4

Economic Regulation of Utility Infrastructure

Janice A. Beecher

Public infrastructure has characteristics of both public and private goods and earns a separate classification as a toll good. Utilities demonstrate a variety of distinct and interrelated technical, economic, and institutional characteristics that relate to market structure and oversight. Except for the water sector, much of the infrastructure providing essential utility services in the United States is privately owned and operated. Private ownership of utility infrastructure necessitates economic regulation to address market failures and prevent abuse of monopoly power, particularly at the distribution level. The United States can uniquely boast more than 100 years of experience in regulation in the public interest through a social compact that balances and protects the interests of investors and ratepayers both. Jurisdiction is shared between independent federal and state commissions that apply established principles through a quasi-judicial process. The commissions continue to rely primarily on the method known as rate base/rate-of-return regulation, by which regulators review the prudence of infrastructure investment, along with prices, profits, and performance. Regulatory theory and practice have adapted to emerging technologies and evolving market conditions. States—and nation-states—have become the experimental laboratories for structuring, restructuring, and regulating infrastructure industries, and alternative methods have been tried, including price-cap and performance regulation in the United Kingdom and elsewhere. Aging infrastructure and sizable capital requirements, in the absence of effective competition, argue for a regulatory role. All forms of regulation, and their implementation, can and should be

Review comments from Tim Brennan, Carl Peterson, Ken Costello, David Wagman, and the Lincoln Institute of Land Policy are greatly appreciated.

evaluated in terms of incentives for infrastructure investment and operational performance.

The Role of Public Utilities

Public utilities are the enterprises that provide vital telecommunications, energy, and water services. Depending on one's perspective, public utilities supply products, commodities, services, information, common carriage, networks (interconnectivity), and access (to multiple providers); foundations for development and society; and engines for technological advancement and prosperity. Utilities help satisfy physiological needs by providing creature comforts (heat, light, and safe drinking water). Essential utility services thus become matters of humanity and human rights in both the developing and developed worlds. Beyond basic needs and living standards, utility services make modern lifestyles possible to a degree that goes largely unnoticed until the slightest disruption occurs. In the United States, a very high level of service reliability is presumed; outages and the cascading consequences of interdependency are met with alarm and dismay. Extended disruptions jeopardize public health, safety, and welfare, and destabilize economic and social systems. It is no wonder that utility facilities are strategic targets for terrorism.

The essential role of utilities in U.S. and global development cannot be overstated, as observed 80 years ago:

> To us of this day these utilities are necessities. It is hard to realize how people lived without them only fifty years ago. They are at our command so easily and so cheaply that we accept and use them as a matter of course—the commonplace things of daily life—without a thought of how they got here. . . . The story of their beginnings, their growth and their place in the social, industrial, and economic fabric of the nation is romance made reality. It is the romance of every day life, by the realization of which we get to know and understand and appreciate better, the times in which we live. (Robinson 1932, 2)

Despite many dimensions and meanings, public utilities essentially deliver services through networks of built infrastructure that are ubiquitous but largely invisible; even noticeable network elements go largely unnoticed unless they have particularly distinctive and controversial presences (such as nuclear plant cooling towers). The physical imprint of utility infrastructure on the U.S. landscape is impressive, as recent estimates reveal:[1]

---

1. These data (verified as feasible) are from periodic online publications of the U.S. Energy Information Administration (2004), the U.S. Environmental Protection Agency (2009a), the North American Electric Reliability Corporation (2011), the Federal Communications Commission (2010c), Silverstein (2011), and industry trade associations.

- 66 nuclear, 580 coal, 1,169 petroleum, and 1,705 gas plants
- 1,432 hydroelectric and 39 pumped storage facilities
- 1,356 renewable energy facilities (nonhydro)
- 395,000 miles of high-voltage (>100 kV) transmission lines
- 15,700 transmission substations
- 6 million miles of electricity distribution lines
- 20,000 miles of gas-gathering pipelines
- 306,000 miles of interstate and intrastate transmission pipelines
- 1,400 gas compressor stations
- 400 underground natural gas storage facilities
- 2 million miles of gas distribution mains
- 75,000 water treatment facilities
- 2 million miles of water distribution mains
- 14,500 wastewater treatment facilities
- 600,000 miles of wastewater collection lines
- 18.7 million equivalent telephone poles
- 1.7 billion miles of metallic wire
- 38 million miles of fiber wire

The United States finds itself in the early stages of what is sure to be an intensive and protracted infrastructure replacement cycle that is not exclusive to utilities but for which investment will be significant and complicated. Depending on conditions, the per-mile cost for replacing water pipes can be as much as $500,000; the per-mile cost of electricity transmission lines ranges from $1 to $15 million. The staggering capital requirements on the sectors will be borne largely by utility ratepayers. The "funding gap" has become a popular construct for rationalizing an accelerated spending pace for infrastructure across the sectors. A gap may be apparent when replacement rates and depreciation practices are unrealistic relative to the actual useful life of utility assets, considering both physical deterioration and technical obsolescence. A lagging replacement rate suggests unrealistic expectations about life expectancy and life-extension potential. A 2006 survey found that U.S. water systems had replaced 2.8 percent of their existing pipe in five years (U.S. Environmental Protection Agency 2009b), a pace that many industry experts consider insufficient. A gap may also arise from failure to meet standards. Many analysts suggest that planned and timely renovation is more cost effective than emergency management after breakage.

Much of the concern about the nation's infrastructure is a function of the age of the existing physical stock along with a perception of disrepair and even disintegration. Though most power systems engineers probably disagree, former Energy Secretary Bill Richardson repeatedly characterized the United States as a "superpower with a third-world electrical grid." In recent years, the number of outages affecting the bulk power grid has increased, but more were due to weather-related events than to infrastructure failure alone.[2] Fortunately, significant natural gas pipeline safety incidents are not trending upward, although events occur regularly and sometimes tragically.[3] The American Society of Civil Engineers (ASCE) has been especially vocal about the condition of the nation's infrastructure, giving it a D grade in its periodic report card (American Society of Civil Engineers 2009) and bringing attention to perceived expenditure deficits as well as the consequences of "failure to act." Transportation and utilities have been a focus of federal funding under the American Recovery and Reinvestment Act (ARRA) of 2009 as a means of both stimulating the broader economy and accelerating the pace of renovation and replacement.

While immediate investment needs are estimated in the billions of dollars, the long-term projections for all of the sectors could total a few trillion. Complicating the challenge are transformational goals related to market structures, technological advancement, and environmental stewardship, namely the reduction of greenhouse gases (especially decarbonization) in the context of climate change. Complicating the economics are the effects of rising costs and prices on discretionary demand for utility services.

For the electricity industry, ASCE estimates that by the year 2040, the nation needs to invest \$401 billion in generation, \$112 billion in transmission, and \$219 billion in distribution, for a total of \$732 billion (2010 dollars). Other estimates double or even triple that amount (Chupka et al. 2008). ASCE also estimates that failure to meet that need will cost much more to the U.S. economy (American Society of Civil Engineers 2011): \$126 billion to businesses, \$71 billion to households, \$656 billion in personal income, \$496 billion in gross domestic product (GDP), \$10 billion in exports, and 529,000 jobs. ASCE provides comparable estimates of economic impact for the water sector.

Other analysts put the price tag for a transformed electricity industry much higher, at \$1.3 trillion (Eggers 2010), when considering the cumulative investment in smart meters (\$22 billion), environmental compliance (\$120 billion), transmission for renewable energy (\$167 billion), nuclear replacement (\$200 billion), compliance with carbon regulation (\$250 billion), and compliance with renewable portfolio standards (\$500 billion). Other estimates put the 20-year need for transmission alone at about \$300 billion (Chupka et al. 2008).

Infrastructure needs for the natural gas industry are not as daunting but still considerable. Newly discovered shale reserves and concerns about age-related pipeline safety are investment drivers for gas transmission and distribution systems. The investment profile reflects the market structure of the industry, which separates wellhead production and gathering, interstate transmission, and

2. Detailed annual events analyses and system disturbance reports can be found at the North American Electricity Reliability Corporation (NERC) website (www.nerc.com).

3. Incident data are available at U.S. Department of Transportation, Pipeline & Hazardous Materials Safety Administration (http://primis.phmsa.dot.gov/comm/reports/safety).

local distribution. The natural gas supply industry estimates "midstream" infrastructure investment needs at $133 to $210 billion, primarily for pipeline assets (INGAA Foundation 2009).

A survey by the U.S. Environmental Protection Agency (2009a) put the total national investment need of the drinking water industry at $335 billion, with 60 percent for transmission and distribution (2007 dollars). Wastewater and storm water management needs total another $300 billion (U.S. EPA 2010). More recently, the American Water Works Association (2012) called for $1 trillion of investment in the nation's drinking water systems over the next 25 years and $1.7 trillion by 2050, with replacement and population growth about evenly responsible for the need. Unlike its sister sectors, the water industry is actually experiencing flat or declining demand (Zeilig 2011), likely due to the combined influence of efficiency standards, prices, and cultural shifts. Compared to energy, water also has few if any new uses. A "new normal" in water demand is cause for reconsidering drinking water infrastructure investment in favor of optimization solutions.

Given that technology has set the replacement pace, the telecommunications sector is better positioned. Although still vital, the risks associated with disruptions are generally not as ominous. Nonetheless, federal regulators have referred to broadband as "the great infrastructure challenge of the early 21st century" (Federal Communications Commission 2010b). A gap analysis in this sector calls for a $23.5 billion investment to reach 7 million unserved homes (Federal Communications Commission 2010a). The economic cost of the "digital exclusion" of more than 40 million households due to a lack of access, affordability, or understanding has been estimated at $55 billion (Digital Impact Group 2010).

Estimates of current investment, planned investment, and "need" are variable, subjective, and inexact. Range estimates help but may still suggest a false sense of precision. Actual needs will be very system specific, depending on the nature and condition of local infrastructure. Each estimate of need for supply presumes a level of usage, but usage changes as prices and other demand determinants change. As with all forecasts, longer time frames add to modeling uncertainty. Nonetheless, it can be said with some confidence that infrastructure requirements are the core driver of past, present, and future utility service costs, as well as a defining characteristic of traditional public utilities generally.

Characteristics of Public Utilities

Public utilities, at least traditionally, shared several salient qualities that reinforce their characterization as monopolies. Utility services are distinguishable from both public and private goods because they share attributes attached to both. Utility infrastructure and network services are rightfully characterized as toll goods, generally defined by economists in terms of lower rivalry and higher excludability. Owing to British common law, and echoed by the U.S. Supreme Court in *Munn v. Illinois* (94 US 113, 1877), utilities are also understood as inherently "affected with a public interest," which sets them apart in terms of not only function but also purpose. The term *public* is not accidental. Utilities provide essential service to the public. Utilities provide public works that in many respects substitute for public services. Utilities make use of public rights-of-way as they build infrastructure for public use, operating under certificates of public convenience and necessity and assuming an obligation to serve along with entitlement to just compensation. Utility companies issue publicly traded stock, and good utilities strive to be deserving of the public's trust.

