, the regulator encourages new entrants to enter the market by reselling or adding value to the incumbent local operator's services or unbundled network elements (UNEs). Initially, competition is based primarily on price and generated largely by arbitrage opportunities. This combination of factors allows the entrants to establish a market presence and quickly generate cash flows that will attract investors to provide the capital to invest later, in their own facilities: switches, trunking, and, on a selective basis, local loops. In the ONM, the regulator requires the incumbent to open and unbundle its

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[1]Avinash K. Dixit and Robert S. Pindyck, *Investment Under Uncertainty* (Princeton, N.J.: Princeton University Press, 1994).

[2]"Telecoms Surge May Go Long Distance," *Financial Times*, Dec. 8, 1999, .33.

network elements and sets the prices of the elements at cost-based levels intended to provide margins for efficient competing service providers. In the United Sates, this has been the dominant approach.

The alternative approach presented here, called the Open Market Model (OMM),takes a longer term view, which is that the public is better served by competition based on alternative proprietary networks. In the OMM, the regulator takes a different view of the investment process; instead of providing early cash flows to new entrants by requiring incumbents to resell and unbundle network elements, the regulator adopts policies intended to provide attractive network investment opportunities.

But the pace of change is faster than existing regulatory approaches can match and suggests the need for a new approach. Inevitably, most telecommunications policymaking, designed for relative stability, falls behind. For example, the European Commission's 1999 Review of the Open Network Provision (ONP) framework proposed policy changes for implementation near 2002.[3]

The proposed approach identifies and focusses on market failures, generates neutral investment signals, and puts the telecommunications sector on the way to regulatory withdrawal in favor of competition law that would be applied to a workable competitive market. The policy framework for this approach is here called "open market architecture."

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[3]ONP, a telecommunications policy framework of the European Commission, is the "Principle of non-discriminating opening of telecommunications networks to all telecom operators and service and service providers on the basis of the harmonisation of access and usage conditions of telecommunications infrastructure with the view to develop a trans-European information market." [On-line]. URL: http://www.ispo.cec.be/infocentre/glossary.html (Accessed Oct. 15, 2000.)

Chapter Two

An Overview of Alternative Policy Frameworks

2.1 Monopoly: Closed Network Architecture

Monopoly franchises combined with some kind of obligation to serve have been and often remain the policy tool used to drive investment in telecommunications networks. In the United States, the monopoly franchise was most often created by state requirements for a "certificate of public convenience and necessity" and combined with common carrier obligations. Elsewhere, government was the exclusive provider of telephone and other communication services.

2.1.1 Impact of Closed Network Policy on Investment

With legal protection against competition, the closed network approach essentially eliminated risks arising either from competition or business failure. Rate-of-return regulation, on top of franchise monopoly, provided returns on capital by applying a fixed percentage return on net capital investments. Simple arithmetic reveals that a 10 percent return on a large investment is greater than a 10 percent return on a small investment. A bigger investment therefore generated bigger returns to shareholders in dollars. The closed network approach created an incentive to invest the billions of dollars a year needed to build and maintain the capital-intensive telephone network as well as to extend wires to almost every household in the United States.

Monopoly was the historical approach also outside the United States, although universal service was not usually the driver of this policy. As government entities, postal, telephone, and telegraph departments (PTTs) generate enormous revenues that help fund general government operations. A PTT tends to behave like a traditional unregulated monopolist, maximizing profits and underserving demand. Long waiting lists, low telephone penetration, and poor quality have been typical in many countries.

In the last quarter of the twentieth century, technological changes that brought enormous reductions in costs and enormous increases in capabilities of new equipment undermined monopoly structures. Internet protocol (IP) telephony, mobile telecommunications services, new network architectures, and cheap, powerful computing and memory became available. The new capabilities allowed low-cost new competitors to offer attractive new services at lower prices than embedded technologies could provide. The reality of competition undermined the old premise of risk and reward underlying investment in the closed network architecture of monopoly telecommunications.

In response to these changes, and driven by fiscal needs, many countries privatized PTTs, in whole or part. At the same time, they tried to fend off competition with legal entry barriers. PTTs instigated and supported this approach, in order to preserve their market position. Governments went along out of the belief that higher tender offers for the PTTs, hence greater revenues to the national treasury, would be generated by a period of exclusive monopoly for the winner.

Despite these efforts, governments have found that market forces nullify legal protections. For example, in the Czech Republic, SPT is the partly privatized incumbent operator with exclusive legal right to carry international traffic, but because callback operators and Internet service providers carry a large portion of that traffic SPT cannot sustain its domestic rate structure.

In practice, exclusivity is no longer sustainable. Governments and incumbent operators are now realizing that their attempts to protect monopoly positions are becoming more and more futile, and in the light of changing technology, not in the public interest. The early response to this recognition in the late 1970s in the United States and the mid-1980s in Europe was known collectively as “open networks” policies.

2.2 Competition Around the Edges: Open Network Architecture (ONA)

Incumbent telephone companies around the world deployed most of their network investments before 1980, the beginning of the period of accelerating technological change. As a result, they remain saddled with a huge embedded network investment not far removed from nineteenth-century technology. These companies face a cruel dilemma: They cannot compete on a head-to-head basis with new entrants that are acquiring their equipment, deploying architectures, and developing and pricing services on the basis of the “new” economics of twenty-first century technology. For incumbents to be competitive would require either massive write-offs against shareholders or turbo-charged acceleration of depreciation, followed by huge investment expenditures to replace their existing networks.

Faced with these prospects, the strategy most incumbents have chosen is to postpone the day of reckoning. They pursue instead other strategies intended to delay investment by and competition from new entrants and increase competitors’ costs. As competition emerged or threatened to in country after country, from the 1970s to the early 1990s, a common pattern of response emerged. With tacit or explicit regulatory approval, incumbents overcharged for interconnection, levied overstated universal service charges, and fought number portability, dialing parity, access to directory information, among other possibilities. Simultaneously, they pursued rate rebalancing, whereby prices in the contested segments of long-distance and (later, as competitive networks emerged in the later 1990s) international calls were reduced. Incumbents generally also sought offsetting increases in local subscriber access and usage prices, but distaste among politicians usually prevented full rebalancing. The resulting “access deficit” was sometimes added to interconnection charges; as was the case for a time in the mid-1990s in the United Kingdom (U.K.), further raising costs of long-distance competitors.

Complaints about such actions eventually led many regulatory bodies to reverse their initial protectionism and to adopt policies intended to curb abuse of dominance and provide a transition to competition. The result was policies that can be grouped under the heading of ONA.

In essence, these policies require the incumbent telco, typically operating in all the traditional segments of the telecommunications marketplace (local, long-distance, equipment), to keep its network and marketing functions at arm's length and to provide nondiscriminatory access for competitors to its local call origination and call termination functions. In addition, they impose some version of cost orientation on the prices to be charged competitors for interconnection.

In the United States, ONA also separated those operations of predivestiture AT&T that offered competitive equipment and services from operations that provide basic monopoly services. In Europe, a slightly different tack was taken under the Open Network Provisioning (ONP) Directive. This Directive from the European Commission directed member states to separate regulatory functions from operations, to license at least one competing mobile operator, and to liberalize leased lines and equipment, while allowing member states to retain until 1 January 1998 the monopoly on basic voice services.

Beginning around 1998, with the acquisition of Tele-Communications, Inc.(TCI) by AT&T, the ONA approach began to be ferociously fought out in the context of access to broadband networks. Telephone incumbents are under pressure to provide unbundled network elements (UNEs) to competitors that want to provide digital subscriber loop (xDSL) high-speed data services over them.[1] The Federal Communications Commission (FCC) has been urged by a coalition of Internet service providers (ISPs) and incumbent telcos to apply ONA principles to U.S. cable television systems. Proponents argue that, just as monopoly local telephone companies have been required to provide equal access to long-distance companies, so should monopoly cable TV operators, so that customers can get equal access to Internet service providers.

On the retail side, the traditional pricing structure of incumbent telephone companies around the world has been to charge high prices for long-distance services and low prices for local-access services. Dramatic reductions in long-distance costs, combined with this retail pricing regime, have made investing in competing long-distance networks attractive but investing in competing local networks unattractive. Most open markets exhibit vigorous long-haul competition at the national and (increasingly) international level but relatively little investment in competing local networks.

[1]"UK Regulator Calls on British Telecom to Offer UNE's to Broadband Competitors," *Telecommunications Reports*, July 12, 1999, 7.

2.2.1 Impact of Open Network Policy on Local Loop Investments

The lack of investment in competitive local infrastructure, it might be argued, is a result of the "natural monopoly" characteristics of the local loop, that is, that the observed pattern of competitive investment is a result of the inherent economics of short-haul versus long-haul networks. The huge investment and evident success of competitive local networks in the U.K., however, could be offered as examples of counterevidence. Open network policies could be said systematically to discourage the long-term investment needed to introduce new technology and competitive networks. Thus, the open network policy framework becomes the problem, not the solution, to the lack of local loop competition.

The arguments that find public policy to be the culprit are as follows:

- Under ONA policies, the call origination and termination functions of the incumbent telco are made available to long-distance operators and service providers at very low rates, typically reflecting some estimate of long-run incremental cost (LRIC) of the underlying network elements. Given the ability to obtain access at cost to an existing local network, why would a company make the huge capital investments required to build a ubiquitous alternative local infrastructure? On a "make-or-buy" basis, the investment simply cannot be justified.
- The intuition of that argument is reinforced by real option theory (see section **4.2**). If a potential service provider can gain access to the network of another operator at that operator's costs, thereby avoiding large sunk and irreversible investment costs, real options theory suggests that the potential provider will defer building its own network. When technology is developing rapidly and costs are dropping, delaying investment is of even greater value.
- The problem is exacerbated when policymakers maintain low prices to end-users for local services and access to the network. Not only does ONA bias the cost side, but the revenue side of a business case also is rendered unattractive because the incumbent's low price sets the market price.

Table 2-1 presents the basic characteristics of the open network model designed to deal with a core monopoly.

Table 2-1

Features of the Open Network Model

Theoretical Assumptions	Regulatory Behavior	Regulatory Tools
Static efficiency and equilibrium	Regulator is substitute for the market	Detailed intervention to preempt outcome
Perfect competition is ideal	Protect consumers	Best deal defined as lowest price
Neoclassical investment theory	Rate-of-return regulation	Cost-plus accounting
No technological change	No surprises	New technology = new markets
Natural monopoly	Profits are bad	Rate-of-return scrutiny
Investment only incremental	Regulatory suspicion of "gold plating"	Separate subsidiaries: Accounting separation, FDC accounting
Universal service	Protect incumbents from competitors	Cross-subsidy, high interconnection and access deficit fees

FDC = fully distributed cost

If open network policies are the problem, then what is the solution? Can a policy structure be devised that does not provide disincentives to investment in local networks while adequately addressing market failure and other policy goals?

2.3 Open Market Architecture (OMA): Full Competition

The analysis in section **2.2** suggests the need for a new policy framework that would have the following characteristics:

- Resilience to rapid and unpredictable changes in the industry;
- Capable of allowing market forces to operate to their maximum extent;
- Regulatory intervention with tight focus on market failures;
- Capable of identifying market failures and categorizing them as transitional or enduring;
- Capable of addressing transitional market failures with transitional policies that have a clear path toward regulatory withdrawal;
- Capable of addressing enduring market failures with policies that can adjust for the failure in ways that minimize spill-over effects and unintended consequences; and
- Policies formulated with an eye to their impact on dynamic efficiency, rather than solely to achieve low prices to users.

Regulation focussed on market failures, with clear objectives and standards for intervention and withdrawal, can provide an investment climate that gives clear guidelines to entrepreneurs and investors in all segments of the telecommunications industry. Given the certainty but unpredictable pace and direction of change, the policy framework will need to focus on a fair and stable process more than on achieving particular outcomes. This situation means that regulators will need to cease attempts to manipulate market structure. Instead, a policy framework is needed that will accelerate and encourage, rather than try to slow and manage, the deployment of new technology and products and services. The goal is to move the field of competition into the marketplace, so that winners and losers can be determined by their prowess in serving customers and developing innovative services and efficient operations, not by their prowess in legal and regulatory pleading.

Table 2-2 presents the basic characteristics of the open market architecture model.[2]

Table 2-2

Features of the Open Market Model

Theoretical Assumptions	Regulatory Behavior	Regulatory Tools
Dynamic economic efficiency	Forbearance	Benefit-cost analysis
Differentiated competition	Tolerance for segmentation	Open entry
Investment theory based on real option theory	Stable policy environment	*Ex ante* guidelines
Dramatic technological change and innovation	Redefine market: profits drive R&D	Call origination and termination, convergence
Enduring market failures	Network effects, externalities, public goods	Interconnection policy, spectrum, numbering, permits
Transitional market failures	Dominance	Price caps and floors; *ex post* competition law

R&D = research and development

The following chapters discuss and contrast the elements of the open network model and the open market model, with, where possible, examples of their effects. Arguments for and against the models are examined. Although the choice of policy will depend on the goals of

[2]These tables should be viewed as caricatures, recognizable in their broad outlines but different in details from their real-world manifestations.

decisionmakers, the framework proposed here may shed light on the tradeoffs and make informed debate and decision more likely.

Chapter Three

Comparison of the Elements of ONA and Open Market Architecture

3.1 Economic Models, Implied Regulatory Behavior, and Regulatory Tools

3.1.1 The Open Network Model (ONM)

The Open Network Model is based on static economic efficiency. Almost any textbook on regulatory economics of the monopoly era will reveal a strong reliance on neoclassical economic theory.[1] The elegant mathematical underpinnings of neoclassical economics stem from the mathematics of "comparative statics." In comparative static analysis, the "answer" is that set of optimal equilibrium conditions and equilibrium outcomes that would prevail if the customers and suppliers in the model react to changes in ways assumed by the model. Comparative static analysis describes the difference between an initial equilibrium and a final equilibrium, but it has absolutely nothing to say, and no insights to provide, about the nature of the between the initial point and the final equilibrium, beyond an assumption that the transition is smooth and continuous. In its mathematical form, the neoclassical model eliminates the messy real-world "friction" of time and space, assumes perfect information, and assumes transactions and transportation costs are zero.

In a well behaved, competitive, neoclassical market, all firms produce at minimum average cost using the best available technology, earn zero economic profits, set price equal to long run marginal cost, and together serve the entire customer set that is willing to buy at that price. This outcome can be shown to be optimally efficient, in that the market price is set so that resources are used efficiently and all customers willing to buy at that price are served. These conditions describe the case of maximum "allocative efficiency."

In the neoclassical model, only at equilibrium are resources used optimally, production and consumption decisions are equal at the margin, only "normal" profits are earned, and therefore no firms either enter or exit the marketplace.

3.1.2 Regulatory Behavior in the ONM: Substitute for the Market

Applying neoclassical economics and comparative static analysis, regulators imagine that they can project the structure and behavior of customers and suppliers in an optimal competitive market, where resources are used to their maximum efficiency because the equilibrium conditions for optimal resource allocation have been met.

