The Causes and Consequences of Growth In the Cable Television Industry

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Abstract

The cable television industry is a large, integral part of the information technology industry in the United States. The purpose of this paper is to describe the development of the cable television industry and analyze the institutional and economic determinants of its growth. As will be shown, the growth in the number of subscribers to cable television services was moderate from its inception until the late 1970s, enjoyed a period of substantial gain from that time until the mid-1980s, and subsequently flattened. While not inconsistent with the natural, unfettered development of nascent industries, the determinants of these periods of growth match closely with the developments in three related areas. These are (1) the seemingly boundless demand for new and varied video programming by consumers, (2) technological innovations in communication distribution technologies, including technological spillovers from other telecommunications industries, and (3) changes in the regulatory environment, or 'rules of the game,' governing both the structure of cost and the competitive environment in the industry. An ancillary goal of this paper is to also consider the implications of the existing institutional structure of the cable television industry in the context of the 'convergence' of telecommunications services mentioned above.

The cable television industry is a large, integral part of the information technology industry in the United States. The vast majority of cable systems provide 30 or more channels of programming to subscribers, aggregate industry program expenditures exceed $4 billion, and so-called 'cable programming networks' like ESPN and CNN are as commonly recognized as their 'big-three' broadcasting counterparts, ABC, CBS, and NBC. As both cause and consequence of this growth in services, the cable industry consists of over 11,000 systems offering service to over 96% of the nation's television homes, providing service to over 60% of them, and earning revenues of over $30 billion per year.

While now nearly ubiquitously available to households in the United States, cable television service has not always been so. The industry first developed as a complement to the conventional broadcast television industry in the early 1950s. 'Cable service' at this time arose to serve those communities just out of reach of broadcast signals and typically consisted of the retransmission of the handful of broadcast programming networks available nearby. Since this time, however, the number of subscribers to cable television services has grown considerably and, as suggested above, the associated programming provided on those services has steadily increased in both number and quality. Recent forays by cable systems into providing information services and telephony suggest that the industry is a leader – with the telephone and possibly utility industries – in the race towards 'convergence,' the provision of a full range of telecommunications services, including video, voice, and data transmission.

The purpose of this paper is to describe the development of the cable television industry and analyze the institutional and economic determinants of its growth. As will be shown, the growth in the number of subscribers to cable television services was moderate from its inception until the late 1970s, enjoyed a period of substantial gain from that time until the mid-1980s, and subsequently flattened. While not inconsistent with the natural, unfettered development of nascent industries, the determinants of these periods of growth match closely with the developments in three related areas. These are (1) the seemingly boundless demand for new and varied video programming by consumers, (2) technological innovations in communication distribution technologies, including

technological spillovers from other telecommunications industries, and (3) changes in the regulatory environment, or 'rules of the game,' governing both the structure of cost and the competitive environment in the industry.

An ancillary goal of this paper is to also consider the implications of the existing institutional structure of the cable television industry in the context of the 'convergence' of telecommunications services mentioned above. As is common among telecommunications industries, the long life the capital equipment required to provide cable television services introduces a path-dependence into industry development which has significant implications for long-run growth in the industry. Principle among these are the competitive consequences of multiple wireline communications infrastructures ('two wires to every home') and the inflexibility of the 'tree' cable network system architecture in providing advanced point-to-point communications services as required to provide many communications services.

The balance of this paper is organized as follows. We first specify what exactly **is '**cable television service' and what is meant by the 'growth' of the industry in light of the extreme heterogeneity across systems described by this definition. We then present a chronological history of the industry, highlighting the growth in both subscribers and services and recounting the technological and regulatory changes which impacted this growth. We then take a long view and provide a common theme for understanding economic growth in the industry built from the three economic and institutional determinants described above. In a final section, we turn our attention forward to consider the long-run implications of the existing institutional structure of the industry on tomorrow's telecommunications marketplace.

Definitions

According to the Code of Federal Regulations (CFR),[1] the 'service' provided by cable television systems is "the one-way transmission to subscribers of video programming..."[2] While concise, this definition masks a large and growing diversity in

[1] The Code of Federal Regulations is the source of all regulatory requirements in the United States.
[2] 47 C.F.R. 76.5.

the nature of the cable service different systems provide to subscribers In 1995, cable television systems had access to hundreds of different broadcast, cable, and premium programming networks; the capacity to provide anywhere from 12 to 150 of them; and the technology to bundle them into Basic, Expanded Basic, and Premium programming services for sale to consumers.[3] Possessing such different capabilities, faced with such choices, and operating in extremely diverse local geographic markets, it will come as no surprise that cable television systems differed quite considerably in the nature of the services that they offered.

To accurately describe cable television services, three principal features are highlighted: the technology underlying the provision of multichannel video programming by cable, the number and popularity of the programming networks provided, and the ways in which these networks are sold to consumers. Cable system technology is fundamental to the nature of cable service as it limits the capabilities of the system. Systems using older technologies have more limited channel capacities and are less able to provide more programming networks than new systems or those that have upgraded to the latest technology. On the other hand, while capacity is clearly important, at least to the system operator, it is probably instead what the operator places on that capacity, the number and identity of the programming provided, which motivates consumers to subscribe to cable. More networks in general, and more popular networks in specific, reflect the provision of a higher quality cable service. Finally, the way these networks are sold to consumers is important as it defines the structure of cable service. In particular, system decisions to offer more or fewer services defines the set of cable choices available to consumers and decides the final price-programming tradeoff they face for those choices.