Traditionally, public utilities were regarded as monopolistic, often labeled as "natural" monopolies. Even across sectors, commonalities and similarities overwhelmed differences. This characterization has become somewhat antiquated in the context of evolving technologies and markets. Although monopolies once were considered creatures of their technical and economic traits, monopolies are also creatures of institutions—an amalgam of laws, regulations, and policies. The view that utility monopolies are as "artificial" as they are "natural" rattles some long-held assumptions. Today, technological differences among the sectors are increasingly relevant to structural design. Nonetheless, some of the inherent traits of utilities that tend to reinforce their market power are difficult to overcome.

The traditional technical, economic, and institutional traits of the monopolies responsible for utility infrastructure are reviewed qualitatively here. Of course, these categories and the indicators within them are nonexclusive and reinforcing. All relate ultimately to the rationale for economic regulation and its form and function.

TECHNICAL CHARACTERISTICS

The technical features of utilities can be defined largely in engineering terms, although they include certain production-cost characteristics that have economic implications. The everyday tasks of flicking a switch, adjusting the thermostat, turning on a faucet, or tapping a keypad are made with little regard to underlying technologies and networks. Most people can only marvel at how electricity infrastructure meets supply with demand in real time; at how natural gas infrastructure collects, stores, and distributes a combustible yet relatively clean and efficient source of energy; at how telecommunications infrastructure integrates wired and wireless systems to relay billions of calls daily; and at how water infrastructure delivers monthly to a typical American home more than 20 tons of a product that is safe to ingest.[4]

Thus, a leading distinction of utilities is that they provide "safe, adequate, and reliable" service "on demand" at an actual moment's notice. Utilities are expected to be "ready to serve" with available and dispatchable supplies (a source of controversy for intermittent or variable resources, such as wind energy).

4. Based on 5,000 gallons per month and eight pounds per gallon.

The value of reliability is very high, but mostly unappreciated. Utility systems must balance supply and demand both spatially and temporally. Utilities have distinctive load characteristics marked by daily, weekly, and seasonal cyclicality that is also affected by factors such as weather. Reliability requires utilities to maintain adequate reserve margins for meeting peak loads.

Traditional utility monopolies were vertically integrated; that is, they were responsible for any and all necessary functions, including supply, storage, transmission, distribution, and administrative functions. They operated closed networks with limited or no access by alternative providers. A single service provider or monopoly avoided wasteful duplication or redundancy within the network (such as pipes, wires, or towers) and facilitated achievement of scale economies in production (discussed below).

Public utilities are sometimes referred to as "fixed utilities" because they require substantial capital investment in long-life, mostly nonfungible fixed assets that, along with technical knowledge, poses a formidable barrier to market entry. Accordingly, utilities exhibit exceptional capital intensity, measured by the ratio of fixed assets (as shown on the balance sheet) to operating revenues (as shown on the income statement) (figure 4.1). Water and wastewater utilities are particularly capital intensive due to long asset lives. New infrastructure investment (e.g., power plants) traditionally comes in very large increments, a trait known as "lumpy capacity." The scale of facilities makes siting politically sensitive due to local environmental impacts. The long lives of utility assets also raise intergenerational equity issues with regard to financing and financial accounting practices (namely, depreciation).

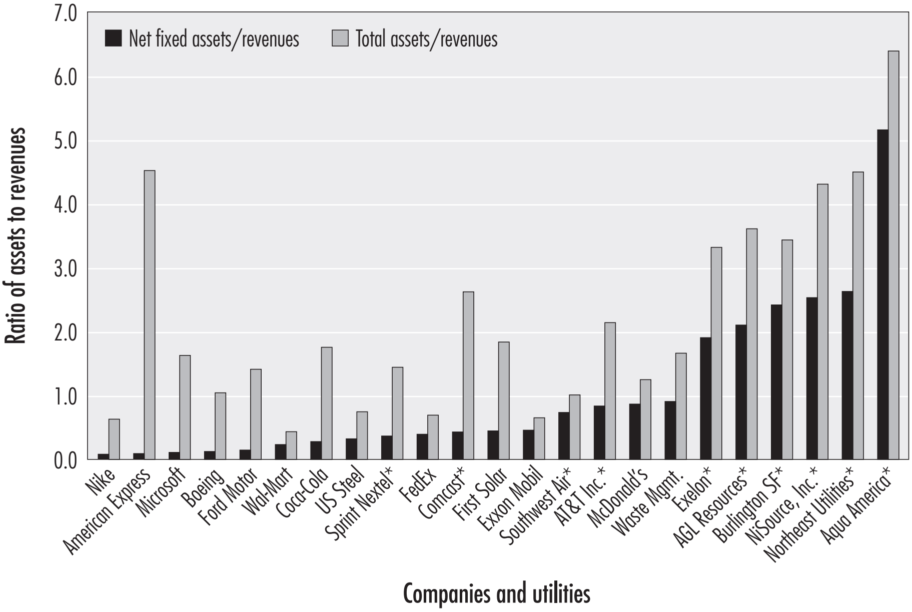
Finally, utilities themselves are technically interdependent. Electricity and gas can be substituted and provided by "converged" utilities. Natural gas and water resources are used in electricity production. Electricity is needed for natural gas and water operations. Water is needed for wastewater service and fire protection. All utilities rely on telephony for operational intelligence and security, including "smart" metering. Many essential social and economic functions depend on the services supplied by utilities, reinforcing the sense of public interest in safe, adequate, and reliable operations.

ECONOMIC CHARACTERISTICS

Although the direct value they add to the nation's gross domestic product is somewhat modest, utilities are significant players in the U.S. economy. Private utilities add about 2 percent in value to the nation's GDP (figure 4.2).[5] The economic characteristics of traditional public utilities are intrinsically related to their underlying technical characteristics, so much so that a subspecialization of "engineering-economics" was once recognized in the field. Although scale econ-

5. Utilities have dedicated stock indexes; once considered "widow and orphan stocks," their securities remain a stalwart source of dividend income in investment portfolios.

Figure 4.1
Capital Intensity of Major Companies and Public Utilities for 2012



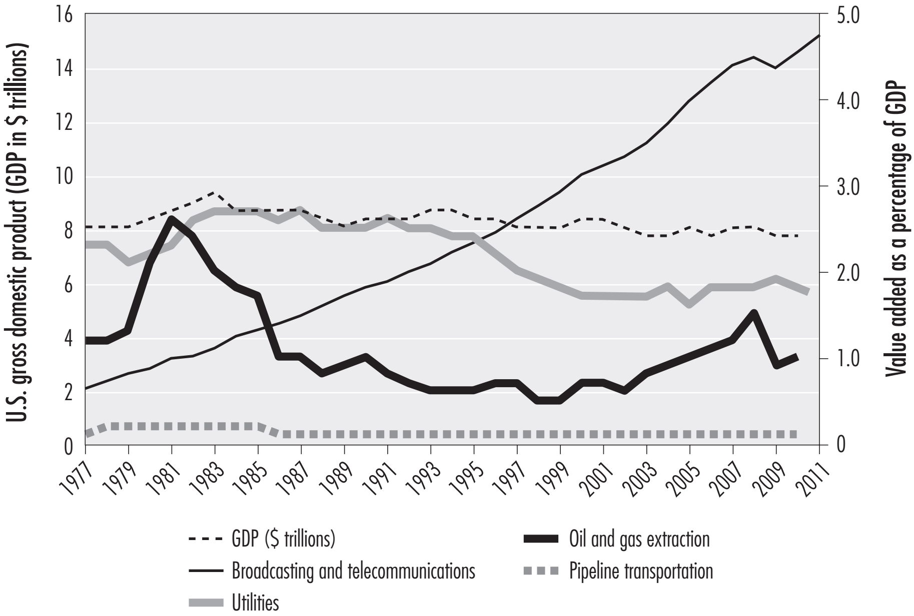
*Infrastructure-intensive network or utility company.
Source: Based on publicly reported financial data (available at hoovers.com).

omies (declining unit costs of production) can be realized in most enterprises, they are pronounced for utilities, particularly supply processes. Scale is achieved in both construction and operation. Scope economies may also be realized, including vertical integration of functions (generation, transmission, and distribution) and horizontal integration of complementary operations (electricity and gas). Utilities also benefit from network economies, meaning the primary and secondary benefits of coordination, interconnection, and "connectedness" among infrastructure providers and users.

Both infrastructure and commodity costs are significant cost drivers for public utilities, especially for energy. The substantial fixed costs of infrastructure, however, can result in a marginal cost of production that is below average costs. As a consequence, the competitive cost of marginal-cost pricing would cause utilities to underrecover costs.

Though scale economies are apparent, they are neither absolute nor unlimited (see Kwoka 2005). Economies in production are offset by eventual diseconomies of transmission and distribution, which is a function of service territory area and density. Although the economics are complex, some alternative technologies for

Figure 4.2
Value Added by Utility Infrastructure to the U.S. GDP, 1977–2011



Source: Based on data from the Bureau of Economic Analysis, NAICS category 22 (available at bea.gov).

the provision of energy and water services, namely distributed resources, conflict with long-held views about the cost advantages of centralized production.

Utilities are distinctive in that product differentiation is very limited due to technological constraints as well as standards that allow little tolerance for deviation. Regardless of size or structure, for example, all electric utilities are expected to comply with voltage standards, and all water utilities are expected to comply with federal drinking water standards. Traditionally, public utilities were also highly constrained in their ability to control supply or demand. Utility services have few if any *practical* substitutes, and switching to alternative technologies or providers is constrained. The utility's core customers are considered captive because they have few if any choices. Again, modern utilities are more likely to engage in more active portfolio design and demand management, and technologies may open service choices to customers.

Utilities typically serve a mixture of residential, commercial, and industrial load. Water utilities tend to rely more on revenues from residential water sales. Demand for utilities varies according to a number of drivers, including income and price. Demand is considered income-elastic but relatively price-inelastic (that is, not highly price-responsive, as characterized by a more vertical demand curve). This is not to say that customers do not respond to price changes, but rather that a change in price will yield less than a proportionate change in quantity demanded. Importantly, however, price elasticities vary for different types of usage. Utilities make for regressive burdens; that is, low-income households pay a much greater share of their income for essential utility services than do high-income households. Rising costs thus have distributional consequences.

Finally, the production and consumption of public utility services result in both positive and negative externalities. Though externalities are typically contemplated in terms of deleterious consequences, namely pollution, a fair accounting also considers the positive public health and welfare effects made possible through access to utility services. Individual utilities are also generally ill-equipped to respond effectively to the problems of externalities without raising the specter of monopoly rents. Externalities may be more appropriately managed through comprehensive public policies (such as standards, mandates, or taxes) with which all market participants must comply (Beecher 2011).

INSTITUTIONAL CHARACTERISTICS

The institutional dimension reflects how utilities are organized, managed, and regulated. Institutions are also connected to the technical and economic features already explored. Although monopoly tends to connote enormity, utility monopolies may be small or large in size. To the captive customer, the size of the provider matters little. Larger utilities dominate U.S. markets, often operating multiple establishments or systems, even as numerous small providers serve adjacent and rural areas. The water sector is particularly bifurcated in terms of size distribution. Market power is generally concentrated, even in the water sector, where only 9 percent of the nation's 50,000 systems serve fully 88 percent of the U.S. population served by community systems (U.S. Environmental Protection Agency 2009b). Some areas are served by converged utilities providing electricity and gas, water and wastewater, and even "water and light" municipal legacy systems. Utilities are also distinguishable in terms of their participation in wholesale (bulk) and retail exchange, as buyers, sellers, or both.