Any departure from equilibrium, even if en route to that happy state, by definition is not optimal. Regulators seeking efficient markets therefore adopt policies that simply impose the

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[1]Alfred E. Kahn, *The Economics of Regulation: Principles and Institutions* (New York: John Wiley, 1970).

equilibrium outcome through regulatory rules. The model predicts that in a competitive market, prices equal marginal cost and economic profits equal zero, so that accounting profits cover only returns to factors of production and there is no entry or exit. If the real-world market appears to deviate in unexpected ways, further interventions are imposed to bring the unruly back into line. Such unanticipated consequences, and the need for constant regulatory oversight, are frequently observed traits of public policy. As a result, market dynamics that might otherwise have developed and maybe even led to the predicted optimal outcome, are pre-empted.

3.1.3 Tools of the ONM: Detailed Intervention to Preempt the Outcome

Most traditional wireline telecommunications regulation has been based on the view that this technology was characterized by natural monopoly, caused by persistent economies of scale. With a natural monopoly, the engine of competition does not drive to the predicted static optimal outcome, but, instead, a single monopoly provider is optimal because it captures internally all the efficiency arising from the persistent economies of scale. Yet comparative static analysis shows that an unregulated, profit-maximizing monopolist underserves the market, earns excessive profits, and sets price above marginal cost. To correct this situation, the regulator must intervene.

The neoclassical standard for intervention holds that

> The proper task of regulation is to intervene where competitive forces are too weak to defend the public interest unaided, with regulation undertaking to restrict or prevent behavior, inadvertent or deliberate, that threatens to damage the public interest because it deviates from what effective competition would have permitted, had it been present. This criterion is the *competitive-market standard* for regulation.[2]

Regulators thus impose results that would have been reached through the competitive process. The tools are quite similar under both the closed network architecture model of complete monopoly and the ONA model of competition around the edges. As practiced in the United States, these include rate-base regulation, rate-of-return regulation, price regulation, universal service obligations, and franchise monopoly.

Rate-Base Regulation. The regulator determines or approves the amount of capital investment that is needed (i.e., "used and useful") to provide the level and quality of service required to serve the market to the public's satisfaction. (The FCC's version of this regulation is the familiar "214 process," whereby telephone companies must get approval to build facilities.) The value of that investment less accumulated depreciation is the cost that the monopolist must recover in order to break even, known as the "revenue requirement." Thus, the regulator

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[2]William J. Baumol and J. Gregory Sidak, *Toward Competition in Local Telephony* (Cambridge, Mass.: Massachusetts Institute of Technology [MIT] Press and the American Enterprise Institute [AEI] for Public Policy Research, 1994), 27. Emphasis in original.

interposes itself into the details of investment decisions, technology choices, depreciation, and the tradeoffs between capital and labor costs. In the language of the neoclassical model, the regulator determines the point on the average cost curve associated with competitive output levels.

This process gives regulators their historic suspicion of "gold-plating," because by over-investing in its rate base, a monopolist can increase the wealth of its shareholders. This effect is a well known incentive under rate-of-return regulation.[3]

Rate-of-Return Regulation. The regulator must estimate or approve the risk-adjusted cost of capital that is to be added to the revenue requirement. To do so, the regulator must determine allowable debt-to-equity proportions and thus interpose itself into decisions about the firm's financial structure, debt service capability, and risk preferences. In the language of the neoclassical economic model, the regulator determines the equivalent of a zero economic rate of return. In this sense, ONA concludes that "profits are bad," because they represent monopoly rents.

Price Regulation. Because in a natural monopoly, price cannot simultaneously equal marginal cost and also allow the firm to break even (because marginal cost is less than average cost), the regulator and the company divide the market into segments according to some rough characterization of willingness to pay. Low prices, which may approximate marginal cost, are charged to the segment with lower willingness to pay, and high prices are charged to the other segments. High margins from the latter groups are used to offset low margins or losses from the former group. The concept of "willingness to pay," while related to price elasticity, in practice includes political representation and income effects.[4]

Universal Service Regulation. To achieve the levels of penetration predicted by the neoclassical model, the regulator imposes an obligation on the monopoly that it must serve all customers. Services that appear to make losses under regulatory accounting practices are subsidized by more profitable services under the pricing system (see section **6.2.1**, on fully allocated costs accounting).

Franchise Monopoly. Recognizing that, in the neoclassical model, economic profits attract entry, the regulator creates a franchise monopoly license based on a finding of "public convenience and necessity." This legal barrier to entry prevents "cream-skimming" entry into the

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[3]This incentive is known as the "Averch-Johnson effect."

[4]The "inverse elasticity" price rule can be shown to minimize distortions caused by prices that deviate from marginal cost according to a pattern whereby higher prices are charged to segments with inelastic demand and, conversely, to those with elastic demand. In the context of a regulated monopoly with a given revenue requirement, this rule is the approach of "Ramsey Pricing." In practice, the telecommunications industry has employed pricing structures that Roger Noll has called "political" Ramsey Pricing, whereby segments (or their representatives) with political power successfully lobbied for low prices, and higher prices were charged to segments lacking powerful representation.

high-profit segments that generate the excess revenues needed to subsidize the loss-making segments.

3.2 The Open Market Model (OMM)

3.2.1 The OMM Is Based on Dynamic Economic Efficiency

The methodology underlying OMA is not rooted in neoclassical economics or the mathematics of comparative statics. In their place, the OMA relies for insights on two elements: dynamic economic efficiency and differentiated competition.

The dynamic approach recognizes that profits are the motivating engine of the competitive process and that, without the prospect of profits, no entry, hence no competition, emerges. Models of dynamic efficiency proceed from the assumption that disequilibrium and the search for profits drive economic growth. There is a tradeoff between the static allocative efficiency of neoclassical economic theory and dynamic efficiency, which incorporates such notions as innovation, technological progress, and evolving market structure.

The neoclassical comparative statics approach treats competition as an *equilibrium outcome* that yields price *equal* to marginal cost and profits *equal* to zero. By contrast, the dynamic efficiency approach sees competition as a *dynamic process*, driving price *toward* marginal cost and profits *toward* zero. The dynamic efficiency model relies for its transforming energy on the striving by entrepreneurs for profitable opportunities. Competition is not a static state described by a set of mathematical functions but, instead, a process through which fallible entrepreneurs search for opportunity. In dynamic markets, profits are the required engine that drives the dynamic allocation of resources. According to this view, the competitive equilibrium of the neoclassical model is a sign of stagnation.

These ideas have been incorporated into a model known as "evolutionary economics," attributed mainly to Richard Nelson.[5] Firms adapt their decision rules to the disequilibria created by unexpected and ever changing circumstances, both in the short run and over the longer term. Their adaptations react to market shifts, changes in technology, and competitive pressures. The search for solutions, which is the engine of industry evolution, unleashes the forces that generate economic growth and innovation. Unlike the neoclassical model, in which the units of analysis are identical "representative firms," evolutionary economics explicitly incorporates novelty, time, learning, and the search for sustainable competitive advantage. Through this adaptive approach, the theory addresses induced innovation and changes in the structure of the industry.

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[5] Richard Nelson, "Recent Evolutionary Theorizing About Economic Change," *Journal of Economic Literature* **33** (March 1995), 48-90.

Remedies for surprises caused by dynamic change can be short-term fixes or long-term solutions. The neoclassical model provides short-term solutions but is silent on the nature of long-term institutional and structural change. A shortfall in profits might be addressed through price increases, by creating greater sales volumes through more aggressive sales efforts, market expansion, or advertising campaigns. Better control of uncollectibles and bad debt can be achieved through strengthened rigorous credit and collectibles procedures. On the cost side, expense controls can be instituted to improve margins; headcount of staff can be reduced, and the typical "scorched earth" approaches to controlling expenses can be instituted. All these, singly or in some combination, may resolve the disequilibrium and eliminate in the next period the "surprise" associated with profits that come in below expectations.

These are traditional business levers. They can be altered rapidly and are largely in the control of management. They are the control variables for addressing surprises that result from factors that normally buffet a business enterprise, such as shifts in demand over the business cycle, aggressive moves by a competitor, or increases in the prices of factor inputs. These tools represent "business as usual" and are short-term solutions to disequilibrium considered "along the rule" adaptations.

More interesting is what happens when short-term fixes are inadequate. Fixes may prove inadequate over several periods in which expectation fails to match reality or more quickly when the difference between expected and actual results is so large that adjusting the short-term variables fails to yield an adequate solution. Business as usual cannot continue. Innovation is required.

A deep examination of the large literature on innovation lies beyond the scope of this paper, but innovation can be thought of as the search for long-term solutions to disequilibrium in ways that fundamentally shift the revenue curve or the cost curve (or both) facing the firm. Solutions that discover ways to shift the revenue curve are "product innovations," while those that shift the cost curve are "process innovations."

Innovations are found broadly through research and development. The approach taken here is in the tradition of "induced innovation," because the process begins from a state of disequilibrium. "The basis for innovation is inevitably an amalgam of a new technological capability and a perceived new need."[6] The evolutionary economics approach makes innovation endogenous to economic theories of the firm. Technological change need not be viewed as a *deus ex machina*.[7]

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[6]Harold A. Linstone and Devandra Sahal, eds,. *Technological Substitution: Forecasting Techniques and Applications* (New York: Elsevier, 1976).

[7]See Hans P. Binswanger and Vernon W. Ruttan, with Uri Ben-Zion, et al., *Induced Innovation: Technology, Institutions and Devlopment* (Baltimore: Johns Hopkins University Press, 1978).

The outcome of the search for solutions to longer-term disequilibrium will be new methods of production and new products and services, which yield a market structure characterized by many firms producing differentiated products (see section **3.3.4**). This outcome is different from that predicted by neoclassical economic theory.

3.2.2 Regulatory Behavior in the OMM: Forbearance

A premise of open market architecture (OMA) is that the regulator cannot possibly predict with any certainty the outcome of the dynamic competitive process. Even the entrepreneur cannot do so. It is the nature of the competitive market process to search for unanticipated and innovative solutions. That is the engine that drives economic growth.

Some extreme libertarians have argued that, because nothing can be known and because the marketplace will eventually find a solution, the proper role of government is to do nothing; indeed, no problem in the marketplace is so vexing that government intervention will not make it worse. OMA does not take this view. Although for other industries such an approach may be justified, telecommunications is rife with market failures that require some form of intervention.

The primary regulatory tool under OMA is forbearance. Forbearance requires that the regulator allow the market maximum scope to find solutions; it recognizes that high profits are not necessarily evidence of market failure and that one size does not fit all, because not all firms or customers are alike. Forbearance avoids forcing a dynamically changing industry into the traditional utility framework. Its implementation as a policy implies a "rebuttable presumption" against intervention, allowing the market maximum scope to find solutions. Legislative directions to regulators would be framed as "Thou shalt not intervene, unless.…,"which is different from most existing legislative language, which more usually runs "The regulator *shall*...."

3.2.3 Tools of the OMM: Benefit-Cost Analysis

Under the ONM, the burden of proof is on the market to demonstrate that it is working adequately before deregulation. In practice, this standard is almost impossible to meet, because regulators look for a neoclassical outcome that can never occur in real markets. But under the approach of the OMA's "rebuttable presumption," the burden of proof is on the regulator to define market failure and to demonstrate that failure to intervene would have damaging results in excess of any damage that would result from intervention. This rule implies that the regulator would be required to perform an explicit benefit-cost analysis before intervening, much like an environmental impact statement. Its effect would be to reduce the all-too frequent interventions in response to short-term political concerns.

Two important implications of putting the burden of proof for intervention on the regulator and requiring completion of a cost-benefit analysis are stable policy and focussed intervention.

Stable Policy. Investment flows are particularly vulnerable to uncertainty (see section **4.2**). To minimize the effects of regulatory uncertainty, the regulator would need to announce ahead the conditions that would draw intervention. These conditions should describe the standards of evidence for market failures and the types of intervention that these failures would draw.

Focussed Intervention. Given a determination that a market failure warrants regulation, the intervention chosen would allow the maximum scope for continued working of market forces. For example, spectrum use has externality characteristics that, were there no controls, would give users no incentive to conserve spectrum and share it efficiently. They would instead compete with one another on signal strength, thus drowning out or interfering with the signals of others. Such overuse resembles overfishing or excessive drilling of an oil field. Intervention is required. But the regulator might ration spectrum through "command and control" mechanisms or use market-oriented mechanisms, such as secondary spectrum markets. Under OMA, the tools chosen would be the most market-oriented mechanisms available.

3.3 Predicted Market Structures, Implied Regulatory Behavior, and Regulatory Tools

3.3.1 The Open Network Model

Perfect Competition as the Ideal Outcome. The market structure under neoclassical theory consists of a stable but large number of sellers of identical products and services, with identical production technology and cost structures, selling at a single market price that no producer is large enough to influence, and earning accounting profits equal to the cost of capital, equivalent to zero economic profits. These atomistic "price takers" sell their identical products to customers that all have identical tastes and preferences. No innovation occurs inside the model. Assumptions of perfect information, perfect mobility of resources, and an absence of market failures eliminate frictions due to time and space. The model thus assumes away any need for marketing, channels of distribution, or customer segmentation, because all customers are assumed to have identical tastes and perfect information and transportation costs are assumed away.

The neoclassical economic model appears to yield predictions about the market structure that emerge from the assumptions made. But, in actuality, the model assumes the market structure that is needed to generate the kind of competitive process and results that it predicts.

3.3.2 Behavior in the ONM: The Regulator's Function Is to Protect Consumers

Although the ideal market structure is atomistic competition, the market failure of natural monopoly requires that there be only a single supplier to achieve optimal efficiency. The role of the regulator is therefore to protect consumers from monopoly abuses of overpricing, inefficiency, price discrimination, and undersupply. The tools of the open network approach (see section **3.1.3**) are intended to help accomplish these objectives.

3.3.3 Tools of the ONM: The Regulator Seeks the Lowest Price for Consumers

Regulators have discretion in pricing telecommunications services under traditional wireline monopoly structures. Although atomistic competition normally would equate price to marginal cost under neoclassical assumptions, this is not possible under natural monopoly. The requirement that the supplier also earn a “break-even” rate of return means that not all prices can be set equal to marginal cost, even if the regulator wanted to do so. Some system of cross-subsidy is needed (see section **3.1.3**), and generally the beneficiaries of these cross-subsidies are those least willing to pay.

A subtle aspect to pricing policy under the open network approach is that in neoclassical economic theory the *only* dimension of competition is price; all other differentiating factors being assumed away. There is no tool for the regulator to evaluate consumer welfare other than price. Hence, the only good price must be a low price. Nowhere is this objective clearer than in the legislation that established the telecommunications regulator in the United Kingdom—”the best deal for the consumer.”

The problem with this approach is that, once market liberalization begins to occur, regulators and consumers tend to judge its success solely by whether or not prices have fallen. And if they have not, because competition is occurring in some other dimension, liberalization is judged to have failed.