In the context of this definition of cable television service, 'growth' in the industry consists of two components. First, growth may be defined conventionally to consist of the increase in the number of subscribers to cable television service(s) over time. This type of growth represents the increase in both the availability of cable television to households and the increase in the consumption of cable service(s) given that availability. In addition, however, we define growth also to include increases in the

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[3] All of the terms here will be defined below.

number of services provided by cable systems and in the number of programming networks provided on those services. Each of these latter types of growth represents an increase in the 'quality' of the menu of cable television services provided consumers and is therefor an important component of the economic growth of the industry.[4]

As both the technological limits and the regulatory constraints systems face have changed over time, the characterization and analysis of each of these types of industry growth depends critically on the era of analysis. As a result, we present a chronology of the development of cable services, highlighting both the increase in the total number of subscribers to cable and the development of the technologies used, the programming offered, and the structure of the services offered as the industry has changed over time. This chronological viewpoint has the advantage of presenting first the fundamental features of cable television technology that remain in effect today, then introducing, as they became available, the breadth of programming options faced by current subscribers to cable television service, and finally chronicling the impact on subscriber growth of programming and service growth.

The Limits of Cable Television Technology: 1950-1979

Commercial cable television service began in 1950 in Lansford, Pennsylvania.[5] At this time, broadcast television programming was becoming increasingly popular, prompting significant gains in viewership and television sales.[6] The supply of outlets for broadcast programming, however, was largely fixed -- regulation of the electromagnetic spectrum by the FCC in 1945 had resulted in the allocation of enough spectrum for 12 television channels for licensing to television stations across the country.[7] To prevent interference from the broadcasting of programming on adjacent channels, providing insufficient geographic separation between broadcasters, or permitting too high an

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[4] More precisely, they constitute an increase in the quality and diversity of cable television services. For simplicity, we refer to both of these as an increase in quality.

[5] Much of the early history here draws from Crandall and Furtchgott-Roth (1996), Besen and Crandall (1981), and Foster (1982).

[6] See Foster (1982), Ch. 5, for an introductory description of the history of broadcast television.

[7] See Noll, Peck, and McGowan (1972), pp. 3-5 for a concise summary of the history of broadcast television regulation.

antenna or too powerful a transmitter, the FCC in 1952 set aside allocations of these licenses in predetermined geographic station assignments. In so doing, they pursued the policy of 'localism', or allocating assignments such that as many communities as possible would have at least one local television station.[8] As a consequence of this policy, coverage by broadcast signals of the entire nation was not quickly achieved. In conjunction with interference from natural features of the terrain, such as hills, dense forest, or buildings, this left many homes without the ability to clearly receive broadcast programming.[9] [See Figure 1-1(a)]

To accommodate this unsatisfied demand for broadcast programming, enterprising individuals placed an antenna on a tall hill or tower, received the television signals broadcast from the nearest town, and transmitted them via coaxial cable to homes in the afflicted community. The result: Community Antenna Television (CATV) Systems. Despite the myriad technological improvements in cable television technology since this time, the transmission of a video signal by cable remains the defining characteristic of a cable television system.[10] A brief discussion of the technological requirements of providing video programming by cable follows.

The principal components of these early cable systems, shared today by all systems, were the headend, cable plant, and customer terminations (television receivers). [See Figure 1-1(b)] Television signals, like FM radio signals, operate on the principle of frequency modulation. An electromagnetic signal at a given frequency serves as the base (carrier) wave for the programming. A video picture is then translated into electrical energy (equivalently, an electromagnetic wave) by means of a video camera.[11] The

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[8] Ibid, pp. 99-120.

[9] An alternative allocation mechanism which would have increased overall coverage at the expense of localism would have been to assign fewer, regional, licenses, but permitted taller antennas and more powerful transmitters. Another, pursued in other countries, was to install as many low-power translators (low power television rebroadcast transmitters) as required to achieve adequate coverage. See Switzer (1983), p. 19.

[10] CATV systems graduated to the more generally applicable title of cable television systems as they began to provide additional programming beyond broadcast networks.

[11] The technological process embodied by a video camera is straightforward. When light waves enter a camera, they strike thousands of light-sensitive elements (pixels), each of which reacts to the amount of light it 'perceives'. An electron gun scans these pixels and records the number of electrons reflected from each. More or fewer electrons are reflected according to the amount of light striking the pixel. In a standard television picture, there are 525 rows of pixels, each of which is scanned 30 times a second by the

information captured in this electromagnetic wave (the signal) is then imposed on the carrier wave by varying the frequency of the carrier according to the frequency of the signal.