Ownership is a particularly relevant structural feature of utilities (table 4.1). In terms of market share, the electricity, natural gas, and telecommunications sectors in the United States are dominated by private ownership, while public ownership prevails for water. Rights-of-way and powers of eminent domain are enjoyed by both publicly and privately owned utilities. Utilities must comply with environmental and other social forms of regulation regardless of ownership. Each sector is also relatively well professionalized and subject to a degree of self-regulation in the form of generally accepted standards and practices. Some practices are probably more variable in the public than in the private sector due to the economic regulation of the latter.

Public utilities are usually enfranchised with conditions for an exclusive service territory. As a result, and along with technical and economic reasons, they

Table 4.1
Ownership Structure for Electricity and Water, 2007

	Providers	Revenues ($ billions)	Percentage of Revenues
Electricity Utilities			
Investor owned	194	224.3	60.9
Power marketers	168	48.8	13.3
Publicly owned	2,006	53.4	14.5
Cooperatives	874	39.9	10.8
Federal power agencies	9	1.8	0.5
Water Systems[a]			
Publicly owned and operated	23,800		
Publicly owned with private partner	1,047	39.5	85.3
Private for-profit	5,407	4.3	9.3
Nonprofit	9,327	2.4	5.2
Ancillary	9,554	0.1	0.2

[a]Many water utilities operate multiple systems.
Sources: Data from American Public Power Association (2012); U.S. Environmental Protection Agency (2009b).

face little competition or contestability and thus incur lower associated risks. In the absence of competition, privately owned utilities—and some publicly owned utilities—are regulated as sanctioned monopolies.[6] As discussed below, the regulatory paradigm centers on a social compact that specifies utility rights and obligations. In the United States, the states and the federal government share jurisdiction for utilities, delineated generally by oversight of wholesale and retail markets, respectively, in accordance with constitutional power related to interstate commerce. Regulation by the Federal Communications Commission (FCC) and the Federal Energy Regulatory Commission (FERC) can be preemptive of the states. There is no federal economic regulatory presence in the water sector, where states have primacy. Most publicly owned or not-for-profit utilities are subject to some form of local oversight by a municipality or an independent governing board.

Structural Change in the Utility Sectors

Once virtually indistinguishable, at least for regulatory purposes, each of the public utility sectors has seen considerable structural change. The restructuring

6. The Wisconsin Public Service Commission has comprehensive jurisdiction for municipal utilities.

movement transpired from the confluence of technological and political forces that challenged long-held presumptions about the vertically integrated monopolies, and thus the traditional regulatory paradigm. The underlying logic and intent are common to all of the industries, but restructuring is contingent on the immutable traits of each sector.

By the late twentieth century, the major utilities were transforming. To some extent, services once provided by utilities became commodities provided by network industries. Deregulation in the telecommunications sector was largely driven by technological innovation that opened markets, enhanced choices, and made traditional regulation obsolete. Deregulation in the energy sector was more policy driven and focused on the separation of both production and transmission from distribution.

Restructuring generally involves both vertical separation of functional responsibilities (in electricity, "gencos, transcos, and discos") and horizontal competition among providers. Wholesale and retail markets are delineated and opened to entry. Open access to transmission networks and "wheeling" are provided with appropriate compensation. Competitive services are also "unbundled." Restructuring introduces new functions and providers, such as licensed suppliers, aggregators, brokers, and marketers. Market-based tools (such as auctions, trading, and hedging) are implemented. Public policies are aimed at facilitating consumer choice (e.g., information campaigns and phone number portability). Restructuring may include "divestiture" of some regulated assets and recovery of certain transition costs (e.g., stranded investment). Finally, restructuring is accompanied by policy reforms, including both alternative regulatory models and selective deregulation when competition is sufficiently workable. The persistent need for market rules, however, means that restructured markets actually remain rather structured.

Fundamentally, markets and competition require enabling technologies. Innovation can cause disruption or even "creative destruction" (Schumpeter 1942) within economic systems. The evolution of telephony, particularly wireless and broadband communications, provides the obvious example. Advances in computational power and information management that lower transaction costs have enabled markets for network services.

Pursuit of economic interests by key stakeholders drove restructuring as well. New market entrants (such as upstarts MCI and Sprint) brought competitive pressure to bear on the AT&T monopoly, leading ultimately to an antitrust investigation by the U.S. Department of Justice. In the electricity sector, large-volume customers (such as ELCON members and water districts) sought to eliminate interclass cross subsidies and exercise purchasing power. Restructuring can partly be explained by rebellious attitudes: anti-incumbency, sympathy for underdogs, and the appeal of change for the sake of change.

Restructuring rests on a theory that favors competitive markets over regulatory institutions for promoting social goals, namely efficiency. Proponents include academics, think tanks, and policy entrepreneurs within legislative and even regulatory bodies (including the FCC and the FERC).[7] International institutions, namely the World Bank, also have promoted market structures that facilitate private involvement in utilities. Deregulation or "liberalization" has an undeniable ideological connection to preferences for limited government (as espoused by both the Thatcher government and Reagan administration). A related and somewhat cynical rationale for deregulation is a perception of regulatory or "nonmarket" failure (see Wolf 1993) and the acceptance of imperfect markets over imperfect regulation.

The promises of restructuring were many. Customers would find freedom from the captivity of monopoly providers and, presumably, not just "choice" but *good* choices promoting economic well-being. Markets would see an influx of new providers, as well as new products and services. The discipline of competition would keep market power in check while promoting innovation and entrepreneurship. Risks would be shifted from customers to investors. Efficiency gains would lower costs, and improved pricing would "de-skew" cost allocation and eliminate subsidies.

Restructuring is an ongoing social experiment that finds each of the sectors, and market segments within them, in a different structural and regulatory status (table 4.2). Persistent technical distinctions and path dependence urge caution about transference and call for sector-specific market and regulatory design.

Although much of the telecommunications sector has been deregulated, corporate consolidation and market power are ongoing concerns, and a number of critical public policy issues remain, including universal service, broadband deployment, emergency calling systems, critical infrastructure protection, and smart-grid convergence. The vertically segregated natural gas sector combines competitive production at the wellhead with federal oversight of interstate pipelines and state oversight of intrastate transmission and local distribution, as well as pipeline safety. Key issues include the economic and environmental impacts of developing and transporting unconventional gas resources and utilizing gas for electricity generation.

The states are about evenly divided in terms of restructuring electricity markets, to mixed effect. Price escalation in the wake of restructuring caused many states to rethink their policies. Reconciling retail customer choice with the utility's ongoing obligation to serve (and associated investment) remains a thorny issue. The interest in restructuring has been eclipsed somewhat by the imperatives of global climate change, energy security and resilience, and grid modernization, although "smart" technologies are also seen to enable consumer choice. Infrastructure investment, both centralized and distributed, continues to be the major cost driver.

Only the water sector remains highly monopolistic and mostly vertically integrated. Water markets do not lend themselves to restructuring because they are

---

7. The assertion that deregulation is sometimes favored by regulators contradicts the concept of regulatory capture.

Table 4.2
Structural and Regulatory Status of the Public Utility Sectors

	Structural Status	Unregulated	Regulated
Electricity	Partial restructuring and wholesale competition with mixed results; some retail choice	Independent power generation; most nonprivate utilities	Interstate and unbundled transmission (federal); retail distribution (state); vertically integrated (shared)
Natural gas	Vertical segregation with competitive wholesale markets; some retail choice	Wellhead (commodity) gas production; most nonprivate utilities	Interstate transmission (federal); intrastate transmission and retail distribution (state); pipeline safety (shared)
Telecom	Oligopolistic with workable competition; regulation is limited in scope	Long-distance, wireless, Internet, and cable services; other services and equipment	Small independent providers (state); network access and universal service (shared)
Water	Generally integrated and monopolistic; some wholesale and contract activity	Most nonprivate utilities; most privatization contracts; most wastewater providers	All privately owned utilities and some nonprivate utilities (state only)

Note: Shared jurisdiction may reflect divided responsibility based on market structure as well as state implementation of federal policy.

largely unstructured and unregulated in the first place. In fact, rising costs and prices may call for more oversight. Wholesale water is not exchanged competitively. Structural change is seen mainly in the form of regionalization and consolidation, as well as public-private contestability. Water's especially essential nature, along with its connection to local economies, human health, and the natural environment, presents a formidable barrier to overreliance on markets.

At the turn of the millennium, the road to restructuring had turned a bit bumpy, and the states began to maneuver more cautiously. Restructured markets are likely no closer to perfection than regulated markets. Efficiency gains have been achieved, but not without trade-offs. Each sector continues to face persistent concerns about service quality and reliability, consumer access and affordability, market and utility performance, and long-term infrastructure investment. Not all utility functions can become sufficiently competitive under current technological and economic realities to achieve desired goals. Despite substantial evolution, there remains a significant role for economic regulation, particularly for distribution services.

Economic Regulation

Economic regulation of public utilities is an essential form of governance in the context of market failure, as manifested primarily in the form of monopoly.

Monopoly provision of electricity, natural gas, and water services, at least at the distribution level, is considered economically efficient due to scale economies, capital intensity, and technological constraints that make competition impractical. Regulation is acknowledged as an essential but imperfect substitute, surrogate, or proxy for competition as well as a corrective policy instrument for a variety of other market failures.[8] Given the foundational nature of utilities to modern society, regulation "in the public interest" also serves broader policy goals.

U.S. economic regulation has its origins in British common law and progressive political movements. Each of the state commissions originated from the railroad commissions of the mid-nineteenth century; their jurisdiction and authority were modernized after the turn of the twentieth century. The federal and state commissions are complex agencies, simultaneously engaged in functions that are quasi-legislative (policy making), quasi-administrative (policy implementation), and quasi-judicial (adjudicative); the regulatory commissioner is at once an expert, a trustee, and a judge (Beecher 2008). A particular emphasis can be placed on the judicial role model because well-functioning regulation follows accepted administrative procedures and rules of conduct that ensure due process for all participants. Regulatory decisions can be appealed, but the courts generally focus on matters of law and defer to regulators as finders of fact with discretion within a broad "zone of reasonableness."

Commissioners may be appointed or elected (in 14 jurisdictions), but commissions are similarly structured to ensure a higher degree of political independence and continuity, assured by staggered terms, partisan balance, and constraints on commissioner removal. An independent professional staff—well qualified and trained in law, economics, accounting, finance, engineering, and policy analysis—is also essential to effective regulation.

In practice, economic regulation has three critical dimensions: jurisdiction (who gets regulated), authority (what activities are regulated), and methods (how regulatory oversight is administered). Jurisdiction, authority, and methods combine to create a variety of regulatory models. Ratemaking is a core function, but modern commissions also control market entry and exit and system expansion; ensure safety, adequacy, and reliability; specify standards and terms of service; process and resolve customer complaints; impose systems of accounts; require annual reports and conduct audits; approve capital structures and financial issuances; review and place conditions on mergers, acquisitions, affiliate transactions, and diversification; conduct prudence reviews and management audits; review resource and infrastructure plans; review forecasts for supply and demand; and ensure openness, transparency, due process, and ethical conduct.