3.3.4 Differentiated Competition is the Market Outcome

Open market architecture predicts a market outcome that accounts for the effects of innovation and product differentiation on industry structure. In the theoretical framework for this approach developed by E. H Chamberlin and Joan Robinson,[8] firms do not produce identical products with identical technologies, as in the neoclassical model; instead, firms strive to differentiate themselves from one another, to create profitable niches of sustainable competitive advantage. Differentiation can come from a variety of sources, including superior marketing, service, location, or technology. The drive for profits generates the search by entrepreneurial investors for sustainable competitive advantage, which, in turn, generates differentiation and innovation, creating economic rents that reward the entrepreneur. This approach looks much more like a competitive process that would be familiar to business strategists.[9]

Sustainable competition in telecommunications results when new entrants make investments in alternative networks that embody new technology. “Most new technologies enter

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[8]E. H. Chamberlin, *The Theory of Monopolistic Competition*, 7th ed. (Cambridge, Mass: Harvard University Press, 1960); Joan Robinson, *The Economics of Imperfect Competition* (London: MacMillan and Co., 1933).

[9]Michael Porter, *Competitive Advantage* (New York: The Free Press, 1985).

the stream of economic life only as the result of an investment decision."[10] Without investment, competition will not emerge. A theory of investment is needed that describes the logic of investors and explains how public policy and regulation affect that logic (for a discussion of investment theory in the open market architecture and a contrast with the investment theory underlying the neoclassical model, see section **4.2**).

3.3.5 Behavior in the OMM: Tolerance of Segmentation

The predicted outcome of the dynamic market process looks very different from the outcome under neoclassical economics. Consistent with the Chamberlin–Robinson model, a competitive telecommunications market may resemble the breakfast cereal aisle in a supermarket. Cereal is a highly differentiated product that is also intensely competitive. Children may choose (with parental consent) sugared cereals packaged with cartoon characters; teenagers seek "high-energy" cereals with sports endorsements; adults want healthful cereals with nostalgic packaging; environmentalists look for natural ingredients sweetened with honey, and the elderly need sugarless and low-sodium bran cereals. Packaging, marketing, pricing, and content vary enormously, and the sovereign consumer gets to choose the value combination that seems most appropriate and to change that choice freely over time. This situation looks nothing like the outcome of the neoclassical model.

In terms of telecommunications, a variety of network operators and service providers offer different features and functions to various targeted segments of the market in a variety of bundled or unbundled packages at varying prices. For example, there may be offerings such as the following, though many others are possible:

- A high-quality "tethered" voice service at a low price (based on traditional twisted-pair technology);
- A low-quality video service bundled with modestly high data rates and tethered voice at a higher price (based on xDSL);
- A video-only or high-quality video bundled with high-speed data service at a bundled price, with tethered voice thrown in free (based on cable-modem technology);
- A medium-quality, untethered mobile voice service at a premium price for business customers;
- A medium-to-low-quality, untethered mobile service with flat-rate, off-peak calls targeted at residential customers (as One 2 One did in the United Kingdom);
- Free Internet access paid by advertising or by incoming interconnection charges (as Freeserve did in the U.K.); and
- Fixed wireless local loops providing cheap dial-tone to remote households.

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[10]David Mowery and Nathan Rosenberg, *Paths of Innovation: Technological Change in Twentieth-Century America* (Cambridge, Eng.: Cambridge University Press 1998), 8.

These offerings begin indeed to look more like the cereal aisle of a supermarket than the homogeneous product with price competition predicted by neoclassical theory. True, some features of telecommunications are special (see **Chapter Five**). But in the real world, outcomes that look like the cereal outcome already exist and demonstrate that, given the right policy framework, telecommunications can perform similarly.

A regulator dealing in this environment will behave differently from one in the world of homogeneous monopoly. In the ONM, the regulator is wary when companies propose differentiation and new products and services targeted at particular customer segments, especially when those segments are not the traditional categories. New segmentations by the incumbent are viewed as vehicles for price discrimination or, in a partly competitive environment, as tools for anticompetitive behavior. New operators targeting particular types of customers or serving particular geographies are often viewed as arbitrageurs and characterized pejoratively as "cream-skimmers," "cherry-pickers," or "bypassers." Their operations undermine public policy goals, because they take advantage of the opportunities created by policy distortions. A good example of this type of regulatory reaction is provided by attempts to stop "uneconomic bypass" of the public switched telephone network (PSTN) in the mid-1980s.

Under the OMM, differentiation and targeted marketing are viewed differently, as activities pursued by entrepreneurs to earn profits by serving the unmet needs of customers. Lower prices provide competition and rationalize the pricing structures of incumbents. New product offerings and new services generate innovation and technological progress. The regulator's role is to encourage such activities while intervening in a measured way where markets demonstrably fail.

3.3.6 Tools of Regulation in the OMM: Open Entry

To encourage innovation and competition, in the OMM the regulator is to stand aside, as a barrier to proliferation of potential entrants. The restrictive licensing policies of the open network model give way to a policy of open entry and hands-off, subject to narrowly defined and nondiscriminatory restrictions and obligations. This approach has been taken by the FCC with respect to the Internet. Where social obligations may be imposed as a condition of entry, such as for national security, universal service, or services for the handicapped, the terms will need to affect all players proportionately, with clear guidelines around the scope of the obligation and the determination of beneficiaries.

An implication of open entry and differentiated competition is that regulators will need to take an expansive view of market definitions. This is important in the context of judgments around competition and antitrust policy and will be addressed in detail below (section **6.2**).

Chapter Four

Investment Theory, Implied Regulatory Behavior, and Regulatory Tools

4.1 The Open Network Model Is Based on Neoclassical Investment Theory[1]

4.1.1 Net Present Value

Investment is the act of incurring an immediate cost in the expectation that it will generate returns in the future. The orthodox approach to evaluating the decision to invest involves three steps: first, estimate the expected stream of future returns and discount that back to calculate its present value; second, estimate the expected stream of costs and similarly discount that back to calculate its present value; and, third, calculate the difference between the two to find the net present value (NPV) of the project. If the NPV is greater than zero, make the investment. Net present value "ultimately boils down to one of two-decisions: go or no-go…[NPV] treats investments as if outcomes are cast in stone."[2]

Underlying this computational description is the neoclassical theory of investment. The rule is to invest until the value of an incremental unit of capital is just equal to its cost. The NPV rule is based on several implicit and often unrealistic assumptions. One is that the investment is completely reversible; should market conditions turn in unexpected ways, the expenditures can be fully recovered. Another is that the decision to invest is now or never; if the investment is not undertaken now, it will never be available again in the future.

Attempts have been made to adapt the NPV approach to account better for risk and uncertainty.[3] One method for doing so is to calculate different NPVs for different scenarios. Each scenario, however, remains fixed on a single future outcome and investment plan, with no clear way to reconcile, aggregate, or choose between scenarios.

A second approach is to employ decision tree analysis, which relies on subjective estimates of probabilities, discount rates, and preferences about the objective.

A third approach is simulation analysis, which lays out a large number of possible paths for uncertain variables but uses a subjective discount rate and does not incorporate financial market information. In the simulation model it is very hard to handle decision opportunities that arise before the final decision date.

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[1]This section draws heavily on Avinash K. Dixit and Robert S. Pindyck, *Investment Under Uncertainty* (Princeton, N.J.: Princeton University Press, 1994).

[2]S. L. Mintz, "Getting Real," *CFO* (November 1999), 53-60.

[3]Martha Amram and Nalin Kulatilaka, *Real Options: Managing Strategic Investment in an Uncertain World* (Boston: Harvard Business School Press, 1999), 39-40.

The implications of an investment model based on neoclassical NPV analysis can be summarized as follows:

- Estimates of the "risk free" cost of capital and the appropriate incremental risk premium capture the time value of money, the risk of debt default, and business risk relative to the market. Other sources of uncertainty are ignored or treated outside the model.
- Additional uncertainty is accounted for by arbitrarily increasing the risk premium. The combination of the risk-free cost of capital and the risk premium generate the "hurdle rate." Anticipated returns must exceed the hurdle rate before the project is undertaken. This has two effects:

– A higher hurdle rate requires faster cost recovery to justify the investment, which creates a bias toward projects with shorter term paybacks; and

– The higher the hurdle rate, the greater the barrier to new investment.

4.1.2 Regulatory Behavior Implied by the Theory: Rate-of-Return Regulation

As applied to most regulatory proceedings that require estimates of the cost of capital, the NPV approach focusses on two factors: the risk-free cost of capital and the appropriate risk premium to be added. Estimates of the former in the United States are generally tied to debates about the prospects for the price of thirty-year government bonds. The interest rate paid on government bonds is largely a function of macroeconomic variables, so the debates in rate cases turn on conflicting estimates of expected inflation rates, levels of government borrowing, and forecasts of economic activity.

Estimates of the risk premium to apply in the case of a particular regulated industry and company tend to be exercises in the application of the capital asset pricing model (CAPM), adjusted for actual or imputed risk as measured by leverage ratios (debt to equity) and other adjustments. Benchmarks are another way of estimating the cost of capital, by looking at the cost of capital floatation of similarly situated companies.

4.1.3 Regulatory Tools of ONA: Cost-Plus Accounting for Price-Setting

Under U.S.-style rate-of-return regulation, the cost of capital is viewed as one component of costs that determine the revenue requirement of the operator. As such, it is an element needed to establish prices for regulated services.

In establishing the cost of capital, the regulator and the operator give only passing consideration to the cost of capital in terms of its effects on investment or the adoption of innovation. Within the operations of a telephone company, investment planning by the network operation tends to be largely driven by engineering considerations, not by strategic and marketplace concerns. Only a small proportion of initiatives is separately evaluated on a project basis. The cost of capital certainly plays a role in the underlying engineering models but is treated as exogenous, given by the regulatory environment.

The regulatory process itself generally treats the cost of capital in purely financial terms. Because the cost of capital is used as part of the price-setting process, the regulator's goal is to set it as low as possible, subject to the constraint that the level yield an overall rate of return on assets sufficient to maintain the dividend yield required to satisfy stockholders.[4] Under this approach, the return to shareholders can be calculated according to the Gordon growth model as a perpetuity according to the following formula:

> $R = D/P + g$, where R = expected return to shareholders, D = annual dividend, P = share price, and g = expected growth rate

The assumptions of neoclassical theory are lurking here. The firm is in equilibrium, investment is primarily for maintenance and replacement, and innovation is, at best, marginal.

4.1.4 The Investment Incentive

The investment incentive under rate-of-return regulation is to grow the net rate base against which the allowed rate of return is applied. In the decades before full network deployment was achieved (roughly, the middle of the twentieth century), growth could be most easily accomplished by extending the network to unserved areas. But once universal telephone availability was approximated, earnings growth (g) had to be achieved by other means. Slowed depreciation, overinvestment in capital, and inflated excess capacity are some of the ways earnings growth could be achieved.

One result of the regulatory bias toward low rates of return was the incentive for regulated companies to seek greener pastures by diversifying into unregulated opportunities. Examples abound with the U.S. railroad industry perhaps providing the best documented case with its moves in the 1960s into financial services, real estate and natural resource development, based on their large land holdings. In the telephone industry, similar patterns emerged after AT&T's divestiture (1984), with the regional Bell operating companies (RBOCs) investing in financial services, real estate, and international ventures.

The lesson from these episodes of diversification is that when regulators set the cost of capital at low levels in order to generate low prices, there are two effects. First, investment and innovation in the core business is stunted, and, second, investment is driven into areas outside the regulatory jurisdiction. The result is starving investment in the core, which can lead to falling quality of service, vulnerability to innovative competitors, and eventual disaster. The history of

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[4]This description is a caricature of the regulatory process, which is rarely so rigorous and is confounded by politics, law, and personal idiosyncrasy. Nevertheless, a senior corporate finance executive once explained rate-of-return regulation to the author in a way that was explicitly based on the Gordon growth model.

the U.S. railroads offers the most chilling example, leading up to the collapse of the Penn Central railroad in 1972.

Given that the neoclassical investment model and the NPV analysis that emerges from it ignore the effects of sunk costs and uncertainty, it is not surprising that the cost accounting employed by regulators also ignores these factors. The regulatory process in the era of closed network architecture essentially foreclosed or mitigated many sources of uncertainty.

4.2 The OMM Is Based on Real Option Theory

4.2.1 Real Option Theory as a Model of the Investment Decision

Real option theory recognizes that, contrary to the assumptions of the neoclassical model, investment decisions are made in a world of uncertainty, sunk costs and irreversible investments, learning, and timing decisions. These real-world characteristics create a range of options that have value and strongly affect a decision to invest in a real asset.

Actions by regulators can have enormous effects on the value of real options and, therefore, on decisions by investors. The OMM incorporates into its policy structure tools to include these effects.

There are two kinds of real option:[5]

- *Timing Option:* Neoclassical NPV analysis indicates that the project should proceed, but, instead, investment is deferred because the option of investing later has value that is extinguished by early exercise.
- *Growth Option:* Neoclassical NPV analysis indicates that the project should be rejected, but, instead, the investment is made because of the value of follow-on investment opportunities, including the value of later abandoning a project that may have significant downside.

The degree to which an investment is reversible has a profound impact on the investment decision. The more an investment is irreversible (i.e., the more that an investment, once made, cannot be redeployed in another use), the more risky the investment is, all else being equal. Real option theory views an irreversible investment as a call option, which gives the holder the right, for some specified amount of time, to pay an exercise price and, in return, receive a real asset which has some value. This option is valuable because of the uncertainty surrounding future values of the real (as opposed to financial) asset being purchased. Hence the term “real option.” The greater the uncertainty, the greater the value of the real option. Actually making the investment exercises the option and “kills” it.

[5]Richard A. Brealey and Stewart C. Myers, *Principles of Corporate Finance* (Boston: Irwin McGraw Hill, 2000), 619-644.

The concept of "sunk costs," which is key to the validity of the real option approach, deserves further explication. To quote from Dixit and Pindyck:

> Investment expenditures are sunk costs when they are firm or industry specific. For example, most investments in marketing and advertising are firm specific and cannot be recovered. Hence they are clearly sunk costs. A steel plant, on the other hand, is industry specific-it can only be used to produce steel. One might think that because in principle the plant could be sold to another steel company, the investment expenditure is recoverable and is not a sunk cost. This is incorrect. If the industry is reasonably competitive, the value of the plant will be about the same for all firms in the industry, so there would be little to gain from selling it.…
>
> Irreversibility can also arise because of government regulations or institutional arrangements. For example, capital controls may make it impossible for foreign (or domestic) investors to sell assets and reallocate their funds…Hence most major capital investments are in large part irreversible….[6]

Under real option theory, the investment rule is that the value of the investment must exceed the purchase and investment installation cost by an amount greater than the value of maintaining the investment option. The value of the option is the difference between the NPV of the project without the option and with the option. This value can be calculated by comparing the NPV of investing today to the NPV of "wait and see." The result is that the "hurdle rate" for an investment is higher than it would be under neoclassical investment theory. One study found that actual hurdle rates in surveyed businesses range from 8 to 30 percent, with a median of 15 and a mean of 17 percent.[7] In some of Dixit and Pindyck's examples, a revised estimate of the cost of capital that accounts for the option to delay could be twice as high as that generated by the traditional NPV approach.