Video images contain a great deal of information and therefore require a wide band of frequencies (bandwidth) in order to accommodate it all. A standard analog television picture can be broadcast on a 6 MegaHertz (MHz) channel, a capacity that could accommodate 30 FM or 600 AM radio channels. In 1945 the FCC had allocated electromagnetic spectrum in the Very High Frequency (VHF) range (30 to 300 MHz) for the transmission of television programming.[12] Existing coaxial cable technology also transmitted frequencies in the VHF range and therefore provided a natural distribution facility for CATV systems. The available broadcast signal would be received by a powerful antenna connected to the cable system's headend. The signal would here be amplified (to combat the signal loss (attenuation) caused by transmission over cable), and passed to the cable plant for distribution to homes. This signal would periodically receive further amplification as needed to ensure a high-quality picture at each customers television receiver. Since the television receivers themselves were designed to receive signals in the VHF range, cable operators distributed each television channel at its assigned frequency, implying no translation (modulation) of the cable signal was required.

Cable operators soon found that they had a distinct advantage relative to their broadcasting counterparts. While two broadcast signals on adjacent channels would cause interference, the same was not the case on cable.[13] As a result, operators found that they had capacity for 12 channels of programming but were often only providing programming on the few of them for which broadcast programming was locally available.[14] Various alternative were tried to find valuable uses for this excess capacity.

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electron gun. The result is an electrical current which fluctuates in direct proportion to the flow of electrons from the electron gun, and thus to the picture on the screen.

[12] Specifically, channels 2 were assigned to occupy 54-72 MHz, channels 5-6 to occupy 76-88 MHz and channels 7-13 to occupy 174-216 MHz.

[13] Subject to minimal separation requirements.

[14] More accurately, coaxial cable could pass 12 of the channels that could be received by existing television receivers. The cable itself had significantly greater capacity. See f.n.

Some early systems ran live video of a clock to tell the time. Later, tele-text permitted operators to pass on news of local events and/or the weather. What consumers really wanted, however, was more programming. To satisfy this demand, cable operators as early as 1951 began importing programming from markets beyond their immediate vicinity. Microwave relays in sequence, each with a range of 20-30 miles and a 250 MHz bandwidth, provided a natural medium-range distribution technology. By 1962, 50 of the approximately 800 cable systems were importing signals from distant television stations.[15]

By 1966, prospects for the development of cable television as an alternative distribution medium to broadcast television appeared strong. Figures 1-2 and 1-3 show the growth in the number of operating systems and subscribers from the early 1950s to 1996. Between 1950 and 1966, systems were introduced at an annual rate of 24.9% per year and subscriber growth averaged 40.1% per year.[16] 1966 was a watershed year in the development of the cable television industry, however. In March of 1966, the FCC imposed a freeze on the importation of broadcast television signals by cable television systems into the top-100 television markets without satisfying the requirement that such carriage "would be consistent with the public interest, and particularly with the establishment and healthy maintenance of UHF television broadcast service."[17] As seen in Table 1-1, over the next six years, the industry response to these regulations was to

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[15] The importation of distant broadcast signals would become an increasingly important source of early demand for cable. [Noll, Peck, and McGowan (1973), Park (1972), Comanor and Mitchell (1971)] The natural question to ask is, 'Why cable? Why couldn't this demand be satisfied by the development of further *broadcast* distribution outlets within each market?' As mentioned earlier, interference prevented broadcasting on adjacent channels or with a certain range of another broadcaster on the same channel. As a practical matter, this limited most urban areas to 2-3 usable VHF channel assignments. The FCC had recognized this weakness and by 1952 had allocated additional spectrum in the UHF range (300 to 3,000 MHz) to address these bottleneck conditions. (Specifically, the FCC set aside spectrum for channels 14-83 at 470-890 MHz.) These channel allocations, however, proved largely ineffective at breaking the bottleneck. UHF frequencies were technically inferior to their VHF counterparts: they were inefficient, requiring more power to reach a given distance, more susceptible to interference, and, worst of all, required consumers who owned existing television receivers to purchase a separate antenna to enable them to be viewed. As a consequence, and despite further attempts by the FCC to favor the development of UHF broadcasting, [see below] cable television soon became the preferred distribution technology for programming beyond the three principal broadcast networks, an advantage relative to broadcast programming that has only grown since that time. See Noll and Owen (1983) for a detailed discussion of the political economy of broadcast regulation.

[16] See also Table 1-1 for annual growth rates after 1960.

reduce the introduction of new systems from an annual rate of 16.1% to 10.4% per year. As a partial consequence of this decline, in 1972 the FCC sought to balance broadcasting and cable television interests by permitting some limited importation of broadcast signals into the top-100 television markets.[18] Further regulations, however, were also imposed.[19] System growth remained slow, averaging only 6.5% over the next 7 years. Importation in specific, and new programming in general, appeared to be critical to the sustained growth of the industry.

The next decade saw a gradual reversal of the restrictive regulations imposed by the 1972 Cable Rules.[20] Indeed, by 1979, signal importation limitations had been lifted and all available over-the-air broadcast signals and several imported broadcast networks were now regularly being offered to subscribers as cable television service. Figure 1-4(a) recaps how cable systems allocated available programming to services in this early period of industry development. Note the uniformity of service choices facing consumers during this period of industrial development -- they either purchased cable service or they did not. The growth in programming choices over the next decade would bring a substantial change to this simple decision.