Regulation seeks a balance between the interests of utility investors, who devote their capital to utility infrastructure, and core or captive ratepayers, who

---

8. Competitive markets, of course, are also imperfect in reality and result.

depend on utility services but have limited choices. A putative social compact specifies the various rights and obligations of utilities. The utility enjoys an exclusive franchise for a certificated service territory, protection from competition and antitrust, an opportunity to recover costs and earn a reasonable return on prudent investments, rights of eminent domain, and the ability to charge for the cost of service. The utility also accepts an obligation to provide all paying customers with safe, adequate, reliable, and nondiscriminatory service on just and reasonable terms, while assuming certain business risks and subjecting itself to regulatory oversight.

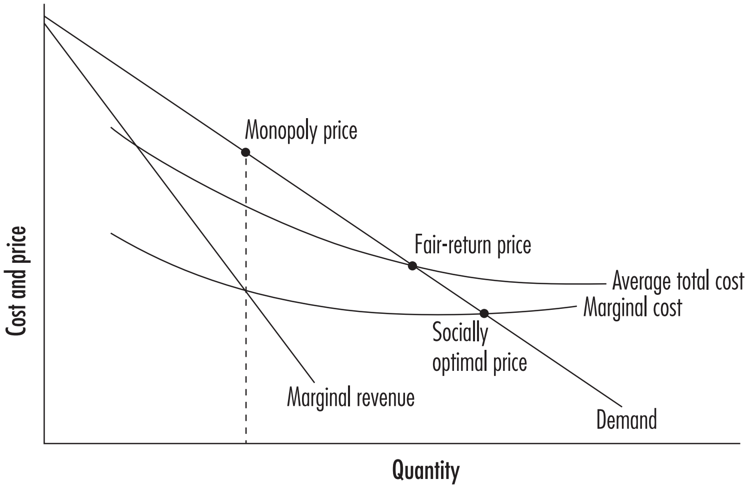
Regulators approve rates in accordance with well-established principles and methodologies. Ratemaking principles are grounded in constitutional law as affirmed throughout a rich history of Supreme Court cases. Many core standards of review are aimed at infrastructure investments, which must be found to be both "used and useful" to ratepayers and "prudent" based on knowable conditions. A "certificate of public convenience and necessity" may be used to establish need, but it does not ensure cost recovery. Utilities must operate with "reasonable economies." Rates of return must be compensatory but commensurate with risk. Both rates charged and returns allowed must be "just and reasonable" and nondiscriminatory. Importantly, profits to utilities are authorized but not guaranteed, and returns cannot place "unjust burdens" on ratepayers.

Full-cost accounting is emphasized, as cost-based rates encourage efficiency in production as well as in consumption and the allocation of society's resources. Full-cost pricing reflects a matching principle whereby "burdens follow benefits" (and vice versa). Costs are assigned or allocated to cost causers according to allocation rules and not knowingly or unknowingly shifted to others (transfers or subsidies). When necessary and justified by policy goals, subsidies should be exposed and the economic implications understood.

The traditional form of economic regulation implemented in the United States, known as the rate base/rate-of-return (RB/ROR) method, applies regulatory judgment to approximate an "efficient" (market-based) price while allowing a "fair" return (figure 4.3). The label *cost-plus ratemaking* (suggesting recovery of cost plus a return) is misleading because it understates the requisite role of the regulator in cost evaluation. Determining and allocating costs is the essence of ratemaking. A "test year" (or "rate year") is used to establish the cost of service and base rates. Under this method, utilities are strongly motivated to invest and to include all known and measurable costs in the estimation of revenue requirements for the prospective period for which rates are set.

Ratemaking involves three key steps and associated goals. First is the determination of the utility's prudently incurred revenue requirements, or total budget, for a given test year, comporting with the goal of full-cost pricing. Second, cost allocation links system costs to usage, consistent with the principles of cost causation and "due and undue" discrimination. The third step, rate design, involves constructing revenue-neutral tariffs to recover the full cost of service from customers through rates and charges, comporting with the goal of just and reasonable rates.

Figure 4.3
Compensatory Pricing for Utility Monopolies



Revenue requirements are determined as follows (and summarized in table 4.3):

$$RR = r(RB) + O\&M + D + T$$

where RR = annualized revenue requirements
r = authorized rate of return
RB = rate base (original cost of utility plant in service, net of accumulated depreciation and adjustments)
$O\&M$ = operation and maintenance expense
D = depreciation expense
T = taxes

Regulation also benefits from uniform systems of accounts and established methods of financial analysis. Utility ratepayers must cover the capital and operating expenses of the utility, including operation and maintenance, depreciation, and taxes (income, property, and other). The depreciation expense compensates the utility for "using up" assets. Depreciation rates are ideally matched to service life, and the associated expense provides cash flow that utilities can use for additional infrastructure investment. Reinvestment of cash is not actually required, but the utility is also expected to be a going concern and meet its obligation to serve.

Table 4.3
Allocation of Utility Revenue Requirements Under Economic Regulation

<table>
<tr><td rowspan="7">Revenue requirements</td><td rowspan="3">Variable operating costs</td><td rowspan="4">Operations</td><td rowspan="5"></td><td>Labor</td><td rowspan="5">**Above the line:** Ratepayers cover the prudent cost of service</td></tr>
<tr><td>Energy</td></tr>
<tr><td>Other inputs and variable costs</td></tr>
<tr><td rowspan="4">Fixed operating costs[a]</td><td>Taxes, insurance, contracts, and other fixed costs</td></tr>
<tr><td rowspan="3">Capital recovery</td><td>Depreciation</td></tr>
<tr><td rowspan="2">Cost of capital</td><td>Interest on debt</td><td rowspan="2">**Below the line:** Ratepayers compensate debt holders and shareholders (net of disallowances)</td></tr>
<tr><td>Return on equity</td></tr>
</table>

[a]In the short run, many operating costs are obligatory and thus essentially fixed.

All utilities invest in and manage infrastructure assets for a public purpose. Publicly owned utilities fund infrastructure through debt instruments (bonds); privately owned utilities utilize a combination of debt and equity (typically about evenly divided). The return on equity is, literally, the price paid for shareholder investment in infrastructure. Setting the rate of return can be difficult and controversial. Investors receive a return of (depreciation) and return on (profit) their investment. Investors expect returns that are nonconfiscatory and compensatory relative to comparable risk, imploring that they must be sufficient to earn positive credit ratings and attract capital. Arguably, the only risk utilities face is regulatory risk, as every regulatory treatment effectively shifts risks between utility investors and ratepayers (with the potential to affect the cost of capital). Upon a finding of imprudence, regulators will impute a reasonable cost and send the disallowed excess "below the line" (deducted from profits).

Revenue requirements determine the size of the pie; rate design slices it up. Rate design can involve science, art, and politics, as compensatory rates are easier to fathom than "just" rates. Rate options can be evaluated according to various criteria, including revenue recovery, efficiency, and equity (see Bonbright, Danielsen, and Kamerschen 1988). Alternative rate structures can recover revenue requirements. A combination of fixed and variable charges is used, but they may not match fixed and variable costs. Conventional ratemaking typically involves averaging costs by customer class. Costs are allocated to customer classes based on usage patterns. Pricing can discriminate among users only based on costs. Controversy arises from departure from cost of service based on social criteria. "Socializing costs" involves spreading costs widely; "social ratemaking" includes special-purpose rates, such as those designed to promote economic development or affordability. Rate changes and design are consequential in that a change in prices can induce a change in usage (based on price elasticity); dramatic short-term reductions in usage are induced by "rate shock."

Regulation and Incentives

Regulators do not manage public utilities. They lack the expertise and information to do so, and it is not their purpose. Regulators always have and always will concern themselves with three basic matters: standards, accountability, and incentives. First, regulators set basic standards in the form of minimal requirements, limits on certain behaviors, or simply the rules of engagement. Second, regulators hold the regulated entity accountable through various reporting, auditing, and review processes. Third, regulators provide incentives (or remove disincentives) for performance, either directly or by shaping the circumstances and opportunities affecting the utility.

The purpose of all forms of regulation is to provide incentives for desired performance. Although the traditional model often is juxtaposed against incentive regulation, all economic regulation is incentive regulation.[9] Like any organization, a public utility will respond to sufficient incentives and disincentives.[10] Despite modern rhetoric about multiple "bottom lines," profit remains the predominant motive.

Criticism of the RB/ROR model rests squarely on the dual concerns that it provides too much incentive to invest and too little incentive for innovation and efficiency:

> *Traditional cost-of-service rates do not promote innovation and efficiency by regulated firms.* Simply stated, cost-of-service rates are based on a "snapshot" of a firm's total cost of providing service plus a "fair" profit. Once the regulator sets rates, there is *no incentive* for a company to try and reduce costs or operate more efficiently since in the long run they could not keep any additional profits in excess of the allowed return. In fact, cost-of-service rates can have the perverse effect of providing incentives for a firm to operate less efficiently. For example, since the rate of return is based on the cost of capital, firms could increase revenues by

---

9. Attributed to economist and regulator Alfred E. Kahn. Economic regulation is more properly characterized as incentive-oriented than "command-and-control" policy. See also Lyon (1994).

10. Energy utility executive John Rowe once remarked, "The rat must smell the cheese" (Edison Electric Institute 1989).

> increasing their invested capital. Also, most day-to-day operating costs, such as the cost of gas for a LDC [local distribution company], can be passed straight through to customers, providing no incentive for firms to seek cheaper gas supplies. (Energy Information Administration 1997, 116, emphasis added)

This "cost-plus" perception of regulation reflects a view that regulation is largely ineffective in substituting for market forces, which raises the question of whether the problem rests with the regulatory model or the quality of implementation. Theoretically and empirically, economic regulation is not necessarily antithetical to efficiency and innovation, or even commercialization (see Porter and Stern 2011). Throughout their long history, regulated utilities and their organizations achieved considerable innovation, as evidenced by Bell Laboratory patents and prizes. Competition among firms following restructuring may explain the apparent shift from collaborative to "sponsored" research.

Regulation can motivate utilities through three loosely hierarchical but overlapping tools (figure 4.4): regulatory lag (primarily for cost control), prudence reviews (primarily for efficiency), and incentive rates of return (primarily for innovation).

Though not well understood in this regard, and thus a source of consternation, regulatory lag motivates utility performance by design and is embedded within the social compact and prevailing ratemaking methodology (Bailey 1974; Pollock 2010). "The primary incentive for utilities to control their operating costs comes from the existence of *regulatory lag* . . . the setting of a price that is fixed until the next rate case" (McDermott, Peterson, and Hemphill 2006, 19).[11] Indeed, "what may be viewed as an inherent defect of the systems turns out to be one of its strengths" (Wein 1968, 63).[12]

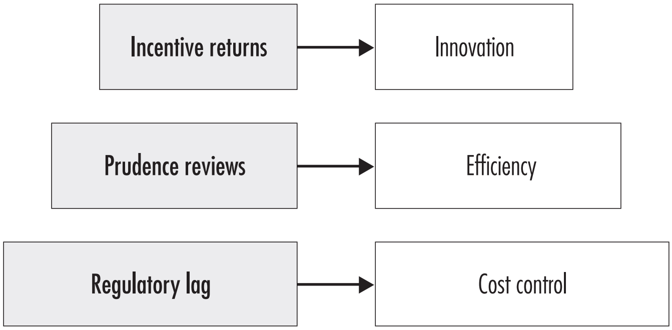
For practical purposes, regulatory lag is the delay between a change in the cost of service (up or down) and a change in authorized rates for service. Alternative conceptions of lag include the time period between when an unregulated firm and a regulated firm could make a defensive price adjustment in response to a cost increase (economic); the time period between rate filing and rate authorization (procedural); the time associated with test-year or cost-adjustment policies (policy); the time associated with decision-making delays (bureaucratic); or the time period between rate-case decisions (systematic).