4.2.2 Variables Affecting Real Option Values

The calculation of the value of an option is based on the Black–Scholes option pricing model, which was designed to calculate the value of a financial option, and the variables that enter the equation are defined in those terms:[8]

- Stock price

[6]Avinash K. Dixit and Robert S. Pindyck, *Investment Under Uncertainty* (Princeton, N.J.: Princeton University Press, 1994), 8.

[7]Lawrence Summers, "Investment Incentives and the Discounting of Depreciation Allowances," in *The Effects of Taxation on Capital Accumulation*, edited by Martin Feldstein (Chicago: Chicago University Press 1987), cited in Dixit and Pindyck, 7, note.

[8]For a description of the derivation of the Black–Scholes Model, see Robert C. Merton, "Applications of Option-Pricing Theory: Twenty-Five Years Later," *American Economic Review* (June 1998), 323-349.

- Exercise price
- Risk-free rate
- Time to maturity
- Variance.

In a real option context, each variable has an equivalent term:

- Stock price = the value of the opportunity
- Exercise price = investment cost
- Risk-free rate = cost of capital, which may be the long-term cost of capital for a long-term opportunity, for example, a local telecommunications network, or the short-term cost of capital for an alternative arbitrage opportunity.
- Time to maturity = time until the option must be exercised or expires. In the context of investing in a network, this is the period in which the investment decision can be deferred. It may be tied to the existence of an arbitrage opportunity, which, once it evaporates, requires a decision either to invest in the network or to exit.

An investment opportunity is like a perpetual call option created by delaying the investment. Deciding when to invest is like deciding when to exercise the option. The value of the option is very sensitive to changes in the estimated value of the opportunity and the cost of making the investment. More subtly, the cost of capital used to value the option, all else being equal, is very sensitive to the time to maturity of the option, i.e., the point when the decision to invest must be made.

4.2.3 An Example of Real Option Analysis: Investing in a Local Network

In the context of investing in local telephone networks, a scenario can be created to evaluate the role of real options in decisionmaking. Suppose that an investor faces the following choices:

- Enter now by investing $100 million in a front-loaded, capital-intensive state-of-the-art local telecommunications network with low operating expenses that can deliver three products: information, communications and entertainment services, with three associated revenue streams. If regulators intervene next year (probability = 0.6), the network will be unbundled and required to sell its capabilities at levels that only earn its cost of capital, so the investment has zero economic value. Exit can occur at any time with a value equal to a multiple of cash flow. All estimates are subject to a variance of 20 percent.
- Alternatively, enter now by reselling the older and more limited technology of an existing network, capable of only one revenue stream. Capital costs are low and revenue-led, and will be fully depreciated in three years. Operating expenses are high. If regulators do not intervene next year (probability = 0.4), margins are negative and the DCF of the business is negative. However, the investor can exit the business by selling the customer base and equipment for a multiple of revenue, which is anticipated to be $5 million at the end of the first year. As in the alternative, the variance is 20 percent.

The example is deliberately simplified. The choices facing the investor actually are more complicated:

- Build new network now, never exit (Utility position)
- Build new network now, exit in one year (Flip it)
- Resell old network now, build new network in one year (Real option)
- Resell old network now, resell new network in one year (Real option)
- Resell old network now, exit in one year (Hit-and-run arbitrage)
- Wait one year, and then either resell or build new network (Real option)

The key source of uncertainty is the decision of the regulator. If the regulator intervenes, which it will with a probability of 0.6, the new network will become a public utility, required to unbundle and offer its network to all comers at economic cost. In this scenario, the reseller will capture all the value of the new network. If no intervention occurs, the network investor will retain that value. But the investor will not know for a year what form the policy will take.

The view "Build new network now, never exit" can be considered to be an about-to-expire call option, where the exercise price is equal to the $100 million up-front capital costs and discounted operating expense of the new network. If one year out the regulator chooses not to intervene, the present value of the forecasted cash flow exceeds $100 million, and the call option's value is the project's NPV. But if the regulator intervenes, the present value of the forecasted cash flow will be less than $100 million, and the project will have a negative NPV.

But if the decision to invest can be postponed a year, the decision is whether to exercise the call option immediately (invest now) or to wait a year. This involves a tradeoff—to forego the early revenue streams that would be earned with an immediate entry versus the avoided downside if the regulator's decision is adverse. If the anticipated revenue stream is substantial, and the capital cost is low, the decision may favor investing now. But when forecasted revenue streams are small, as they would be in a start-up with the described characteristics, investors are inclined to keep their powder dry and wait, even though the project has a positive NPV. The regulator has created a "timing option."

The calculations can be stepped through as follows:

Invest in the new network now:

Investment cost = $100M

EOY revenue = $20M

Exit value = $175M

Probability of adverse regulation = 0.6

Long-term cost of capital = 12 percent

This alternative carries a NPV of about $50 million dollars.

4.2.4 Resell the Old Network Now, Invest in the New One If Regulation Is Favorable

Investment cost = $2M

EOY revenue = $5M

Exit value = $40M

Probability of adverse regulation = 0.4

Short-term cost of capital = 9 percent

The NPV of this alternative is about $33 million. The expected value of these alternatives comes out about equal.

E(NPV) invest now = .4($50) + .6(0) = $20M

E(NPV) resell now = .6($33) + .4(0) = $19.8M

Purely on the basis of these calculations, the investor would be indifferent to either investing now in the new network or reselling the old network for a year and then making a decision. This approach ignores the value of the real option created by the uncertainty generated by the regulator. The Black-Scholes Model calculates the value of the real option as $78 million. If this value were included in the calculus, the decision would swing decisively away from investing in the new network today.

The result (admittedly artificial, but not unrealistic) in this example is that, as the regulator comes to a decision, it will observe no new network competitor in the market. The lack of an alternative operator is liable to lead the regulator to impose the unbundling and pricing policies that turn the existing operator into a utility operator with zero economic returns. The new technology that would have been put into the market does not appear, and resellers capture all the market value created in the network.

The problem is not the market but the policy that fails to recognize that regulatory uncertainty creates real options that have financial value and affect investment decisions.

Increased uncertainty increases the value of future investment opportunities by increasing the value of the real options, but they decrease the amount of actual investing that will occur. The paradoxical result is that increased uncertainty in the market or environment may cause the value of a firm to go up. (“Uncertainty” is not the same as “risk”: uncertainty arises from lack of information about future states of the world, while risk, in financial parlance, refers to variability in future returns.)

In the example, the issue of "time to build," although clearly an important component of the investment decision, was not addressed. Longer deployment times, which are typical of an extensive network investment, magnify the effects of irreversibility and uncertainty. The lower the maximum rate of investment (i.e., the more time needed to build), the higher the threshold for investment, because the project's value in the future becomes more uncertain. For example, the failed Iridium satellite project, designed for voice traffic in the 1980s but not launched until the late 1990s, should have had a very high real option value in its business plan.[9]

4.2.5 The Case of Sequential Investments

Another application of real option theory is the case of sequential investments. Such investments are represented as compound options, where a decision can be made at each stage or decision point to go on to the next phase. Research and development spending is a typical case. In each stage, the research effort yields information that reduces the uncertainty about the value of the completed project. Projects can be stopped at any time, so that, even though the *ex ante* NPV of the project may be negative, investing in the early phases of research may be worthwhile. This is a good example of the difference between the neoclassical investment model and the real option approach. Under the simple NPV rules of the neoclassical model, projects would be rejected that under the real option model should be undertaken.[10]

The Contrast with NPV and Another Example Involving Sequential Investments. A parable, based on a real situation, offers another example of the difference in investment behavior generated by the neoclassical investment model and real option theory. A large U.S. company sought to provide mobile telephone and broadband services in a developing country. Owing to recent colonial experience and despite its desperate need for infrastructure investment and technology transfer, the target country was ideologically suspicious of foreign investors. Yet the country saw an opportunity to raise money for its treasury by auctioning long-term (twenty-year) licenses. The U.S. firm was uncertain whether sufficient demand existed for its proposed service, given high poverty levels and a large underground economy. In addition, the firm's proposed network involved a new and untested architecture. Facing three sources of uncertainty—political risk, market risk, and technology risk—the U.S. business development team on the ground persuaded the government to give the firm a license for a "pilot project." Under the terms of the project, the firm could enter an attractive market region, deploy the new technology including any modifications necessary, pay no fee for the license, and interconnect at reasonable rates. The only catch was that the license expired after only five years. At that time, either party could terminate the pilot, and the investor could sell the assets at market price. From the perspective of the national government, the pilot project gave it a compound option, where a sequential decision

[9]"Flaming End for Satellites," BBC News, March 18, 2000.

[10]Kevin Roberts and Martin Weitzman, "Funding Criteria for Research, Development, and Exploration Projects," *Econometrica* **49**, 5 (September 1981), 1261-1288.

could be made after the initial license fee. The government could evaluate the performance and integrity of the firm, establish a relationship of trust, and then go forward at its option. The firm effectively gave the government a real option as the quid pro quo for the pilot license. And it received an investment opportunity with low sunk costs and high reversibility.

Back in the United States, corporate headquarters did not take into account the value created by the real options. When the corporate finance department evaluated this opportunity using a conventional NPV model, it rejected the opportunity to invest. Instead, the company opted to participate in the high-priced auctions for a twenty-year license. The rejection was based on the conclusion that, because all the costs were up front, the five-year license period was too short to generate a positive rate of return. Under conventional NPV analysis, this was the right decision. But, viewing the project as a compound option, with sequential investment, it might have been the wrong answer. No consideration was given in the analysis to whether the project might have an option value, because it might have been extended into a commercial license, or to an exit that might have been accompanied by full reimbursement of the investment at market value. Including the value of the option in the financial analysis might have led to the pursuit of the pilot project.

The lesson of the parable is that information gathering adds a shadow value to the early stages of a multistage investment. Ignoring that shadow value means that at least the first stages of some projects that should be accepted are instead rejected. Rejection of the first stage brings rejection of the whole project.

4.2.6 Summary and Implications of the Real Option Theory of Investment

The implications of an investment model based on real options can be summarized as follows:

- The value of the "call option" associated with delaying a project can be very high and becomes capitalized into the market value of the firm.
- The lower the expected stream of profits, the greater the value of delaying the project.
- The more "sunk" and irreversible an investment, the greater the value of delaying the project.
- The longer the time needed to deploy the investment, the greater the value of delaying the project.
- The more uncertainty, the greater the value of delaying the project.
- The more an investment is sequentially staged, the greater the value of the early stages, because each stage generates information and gives the firm the option of proceeding to the next phase.

4.3 Regulatory Behavior Implied by Real Option Theory: Minimize Regulatory Uncertainty

If the public policy goal is to maximize the flow of investment into new networks and technology, the policy framework suggested by real option theory is very clear. In order to minimize the policy barriers to new investment, policymakers need to create a stable regulatory environment, removing policy as much as possible as a source of uncertainty. In this context, stability does not mean that policy never changes. Rather, it implies that the conditions that will cause intervention are announced in advance, so that investors understand and can consider the policy impacts on their decisions.

In the 1999 Review of ONP by the European Commission, one of the subjects of the consultation was the extent to which regulatory intervention should be *ex ante* or *ex post*. According to real option theory, the answer could be to announce *ex ante* those areas that would to be regulated on a continuous basis because of enduring market failure. Similarly, *ex post* intervention would occur when specific behavior warranted it, but the standard and tools for that intervention would be different. In practice, the distinction would separate industry-specific regulatory intervention from more general intervention under competition law. Clarifying this jurisdictional separation would, in itself, reduce uncertainty in the market.

4.3.1 Regulatory Tools Implied by Real Option Theory: Stable, Focussed Intervention

Consistent with the behavior described in the previous section, a stable framework for regulatory intervention could operate as follows. Regulators, after appropriate consultation, would identify areas of market failure in telecommunications. This process is liable to be contentious, as different segments of the industry hold different views. The following are candidates for a finding of industry-specific market failure:

- Network effects and externalities,
- Spectrum interference and public goods,
- Numbering resources,
- Public rights of way,
- Dominance, and
- Natural monopoly.

At one time or another, some or all of these have been alleged as relevant to telecommunications. The interesting policy issue is to understand the nature of these failures and to what extent they are relevant today and to find means to address them that minimize the distortions on investment decisions and market outcomes. Approaches to these issues consistent with open market policy are addressed in the next chapter.

Chapter Five

Market Failure, Implied Regulatory Behavior, and Regulatory Tools

5.1 The ONM Is Focused on Natural Monopoly

5.1.1 Natural Monopoly

A focus on natural monopoly is the core market failure that justifies open network architecture policies. Unlike closed network architecture, ONA does not treat the entire telecommunications market as a natural monopoly. Instead, it separates out specific areas viewed as having natural monopoly characteristics and subjects them to regulation based on traditional neoclassical theory.

At the time of the breakup of the Bell System, the underlying theory of divestiture was that there should be a separation between the naturally competitive elements and the natural monopoly elements. This view led Peter Huber to the ironic observation that

> Low-volume, local exchange service is a natural monopoly; high-volume, long distance service is not. In 1982, the Bell System was broken into eight pieces on the strength of that assumption. But it is now clear that the assumption was wrong. In fact it was worse than wrong; the architects of the Bell divestiture got it backwards. If there is going to be a monopoly, it will be in the long distance market. The local exchange should be—and soon will be—competitive.[1]

Whether or not one agrees with this view, the approach of the Modified Final Judgment which governed the settlement of the antitrust suit by the U.S. Department of Justice accepted the premise of local natural monopoly. The litigators did not invent this premise. The Consent Decree simply incorporated the view that had been the basis of FCC policies since 1978, when the Commission issued its decision in the Second Computer Inquiry (Computer II). This approach and the largely unquestioned assumptions of that FCC decision continue to drive a great deal of policymaking at the start of the twenty-first century. For that reason, it is worth reviewing the history of the FCC's policies and its decision in Computer Inquiry II.

5.1.2 Natural Monopoly, Computer II, ONA, and Divestiture

Motivated by the obvious convergence between unregulated data processing and regulated telecommunications, the FCC in 1977 proposed a distinction among three categories of service: voice, basic nonvoice, and enhanced nonvoice. In its Final Report in 1980, the FCC determined,

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[1]Peter W. Huber, Michael K. Kellogg, and John Thorne, *The Geodesic Network II: 1993 Report on Competition in the Telephone Industry* (Washington, D.C.: The Geodesic Co., 1992), 1-1.

among other things, that basic services would continue to be regulated.[2] This decision moved U.S. telecommunications regulation from the closed network architecture monopoly phase to one of open network architecture.

In its Second Computer Inquiry Order, the FCC determined that customer premises equipment (CPE) and "enhanced" services were sufficiently competitive that they could be deregulated. "Basic" services, however, would continue to be regulated, as before. The FCC ordered the predivestiture RBOCs to develop cost-based tariffs that separated the basic elements of their networks from the enhanced elements. The language justifying separation depended on whether it came from a lawyer or an economist. If from the former, the justification lay in the view that the local exchange was a "bottleneck facility"; if from the latter, that it was a natural monopoly. This basic service monopoly mindset became the basis of the settlement of the antitrust suit against AT&T.