The Era of Programming Growth: 1979-1991

Two of the many rulings produced by the courts and regulators in the period 1974-1979 proved particularly important for the future development of the cable television industry. The first regarded regulations restricting the ability of the FCC to restrict the sale of 'pay cable', programming offered on a pay-per-program or pay-per-channel basis.[21]

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[17] 2 FCC 2d at 782 as cited in Besen and Crandall (1981), p. 90.

[18] In particular, in markets 1-100, cable systems were permitted to import 2 additional independent stations.

[19] In particular, systems were required, inter alia, to carry all local broadcast signals available in their franchise area (the "Must-Carry" requirement), to provide a minimum of 20 channels of service, to originate programming, and to provide free public, educational, and governmental access channels ("PEG channels). See 2 FCC 2nd (1972).

[20] See Besen and Crandall, op. cit. 2.

[21] The concept of fee-supported, rather than advertising-supported, television had long been recognized in the broadcasting industry. As early as 1950, Zenith was granted a limited trial for its Subscription Television product, Phonevision. [See Noll, Peck, and McGowan (1973), Chap. 5, for a discussion of the developmental and regulatory history of Subscription (broadcast) Television] Regulatory permission for pay-per-program television, over either broadcast or cable distribution paths, was slow to develop, however. As of 1973, there were only 4 operating STV stations. Between the period 1968-1975, the FCC restricted

In 1975, Time, Inc. introduced Home Box Office (HBO) for the purpose of providing feature films on an advertising-free, fee-supported cable network for distribution over it's New York City cable systems. Time was soon distributing HBO to neighboring systems over microwave relays and brought suit against the FCC to prevent continued content restriction.[22] In 1977, the courts vacated all content limitations of pay-per-channel programming on First Amendment grounds and further suggested that the FCC had no grounds for any regulation of pay cable. Chastened by the courts, the FCC made no further effort to regulate the medium, freeing systems to provide on cable highly valued programming that was not available on broadcast television.

The second important ruling to impact the development of cable television was a 1977 ruling permitting cable systems to receive satellite signals on 4.5 meter, rather than 9 meter, earth stations. As the smaller satellite dish systems were significantly less costly to construct that their predecessors, cable systems were now able to receive programming via satellite on a much more economical basis. This reduction in costs at the system level had far greater implication for the (input) programming market, however. As systems invested in the inexpensive satellite receivers, programming could now be distributed as easily to thousands of systems nationwide as to one.[23] Since the production of programming itself is a public good, this immediate and sharp introduction of a distribution technology with sizable economies of scale revolutionized the availability of programming for cable systems. [24] Program producers, like HBO, could now afford to share their costs of production **and** distribution over a much larger set of cable systems than had before been possible using microwave distribution technologies. As a consequence, more money could be invested in higher quality program production.

In response to these technological and regulatory developments, program

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both broadcast stations and cable systems from providing feature films and sporting events on subscription channels in order to protect the 'siphoning' of such programming from broadcasters. [Besen and Crandall (1981), p. 101.]

[22] See H.B.O. vs. FCC, 567 Fd 2nd 9. (1977)

[23] Such programming is typically distributed by geo-synchronous satellites. Satellite coverage areas (footprints) naturally depend on their location above the earth, but can exceed the geographic region of the entire United States.

[24] See Owen and Wildman (1991) for a detailed discussion of the economics of program production and distribution.

producers began to introduce national programming networks for distribution specifically on cable. HBO began immediately after its legal victory over the FCC in 1977. Ted Turner, through his affiliated Satellite Services Corporation, began offering the programming of a small, Atlanta UHF station, WTBS, nationally to cable systems for a modest fee in 1979. He soon followed with the introduction of an all-news channel, Cable News Network (CNN). Entertainment Sports Programming Network (ESPN) began an all-sports channel in 1980. In all, no less than 13 of the 15 most widely available advertising-supported programming networks, and all of the top 5 most widely available fee-supported programming networks, were launched between 1977 and 1984. (See Tables 1-2(a) and 1-2(b)). Growth in the availability of programming networks for distribution over cable has matched this explosive beginning: the number of such networks has grown from 8 in 1978 to 47 in 1984, to 99 in 1993.[25]

This widespread introduction of programming networks for distribution on cable required several technological changes in the provision of cable service. First, capacity on cable systems was required to provide these new programming networks. Standard coaxial technology, recall, transmitted at frequencies between 30 and 300 MHz, sufficient capacity for approximately 36 channels.[26] While many of these would be claimed by the Must-Carry and PEG provisions of the 1972 Regulations,[27] there remained still capacity for many new networks. The technology to view these new channels was not in place, however. Standard television sets were designed to receive channels 2-13 and 14-83, which occupied only *portions* of the VHF and UHF bands. For example, a signal occupying the 48-54 MHz range (below Channel 2) would be unable to be tuned by existing television receivers. To exploit the full range of frequencies available on coaxial cable, then, required two steps. First, upon reception of broadcast and satellite-distributed signals at the headend, these signals had to be translated (modulated) to the frequencies

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[25] Hazlett (1995).

[26] Without any interference concerns, a standard coaxial cable could theoretically provide up to (270/6) = 45 broadcast television channels. In practice, however, providing buffers between channels, increased attenuation at the high end of the spectrum, and providing bandwidth for upstream transmission capability (as required in the 1972 Cable Rules) limited systems to capacities between 36-39 channels.