Lag is affected by the timing of a filing, suspension period, statutory deadlines, agency workload and resources, and the quality of the submission, including the robustness of evidence (e.g., cost studies and load forecasts). Lag is directly countered by "automatic" cost-adjustment mechanisms that should be limited to

11. See also Kahn (1971).

12. Wein (1968) further notes that nonregulated firms also use lagging responsiveness to competitive advantage.

Figure 4.4
Regulatory Tools and Incentives



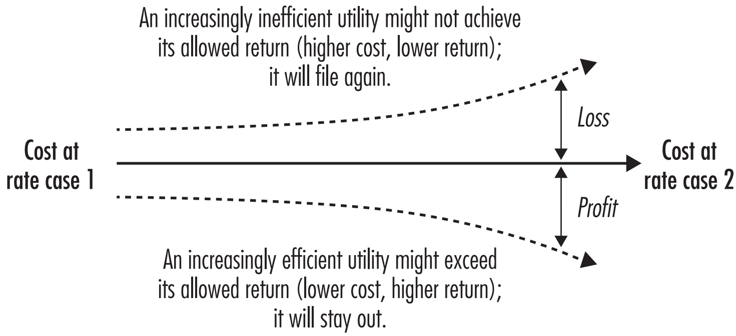
costs that are substantial, recurring, volatile, and uncontrollable and still subject to regulatory scrutiny and reconciliation. These mechanisms, once confined to variable operating costs, have in recent years been extended to capital costs in the form of system improvement surcharges (rationalized on the basis of safety and reliability). Their use in this regard justifies regulatory review of capital asset planning and management as well as net effects on revenue requirements.

Regulatory lag is strongly associated with regulatory risk. Importantly, lag cuts both ways. Although typically portrayed pejoratively in terms of downside risk for utilities, lag also presents upside opportunity. Moreover, while uncertain and protracted cost recovery shifts risk to investors, certain and expedient cost recovery shifts risks to customers. The effects of lag are related to both utility performance and cost inflation, and the range of possibilities widens with time (figure 4.5). Incentives tend to be weak when costs and prices are stable (favoring the status quo). When costs are rising, however, incentives for cost control are stronger. High-performing utilities are more likely than low-performing utilities to realize authorized returns (see Wein 1968). Authorized rates will be ratcheted upward if costs rise, and reset downward if costs fall. Utilities lament, of course, that regulators seize the rewards of performance gains made between cases, but the point is to sustain incentives.

In sum, regulatory lag provides potentially powerful (albeit inexact and somewhat clunky) motivation for both efficiency and innovation. It is not suggested here that regulation should be intentionally process inefficient, but rather that lag be recognized for incentive effects. Indeed, regulators might even seek "optimal timing" to encourage innovation and share rewards between utilities and ratepayers (Bailey 1974).

Prudence reviews are a more proactive regulatory tool. The well-studied Averch-Johnson, or "AJ," effect finds that regulated utilities are motivated to invest in the regulated rate base: "For each additional unit of capital input, the

Figure 4.5
Regulatory Lag and Incentives



firm is permitted to earn a profit (equal to the difference between the market cost of capital and rate of return allowed by the regulatory agency) that it would otherwise have to forego" (1962, 1953).[13] Researchers have estimated the level of overcapitalization at 20 to 30 percent for electricity generation (Lavado and Hua 2004) prior to, and providing an impetus for, restructuring. As other approved expenses are generally passed along to customers, profit is made through capital investment combined with favorable returns. The value of the rate base, and thus the potential for profit, is a function of the scale of investment and the pace of replacement. Left to their devices, utilities will favor capital-intensive investments and accelerated depreciation. To the extent that operating expenses are essentially passed along to ratepayers, they have weak incentives for cost control as well as technical innovation. Absent a mandate or incentive mechanism, they also are unlikely to spend on demand management that would depress sales and thwart long-term investment opportunities.

Regulators must counter these tendencies and encourage not just any investment but economically efficient and prudent investment. Regulation may induce more or less spending, depending on needs and circumstances. Prudence reviews and audits help guard against preventable excess, waste, and cost inflation. However, they may also encourage investment in conventional technologies over "promising but risky" innovation (Lyon 1995). The cumulative cost and technical complexity associated with infrastructure replacement argues for renewed attention to ensuring prudence. Somewhat ironically, given interest in alternative models, RB/ROR may prove to be an attractive policy instrument precisely because of its potential to harness and manage competing incentives.

---

13. Publicly owned utilities, by comparison, may be more prone to deferral and underinvestment, in order to avoid rate increases to constituent-ratepayers.

The authorized rate of return is a third critical regulatory tool. Returns on equity relate directly to perceptions about regulatory climate and regulatory uncertainty, factoring into ratings of both companies and regulators. In the regulatory process, returns are authorized as an effective earnings cap, ceiling, or band. The utility is entitled to the opportunity to earn a fair return, but returns are not guaranteed. In between rate cases, returns can be higher than authorized. In actuality, the authorized return may be very difficult to achieve and very often is unrealized. Returns work similarly to and in tandem with lag to force utilities to reach for profit, much as competitive firms must do. Regulators may consider performance incentives—premiums (carrots) and penalties (sticks)—in setting returns.

As long as they are just (neither excessive nor confiscatory), regulators can deliberately use rates of return to reward or punish utilities based on performance. Disallowances and penalties lower effective returns and send a signal about performance expectations to all regulated utilities. A utility that fails to meet performance requirements might also suffer a lower allowed return on equity. Though perhaps less common, incentive returns can be used to reward extraordinary efficiency and innovation. Like other subsidies, returns above the cost of capital are redistributive; they should be well justified by social goals, used sparingly, and limited in scope and duration. A utility, for instance, might be rewarded for investing in research and development that leads to a transformative technological or process improvement.[14]

Capitalization with returns has been considered for goal-oriented operating expenses (such as those associated with efficiency programs), but enhanced or bonus returns are typically conceived as a means to induce infrastructure spending. A contemporary example is the comparatively generous incentive returns, or "adders," provided by the FERC for private sector expansion of the transmission network, pursuant to the 2005 Energy Policy Act. Electricity market restructuring resulted both in the loss of vertical economies and in inadequate transmission investment (Brennan 2006). Transmission investment continues to escalate (Pfeifenberger and Hou 2011), but it is unclear whether incentive returns are necessary or efficient (Lyon 2007). Any unchecked investment incentive runs the risk of overinvestment. Another frequent complaint is that profit premiums are not explicitly tied to technical innovation.

Alternative Regulatory Models

Regulatory scholars long have been cognizant of the incentives and disincentives attached to the traditional regulatory model (Trebing 1963). A coherent system of standards, accountability, and incentives (as compared to micromanagement

14. Conventionally, research and development costs are typically borne by shareholders, who benefit from performance gains due to regulatory lag.

Table 4.4
Select Alternatives to Ratebase/Rate-of-Return Regulation

Incentive-based methods	Price-cap regulation (PCR) Performance-based regulation (PBR) Profit sharing
Revenue-assurance methods	Cost indexing Revenue decoupling Formula rate plans
Structural methods	Contract-based regulation Structured competition Deregulation

of utilities) is the key to effective regulation. Under the traditional compact, regulators are responsible for ensuring performance. Incentive-based and revenue-assurance methods supplant RB/ROR, while structural methods relinquish considerable responsibility to markets and other institutions (table 4.4). The interest in regulatory alternatives is motivated by concerns about regulatory efficacy as well as the cost of implementation. Certain methods are designed specifically to reduce regulatory caseload and expense. In many jurisdictions, utilities must support the cost of regulation through assessments and fees.[15] At the federal level, expenditures on economic regulation are much less than expenditures for social regulation (Dudley and Warren 2012). Demonstrating benefits relative to costs, however, is a unique challenge for economic regulation given its quasi-judicial nature.

As noted, incentive regulation focuses on performance results versus the particular processes by which they are achieved (that is, ends over means). Over the years, the basic regulatory model has been adapted to address a broad spectrum of social goals. Forward-looking test years, treatment of construction costs, normalization methods, cost-adjustment mechanisms or trackers, special-purpose surcharges, and rate-design innovations are examples. Many of these methods hasten compensation and forestall full rate cases but are suggestive of problematic "single-issue" or piecemeal ratemaking that emphasizes cost recovery over cost minimization (Pollock 2010). While adaptive techniques seek to modify and improve the traditional process, some alternatives seek more radical change.

The several variations on the theme of incentive regulation are designed to promote efficiency and innovation by utilities and in the regulatory process itself.

15. In 2011, the American Water Works Company (2012), which serves 3.1 million customers in 16 states, incurred regulatory expenses of $7.4 million, amounting to about $2.40 per customer annually.

U.S. regulators have tried selective alternatives in connection with restructuring, but other nation-states have become relevant experimental laboratories for broader market structure reforms (see Florio 2007; Jamison 2009). The methods available are not necessarily mutually exclusive.

PRICE-CAP REGULATION

Price-cap regulation (PCR) is the leading methodological alternative to RB/ROR (see King 1998). PCR and its variants (such as revenue caps) are referred to as incentive ratemaking because they are designed and advocated specifically to address the perceived incentive deficiencies of RB/ROR. Price-cap regulation requires utilities to price basic services at prices no higher than specified levels for a specified period of time, thus motivating utilities to reduce costs in order to realize higher and thus more "flexible" returns. From a theoretical standpoint, price caps provide incentives for both cost control and price efficiency (Vogelsang 2002) and "can positively affect a utility's long-term performance" (Costello 2011). Pragmatically, multiyear price caps formalize regulatory lag and can reduce the frequency and cost of rate cases.

According to the method, as originally applied, annual price caps are set for each regulated company based on the retail price index, plus an additional "K" factor representing productivity expectations, as follows (Office of Water Services 1994):

$$PC = \text{Price level} \pm RPI \pm K$$

where *RPI* is inflation and *K* is a composite of anticipated gains in efficiency (–*X*) and expenditures for service quality improvement (+*Q*).

The K factor, which can be reset during periodic reviews (typically every five years), takes into account the investments needed to meet applicable quality standards as well as offsets for anticipated productivity savings. British regulators use price caps in conjunction with performance benchmarking (discussed below) as well as licensure and competition policies. Price caps were the preferred method adopted by U.K. regulators following privatization of their utility industries. In the United States beginning in the 1980s, price caps were applied in the telecommunications sector in the transition to competition. Price freezes, a form of capping, were used in electricity restructuring.

Although the theory behind price-cap regulation is sound, it is not without implementation challenges. Analytical and monitoring effort can be significant. Regulators still must determine the initial base for rates and select an appropriate cost index. Given the chance for error, PCR may be "overpowered" for some newly privatized industries (Wolak n.d.). PCR requires periodic regulatory reviews to realign prices with the cost of service and to ensure that price competition is effective (Loube 1995). Price-cap regulation may be prone to accounting manipulation that would be revealed only through auditing. In terms of incentives, the chief concern is that profit motive will result in cost avoidance and degradation of service quality, which is why PCR is often paired with performance-based regulation. The potential for excess earnings is another concern, but it can be ameliorated somewhat by profit sharing.