> [Assistant Attorney General] Baxter believed that for genuine competition in telecommunications to exist, legislative or judicial action was needed to prohibit AT&T from using its 'bottleneck' regulated local exchange monopolies, especially with respect to long distance services, telecommunications equipment, and related information markets.... Baxter's…ideal solution was to separate—"quarantine"—the competitive and potentially competitive from the monopoly portion of AT&T, and then to require the divested local exchange companies to provide all long-distance carriers equal access and service to their bottleneck local facilities.[3]

The economist's view was similar to the lawyer's, but the language did not reflect simply the legal concept of "bottleneck" but also the economics of natural monopoly.

> [One] *would identify the facilities of a local exchange carrier that currently exhibit 'natural monopoly' cost characteristics. In modern U.S. telecommunications, local loop facilities seem to possess these characteristics, especially given the scale economies that apparently obtain with the increasing use of fiber optics in the loop. In contrast, local switching and ancillary central office equipment seemingly do not feature such cost traits. Separate access companies could be created to handle the loop portion of the network.*
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> *Under this scenario, regulation would be confined to the distribution, transport and access interface services provided by these access entities.*

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[2]Second Computer Inquiry, *Final Decision*, 77 FCC 2d 384, *modified on reconsideration,* 84 FCC 2d 50 (1980), *further modified on reconsideration,* 88 FCC 2d 512 (1981), *off'd sub nom. Computer and Communications Indus. Ass'n v.FCC,*693 F.2d 198 (D.C. Cir 1982), *cert. denied,* 461 U.S. 938 (1983), *aff'd on second further reconsideration,* FCC No. 84-190 (released May 1984).

[3]Barry G. Cole, ed., *After the Breakup: Assessing the New Post–AT&T Divestiture Era* (New York: Columbia University Press, 1991), 6-7.

> *Providers of other services interconnecting with the loop would be totally deregulated since they lack control of bottleneck facilities and, hence, wield little market power*.[4] [Italics in original.]

Another view that elements of the local exchange business reflect natural monopoly comes from Baumol and Sidak:

> In some of these areas [of local telephone services]—the natural monopoly arenas of local telecommunications—entry probably will not occur even under the best of circumstances, or if it does take place, it will not last... In the areas of natural monopoly the rules are designed to approximate the results that characterize a competitive market, and therefore it can be hoped that they will serve the public interest nearly as well as a competitive market can.[5]

In summary, the view of the local loop as a natural monopoly drove and continues to drive policies of open network architecture.

The definition of natural monopoly (in the single-product context) is a situation in which long-run average costs are continuously declining; in other words, where economies of scale are persistent. The greater the volume produced, the lower the cost per unit. These ever-falling costs imply that when only one firm produces all the output needed to satisfy the market the situation is most efficient, because that firm can then achieve the lowest unit cost. By contrast, if there were two firms, each serving only half the market, neither would achieve the full benefits of scale economies available to a single operator. As a result, with competition, resources would not be used to their maximum efficiency, while with monopoly they would.

In telecommunications, assertions of natural monopoly rest on the existence of large "fixed" costs associated with building local-loop networks. For both pricing and costing, the telephone industry defines its unit of output as "minutes of use" of traffic carried on the network. Given that the cost of circuit-switched local-loop networks does not vary much with traffic levels, and given that this cost is very high, dividing it by ever increasing levels of traffic generates an ever declining average cost curve, which characterizes a natural monopoly. So the finding of natural monopoly in telecommunications is a mathematical consequence of the large proportion of nontraffic-sensitive costs.

Cable TV systems, which build similar local networks, have not traditionally been characterized as natural monopolies. One possible explanation is that, unlike telephone

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[4]Walter G. Bolter, James McConnaughey, and Fred J. Kelsey, *Telecommunications Policy for the 1990s and Beyond* (Armonk, N.Y.: M. E. Sharpe, Inc., 1990), 384 (footnotes omitted; emphasis in original).

[5]William J. Baumol and J. Gregory Sidak, *Toward Competition in Local Telephony* (Cambridge, Mass.: Massachusetts Institute of Technology [MIT] Press and the American Enterprise Institute [AEI] for Public Policy Research, 1994), 6. **OR** Baumol and Sidak, *Toward Competition in Local Telephony*, 6.

companies which bill on throughput, cable TV systems traditionally define their unit of output as a “customer subscriber” and bill on the basis of monthly subscription fees.[6] Defining its product as “connections,” a cable TV system has almost no joint and common network costs to be allocated. Consequently, when the cost of a cable TV system is divided by an increasing number of customers, the economies of scale are not nearly so dramatic as in telephone networks, because the average cost per customer becomes pretty flat once the common trunking costs are amortized.

It would be ironic if the belief in natural monopoly, which has driven so much public policy ferment and economic analysis, were found at its heart to be an artifact of what the industry decided to put on the x-axis of its cost graphs. It would also be ironic if even the existence of the massive “joint and common costs” allocated under the fully distributed cost system (see section **6.2.1** turned out to be an artifact of the same decision.

The statement from Huber, Kellogg, and Thorne that long-distance is more likely to be a natural monopoly than local service points to another source of economies of scale—trunking efficiency. On the basis of queuing theory, traffic engineers can predict the number of trunks needed to carry a given volume of traffic at a given grade of service (blocking probability). Doubling the amount of traffic less than doubles the required number of trunks, and this relationship is the basis of considerable scale economies in long-distance networks. In the local loop, however, this concentration has not yet taken place or is minimal. The effect of concentration therefore is not an explanation that supports local-loop natural monopoly.

5.2 Regulatory Behavior Under the Open Network Model: Profits Are Bad

The ONA was characterized as “competition around the edges” (see section **2.2**), and similar regulatory tools to those used in closed network architecture are brought to bear on the segments of the industry that remain under monopoly. There is a strong link between the ONA approach and the FCC’s views on interconnection. Because interconnection policy, in turn, has enormous impact on network investment decisions, the Computer Inquiry decision needs to be revisited (see section **5.1.2**), this time from the perspective of interconnection.

5.2.1 The Transition from Closed to Open Network Architecture

Although the term “open network architecture” was not coined until the late 1970s, the beginnings of the new policy framework may be traced back to decisions in the United States in the mid-1950s that initially opened the communications equipment market to competition. In its tariffs, AT&T had a standard codicil prohibiting what it called “foreign attachments,” i.e., any equipment not provided by the Bell System. The initial rationale for its prohibitions was to prevent damage to the network by preventing interconnection with equipment that did not meet

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[6]This view is changing as “pay-per-view“ becomes more established, but subscription is still the most common cable billing practice for the bulk of its programming.

the technical standards required for integration into the "one system, universal and end-to-end" which Theodore Vail had designed. An economic rationale was added in the 1950s, based on the argument that revenue from equipment rentals subsidized universal service, especially for residential subscribers.

On the basis of language from the Court of Appeals Hush-a-Phone decision, the FCC in 1968 determined in the Carterfone decision that the Carterfone was an attachment that provided "private benefits without public detriment," and the FCC voided all AT&T tariff restrictions that did not meet that test.[7]

In 1972, the FCC adopted a registration program for CPE. The goal was to provide type approval for all equipment that complied with general safety standards set so as to prevent damage to the network and to prevent radio interference. Any equipment that met these standards under testing could be attached to the network with no requirement of interface devices. Equipment was soon developed using the RJ 11 standard jack, which allowed any provider of telecommunications equipment to "plug and play." The result was explosive growth and vigorous competition, as well as an outpouring of technical innovation and dramatic declines in prices.

This success was what the FCC had in mind when it embarked on the First and Second Computer Inquiries. It sought to apply to enhanced services providers (ESPs) the "plug and play" aspects of its successful policies to open the CPE market.

ESPs, which emerged in the late 1950s and 1960s as a result of the growing use of computers, provided data networks to serve the needs of banks and data processing firms. Before ONA, the Bell System's local telephone monopoly treated ESPs like any other business customer, refusing to allow direct connections to its network. ESPs could only buy finished business services out of the Bell tariff, paying standard business rates. Local Bell System companies permitted the connection only of devices provided by AT&T under tariff. Features and functions from different tariffs could not be recombined to meet the more sophisticated needs of data networks. In most cases, the standard Bell services were designed to meet the needs of voice users, not data networks. To meet the unserved needs of the ESPs, the FCC imposed ONA obligations on the local monopoly carriers and obliged them to provide "building blocks" of services that could be unbundled and priced separately.

In early 1988, the Baby Bells and AT&T filed ONA plans with the FCC that created a variety of highly unbundled "basic service elements" (BSEs) and less unbundled "basic serving arrangements" (BSAs). There were typically five BSAs: three types of circuit-switched access, packet-switched access, and private-line access. There were as many as ninety-one BSEs. Co-

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[7] *Hush-a-Phone Corporation et al. v. United States of America and Federal Communications Commission, et al.,* F.2d 266,268 (1956); FCC, *In the Matter of Use of the Carterfone Device in Message Toll Service,* Decision, 13 FCC 2d 420, 427 (1968).

location, the ability of an ESP to put its server and equipment physically in the telephone company's central office, also became an important component of ONA.

Two premises underlay the FCC's ONA policy. The first was an assumption that local telephone service was economically a natural monopoly and legally an essential facility. This assumption implied that there could be no option for ESPs to reach their customers except through the "bottleneck" facility controlled by the local telephone company. Legal barriers to entry at the state level made it impossible for local competition to develop and thereby test the FCC's assumptions. The local loop was a scarce resource, and ONA was a policy tool to provide fair and cost-based access to it.

5.2.2 ONA Becomes Interconnection Policy

The second premise of ONA, which was revealed in the FCC's use of the term "comparably efficient *interconnect*" in its Computer II Order,[8] was that the FCC viewed the connections to be provided by local operators to ESPs as similar to those being provided to long-distance operators; i.e., as "interconnection." "Public policymakers at the FCC envision ONA as an 'equal access' approach to promoting competition…."[9] But the Commission was not very consistent in this view, exempting ESPs from paying certain charges and eventually affirming that ESPs were customers, not carriers.

The view of "comparably efficient interconnection"(CEI) as "interconnection" made it easy and natural for ONA to metastasize from a service for ESPs into a policy applicable to all network operators. This policy culminated in the FCC's 1996 Local Competition Order,[10] in which the view that ONA had to be an integral part of interconnection policy owing to the natural monopoly characteristics of the local loop was made clear in Sections 231 and 232.

> 231. In the [notice], [the FCC] noted Congress's view that, when new entrants begin providing services in local telephone markets, it is unlikely they will own network facilities that completely duplicate those of incumbent LECs because of the significant investment and time required to build such facilities. The statutory requirement imposed on incumbent LECs to provide access to unbundled network elements will permit new entrants to offer competing local services by *purchasing from incumbents,*

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[8]Second Computer Inquiry, *Final Decision*, 77 FCC 2d 384, *modified on reconsideration,* 84 FCC 2d 50 (1980), *further modified on reconsideration,* 88 FCC 2d 512 (1981), *off'd sub nom. Computer and Communications Indus. Ass'n v.FCC,*693 F.2d 198 (D.C. Cir 1982), *cert. denied,* 461 U.S. 938 (1983), *aff'd on second further reconsideration,* FCC No. 84-190 (released May 1984).

[9]Walter Bolter, James McConnaughey, and Fred J. Kelsey, *Telecommunications Policy For the 1990s and Beyond.* (New York: M.E. Sharpe, Inc. 1990), 372-373.

[10]Implementation of the Local Competition Provisions of the Telecommunications Act of 1996, CC Docket No. 96-98, First Report and Order, 11 FCC Rcd 15499 (1996).

> *at cost-based prices, access to elements* which they do not already possess, unbundled from those elements that they do not need.
>
> 232. It is possible that there will be sufficient demand in some local telephone markets to support the construction of competing local exchange facilities that duplicate most or even all of the elements of an incumbent LEC's network. In these markets new entrants will be able to use unbundled elements from the incumbent LEC to provide services until such time as they complete the construction of their own networks, and thus, no longer need to rely on the facilities of an incumbent to provide local exchange and exchange access services. It is also possible, however, that *other local markets, now and even into the future, may not efficiently support duplication of all, or even some, of an incumbent LEC's facilities.* Access to unbundled elements in these markets will promote efficient competition for local exchange services because, under the scheme set out in the 1996 Act, such access will allow new entrants to enter local markets by leasing the incumbent LECs' facilities at prices that reflect *the incumbents' economies of scale and scope*.[11] [Emphasis added.]

In these sections, the FCC revealed its skepticism at whether new entrants would build extensive competing local facilities because of the advantages enjoyed by the incumbent in terms of economies of scale and scope-in other words, their natural monopoly position.

Holding the view that the local network is at least presumptively a natural monopoly and therefore could be treated as an essential facility, the FCC, in paragraph 287, first approvingly reiterated the natural monopoly view attributed to Congress and, then, concluded that all elements of that local network were equally essential. This conclusion meant that the incumbent local exchange carrier (ILEC) has an obligation to provide all the elements, even where a particular one might be self-provided or available from another source on a competitive basis. Self-provisioning would be slow, costly, and inefficient.

> "287. …Congress made it possible for competitors to enter local markets through the purchase of unbundled elements because it recognized that *duplication of an incumbent's network could delay entry, and could be inefficient and unnecessary*....[12] [Emphasis added].

It was therefore a simple step for the FCC to apply the neoclassical comparative static model once again to arrive at its pricing policy:

> "672. …[W]e conclude here that prices for interconnection and unbundled elements…should be set at forward-looking long-run economic cost. In

[11] Ibid.; footnotes deleted.

[12] Ibid. 132.

> practice, this will mean that prices are based on the TSLRIC [total service long run incremental cost] of the network element, which we will call Total Element Long Run Incremental Cost (TELRIC), and will include a reasonable allocation of forward-looking joint and common costs.…We believe that the prices that potential entrants pay for these elements should reflect forward-looking economic costs….”[13]

The combined effect is that the FCC accepted the principle that local networks are natural monopolies and extended the “building block” notion of ONA into interconnection. The FCC then put the final piece of its policy into place by ordering, in paragraph 672, that each element must be priced on the basis of forward-looking LRIC.

With this framework, the comparative static neoclassical economic model was fully applied. The FCC concluded that a well-behaved efficient competitive market would price the elements of a local network at LRIC and so set the regulated price at that level. This action preempted the process by which real markets, even when they resemble well-behaved neoclassical markets, actually arrive at that result.

5.3 Regulatory Behavior Under the ONM Outside the United States

The European Commission established a policy similar to the FCC’s telecommunications policy; known as Open Network Provisioning.[14] Because of the legal structure of the European Union, most of the European Commission’s policies must be implemented by member states. Only since 1 January 1998 have member countries been obliged to open basic telephone service to full facilities-based competition. Despite the national scope for variation and the recent implementation of the policy framework, results like those in the United States are visible.