[27] See f.n. 13.

passed by the cable.[28] These frequencies had to then be again translated at the customers home and passed to a channel recognized by the consumer's television set. This simple electronic process introduced a new element, the converter box, to the customer home. The customer would choose the desired station on the converter, causing it to select the appropriate frequency on the cable and to translate it to a frequency recognizable by the television (usually channel 3 or 4).[29]

The advent of pay programming networks also introduced a new element to cable television service : choice. Since pay networks were optional for subscribers, cable systems were faced with a subscriber base purchasing different sets of services. This heterogeneity demanded a method of excluding pay programming to non-subscribers. The initial solution pursued by systems was traps, electro-mechanical devices placed on the lines of all such non-subscribers which physically blocked the incoming premium signal.[30] Over time, however it became apparent that there was substantial, permanent turnover (churn) in premium programming subscriptions. Since a service technician was needed to visit the connection to the subscribers home (drop) at each subscription change, traps were fairly costly to maintain, particularly when systems offered more than a few premium networks. Exploiting the presence of converters in homes, systems began instead to scramble premium programming. When customers added a premium subscription, only the converter would then need to be modified to unscramble the signal prior to passing it to the television. Relative to traps, this method was less costly and permitted systems more flexibility in adding additional premium programming.

The widespread introduction and carriage of new programming networks changed the nature and popularity of cable television service. Advertising-supported non-broadcast networks, by virtue of their association with cable, became known as *cable programming networks* while fee-supported non-broadcast networks became known as

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[28] In particular, programming broadcast on the UHF band had to be modified to be carried on the VHF band passed by the cable.

[29] Later, television manufacturers themselves began making 'cable-ready' television receivers with tuners capable of making such translations automatically.

[30] Due to the high cost of installing and maintaining traps, their use was limited to those programming networks (i.e. premium networks) that could command a price sufficient to justify their cost. See Figure 1(b).

premium programming networks. These latter were typically offered on an individual basis to subscribers on what became known as *premium cable service*, while the former networks were bundled with whatever broadcast programming was offered on what became known as *basic cable service*. To purchase a premium service, consumers were first required to purchase the basic service.[31]

Figure 1-4(b) recaps the allocation of programming to services during this period of cable television development. As suggested earlier, with the introduction of premium programming services, consumers began to face some choices with respect to the exact nature of the cable services that they purchased.

Fueled by the growth in programming and services outlined above, the industry expanded at rates not seen since the early 1960s. Table 1-3 chronicles the growth in the number of new systems as well as total subscribers to cable television service between 1979 and 1991.[32] While system growth was not immediately strong, after 1981 the industry grew at a rate no slower than 5.3% per year and averaged 8.2% per year over the 12 year period. Subscriber growth was even greater, averaging 11.3% per year over the same period. By the end of the period, there were over 50 million cable subscribers, more than half of the number of U.S. television households.

While the scope of federal regulation had diminished by 1979, state and local regulations remained. These restrictions were embodied in franchise agreements between most cable system and the governmental body (usually a municipality) responsible for the ways and means of a geographic area, access to which was needed by the system in order to provide service. These agreements specified the proposed terms and conditions of cable service, at times including the required channel capacity of the system, Public, Educational, and Governmental (PEG) access channel requirements, the services offered, and the programming offered and price charged for those services. In exchange, the cable system was typically granted an exclusive franchise to use municipal rights-of-way to lay

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[31] This practice, known as tying, has persisted since that time. We explore in Chapter 3 the profit and welfare consequences of abrogating this restriction.

[32] 1991 was the last full year before reregulation of the cable industry with the passage of the 1992 Cable Act.

cable plant.[33] By 1984, however, the price terms of these contracts came under attack as the "deregulation revolution" swept through Congress.[34] Convinced that three or more over-the-air broadcast television signals provided a sufficient competitive alternative to cable television service, Congress passed the 1984 Cable Act to free the vast majority of cable systems from all price regulation.[35]

Unlike other industries party to the 'revolution', however, entry into cable television markets was limited,[36] and where these other markets witnessed substantial price competition and subsequent aggregate price declines, cable prices increased dramatically. Figure 1-5 chronicles the increase in both nominal and real cable television prices, as measured by the Consumer Price Index for Cable Television Service, between December, 1984 and July, 1995. As indicated in Table 1-3, between December, 1986, the month rate deregulation took effect, and October, 1992, the month further rate regulations were legislated, cable prices increased at an annual rate of 8.2% in nominal terms and 3.7% in real terms.[37]

As a consequence of these price increases, Congress in October of 1992 passed the 1992 Cable Act, one of the principal purposes of which was "to provide increased consumer protection ... in cable television markets."[38] Pursuing this mandate, the Federal Communications Commission (FCC) promulgated a set of rate regulations which permitted franchise authorities, upon certification, to cap the per-channel prices cable systems could charge for most types of cable television service.[39]

The Era of Service Diversification: 1991-present

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[33] Cable franchise agreements arose at the inception of the industry in response to a lack of federal regulatory requirements. See Prager (1986) for a detailed account of the history of cable franchise agreements.