Researchers have shown potential benefits of price-cap regulation in terms of price levels (Mathios and Rogers 1989), cost control (Clemenz 1991), and productivity (Seo and Shin 2011). However, PCR also tends to raise the cost of capital and shift risk from consumers to investors (Alexander and Irwin 1996), as well as invite significant regulatory risk in terms of the probability of very high or negative profits (Wolak n.d.). On the whole, the empirical evidence on how PCR affects investment, efficiency, and innovation is conditional or inconclusive (Goel 2000; Grobman and Carey 2001; Roques and Savva 2009). Like other methodologies, it is difficult to distinguish a firm's efficiency improvements from broader influences on performance, including market forces.

RB/ROR and PCR appear to require comparable regulatory effort and resources. When practiced well, these methods seem to work fairly similarly and will likely yield similar results, although both tend to presume natural monopoly (Liston 1993). PCR seems to work well when costs are declining (Sappington and Weisman 2010), as technological advances might facilitate. Given very different sector profiles, the experience with PCR may not be easily transferable:

> While it is clear that price regulation is superior for telecoms where it may only be needed in the transition to deregulation, it is less clear that permanent price regulation with periodic reviews is superior for core network monopolies like water, gas and electric distribution, balancing the better incentives of price regulation against the lower perceived investor risk and cost of capital of rate-of-return regulation. (Newbery 1997, 8–9)

In 2010, regulators in the United Kingdom introduced a new performance-based regulatory model (RIIO) that includes eight-year price-control periods and incentive returns aimed at attracting infrastructure investment (Office of the Gas and Electricity Markets 2010).[16]

PERFORMANCE-BASED REGULATION

The various renditions of performance-based regulation (PBR) shift attention from costs and inputs to performance and outcomes. PBR is used to varying degrees in all regulatory regimes. Performance assessment is used in conjunction with RB/ROR, PCR, and regulatory methods that rely on indexing to ensure that profit incentives do not have deleterious effects. Under the traditional model, prudence reviews inform cost disallowances, but not necessarily as part of an overall system of performance regulation. As part of an alternative scheme, PBR

---

16. RIIO: revenues = incentives + innovation + outputs.

can also take the form of flexible returns or even incentive compensation for achievement of specified performance targets.

PBR is also known as yardstick or benchmark regulation or comparative competition. Utility companies use financial and nonfinancial benchmarks to track performance internally and comparatively. Performance metrics can be developed across various aspects of utility operations, including productivity, service quality, and reliability; customer service and satisfaction; worker safety; employee compensation; load management; losses and loss management (wires and pipes); recovery from outages; and rates charged for services. In some conceptions of PBR, utilities operating within the range of specified benchmarks might be exempt from certain forms of oversight (also known as a "safe harbor" approach).

PBR can be used as a deliberate incentive tool. Performance comparison introduces a surrogate form of competition intended to motivate utilities to control costs, make improvements, and adopt innovation. Publicizing performance ratings can be used to educate consumers and pressure utilities to address deficits (Kingdom and Jagannathan 2001). Regulators also can attach incentives to measurable performance standards or goals. Examples include construction-cost or demand-management targets that trigger cost recovery or bonus returns. Like PCR, PBR is intrinsically related to restructuring (Biewald et al. 1997).

The usefulness of performance benchmarking depends entirely on the development of valid and reliable measures of industry-specific and generally accepted indicators, so that comparisons can be meaningful. Comparison over time addresses methodological limitations by focusing on trends rather than snapshots. Although the theory of performance regulation emphasizes an orientation toward results (versus means), a relevant risk is the potential for micromanaging utilities, which runs contrary to traditional regulatory principles and precedents. Moreover, the use of incentive returns may be inefficient and largely unnecessary. Kihm (1991) suggested that rewarding managers and employees for performance might be as effective but less costly to ratepayers. Executive compensation and its relationship to performance is generally left to shareholders, although the subject occasionally piques the interest of regulators. By around 2000, the states seemed to be turning from targeted incentive plans to broad-based PBR (Sappington et al. 2001) and to other regulatory alternatives.

PROFIT SHARING

A system for sharing profits or earnings encourages efficiency and innovation by allowing the utility to apportion both risks and rewards with customers. Traditional methods are used to establish baseline revenue requirements and allowed returns (either a level or earnings band). Profits may be shared on a 50-50 basis or another formula, including a sliding scale linked to performance criteria or policy goals.

Profit sharing helps address the potential disincentive to control costs under RB/ROR regulation. Profit sharing can also help overcome disincentives for innovation associated with prudence reviews (Lyon 1995). A profit-sharing approach can increase flexibility in terms of expanding utility service offerings. Performance assessment can help ensure that less profitable core functions do not suffer from a shift in focus to more profitable pursuits. Profit sharing can present some cost accounting challenges, although it preserves opportunity for regulatory review. A salient policy issue is whether ratepayers should bear a symmetrical risk of losses when utility ventures fail.

COST INDEXING

Cost or rate indexing is a method for adjusting rates according to changes in a standard inflation index, such as consumer or producer prices. A key problem with general indexing is that price inflation becomes self-fulfilling. Indexing also can be used to adjust rates for particular categories of costs (such as energy costs). Once a baseline revenue requirement is established, indexing vastly simplifies the process of adjusting rates. Indexing can be used when setting rates for multiple years to guard against overearning or underearning by the utility due to fluctuations in the overall economy. Indexing motivates efficiency because utilities that are able to keep actual costs below indexed costs are allowed to retain the savings; conversely, utilities will absorb cost overruns.

The purpose of rate indexing may differ by the size of the system. For small systems, indexing ensures that utility revenues will keep pace with inflation. However, prudent costs actually may exceed the rate of inflation. Indexing does not promote additional investments and expenditures that may be necessary for the proper maintenance of the system. For larger systems, cost or rate indexing with an inflation adjustment also can be used in conjunction with performance measures.

REVENUE DECOUPLING

Though rationales vary historically and by utility sector, certain revenue assurance mechanisms—namely revenue caps and revenue decoupling—seek to address a particular set of incentive issues associated with lost revenues due to declining demand. Like price caps, revenue caps rely on an established index but are more appropriately used when costs do not vary appreciably with sales (Jamison n.d.).

Decoupling is a contemporary form that detaches sales from revenues and profits to address perceived problems with the utility's presumed "incentive to sell." Aligning fixed and variable costs with fixed and variable prices is a basic form of decoupling; it provides revenue stability but raises concerns about affordability. Full decoupling establishes a revenue cap and can be suggestive of fixed-fee pricing. Reductions in sales are offset by price increase to maintain overall or per-customer revenues (revenue neutrality); revenue stability for the utility is achieved at the expense of rate stability for customers. Although decoupling compensates utilities and neutralizes sales incentives, it does not actually provide positive incentives to reduce sales through conservation programs. Like other methods, decoupling may be used with performance incentives.

Decoupling presents a number of issues. Decoupling was originally offered as a means of compensating utilities for purposive or mandated demand repression, presuming both that special incentives are needed and that reductions in demand can be attributed to utility programs. In reality, utilities "enjoy" higher sales but can do little to actualize them except underprice. Lost investment opportunity (versus lost sales) is the more intractable dilemma for investors. Decoupling contrasts with how the marketplace is supposed to reflect utility conduct and consumer value (Brennan 2010; Costello 1996). In particular, decoupling sends weak price signals about long-run capacity costs. By disconnecting costs and prices, decoupling thus undermines the principle of consumer sovereignty. Decoupling also conflicts with preferences for variable pricing, incentives for utility performance, and conventions for risk allocation under the social compact. Many of the concerns used to rationalize decoupling actually can be addressed through traditional ratemaking tools.

FORMULA RATE PLANS

Also promoted as a "rate stabilization" method, a formula rate plan (FRP) is an alternative ratemaking method "in which the utility adjusts its base rate outside of a general rate case, usually annually, based on an actual or projected rate of return (ROR) on rate base or equity that falls outside some commission-defined band" (Costello 2010, 8). Utilities favor FRPs in light of rate-case expense, regulatory lag, rising costs, and falling earnings.[17] FRPs consider both costs and revenues and thus can be used in place of more conventional cost-adjustment mechanisms, as well as revenue decoupling. Regulators still must establish base rates, as well as cost-allocation policies, and rate design. FRPs should reduce the frequency of comprehensive rate cases, but performance incentives may be weakened, and prudence reviews remain essential. Under some plans, rates are adjusted before regulatory review, and disallowances result in customer refunds. The FERC applies formula rates to interstate pipeline and transmission providers.

Although conventional ratemaking is formulaic, FRPs raise several significant regulatory policy concerns (Costello 2010, 2011). An FRP can be rationalized only when traditional methods fail and the plan can be shown to serve the public interest and result in just and reasonable rates. FRPs should be conditioned on meeting performance standards, with penalties for noncompliance. Authorized returns should be adjusted for reduced risk and not guaranteed. The earnings band should be wide enough to provide incentives for cost control, and rate adjustments should keep targeted returns beyond the boundaries of the band in

17. ComEd (Exelon) argues, "Our nearly 100-year-old process for determining rates is out of step with modern realities" because cost recovery is unpredictable and not timely, undermining state competitiveness (n.d.).

order to provide continued incentives and risk sharing. In any case, cost recovery should not be automated or implied as such; rate adjustments should still be subject to prudence reviews, and general rate cases should be conducted periodically to review earnings bands, cost allocation, and rate design.

CONTRACT-BASED REGULATION

When utilities are publicly owned, contract-based regulation becomes an option. With variations in scope, privatization arrangements are used widely in the water sector for capital projects and operations, domestically and globally. Advocates contend that public-private partnerships through various available contractual vehicles offer a number of taxation, financing, efficiency, and other advantages. Long-term contractual agreements are comparable to concessions and charters utilized in Europe. In the United States, the contract model preserves municipal ownership and circumvents economic regulation because of the limited state jurisdiction in this area, which some view as an advantage of contracting. Local governments that engage contractors are responsible for the economic regulatory function, including cost reviews and rate setting.

Municipal contracts are used to establish or maintain governmental control while promoting a degree of competition among alternative vendors. However, privatization cannot be equated with competition. The contest for contracts tends to be oligopolistic and short-lived, particularly for larger systems; long terms of engagement and no-bid renewals are monopolistic. The structural monopoly of the utility also remains intact. Thus, incentives for efficiency and innovation are weak and arguably weaker than those provided through regulation. Contracting inevitably raises principal-agency issues as well. Separating ownership from operation can lead to suboptimal performance and conflict over investment and expenditure decisions. Effective local regulation requires a sound contract vehicle with performance incentives, significant local oversight capacity, dispute resolution processes, appropriate risk allocation, and meaningful monitoring and enforcement mechanisms to ensure service quality and prevent abuses (see Marques and Berg 2010).

STRUCTURED COMPETITION

Although more conservative than deregulation, structured competition still seeks to exploit competitive forces within imperfect markets. Structured markets depend in large part on the concept of contestability or competitive threat to motivate performance. Some markets or market segments may be contestable if technical, economic, and institutional barriers to entry are low. A degree of contestability can also be found among utilities of different ownership forms; a notable example is the ongoing consideration of public versus private ownership of water utilities.