Once Germany decided to liberalize, the government was particularly aggressive in adopting open network policies. The result has been a dramatic drying-up of local infrastructure investment in favor of reselling the unbundled local loops of Deutsche Telekom. In the summer of 1998, OPTA, the regulator in The Netherlands, also began a consultation to force its incumbent carrier, KPN, to begin selling unbundled special-access facilities at prices based on LRIC. Loud protests came from the incumbent, as might have been expected, and also from operators that had begun to provide alternative local infrastructure, cable operators A2000 and UPC. Even the United Kingdom, which had adopted proinvestment policies in the early 1990s as it deregulated the telecommunications sector, is being forced through EU rules to reverse its demonstrably successful policies and adopt elements of the ONA framework.

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[13] Ibid.

[14] ONP covers a wider scope than ONA but incorporates its basic elements.

In addition to the appearance of open network policies in other nations, the approach is spreading to other sectors. In December of 1998, Oftel, the regulator in the United Kingdom, issued a consultation document and subsequent determination that British Telecom should be required to provide unbundled local xDSLs so that alternative operators can provide video and data services over them.[15] Debates heated over whether cable TV operators should be required to open their broadband networks to the services of other ISPs. Proceedings are also under way in various countries on whether mobile network operators should be required to provide cost-based national roaming to new mobile operators. In these debates all proponents of openness implicitly or explicitly rely for their justification on the logic and underlying assumptions of ONA policies.

5.3.1 The OMM Considers Enduring Market Failures Other Than Natural Monopoly

The existing telecommunications infrastructure worldwide is based on widespread deployment of copper wire to connect user premises to a hierarchy of switching centers and traffic concentration points. The architecture of this network is based on cost economics that prevailed until about 1980.

Beginning about then, and driven by dramatic improvements in microchip and transmission technology, the costs of transmission, switching, and memory storage began to drop exponentially. Over the fifteen years from 1980 to 1995, transmission costs fell by about 3 orders of magnitude. Switching costs also dropped dramatically.[16] Even though these changes are here described as trends, some of the underlying breakthroughs may be better described as discontinuities. For example, IP-centric networks and switching and dense wavelength division multiplexing techniques are such dramatic improvements that they might be better thought of as a step function. The impact of these changes is profound and is still playing out while the changes continue and accelerate.

The implications are enormous:

- The overall unit-cost level of telecommunications network components has dropped precipitously, shifting downward the industry average cost curve.
- Compared to networks built into the early 1980s, new networks use much more transmission than switching. Because transmission costs are largely traffic-sensitive, using more transport and less switching means that fixed costs are less significant and that variable (i.e., traffic-sensitive) costs are more significant than in earlier network designs. This tendency is even more pronounced in wireless networks.

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[15] Oftel Consultation Document, “Access to Bandwidth: Bringing Higher Bandwidth Services to the Consumer,“ December 1998, [On-line]. URL: http://www.oftel.gov.uk/ (Accessed October 2000.)

[16] P. E. White, “The Changing Role of Switching Systems in the Telecommunications Network,“ *IEEE Communications* (January 1993), 12-13.

- The relative reduction in fixed costs reduces the previously enormous importance of scale economies, generated by spreading high fixed costs over large volumes of traffic. Scale economies are the basis for natural monopoly, defined as the presence of continuously declining average costs over the entire extent of the market.

- Falling cost levels and reduced economies of scale mean that network competition is now economically viable. Earlier arguments against competition based on the efficiency of natural monopoly are no longer valid. Indeed, competitive supply of telecommunications services is now the presumptive standard worldwide.[17] The dominant position of incumbent operators is no longer a result of a permanent market failure rooted in the underlying economics of telephone networks but is, instead, a legacy of that condition.

Competition did not enter all segments of the industry uniformly. Long-distance trunks are the most transport-intensive portions of traditional networks. High retail prices under monopoly combined with rapidly falling costs meant that long-distance services presented the greatest profit opportunities for new competitors. Not surprisingly therefore, this was the first segment that attracted competition. Local services, characterized by low prices and legal barriers to entry, lagged significantly behind long-distance but, as of the year 2000, have begun to catch up. On the wireline side, digitization, the technologies of compression, packetization, and improved multiplexing are making cable TV networks capable of offering local two-way services. On the wireless side, agile switching and greatly improved multiplexing have made cellular technology and spectrum reuse possible and hugely increased the capacity of mobile systems.

The policy implications of these technological and economic changes are profound:

- Despite early attempts, regulators could not prevent the emergence of competition for telecommunications services from a hitherto unexpected source—users. The falling costs of self-provisioning meant that customers could effectively build private networks, and substitute their own switching gear in the form of public branch exchanges (PBXs) for the telephone company switch.

- The architecture and most of the equipment of incumbent telephone companies was installed under the high relative cost conditions associated with older technology; in contrast, new entrants are operating with technology that is lower in cost and embodies greater capabilities. Hampered by their embedded base and underdepreciated investments, incumbents faced great barriers in getting their costs down to a level competitive with new entrants. In the United States, attempts to accelerate depreciation have faced regulatory resistance, because they tended to increase current prices. But even when incumbents successfully lower costs and write down their earlier investments, entrants can succeed, because the capabilities offered by the new technologies are superior in functionality and cost.

- The best defense for incumbents has therefore been a combination of initiatives that delayed the incursion of competition and increased competitors' costs. The tactics were

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[17] General Agreement on Tariffs and Trade (GATT), Annex 1B: General Agreement on Trade in Services, 1998, [On-line]. URL: http://www.wto.org/ (Accessed October 2000).

high prices for interconnection and universal service funding along with low prices to end-users. This strategy played out in the arena of public policy and regulation.

- To the extent that public policy cooperates with incumbents, the business case for alternative suppliers is affected and the direction and level of investment are altered.

5.4 Other Market Failures Addressed by the OMM

The open market model is based on the presumption that there is no natural monopoly in local telecommunications. Consequently, rather than seeking to impose efficiency on a monopoly, its policy mission is to establish the conditions that will encourage the investment necessary to transform the monopoly structure into a competitive one.

The elements of OMM policy involve open licensing, rate rebalancing, and a focus on abuse of dominance, especially as dominance affects interconnection.

At the same time, the open market approach recognizes that other market failures than natural monopoly exist in telecommunications. It seeks to address these in ways that minimize interference with the flow of investment.

On the basis of the view that the effects of technology have largely eliminated natural monopoly in telecommunications, open market architecture develops its framework for intervention by examining whether and to what extent other market failures are present. Four enduring market failures are identified: any-to-any connectivity, spectrum interference, numbering and addressing, and access to rights of way. One transitional but critical market failure is identified: dominance.

5.4.1 Any-to-Any Connectivity and Interconnection in the OMM

For a network to be valuable, people must be able to communicate, regardless of the network on which a call is originated or terminated or of the technology employed. Under monopoly, everyone is on the same network, but once many network operators appear in the marketplace, any-to-any communications requires networks to interconnect. New entrants understand this need immediately. Without interconnection such that their customers can call and be called by customers of other networks, entrants have no viable commercial proposition to offer the market.

The term “any-to-any” incorporates the economic notion of the “externality” market failure. An externality, or spillover effect, is a form of market failure in which an economic decision-maker fails to account for the costs or benefits that a decision creates for others.

Externalities may be negative or positive. Pollution is a typical example of a negative externality. In telecommunications, however, the positive externality is most relevant. A network is more valuable the more people are connected to it. Adding a subscriber increases the number of potential communications paths for the subscribers that came before. The externality arises, because a new subscriber ignores the benefits to preexisting subscribers and therefore too few will subscribe unless there is a subsidy. Existing subscribers that will benefit by increased usage potentially subsidize new subscribers. This is the economic basis for the argument that usage should subsidize access, which has been used to justify the typical pricing structure of a monopoly telephone company as well as policies to encourage universal service.

Interconnection policy is what most clearly distinguishes the OMM from the ONM. In the open networks view the local loop is regarded as a natural monopoly and essential facility, and all its policy features are based on that premise. By contrast, in the open markets view the focus is not on the physical loop but on the services provided over it. From that perspective, two services are offered: call origination and call termination.

Call origination is the ability to initiate a communication over the facilities of a local network operator that provides the connection between the end-user and the PSTN. In return, the user pays some retail or wholesale price to the network operator. The user may be a retail customer, in the sense that the call-origination service is sold directly. Alternatively, call origination may be purchased by a wholesale user, that either resells it or bundles it as an intermediate input into other services then sold to end-users. In either case, the relationship between the purchaser of call origination and the network operator is one between a supplier and a customer. Call origination is a customer-facing service.

As a customer-facing service, call origination is offered in a potentially competitive market. Provided that investments in alternative networks take place, a number of providers can offer call origination services, and the market may eventually look like the cereals aisle in a U.S. supermarket (see section **3.3.5**). This is the goal of the OMM.

Call termination is a service provided by local network operator to another network operator, not to an end-user customer. It involves acceptance by the terminating network of a transmission from another network, the carrying of the transmission over its facilities to the recipient user's terminal equipment, the signalling of the equipment that a call is coming, and the completion of the path needed for two-way real-time communication to take place between the originating and terminating users. Unlike call origination, in which the relationship is between a network operator and an end-user, call termination is a relationship between two network operators. If the terminating operator refuses to provide the call-termination service, no communication between subscribers is possible. This refusal violates the public policy requirement that any-to-any communications be maintained, even in a world of competitive network operators.

Call termination requires regulatory oversight, not because it is a natural monopoly but because it provides an opportunity for abuse of dominance and entrenchment of dominance in the market for call origination.

At mid-2000, absolute refusal to interconnect is, in liberalized countries, rarely the issue it once was, though it remains a problem in nations that are earlier in the liberalization process. Today's debate in liberalized markets is primarily about price. The OMM's pricing policy flows from the view that there is a public interest both in preserving any-to-any calling and in encouraging efficient investment. These twin objectives imply that the price for call termination should be the lowest efficient price that fairly compensates operators for the cost incurred in completing one another's calls while giving proper investment signals. That price is based on forward-looking LRICs, including relevant overhead and a rate of return on the capital employed.

Call termination consists of a relatively small set of functions. In its simplest form, call termination uses only end-office switching and associated signaling systems, maintenance and relevant overheads. It may also include a single or a double tandem switch and associated trunking. The relevant costs to be included should be only those additional, forward-looking costs that would be borne by the wireline incumbent for completing calls to its customers from the customers of other carriers. Costing should be based on an understanding of the fundamental cost drivers of the network functions involved, such as busy-hour Erlangs[18] and call attempts.

Only the incumbent operator would benefit by denying or overpricing calls from other networks because of its dominant position in the call origination market. This can be see in the following thought experiment. An incumbent with 98 percent of the customers in a market of 1000 customers would have 980 customers, while a competitor would have only 20 customers. If the incumbent refuses to terminate incoming calls, only 20, or 2 percent, of its customers would be inconvenienced, while 100 percent of the customers of the entrant would be inconvenienced. Customers on the entrant's network can call only one another. That is not a commercial proposition in most cases, so refusal to terminate would cause the competitor to fail.

On the other hand, if each operator had 50 percent of the market, each would have an incentive to complete calls for the other. So only the dominance in the access market makes it necessary to regulate call termination charges (see section **5.4.6**, on dominance).

5.4.2 Spectrum Markets and the OMM

Introduction of a secondary spectrum market would further the goal of encouraging investment and competition that underpins the open market model.

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[18] An Erlang is "A dimensionless unit of traffic intensity used to express the average number of calls under way or the average number of devices in use. One Erlang corresponds to the continuous occupancy of one traffic path. Traffic in Erlangs is the sum of the holding times of paths divided by the period of measurement. The term Erlang can be used to express the capacity of a system; for example, a trunk group of 30 trunks, which in a theoretical peak sense might carry 30 Erlangs of traffic, would be a typical capacity of perhaps 25 Erlangs averaged over an hour." From the Glossary in *Engineering and Operations in the Bell System*, Prepared by Members of the Technical Staff and the Technical Publications Department, Bell Telephone Laboratories (Indianapolis, Ind.: Western Electric, Bell Telephone Laboratories, Inc., 1977, Select Code No. 500-478; 7th printing, 1982), 653.

- Making spectrum available on the open market to any operator willing to pay the going rate and to meet interference standards removes spectrum as a barrier to entry.
- The "spectrum is scarce" argument for applying open network polices on wireless operators would be eliminated. Such structural intervention policies as mandatory national roaming at cost, mobile number portability, and other aspects of the wireline model applied to the mobile sector would become unnecessary, because spectrum would no longer be a "bottleneck" resource.
- By allowing holders of spectrum to provide any service they wish, competition would be accelerated for existing operators and new services would be encouraged.
- By creating an opportunity cost for holders of spectrum, introduction of a secondary spectrum market would encourage development of technologies that are more spectrum-efficient.
- Removing regulators from the process of spectrum allocation and assignment and focussing them on the issue of spectrum interference would remove insert: both the government monopoly of spectrum and the political aspects of its allocation.

Taken together, the result would be to improve the business case for investment in spectrum-using technologies and to provide greater encouragement for innovations that conserve spectrum.

5.4.3 Numbering and Directory Services

The telephone numbering system is an asset that is integral to the ability of any subscriber to complete calls and a key element of a policy based on "any-to-any." Without knowledge of the right telephone number "address," the network is valueless to the user, because it cannot properly route calls. Because completeness and accuracy are required features of numbering systems, they can provide a lever for abuse of dominance if kept proprietary to one competitor. Each network operator must be able to identify subscribers on other networks and route calls to them efficiently. A single integrated system is most conducive to maintaining completeness and accuracy of the database. Therefore, under open market policies, numbering systems need to be supported, shared, and maintained by all network service providers, under supervision by an independent entity. Numbering systems are critical to provision of a seamless network for users.

Another key data source that is integral to the ability of users to initiate and complete calls is the directory database. Users must be able to find the telephone numbers of their correspondents easily so that they can place calls to them. This database is used both for the provision of directory inquiry services and for preparation of the directory. It should include the telephone numbers of all customers, including those who have chosen to subscribe to a service provider other than the incumbent. All service providers need to be required to support maintenance of this database.

Both the numbering system and the directory database need to be viewed as infrastructure available equitably to all service providers. They should be managed and funded as a public asset, under government supervision.

The ability of all providers to gain access to the raw identifying information for placing and routing calls does not mean that operators need to be forced to provide access to value-added functions based on the directory system. The public interest is not served by allowing “free riders” to benefit from the investments made by one operator to offer differentiated services to its customers. A clear policy distinction needs to be made between the core information needed to operate a network and place a call and the enhanced services that use this core information to provide other services.

The public policy goals appear quite straightforward. The policy is intended to allow entrants an equal chance to acquire customers by maximizing their ability to offer service that is convenient and familiar to use. The policy minimizes customers’ inconvenience and disruption while maximizing their service options. It embodies the flexibility to allow all suppliers to offer innovative, differentiable services in response to market needs.