[34] See Kahn (1991), pp. xv-xxiii for a discussion of the deregulatory movement in the U.S. in the 1980's.

[35] Other terms of franchise agreements, e.g. PEG Access channel requirements, remained in effect. See GAO (1989) for a review of the regulations imposed by the 1984 Cable Act.

[36] As of 1992, 97% of cable systems were the sole providers of multi-channel video programming in their franchise areas. See Hazlett (1990).

[37] These conclusions were confirmed in a series of General Accounting Office price surveys (GAO 1989, 1990, 1991), which documented that prices rose 56% in the four-year period between November, 1986 and April, 1991.

[38] Cable Act (1992).

[39] See Chapter 4 for a detailed description of the regulations imposed.

Buoyed by the growth in subscribership and prices in the 1980s, systems continued to invest in new technologies in order to provide new services. Principal among these was pay-per-view, programming offered on a per-program, rather than per-channel basis. The allure of pay-per-view programming rested with real-time subscriber interaction: customers would be able to make their purchase decision and immediately view the desired programming. Permitting the implementation of pay-per-view offerings was the advent and widespread diffusion of addressable converter technology in the 1980s and 1990s. Each converter was coded with an electronic address recognizable from the headend. Bandwidth was then allocated on the cable for simple, upstream signaling capabilities, such that when a customer desired a pay-per-view program, they keyed their choice into the converter, it notified the headend, and an electronic key was sent to that converter enabling it to unscramble the desired program.

Armed with a convenient, low-cost method of subscriber exclusion, systems began to introduce even more new services. Recognizing that some consumers might desire just over-the-air broadcast programming while others would want the full portfolio of broadcast and cable programming networks, some systems split conventional basic service into two components. All over-the-air broadcast programming, Public, Educational, and Governmental access channels, and (perhaps) a few selected cable programming networks were bundled together and offered as a newly-defined basic service.[40] The balance of cable programming networks were bundled together and offered as *expanded basic service*. Some systems even began to offer multiple tiers of expanded basic service.[41]

The introduction of pay-per-view and expanded basic services, in addition to further growth in the provision of premium services, accelerated the scope of consumer choice in cable television markets. Figure 1-4(c) recaps the typical allocation of the different types of programming to the different types of cable service mentioned in this section and provides a snapshot of contemporary cable television service options for systems that do and do not offer expanded basic services. As indicated, an individual

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[40] In the industry, such services were often called limited basic services.
[41] See Table 1-5.

cable subscriber may be confronted with a menu of choices including several tiers of basic service and even more premium services.

Determinants of Growth in the Cable Television Industry

The description of each of these periods of growth in the cable television industry has highlighted many of the diverse factors which have contributed to each. The purpose of this section is to highlight three common institutional and economic characteristics which were critical to the timing and extent of this growth. In order of consideration, they are the demand for varied programming by consumers, technological innovation in cable distribution technology, including spillovers from other telecommunications industries, and, most importantly and most consistently, the regulatory environment restricting the supply behavior and competitive conditions of cable markets.

Demand for Varied Programming

Driving the growth of both subscribers to cable television services and of the services themselves has been seemingly insatiable consumer demand for more and varied programming. The original impetus for individuals to provide Community Antenna Television was to provide consumers with the programming available in nearby communities but unavailable to the community under consideration. Still within this early period, the signals of broadcast networks imported from distant television markets via microwave relay also provided a strong incentive for consumers to subscribe. Indeed, the period of tremendous subscriber growth of the early 1980's described in Table 1-3 was driven by the provision of newly-available cable and premium programming networks not otherwise available elsewhere. More recently, consumer demand for pay-per-view programming has continued this trend.

The dependence of economic growth on a strong, sustaining demand for the products of consumer desire is a near-necessary component to sustained industrial growth. The ability of the entrepreneur to reap the rewards of innovative activity through the sales of consumer products embodying those innovations prompts the initial efforts to innovate. As the examples of the previous paragraphs demonstrate, in the context of

cable television programming, demand for more and varied programming has been a consistent, sustaining source of demand both for sales of existing services as well as for sales of new services containing new programming. Indeed, talk in the industry trade press of 500-channel systems and video-on-demand all speak to the motivation to satisfy consumer desire for just the programming they desire at just the moment they desire it.

Technological Limitations to Cable Supply

While this demand for the products embodying innovative activities is a necessary condition for industrial development, it is by no means sufficient. What is additionally required are the economic and institutional forces to permit the supply of these products. Both limited technological capabilities and regulatory constraints each have limited the ability of systems to provide as flexible and popular a portfolio of programming as would be desired by each individual subscriber. With respect to the former category, these limitations have historically come from two sources: limitations in the availability of programming to provide on existing capacity and limitations on the capacity itself.