Artificial markets are structured through alternative regulatory methods that attempt to create and maintain a level playing field for competition. Potential regulatory tools include certification or licensure of providers and competitive bidding or auctions to allocate market shares. Regulators also play new roles in monitoring markets and resolving disputes among providers. Structured competition has been used most extensively in wholesale electricity markets, with a significant level of institutional complexity.

DEREGULATION

The economic regulation model is premised on the idea that economic regulation is necessary when markets fail, as is the case with traditional utility monopolies. The flip side implies that markets offer superior social controls and performance incentives. Deregulation places a high value and great reliance on customer choice and individual incentives as means of forcing economic discipline. Deregulation constitutes nonincremental or radical policy change. Over time, the United States essentially deregulated banking, transportation (trucking and airlines), cable television, and much of the telecommunications sector. The Interstate Commerce Commission and the Civil Aeronautics Board were terminated. Prior experience with deregulation has motivated interest in deregulating energy and, to a much lesser extent, water.

Deregulation cannot be ideological or a matter of faith and is feasible and appropriate only when regulation was a mistake in the first place (Peltzman 2004) or when technological and other forces facilitate the emergence of markets. Competition must be workable and sufficiently robust to relax or eliminate safeguards; residual imperfections must be trivial or tolerable. Utility restructuring in the United States has seen mixed results. In some instances, it has included asset divestiture, which is largely irreversible. It also has included partial deregulation of market segments or "de-tariffing" only. A paradox of deregulation is the need for more regulatory capacity related to market standards, analytics, and oversight. Deregulation defers to reactive policy tools for checking market power, namely fair trade, consumer protection, and antitrust enforcement. Deregulation should achieve net benefits to society with acceptable costs, taking a full range of criteria into account. The biggest concern about deregulation is the denial of underlying market failures, including those related to social equity.

Evaluation and Conclusions

Evaluating regulatory alternatives requires consideration of multiple criteria. The efficacy of any model rests on certain assumptions. Care must be taken to recognize how well the model fits with sector-specific characteristics, circumstances, performance goals, and, most important, the public interest. The influence of regulation on utility performance must also be considered within the context of other endogenous and exogenous factors, including managerial competencies, shareholder expectations, economic forces, credit and equity markets, environmental regulations, and so on. All forms of regulation and their implementation should be evaluated in terms of implications for performance incentives and risk allocation.

The advantages of traditional regulation are several, and some come from sheer experience. In the past as well as today, regulation encourages long-term infrastructure investment of scale and provides reasonable, if imperfect, performance incentives associated with efficiency and other social goals.[18] Even advocates of regulation, however, recognize potential disadvantages. In particular, the traditional methodology can provide too much incentive for cost maximization and overinvestment ("gold-plating") and too little incentive for cost control and innovation ("clawing back the savings"). Like all modes of social control, regulation may have reasonable theoretical foundations but is only as good as its stewards.

The various alternatives also have advantages and disadvantages, depending on design and implementation. Performance metrics and expectations can be clarified. Incentives can be targeted to a variety of social purposes. Flexibility can allow utilities to respond more effectively to market forces. Risks and rewards can be more efficiently allocated. The administrative cost of regulation to utilities and the state can be reduced. Critics worry, however, that many regulatory alternatives are unproved in terms of long-term results and that unintended consequences are likely. Alternative methods can shift risks and introduce considerable uncertainty to utilities, ratepayers, and regulators. Many techniques require expanded regulatory capacities and resources and thus add to regulatory expense. Some models can complicate, diminish, or sacrifice oversight. Incentive schemes can lead to micromanagement by regulators, who also may be tempted to use rewards to favor a solution or technology, regardless of efficiency or impact. Driven by profit motives, utilities may take on excess risks or reap excess earnings.

Incentives can become too much of a good thing. Perhaps the biggest risk of incentive-oriented regulation is that it will overcompensate utilities for doing what they are supposed to do—and what competitive markets would force them to do—in the first place. Regulatory lag should be recognized more explicitly for its role in imposing cost control, essentially by exploiting short-run profits that "provide the essential driving force for progress" (Bailey 1974, 286, drawing on Schumpeter 1934). The prudence standard suggests fair compensation for efficient performance, not extraordinary rewards. Regulation may be ripe for a "new prudence" centered on promoting optimal utility performance relative to rigorous but achievable standards.

Given complex goals, trade-offs, and uncertainties, prudence today may call for flexible approaches to infrastructure investment, including incremental, modular, and decentralized technologies. While regulation can identify and motivate efficiency, innovation is a more elusive goal under traditional and alternative regulatory models. By its very nature, innovation cannot be either "standardized" or forced. Incentive returns might be used more deliberately toward this end, though ideally reserved for innovation above and beyond the norms of prudence.

---

18. Kerin (2012) makes the case that regulation should focus on efficiency as a means of serving the public interest and should leave other social objectives to other institutions.

Calls for a “new” regulatory paradigm are rampant today (Clifton, Lanthier, and Schroter 2011; Fox-Penner 2010; York and Kushler 2011). New business models for public utilities are presumed to require new models for their oversight. The original regulatory paradigm was premised on concerns about market failure, infrastructure investment needs, rising costs, social goals, distributional equity, and risk allocation; today is not so different (see Clifton, Lanthier, and Schroter 2011). Given immense challenges, more, not less, regulation arguably is needed. Incentives under traditional regulation are imperfect but in many respects more clear and consistent than those provided by alternative means. Surely, if monopoly structures remain and infrastructure investment is the prevailing social goal, a refined RB/ROR method can be a reasonable choice for ensuring that the public interest is well served. In the end, regulatory certainty may prove more important than regulatory perfection.

REFERENCES

Alexander, I., and T. Irwin. 1996. Price caps, rate-of-return regulation, and the cost of capital. *Public Policy for the Private Sector*. Note no. 87 (September).

American Public Power Association. 2012. *2012–2013 annual directory and statistical report*. Washington, DC: American Public Power Association.

American Society of Civil Engineers. 2009. *Infrastructure report card*. Reston, VA: American Society of Civil Engineers.

———. 2011. *Failure to act: The economic impact of current investment trends in electricity infrastructure*. Reston, VA: American Society of Civil Engineers.

American Water Works Association. 2012. *Buried no longer: Confronting America's water infrastructure challenge*. Washington, DC: American Water Works Association.

American Water Works Company. 2012. *2011 annual report*. Voorhees, NJ.

Averch, H., and L. Johnson. 1962. Behavior of the firm under regulatory constraint. *American Economic Review* 52:1052–1069.

Bailey, E. E. 1974. Innovation and regulation. *Journal of Public Economics* 3(3):285–295.

Beecher, J. A. 2008. The prudent regulator: Politics, independence, ethics, and the public interest. *Energy Law Journal* 29:577–614.

———. 2011. Why public utilities should ignore externalities. *U.S. Association for Energy Economics Dialogue* 19(1).

Biewald, B., T. Wolf, P. Bradford, P. Chernick, S. Geller, and J. Oppenheim. 1997. *Performance-based regulation in a restructured electric industry*. Cambridge, MA: Synapse Energy Economics.

Bonbright, J. C., A. L. Danielsen, and D. R. Kamerschen. 1988. *Principles of public utility rates*. Reston, VA: Public Utility Reports.

Brennan, T. J. 2006. Alleged transmission inadequacy: Is restructuring the cure or the cause? *Electricity Journal* 19(4):42–51.

———. 2010. Decoupling in electric utilities. *Journal of Regulatory Economics* 38(1):49–69.

Chupka, M. W., R. Earle, P. Fox-Penner, and R. Hledik. 2008. *Transforming America's power industry: The investment challenge, 2010–2030*. Washington, DC: Edison Foundation.

Clemenz, G. 1991. Optimal price-cap regulation. *Journal of Industrial Economics* 39(4):391–408.

Clifton, J., P. Lanthier, and H. Schroter. 2011. Regulating and deregulating the public utilities, 1830–2010. *Business History* 53(5):659–672.

ComEd (Exelon). N.d. Formula rates: A new approach. Brochure.

Costello, K. 1996. Revenue caps or price caps? Robust competition later means healthy choices now. *Public Utilities Fortnightly* (1 May).

———. 2010. Formula rate plans: Do they promote the public interest? National Regulatory Research Institute.

———. 2011. Some advice to regulators on formula rate plans. *Electricity Journal* 24(2):44–54.

Digital Impact Group. 2010. *The economic impact of digital exclusion.* Philadelphia, PA: Econsult Corp.

Dudley, S., and M. Warren. 2012. *Growth in regulators' budget slowed by fiscal stalemate: An analysis of the U.S. budget for fiscal years 2012 and 2013*. St. Louis, MO: Weidenbaum Center at Washington University; Washington, DC: George Washington University Regulatory Studies Center.

Edison Electric Institute. 1989. Washington letter. Washington, DC (15 September).

Eggers, D. 2010. Impediments to achieving the vision. Paper presented at the Aspen Institute Energy Policy Forum, Aspen, CO (3 July).

Energy Information Administration. 1997. *Natural gas, 1996: Issues and trends.* Washington, DC: Energy Information Administration.

Federal Communications Commission. 2010a. *The broadband availability gap*. OBI Technical Paper No. 1. Washington, DC: Federal Communications Commission.

———. 2010b. *National broadband plan: Connecting America.* Washington, DC: Federal Communications Commission.

———. 2010c. *Statistics of communications common carriers 2006/2007 edition.* Washington, DC.

Florio, M. 2007. Electricity prices as signals for the evaluation of reforms: An empirical analysis of four European countries. *International Review of Applied Economics* 21(1):1–27.

Fox-Penner, P. S. 2010. *Smart power.* Washington, DC: Island Press.

Goel, R. K. 2000. Price-cap regulation and uncertain technical change. *Applied Economic Letters* 7(11):739–742.

Grobman, J. H., and J. M. Carey. 2001. Price caps and investment: Long-run effects in the electric generation industry. *Energy Policy* 29(7):545–552.

INGAA Foundation. 2009. *Natural gas pipeline and storage infrastructure projections through 2030.* F-2009-04. Washington, DC: Interstate Natural Gas Association of America.

Jamison, M. A. 2009. Towards new regulatory regimes in globalized infrastructure. In *Internationalization of infrastructures*, ed. J.-F. Auger, J. J. Bouma, and R. Kunneke, 257–273. Delft, The Netherlands: Delft University of Technology.

———. N.d. *Regulation: Price cap and revenue cap.* Gainesville, FL: Public Utility Research Center, University of Florida.

Kahn, A. 1971. *The economics of regulation: Principles and institutions.* Cambridge, MA: MIT Press.

Kerin, P. 2012. In whose interest? *Network* (publication of the Australian Competition and Consumer Commission) 43(March):1–7.

Kihm, S. 1991. Why utility stockholders don't need financial incentives to support demand-side management. *Electricity Journal* 4(5):28–35.

King, S. P. 1998. Principles of price cap regulation. In *Infrastructure regulation and market reform: Principles and practice*, ed. M. Arblaster and M. Jamison. Melbourne, Australia: Competition and Consumer Commission.

Kingdom, W., and V. Jagannathan. 2001. *Utility benchmarking: Public reporting of service performance*. Washington, DC: World Bank.