5.4.4 Number Portability

As new local infrastructure operators begin to offer facilities-based choices for dial tone, the importance of number portability increases. Its importance is further raised as number resources begin to reach limits. A typical business card is running out of space for all the addresses, physical and electronic, it must carry.

Telephone subscribers, especially business subscribers, have an investment in their telephone number. It is the means by which their customers reach them. If a business must change its phone number or add a second number in order to subscribe to a competitor, that would be a powerful impediment to change. The importance of this impediment is demonstrated by evidence from the United Kingdom. Telewest, which provides integrated cable TV and telephone services, conducted market research on the importance of various service features in its decision to purchase telephone service. Of the respondents, 14 percent cited “Not Having to Change Phone Number” as “Very Important.”

Even if the competitor’s service is taken, it is often in the form of a second line. This line will be used for outgoing calls, to take advantage of the lower rates offered by the competitor. But the traditional provider’s line will remain for incoming calls, because that is the number known to correspondents.

The resulting imbalance of incoming and outgoing traffic between an entrant’s network and the incumbent’s network can have major implications for the payment flow for interconnecting traffic. The entrant’s lines will be used for outgoing calls, the incumbent’s for incoming calls.

Imbalanced traffic creates financial pressure on the system, especially if the price for call termination is set too high.

The recent phenomenon of entrants creating hosting sites for ISPs provides an example. Because ISPs are typically new companies with no history, they have no need to change numbers as they enter the market. Because they generate a large volume of incoming calls with very long holding times, the disadvantage faced by entrants in the voice communications world is reversed in the data communications world. The traffic balance shifts in favor of the entrant. Incumbents, unaccustomed to writing large checks for interconnection services, are noticeably chagrined by this development and have challenged the arrangements, but they have generally been defeated in these attempts. In the United Kingdom, Freeserve has been able to offer "free" Internet access to end-users because it makes its money from incoming call payments, primarily British Telecom.[19]

5.4.5 Rights of Way

The use of public rights of way and other local ordinances governing civil engineering and zoning can help entrench the market dominance of the traditional public utility. One of the more casual arguments for monopoly provision of public utility services is that it would be too disruptive if multiple entities were digging up the streets. There are several aspects to this subject. One has to do with the actual rights of way—the footpaths, utility easements, and public ways. Although these clearly need to be available on a nondiscriminatory basis to all providers of service, one could imagine a future in which all public thoroughfares are marked *ad infinitum* by red construction cones. Some communities have addressed this issue by requiring that any opening of trenches must take place in a coordinated and timely way and that open trenches must be shared. Although no "magic bullet" solution has been discovered, this way forward seems both sensible and practical.

Zoning restrictions have been a barrier to entry primarily in the case of transmission towers and home satellite dishes. In the United States, the Telecommunications Act of 1996 preempted the right of local municipalities to use zoning as a barrier to entry by new telecommunications operators.

A related issue is access to what might be called "private rights of way." This refers to access to risers and ducts that are owned by building owners. Incumbent telephone companies typically had access to these facilities under their monopoly franchises, because they were the owners of their inside wire. In the United States in the early 1980s, inside wire was deregulated and now belongs to the property owner in the same way as household electrical wires. Access to these risers and cables has been a matter of great contention as U.S. competitive local exchange carriers (CLECs) strive to penetrate the market in multiple dwelling units (MDUs). Similar

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[19] "Lex: Freeserve," *Financial Times*, Sept. 28, 2000, [On-line]. URL: http://www.ft.com/ (Accessed October 2000.)

disputes have arisen in other countries. Particularly in Asia, where long-standing relationships tend to govern business relations, building owners are generally reluctant to allow unknown upstarts to enter their buildings to string wire and cable. These are not “enduring market failures” in the sense used for issues such as any-to-any and spectrum interference, despite the plea by U.S. CLECs for intervention by regulators to guarantee them access. Indeed, it might be argued that the market is working perfectly to the extent that the property owner is making a private decision on access to the property.

It seems probable that the market will resolve these debates. The Real Access Alliance, a coalition of real estate interests focussed on telecom carrier access to buildings,[20] believes that “building owners understand the value of giving their tenants access to advanced telecom capabilities.... But building owners want to make sure that carriers using their riser space are viable companies and won’t turn out to be the ‘eight-track cassette’ vendors of the telecom industry.”[21]

[20]“Building Owners Say CLECs Are Partners, Not Adversaries,” *Telecommunications Reports*, Jan. 10, 2000, 29-31.

[21]Ibid.

Chapter Six

Competition, Technological Change, and Market Definitions

6.1 Abuse of Dominance: Transitional Market Failure

A transitional market failure is one that will eventually be erased by market forces, but which requires short-term intervention by regulators. The potential for abuse of dominance is the key transitional market failure to consider. To reiterate points made in section **5.4.1**, incumbent operators understand instinctively that they can put new entrants out of business by denying or overpricing the essential facility of call termination. Thus, the incumbent has an incentive to abuse its dominant position. This incentive will diminish as the incumbent loses marketshare. If all competing operators had the same market share, they would all have a natural incentive to interconnect voluntarily. This can bee seen in international agreements to interconnect. Abuse of dominance, although a transitory phenomenon, must be controlled.

A key element of assessing abuse of dominance under most competition laws is to arrive at a definition of the relevant market. This definition must then be followed by a standard for judging some concept of dominance. Both market definitions and thresholds of dominance are issues in flux, particularly in Europe.

6.2 The ONM Defines Markets by Technology

Defining markets in telecommunications has never been a straightforward process. Many factors are involved, one of them being technological change. In neoclassical economic theory, technological change is treated as something outside the model, exogenous and unpredictable. Thus, a regulatory structure built on neoclassical theory does not have a ready mechanism to address it. In practice, a new technology has typically been treated as a new product and therefore as a new market.

The FCC's logic following the "Above 890" decision provides a classic example.[1] Microwave technology, which is based on radar developed during World War II, could be used to transmit voice and video services over long distance. In 1959, the FCC decided to liberalize licensing of private microwave systems. In response, MCI was formed in 1963 to provide private point-to-point microwave circuits between Chicago and St. Louis. Customers provided their own links from their Chicago and St. Louis locations to the MCI switch, and the long-distance portion of the call was carried over MCI facilities.

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[1]FCC, "In the Matter of Allocation of Frquencies in Bands Above 890 Mc," Memorandum Opinion and Order, 29 FCC 825 (1960), Docket 11886.

In 1969, the FCC decided to denote a new class of carriers, called "Specialized Common Carriers," defined to include private-line microwave carriers, satellite relay carriers, and digital data transmission.[2] The FCC and its staff believed that, by approving these types of carriers, they were not impinging on the business of the traditional carriers. The FCC based this belief on the view that the approved services under the Specialized Common Carrier decision were in no way substitutes for the services offered by the traditional carriers and operators of the PSTN. In other words, these services were a separate *market*, not merely a separate tariff. The Specialized Common Carrier decision established the principle of open entry and competition for specialized services. Traditional rate-of-return and tariff regulation were maintained for AT&T.

The FCC's view fell apart as soon as MCI began to offer its Execunet service, which used local foreign exchange (FX) lines that allowed customers dial-up access to the MCI network. As a result, MCI was suddenly competing with the PSTN. The FCC's assumption that specialized common carriage was a separate market from switched services was completely destroyed.

Having mistakenly treated private-line and switched services as separate markets, U.S. regulators compounded the problem by treating local and long-distance as separate markets instead of as pricing plans and regulatory jurisdictions. For example, while critically examining the AT&T consent decree, one study simply accepted the key notion that local and long-distance are different markets. A chapter in this study "first describes *long-distance markets* and regulation before divestiture. Next, the chapter analyzes the divestiture decree itself and what it was expected to accomplish with the reality of today's *long-distance markets*."[3] Another study more carefully referred to the variety of *services* offered by telephone companies.[4]

Similarly, mobile telecommunication was treated as a separate market from fixed-line because its technical and cost characteristics were different, even though the service rendered was a clear substitute for local exchange services. Because cellular was treated as a separate market in both the United States and the European Union, as well as in many other nations that followed this pattern, giving a license to the incumbent fixed line operator could be justified. Indeed, this license was often given free and with a substantial lead time, while the second license was auctioned at a later date.

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[2]FCC, "In the Matter of Establishment of Policies and Procedures for Consideration of Applications to Provide Specialized Common Carrier Services in the Domestic Public Point-to-Point Microwave Radio Service and Proposed Amendments to Parts 21, 43, and 61 of the Commission's Rules," First Report and Order, 29 FCC 2[d] 970 (1971).

[3]Paul. W. MacAvoy, *The Failure of Antitrust and Regulation to Establish Competition in Long-Distance Telephone Services* (Cambridge, Mass.: MIT Press and EEI Press, 1996), 8.

[4]Robert Crandall, *Managed Competition in U.S. Telecommunications* (Washington, D.C.: AEI/Brookings Joint Center for Regulatory Studies, Working Paper 99-1, March 1999).

6.2.1 Fully Allocated Cost Accounting and Market Definitions

The root of these problems of market definition arises from the framework of cost accounting used in both the open and closed network architecture models. Typically, pricing of incumbent telephone services is regulated by a system of fully allocated cost accounting. Prices for services are set so as to recover the allocated costs. Profits and losses by service are calculated after allocating the very large proportion of costs that are "common" across-various services. In the United States, allocation problem is further complicated by the dual system of federal and state regulation, which leads to jurisdictional separations of revenue requirements.

The problem begins with the view that various telephone services are separate products in principle but with a strong component of common costs. In a factory that produces passenger cars, light trucks, and ambulances, the accountants need to allocate the common costs across the various product lines, and regulators adopt elaborate rules for that process in telecommunications. The result is that each telecommunications "product" is saddled with a portion of the very large "common costs" of the network. A fully allocated costing system is imposed that envisions the telephone network as a factory that produces a number of "products"—local services, long-distance services, and vertical services.

There is no "correct" way to allocate the common costs of local loop and associated gear, so the allocations are necessarily arbitrary. Arbitrary allocations give a system of "price-based costing" the appearance of "cost-based pricing."[5] Around the world, the allocative process and its national variations yielded much the same outcome: prices for international and long-distance services were held at high rates, while prices for local services were kept relatively low. Moreover, the system generates a common pattern of profits and losses: long-distance services appear profitable and local access services appear to lose money. The former subsidize the latter. Shifting these costs to attain a different pattern of prices, lower for long-distance and higher for local, constitutes '"rate rebalancing." This term is sometimes used also to refer to a shift of revenue recovery by lowering high business tariffs and raising low residential tariffs.

But telephone networks are not like car factories, where the products are quite different from one another and the common costs are small. The switched services of a telephone network are not separate products at all, but merely pricing plans for minutes of use on a time-sharing network. And in the United States, the services do not serve different geographic markets; instead, they fall into different regulatory jurisdictions. Over time, the industry and its regulators have come to confuse these pricing plans and jurisdictions with products and markets.

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[5]For a detailed description of the allocation process in the United States, with focus on the Bell System, see Richard Gabel, *Development of Separations Principles in the Telephone Industry* (E. Lansing, Mich.: Institute of Public Utilities, Michigan State University, 1967).

Aside from the problems raised by this fully allocated cost accounting system for debates about universal service, investment signals, and pricing policy, there are severe consequences for competition enforcement. If the markets are incorrectly defined, then conclusions about dominance and its abuse are liable to be incorrect.

6.2.2 The Threshold for Measuring Dominance

Even were markets correctly defined, problems would arise in determining the level at which a firm's market share would warrant regulatory intervention. Some recent European decisions provide an example. Under EU competition law, a firm with 40 percent share of a relevant market is deemed likely to be dominant, while a 50 percent share provides a rebuttable presumption of "dominance." The Interconnection Directive, which explicitly applies to telecommunications operators, directs those with "significant market power" to meet all reasonable requests for interconnection.[6] "Significant market power" is presumed to accrue to operators with more than 25 percent marketshare. Oftel, in the United Kingdom, has applied these definitions to three broad sectors: fixed lines, leased lines, and mobile. Thus, Oftel has defined markets by technology. In addition, it has provided in its guidelines that no dominance would be likely if an undertaking has less than 25 percent marketshare. This conclusion was then applied in April 1997 in the Oftel proceeding "Fair Trading in the Mobile telephony Market."[7] But interestingly, Oftel found that "A dominant firm will most certainly possess market power, but firms which are not by themselves dominant may also have market power."[8] Regulators seem to be choosing the marketshare threshold that would justify their intervention.

6.3 The OMM Defines Markets by Economic Substitution

6.3.1 Technological Change, Market Definitions, and Abuse of Dominance

The OMM takes a different approach to market definition. It recognizes that it is important not to be trapped into treating different technologies as different markets but, instead, to focus on the economic nature of the service being provided. The OMM recognizes that substitutable services will be offered using different technologies. Consistent with the Chamberlin–Robinson models (see section **3.3.5**), the OMM also recognizes that there will be substantial product differentiation. Thus for example, there may be three network operators in a market, all selling dial-tone to end-users and wholesale customers. The first, the traditional wireline operator, could market to those desiring high-quality plain old telephone service (POTS) at low prices; the second, the cable TV operator, could bundle voice services in with a video entertainment and

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[6]Directive 97/33/EU, OJ L199, p. 32 of 7/26/1997.

[7]Oftel, "Fair Trading in the Mobile Telephony Market," 13 May 1997, [On-line]. URL: http://www.oftel.gov.uk//fairtrade/mobser.htm (Accessed October 2000.)

[8]Ibid.

Internet access service; and the third, a mobile operator, could provide voice services with mobility at premium prices over a cellular network. But all are providing voice services to end-users and therefore are competing in the same market. Similarly, cable TV, broadcast TV, and direct to-the-home DTH satellite services are all competing in the market for video entertainment. Similarly, for data services, telephone dial-up services, xDSL services, and broadband cable TV's data services all are in the same market.

The distinction between call origination and call termination, arrived at in the context of interconnection policy (see section **5.4.1**), also provides a basis for taxonomy for defining telecommunications markets.

Call Origination. To repeat the points made in section **5.4.1** in this new context, call origination, often called "access," is a service provided by a network operator to a customer. The customer may be an end-user, or it may be a service provider that buys call origination as an intermediate product. There can be multiple competing providers of networks connecting end-users. These local network operators compete for subscribers that want to *originate* calls on the network of their choice. The local networks can also provide call origination services on a wholesale basis to resellers, ISPs, and as many other wholesale customers as marketing departments can imagine. Call origination services are not treated as interconnection, as they are under the FCC's ONA approach. And because "call origination" can be a competitive market, it does not qualify as an essential facility.

Call Termination. By contrast, once a caller has dialed a telephone number, there is no competition or choice about call termination. Only the network operator that has been assigned that number can make the telephone ring. If that operator refuses to do so, then the call cannot be completed, and a dominant operator has an incentive and the ability to refuse as a means to suppress competition in the call origination market.

A special word is warranted on treatment of call termination. Each network operator in a sense has a monopoly on call termination to its customers. Only the operator that has the number assigned to it for a given customer can make the device associated with that number signal the arrival of an incoming call and then complete the call. Although a customer can change carriers or have several devices subscribed to different networks, and although a customer even can forward calls from one device to another, at the end of the line, only one operator can complete the call.