The early period of cable's development was characterized by limitations in the availability of desirable sources of programming. While nascent cable systems had capacity for as many as 12 channels of broadcast programming, they often only provided the handful of networks available over-the-air in their cable market. As described above, where economically and technically feasible, early systems attempted to fill this capacity by importing additional broadcast signals from distant broadcast markets via microwave relay or originated their own programming. Since the costs of such programming could only be shared over the base of subscribers to each individual system, the quality of this local origination was markedly low.[42]

The combined watershed events of the development of satellite technology by the early 1980s and the widespread diffusion of receive-only earth stations to exploit this technology radically changed the restrictions on the supply of desirable programming to subscribers. With the development of myriad general- and special-interest programming

[42] As mentioned in the previous sections, sometimes this 'programming' consisted only of a live video of a clock to provide the time.

networks spurned by the economies of scale in production and distribution, systems soon faced a problem in distinct opposition to the one they had faced 10 years earlier. Instead of not being able to obtain programming of sufficient quality to provide on their existing capacity, systems were now unable to find existing capacity to provide available high-quality programming. The underlying technological capabilities of the coaxial cable limited systems to a capacity of approximately 36 channels of programming. Additional capacity had either to come from laying a second coaxial cable, an expensive proposition, or exploiting other distribution technologies with greater capacity.[43]

The limitation of existing capacity to provide the programming desired by consumers described above has recently had important incentive effects on the development of alternative technological solutions. Two solutions appear to have the greatest promise. The first of these is that of digital compression. Recall that an existing analog television signal reads and transmits a video image 60 times per second. Since much of what is shown does not vary this quickly, much of each of these images is duplicated from frame to frame. Digital compression exploits this fact by first translating the analog signals to digital signals and then exploiting computer technology to identify what is duplicated and transmitting only that information that changes between each frame. Due to the tremendous amount of duplication inherent in an analog signal, up to only $1/10^{th}$ of the bandwidth is required to send a compressed digital signal as would be required to send its uncompressed analog counterpart. Such compression rates, if implemented on a cable system, would then permit existing cable infrastructures to provide up to 10 times as many programming networks. The second technological alternative is that of fiber optic distribution technology. Fiber optic threads transmit electromagnetic signals using light waves as carriers instead of electrical impulses. Due to the wide range of frequencies available in the spectrum of visible light, these fibers

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[43] Developments since this time have only reinforced this constraint. As media companies have continued to diversify their distribution outlets to create a larger pool of consumers over which to share costs, program networks have proved a potentially lucrative candidate. (Examples abound in the specialized categories of news and sports. CNN/SI, MSNBC, Fox/TCI and others are all competing to distribute news and sports information over cable.)

have tremendous bandwidths.[44] On a per-user basis, however, fiber optic technology is extremely expensive and appears not to be economically feasible at the current time.[45]

In addition to these technological impacts, capacity limitations have also had competitive impacts in the market for multi-channel video programming. In particular, consumer dissatisfaction with 36 channels of programming has spurred the development of Direct Broadcast Satellite (DBS) systems. Embodying the same technologies used by cable system's themselves, programming is broadcast directly to the consumer home, bypassing the need for distribution via coaxial cable. Driving the growth in DBS systems has been the recent availability of small, inexpensive receive-only earth stations. At an initial investment of $200 plus a monthly cost comparable to that of cable service, DBS is the first widespread competitor to many local monopoly cable systems.

This dependence of the supply of multi-channel programming, either by cable or by DBS, on satellite distribution technology represents an important example of the importance of technological spillovers on economic growth. Satellite technology itself was originally developed for long-range point-to-point telephone transmission. Given the cost and reliability problems associated with undersea cables, satellite transmission of telephone signals represented a low-cost, high-reliability method of signal carriage. Only later was it realized that the inherent point-to-multi-point nature of satellite broadcasting was ideal for the distribution of video programming as well.

Regulatory Constraints on Cable Supply

Limitations to the supply of cable programming caused by regulatory constraints have probably been the most important determinant of growth the cable television industry. The 1972 Cable Rules limited the ability of cable systems to import distant broadcast programming networks, thereby also limiting the ability of systems to arrange for the most desirable portfolio of programming available. These rules also imposed local origination requirements, upstream signaling capabilities, and broadcast

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[44] As a consequence, fiber optic cables form the backbone of high-speed telephone and telecommunications networks.

[45] 'Fiber-to-the-home' is currently economically infeasible. 'Fiber-to-the-neighborhood' has been explored by some cable systems.

programming carriage requirements, each of which limited the capacity available to cable systems to provide other, more desirable programming networks. Similarly, the rate limitations imposed by the terms of cable franchise agreements limited the ability of systems to reap the rewards of providing more programming or programming of a higher quality. It is no accident that the tremendous growth of subscribers and services described in the last section occurred in the period after the passage of the 1984 Cable Act which removed all such price limits for the vast majority of cable systems.

These definition of the 'rules of the game' have clear and important implications for the ability of cable systems to design the optimal portfolio of programming and services and to price them as they see fit. Moreover, entry restrictions in cable markets embodied in cable franchise agreements permitted, until recently, the successful appropriation of the rewards of providing new and varied programming networks, spurring their development. Recent regulatory efforts, however, have focused on *promoting* competition in markets for video programming and include the diffusion of DBS systems and the introduction of rules, in the 1996 Telecommunications Act, to permit the distribution of video programming by local telephone companies. These rules could, depending on the extent of economies of scale of these alternative distribution technologies and the diffusion of programming networks over these distribution technologies, promote further growth in the development of programming to satisfy consumer demand.