Kwoka, J. E. 2005. Electric power distribution: Economies of scale, mergers, and restructuring. *Applied Economics* 37(20):2373–2386.

Lavado, R., and C. Hua. 2004. An empirical analysis of the Averch-Johnson Effect in electricity generation plants. Working Paper No. 7. Honolulu, HI: East-West Center.

Liston, C. 1993. Price-cap versus rate-of-return regulation. *Journal of Regulatory Economics* 5:25–48.

Loube, R. 1995. Price cap regulation: Problems and solutions. *Land Economics* 71(3):286–298.

Lyon, T. P. 1994. Incentive regulation in theory and practice. *Topics in Regulatory Economics and Policy Series* 18:1–26.

———. 1995. Regulatory hindsight review and innovation by electric utilities. *Journal of Regulatory Economics* 7(3):233–254.

———. 2007. Why rate-of-return adders are unlikely to increase transmission investment. *Electricity Journal* 5:48–55.

Marques, R. C., and S. Berg. 2010. Revisiting the strengths and limitations of regulatory contracts in infrastructure industries. *Journal of Infrastructure Systems* 16(4):334–342.

Mathios, A. D., and R. P. Rogers. 1989. The impact of alternative forms of state regulation of AT&T on direct-dial, long-distance telephone rates. *RAND Journal of Economics* 20(3):437–453.

McDermott, K. A., C. R. Peterson, and R. C. Hemphill. 2006. *Critical issues in the regulation of electric utilities in Wisconsin*. Thiensville: Wisconsin Policy Research Institute.

Newbery, D. M. 1997. Rate-of-return regulation versus price regulation for public utilities. Department of Applied Economics, Cambridge University, U.K. (14 April).

North American Electric Reliability Corporation. 2011. *2011 long-term reliability assessment*. Atlanta, GA: NERC.

Office of the Gas and Electricity Markets. 2010. *RIIO: A new way to regulate energy networks*. Factsheet 93. London.

Office of Water Services. 1994. *Future charges for water and sewerage services*. Birmingham, U.K.

Peltzman, S. 2004. *Regulation and the natural progress of opulence*. Washington, DC: AEI-Brookings Joint Center for Regulatory Studies.

Pfeifenberger, J. P., and D. Hou. 2011. *Employment and economic benefits of transmission infrastructure investment in the U.S. and Canada*. Washington, DC: Working Group for Investment in Reliable and Economic Electric Systems.

Pollock, J. 2010. Streamlined ratemaking: Recognizing challenges for consumers. *Electricity Journal* 23(9):7–12.

Porter, M. E., and S. Stern. 2011. National innovative capacity. In *Global competitiveness report, 2001–2002*. Oxford, U.K.: Oxford University Press.

Robinson, H. M. 1932. *Public utilities and the people*. Dallas, TX: B. Upshaw.

Roques, F. A., and N. Savva. 2009. Investment under uncertainty with price ceilings in oligopolies. *Journal of Economic Dynamics and Control* 33(2):507–524.
Sappington, D. E. M., J. P. Pfeifenberger, P. Hanser, and G. N. Basheda. 2001. The state of performance-based regulation in the U.S. electric utility industry. *Electricity Journal* 14(8):71–79.
Sappington, D. E. M., and D. L. Weisman. 2010. Price cap regulation: What have we learned from 25 years of experience in the telecommunications industry? *Journal of Regulatory Economics* 38(3):227–257.
Schumpeter, J. A. 1934. *The theory of economic development.* Cambridge, MA: Harvard University Press.
———. 1942. *Capitalism, socialism and democracy.* New York: Harper.
Seo, D., and J. Shin. 2011. The impact of incentive regulation on productivity in the US telecommunications industry: A stochastic frontier approach. *Information Economics and Policy* 23(1):3–11.
Silverstein, A. 2011. *Transmission 101.* NCEP Transmission Technologies Workshop, Denver, CO (20–21 April).
Trebing, H. M. 1963. Toward an incentive system of regulation. *Public Utilities Fortnightly* 72:22–39.
U.S. Energy Information Administration. 2004. *The basics of underground natural gas storage.* Washington, DC: U.S. Department of Energy.
U.S. Environmental Protection Agency. 2009a. *EPA's 2007 drinking water infrastructure needs survey and assessment.* EPA 816-F-09-003. Washington, DC: Environmental Protection Agency, Office of Water.
———. 2009b. *2006 community water system survey*. EPA 815-R-09-001. Washington, DC: Environmental Protection Agency, Office of Water.
———. 2010. *Clean watersheds needs survey, 2008: Report to Congress*. EPA-832-R-10-002. Washington, DC: Environmental Protection Agency.
Vogelsang, I. 2002. Incentive regulation and competition in public utility markets: A 20-year perspective. *Journal of Regulatory Economics* 22(1):5–27.
Wein, H. 1968. Fair rate of return and incentives: Some general considerations. In *Performance under regulation*, ed. H. Trebing. East Lansing, MI: MSU Public Utility Studies.
Wolak, F. A. N.d. *Price-cap regulation and its use in newly privatized industries*. www.stanford.edu/group/fwolak/cgi-bin/sites/default/files/files/Price-Cap%20Regulation%20and%20Its%20Use%20in%20Newly%20Privatized%20Industries_Wolak.pdf.
Wolf, C. 1993. *Markets or governments: Choosing between imperfect alternatives*. Santa Monica, CA: Rand.
York, D., and M. Kushler. 2011. *The old model isn't working: Creating the energy utility for the 21st century.* Washington, DC: American Council for an Energy-Efficient Economy.
Zeilig, N. 2011. Declining demand likely to continue beyond recession. *AWWA Streamlines* 3(20).

COMMENTARY

Timothy J. Brennan

In the true multidisciplinary spirit of the Lincoln Institute of Land Policy, Janice A. Beecher, a political scientist, has provided a superb review of the basic economics of infrastructure regulation. This leaves me, an economist, to add in some of the noneconomic factors that both motivate and influence the paths that infrastructure regulation can take.

Beecher's contribution serves well as a primer for the rationales, history, and methods of regulating the price of infrastructure services. The standard justification is that many infrastructure services are likely to be provided by monopolies because the high fixed costs associated with their installation—think water mains or local electricity distribution grids—will discourage more than one firm from entering the market. Because the public typically regards these services as essential—water and electricity again being excellent examples—such monopolists would be able to charge extremely high prices. Regulation can protect customers from exorbitant bills and prevent the reduction in purchases that comes about from such high prices.

The traditional method for controlling prices is to set them at the average cost of service, just enough to allow the infrastructure provider to earn a reasonable return on its investments. As Beecher notes, because this "cost-of-service" ratemaking stifles incentives to cut costs, regulators have adopted price caps and other methods that break the link between prices and costs, protecting consumers while allowing firms to profit from more efficient operations. Moreover, regulators are also concerned with protecting incentives to invest. Once fixed infrastructure costs are sunk, a regulator could in principle allow the firm to charge just enough to cover operating costs. Investors who see this coming would refuse to provide the infrastructure. To ensure against this, U.S. law strongly guarantees a "fair opportunity" to earn a "just and reasonable return."[1]

One way to add to Beecher's survey is to examine the boundaries of regulation. Not all infrastructure services are regulated; cable television, broadband Internet, and computer operating systems come to mind. For television and broadband, we have some competition because two originally incompatible wire networks (cable and telephone) fortuitously evolved to become competitors. With computer software, costs and capabilities change far too fast for regulation to make useful price determinations.

Another boundary issue is the regulation/competition line within infrastructure sectors. Leading examples include the breakup of AT&T into regulated local

1. A colleague from Australia, Darryl Biggar, observes that regulation similarly prevents the firm from taking advantage of investments that consumers might make, such as charging high electricity prices to those who have invested in electric heat.

service and competitive equipment and long-distance markets, deregulation of wellhead natural gas prices, and restructuring of the electricity sector with competing generators delivering power through regulated transmission and distribution lines. The rationale was to reap the fruits of competition wherever possible, but doing so presents a number of complex governance problems. To preserve competition in the open markets, regulators have to limit or proscribe the regulated firm from operating in those markets, creating difficult trade-offs between the benefits of competition and the cost savings and improved coordination from continued integration. In addition, rather than setting relatively simple end-user prices, regulators have to determine access charges paid by competing buyers. When buyers are competitors, they care more about ensuring that no one gets a discount than about whether overall prices are low, leading regulators to care as much or more about preventing discrimination than about keeping prices low overall.[2] Moreover, particularly in telecommunications, regulation can facilitate competition through mandatory, cost-based standardization and interconnection to ensure that all competitors can reap the benefits of being on the same network.

As the process of introducing competition within sectors unfolded, sector regulators found their responsibilities overlapping with antitrust authorities. For example, electric utility mergers are reviewed by state regulators, the Federal Energy Regulatory Commission, and the Department of Justice's Antitrust Division. This creates an institutional tension between regulators, who are inclined to find substitutes for markets, and antitrust enforcers, who are dedicated to letting markets work. In the United States, recent Supreme Court decisions have largely precluded antitrust enforcement in regulated sectors.

With regard to regulatory governance more broadly, regulatory authority in the United States is divided between the national government and the states. For example, the federal government has authority over interstate transmission and bulk power markets, while state utility commissions determine rates for distributing electricity and decide whether and how to regulate retail electricity rates. Another governance issue is whether the government will regulate a private infrastructure provider or will provide the service itself. Generally, but not universally, the former is typical for telephone and electricity service, while the latter holds for water, mail, roads, and local mass transit. A simple explanation for this complex distinction is that for some infrastructure service, concerns beyond control of monopoly, such as universal service or free access, may warrant public provision.

Regulation's justifications go beyond market power and potential expropriation to include the admittedly open-ended "public interest." One such consid-

2. Notably, the 1887 Interstate Commerce Act, the founding statute of U.S. federal regulation, was focused more on ensuring that each customer paid the same price than on the price itself.

eration involves promoting access to infrastructure services, including universal service obligations imposed on mail and telecommunications carriers, and setting limits on cutting off delinquent accounts for electricity, heat, and water. To maintain social equality in access, regulation includes assorted subsidies, such as equalizing mail rates for all distances, telephone rates in more expensive sparsely populated areas, and provisions to assist low-income households with energy purchases. A leading telecommunications concern is whether the public should have access rights to broadband and wireless services beyond those provided by the marketplace. But in recognizing the public interest, one also has to recognize political and economic arguments that the regulatory outcomes will tend to be biased toward the interests of the regulated firms and away from those of dispersed consumers, each of whom has little ability or interest in taking part in the process.

A final set of issues facing infrastructure regulators has significant effects on land use. Electricity regulators are increasingly charged with addressing environmental concerns, particularly through policies designed to promote renewable generation, foster energy efficiency, and, counter to their historical mandate, discourage electricity use. Along with effects on the atmosphere, particularly from greenhouse gas emissions, these policies can have significant effects on land use. The list includes increased hydrofracturing to produce relatively clean natural gas, the growth of both onshore and offshore wind farms, and centralized solar generation mirror farms. To get energy from these sources to the public, extensive transmission and delivery investments, taking up more land, will be needed. On the flip side, reduced use of coal will reduce the need to take up land through mining. In either direction, infrastructure regulation affects land policy specifically, as well as the larger economy and society for which an efficient and equitable infrastructure is crucial.