That unique ability to terminate a call is not necessarily a bottleneck, however. Only when an operator can use its control over call termination to stifle competition in the call-origination market is specific regulation required. If all operators had equal marketshare of call origination, self-interest would drive them to interconnect. Otherwise, their customers could not receive calls from the rest of the market, and the blocking network would merely be a closed user group, rather than a public network.

A real-world example exists. In Japan, TTNet first entered the market using the network capabilities of the Tokyo Electric grid. When TTNet installed its own switches, it chose a numbering pattern that was not recognized by the Nippon Telegraph and Telephone (NTT) network. As a result, TTNet subscribers were able to make outgoing calls and could call one another but could not receive calls from NTT subscribers. TTNet had to make extensive and expensive modifications to become commercially viable.

6.4 Other Abuses of Transitional Dominance: Monopoly Pricing

Regulators usually try to set rates as low as possible, even if they are completely ignorant of the implications of neoclassical economics and natural monopoly, out of several interacting considerations:

- that incumbent operators are inefficient and exaggerate their costs to obtain higher prices;
- that monopolists, natural or not, tend to overcharge;
- that legislative mandates direct the regulator to obtain the “best value for customers”; and
- that regulators seek to be perceived as both “active” and “tough.”

Setting prices on the basis of cost has a very detrimental effect on the development of competition. Excessively low retail prices shrink the revenue stream available to new entrants increase the difficulty of justifying a business case that exceeds the hurdle rate. Similarly, setting wholesale call-origination rates at LRIC simply tilts the entrant’s make-or-buy decision away from building its own network. Open market policies, with the goal of encouraging investment, provide different guidelines from those offered by open network approaches.

6.4.1 Access Pricing and Tariff Rebalancing

Even with broadened market definitions, incumbent operators will remain dominant for some time and, therefore, warrant special attention. Those that face new competition enjoy the enormous first-mover advantage of ubiquity. That is, while competitors are building out their networks and deploying their services, many customers in many locations and for many services will not have competitive choices for some time. The incumbent can dramatically lower the prices in those few segments and places where competition is present while raising prices only slightly to the many monopoly segments and places. This kind of anticompetitive “cross-subsidy” is a common accusation lodged against incumbents by new entrants.

Dominance in the retail and wholesale markets for call origination is a transitional market failure, and transitional polices are appropriate to control it. Tariff rebalancing is a prime issue and involves risks that at one extreme the incumbent will set prices at abusively high levels for captive customers but at predatory low levels for customers that are contested.

Discussions of tariff rebalancing generally focus on issues of cross-subsidy from long-distance and international services to local-access services. (This discussion implicates issues of universal service; see section **6.5**.) In the European Union, under Article 1 (6) of the Full Competition Directive, member states are obliged to allow their telecommunications organizations to rebalance tariffs toward cost and to establish a timetable for those member states that had not completed rebalancing before 1 January 1998.

For a proper policy on rebalancing, it is important to emphasize that "access" is not "interconnection." Confusion on this point leads to the worst regulatory practice from the perspective of enabling investment in competitive networks. Setting the price of wholesale call origination on the basis of the forward-looking incremental costs of the incumbent's network facilities makes the new entrant indifferent to (1) using the incumbent's call origination service and (2) investing in facilities of its own. Indeed, given the approach of real option theory, LRIC-based pricing of access allows the entrant to capitalize the real option to invest in the future and stacks the deck against making investments in the present, which would bring the benefits of facilities-based competition.

Local access services enable customers to originate calls. The prices for call-origination services must recover not only the costs of the underlying network facilities but also most of the costs of running a local telephone business—sales and marketing, customer service, general and administrative costs, depreciation, billing, etc. Customers are always the source of the revenues needed to recover these costs. After all, if there were no competitors, these costs would all need to be borne by and recovered from end-users. If the market will not bear the required prices, either owing to inefficiency or to historical practices, then shareholders must bear the risk, as in any business. Customers generate revenues through charges for the array of services they buy. In a nation that has separate local and long-distance operators, customers may pay either directly to the local access provider or indirectly through their long-distance bill.

The appropriate policy principles require that customers, whether "retail" end-users or "wholesale" service providers, should pay for the services that they buy. Ideally, market forces would set those prices. But in the evolution to a competitive market, transitional price regulation is needed, both (1) to protect consumers and (2) to encourage effective competition. These two goals are in conflict: high retail prices will attract new investment but may hurt consumers; low retail prices will protect consumers but could discourage investment.

The necessary balance can be struck by establishing price caps, with adjustments for inflation that are sufficiently flexible to allow for rebalancing. Reduction of long-distance and international rates, with offsetting increases in rates for local-access and other services, to take place over a reasonable period, would accomplish both goals. To address the issues of affordability, a low user tariff with limited features at low prices could be introduced.

Within the price caps, upper and lower bounds of pricing flexibility would allow the incumbent a reasonable opportunity to respond to competition while controlling the risk of cross-subsidy or predatory pricing. The bounds need to be quite narrow in the early period, when concern about dominance is strongest, and to widen gradually, as competition emerges and market forces begin to constrain pricing. The timing of this transition needs to be tied to marketshare loss, with the market broadly defined as “call origination” within a country. During the price-cap transition period, call charges would remain the same nationwide, i.e., no geographic de-averaging, for two reasons: first, so that customers in areas without competition do not cross-subsidize contested parts of the country; and, second, so that the benefits of competition can spread to all citizens. Eventually, when incumbent marketshare falls below 50 percent of the call-origination market, the bounds would converge to a ceiling of fully allocated or stand-alone costs (whichever is higher) and a floor of LRIC. These are the usual standards under competition law for judgments about monopolistic and predatory pricing. At that point, industry-specific regulation of prices could be eliminated, and normal applications of competition law would apply.

6.5 Universal Service and Social Obligations[9]

Traditionally, monopoly telecommunications providers have carried with their license a responsibility to provide universal service. The bases for universal service assertions are rooted in several economic arguments. These arguments are outlined in the following sections.

6.5.1 A Profit-Maximizing Monopolist Will Not Serve the Entire Market

This is a straightforward application of economic theory. An unregulated monopolist maximizes profits by expanding service until the marginal revenue earned from the last customer is equal to the marginal cost of serving that customer. High-cost, low-revenue customers remain unserved. The ONM rectifies this problem by imposing a common-carrier service obligation, as well as by imposing price regulation and (in the United States) rate-of-return regulation to keep service affordable. The OMM solves this problem by a combination of policies to encourage competition, along with transitional price caps to prevent abuse of dominance in the short run. In addition, the OMM encourages both incumbents and entrants to invest in new, lower cost technology, so that the reach of the costs of the network overall are reduced, thereby increasing the affordability of service.

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[9]This section draws heavily on Martin Taschdjian, “The Universal Service Obligation in a Competitive Environment: Diagnosis and Prescription,” in *USO In a Competitive Telecoms Environment: Expert Symposium*, edited by Nick Gray (Cambridge, Eng.: ANALYSYS Publications, 1995), 197-207.

6.5.2 The Network Externality Justifies Subsidies from Usage Service to Access Service

The network externality is a legitimate market failure that can justify cross-subsidies between usage and access. This view may be accepted, with certain questions raised:

- Because most telephone subscribers do not pay for incoming calls but, presumably, get value from them (junk calls aside), is there not already a subsidy from user (i.e., call initiator) to access (i.e., call receiver)? Why is the "free incoming call" subsidy not sufficient?
- Where universal service has been virtually achieved, why is a continuation of subsidy necessary?
- As household penetration of telephones increases, surely the social value to the additional subscribers joining the network diminishes and grows marginal? Should society bear the same subsidy level to get the 99th percent of households onto the network as the first 10 percent?

The actual achievement of universal service reduces the need for subsidy from usage to access. Certainly, the FCC data show that shifting substantial costs from interstate toll back to local access has not affected household penetration negatively. [10]

6.5.3 Residential Service Is Heavily Cross-Subsidized

Heavily cross-subsidized residential service permits competition for more lucrative services that would erode these subsidies. Because forcing customers to pay for the full costs of their access would be unaffordable, they would not subscribe, which would reduce the value of the network for all.

This is the argument about cream-skimming. It is based on fully allocated cost accounting (see section **6.2.1**). In the monopoly environment, this process allocated the "joint and common" costs in order to achieve a politically acceptable tariff structure. As a result, residential access service appears to lose money, because it is provided at low prices and, on the basis of cost-causer arguments, bears a high proportion of the costs. Losses are cross-subsidized by high margins earned in segments of business services, vertical services, and long-distance services. But this outcome is purely arbitrary, one based on the results of arbitrary cost allocations. And if cost-causer arguments are valid on the cost side, then it is just as reasonable to allocate revenues from other services to the revenue causer—the end-user. That outcome could show high margins for residential and business local service and losses in toll services.

Under OMA, universal service is dealt with by policies that reduce the costs of providing service. Competition, price caps, and the optimal use and mix of technologies are the best tools

[10] Monitoring Report, Federal-State Joint Board; Docket CC 80-286.

for achieving it. Entry, spectrum, pricing, and interconnection policies all interact to contribute to these forces that reduce costs. Where subsidies remain necessary, OMA would focus on two forms:

- "Needy" individuals receive direct subsidies, and
- Geographic subsidies for high-cost areas, distributed by auction. Where an existing carrier wants to exit particular geographic areas, the government could hold an auction to offer a subsidy of, say, $10 per month per subscriber to any operator willing to serve, subject to quality standards. If there were no takers, the subsidy could rise to $11, then $12, until someone would agree to serve. This process would guarantee that service would be provided at the lowest possible subsidy and at the lowest cost technology. The problem of carrier of last resort would be eliminated, and the approach would be flexible to various definitions of universal service. In a competitive environment, the subsidy would follow the customer regardless of the carrier chosen.

Open market policies that enable investment and competition in local infrastructure make the traditional arguments for universal-service support largely moot. With competitors entering local markets using new technology, their lower costs will hold prices to affordable levels and drive services to the entire market. Even with full competition and efficient technology, some areas or users may still need subsidy. Government will need to subsidize services for consumers and geographies that would not be served even by a competitive market. Such subsidies will need to be carefully targeted, and care will be needed in their collection and distribution to minimize market distortions.

6.6 Security and Emergency Services

The protection of national security, the pursuit of criminal investigations, and the delivery of emergency services are all legitimate government functions, but for agencies accustomed to dealing with "one stop" monopolists, procedures will become more complicated. When the monopoly telephone company was a creation of the state, technical capabilities could be imposed as a quid pro quo for the monopoly license, but in a competitive market such obligations look like expropriation of assets, especially when they are not evenly applied.

Under the open market approach and in a competitive market, government is treated as simply another user of telecommunications services. While it can demand priority access and a set of services that would not be provided to other users, it can no longer bury the costs it imposes within the monopoly rates of ordinary users as a hidden tax. And if government were allowed to impose requirements unevenly, both cost structures and investment decisions would be distorted and the effectiveness of enforcement would be reduced. Adequate funding for special services demanded by government from general taxes would minimize competitive distortions and maximize the effectiveness of government protections.

Chapter Seven

Conclusions

This report has examined the theoretical underpinnings of current regulatory models and their application, generically described as the "open network model." It has shown that these policies have slowed investment in local networks and that that is the reason for the lack of widespread facilities-based competition in most telecommunications markets around the world. Open network policies have encouraged the development of services and service providers that use the existing local networks.

If reliance on existing technology and regulated monopoly provision of access networks is seen as made necessary by its natural monopoly characteristics, that is an appropriate outcome. But this report shows that that the existing local monopoly structure is the result of regulatory policy, not its cause. According to this view, real competitive markets will not exist until many local networks are serving end-users. According to this view, open network policies are not the solution—they are the problem. The issue then raised is what might be the appropriate replacement.

The report has suggested a replacement framework, described as the "open market model." This model is based on different theoretical underpinnings from those of open network architecture. It replaces the neoclassical economic model with one based on evolutionary economics, differentiated competition, and real option investment theory. It takes as its goal the encouragement of investment that will bring with it new technology and local-loop infrastructure competition that is sustainable in the long run. By focusing intervention policies on market failures, and by distinguishing between permanent and transitory failures, the model provides a path for regulatory withdrawal in favor of competition law, once the appropriate conditions are met.

The OMM distinguishes between call origination, or access, and call termination, or interconnection. With that distinction in mind, and with regulation focussed on market failure, regulatory uncertainty can be minimized and thus mitigated as a barrier to investors contemplating long-term sunk and irreversible investments in building out local infrastructure. That distinction also provides market definitions for assessment of and abuse of dominance.

Table 7-1

Comparison of Policies Summarized

Policy Element	Open Network Policy	Open Market Policy
Policy goal	Protect from monopoly	Erode the monopoly
Interconnection definition	Access and termination	Termination only
Interconnection pricing	LRIC for both access and termination	LRIC for termination
End-user prices	Rebalance slowly to prevent rate shock	Rebalance quickly to attract investment; wholesale rates for *call origination*
Market definitions	By technology (local loop, trunk, fixed, mobile)	By service (call origination, call termination)
Universal service	Service X-subsidy; geographic price averaging	Competition; customer-direct subsidy; encourage low-cost technology
Burden of proof for intervention	On market	On regulator
Spectrum management	“Command-and-control” allocation by licensing	Secondary markets

LRIC = long-run incremental cost X-Subsidy = cross-subsidy

Acronyms

AT&T	American Telephone and Telegraph
BSA	basic serving arrangements
BSE	basic service element
CAPM	capital asset pricing model
CEI	comparably efficient interconnection
CLEC	competitive local exchange carrier
CPE	customer premises equipment
DBS	direct broadcast satellite
DTH	direct-to-home satellite
E(NPV)	expected NPV
EOY	end of year
ESP	enhanced service provider
EU	European Union
FAC	fully allocated cost
FCC	Federal Communications Commission
FDC	fully distributed cost
FX	foreign exchange
GATT	General Agreement on Tariffs and Trade
ILEC	incumbent local exchange carrier
IP	Internet Protocol
ISP	Internet (or information) service provider
LEC	local exchange carrier
LRIC	long-run incremental cost
MDU	multiple dwelling unit
NPV	net present value
NTT	Nippon Telegraph and Telephone
Oftel	Office of Telecommunications, the U.K. regulator
OMA	open market architecture
OMM	open market model
ONA	open network architecture

ONM	open network model
ONP	Open Network Provisioning (European Commission)
OPTA	Dutch regulator of telecommunications
PBX	private branch exchange
POTS	plain old telephone service
PSTN	public switched telephone network
PTT	postal telephone, and telegraph
R&D	research and development
RBOCs	regional Bell operating companies (also known as the "Baby Bells")
TELRIC	total element long run incremental cost
TSLRIC	total service long run incremental cost
TV	television
UK	United Kingdom
UNE	unbundled network element
USO	universal service obligation
xDSL	digital subscriber loop
X-subsidy	cross-subsidy

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