What the Future Holds: Cable Television Development and Path-Dependence

A recurring theme in the economic growth of telecommunications industries is the dependence of tomorrow's growth on economic decisions made today. This *path-dependence* stems from the long life of the capital stock used to supply telecommunications services.[46] This feature is as true for cable television systems as for telephony as the existing coaxial cable infrastructure currently in use by the vast majority of cable television systems will be used for many years to come.

This dependence of the future growth of an industry on its existing institutional characteristics has particular implications for the future of the cable television industry. Two of these are particularly important for predicting the success of the industry in providing the range of telecommunications services predicted by 'convergence': the existence of two wires to every home and the 'tree' architecture of the vast majority of existing cable systems.

Since over 99% of all households have access to telephone service and over 96% of all households have access to cable television service, most households will face at least two providers of a range of telecommunications services. In addition to the possible emergence of 'wireless' providers of either niche services or a full panoply of telecommunications services, the future telecommunications marketplace is guaranteed to exhibit competition for subscribers. Given both the economies of scale in the production of information and economies of networking inherent in telecommunications systems, this competition can have beneficial or harmful consequences. To the extent that separate industries over-invest in building the infrastructure necessary to provide the range of telecommunications services which are anticipated to be desired, social welfare will be decreased by the duplication of resources necessary to efficiently provide such services.[47] On the other hand, to the extent that such economies are small, competition for consumers will promote innovation and diversification of the number and types of services offered.

For the cable television industry, efforts to provide advanced telecommunications services will be stymied by their existing network architecture. Since cable systems, like their broadcast television cousins, were originally developed to provide point-to-multi-point service, the natural network architecture used was that of a 'tree'. The cable headend formed the 'root' and each individual subscriber formed an end 'branch'. Tree architectures, however, are very inefficient at providing multi-point-to-multi-point services as there is often only a single path between two nodes (branches). This required significant capacity requirements beyond that which would be required by a 'star' system,

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[46] See Rosenberg (1994), Chapter 11.

which has many interconnections between nodes. Since the network architecture is a fundamental, nearly immutable design feature of cable systems, efforts to quickly modify it will likely not be successful.

Conclusion

The goal of this analysis has been to present a history of economic growth of the cable television industry and to analyze the determinants of that growth. The seemingly endless demand for programming by consumers and the technological and regulatory limitations on the supply of that programming are largely responsible for that growth. Furthermore, the dependence of further cable and telecommunications development on the existing institutional structure of the industry suggests that the convergence of the telecommunications industry is yet uncertain and may provide or deny economic benefits to consumers and producers alike.

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[47] The dollar magnitudes of investment in telecommunications infrastructures are astounding. Local Bell Operating Companies alone spent over $10 billion in Fiscal Year 1995 on capital investments.

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Table 1-1. Operating Cable Television Systems
1960 - 1979

Year	Systems	Growth Rate	Growth Rate By Period
1960	640	----------	
1961	700	9.38%	
1962	800	14.29%	16.13%
1963	1,000	25.00%	(1960-1966)
1964	1,200	20.00%	
1965	1,325	10.42%	
1966	1,570	18.49%	
1967	1,770	12.74%	
1968	2,000	12.99%	
1969	2,260	13.00%	10.39%
1970	2,490	10.18%	(1966-1972)
1971	2,639	5.98%	
1972	2,841	7.65%	
1973	2,991	5.28%	
1974	3,158	5.58%	
1975	3,506	11.02%	6.52%
1976	3,681	4.99%	(1972-1979)
1977	3,832	4.10%	
1978	3,875	1.12%	
1979	4,150	7.10%	

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Source : Television and Cable Factbook (1996)

Table 1-2(a). Top-40 Cable Programming Networks
Ranked by Total National Subscribers (in millions)
December, 1992

Rank	Network	Subs (millions)	Launch Date	Rank	Network	Subscribers (millions)	Launch Date
1	ESPN	61.4	1979	21	Black Entertainment TV (BET)	34.3	1980
2	Cable News Network (CNN)	61.2	1980	22	Prevue Guide	29.7	1988
3	WTBS	60.0	1976	23	C-SPAN II	29.3	1986
4	USA Network	60.0	1980	24	EWTN: The Catholic Network	29.0	1981
5	The Discovery Channel	59.0	1985	25	Comedy Central	27.0	1991
6	Nickelodeon / Nick at Nite	58.7	1979	26	Mind Extension University	23.0	1987
7	The Nashville Network (TNN)	58.5	1979	27	E! Entertainment TV	21.5	1990
8	TNT	58.3	1988	28	Home Shopping Network I	21.0	1985
9	MTV: Music Television	57.3	1981	29	VISN/ACTS	19.0	1988
10	The Family Channel	57.2	1977	30	The Learning Channel	18.8	1980
11	C-SPAN-I	56.9	1983	31	Country Music Television	18.1	1983
12	Lifetime Television	56.7	1984	32	The Travel Channel	17.5	1987
13	Arts and Entertainment (A&E)	56.1	1984	33	TBN Cable Network	16.5	1978
14	The Weather Channel	53.3	1982	34	Nostalgia Television	14.7	1985
15	Headline News (HNN)	51.4	1982	35	WWOR	14.5	1979
16	CNBC	47.7	1989	36	The Box	14.0	1985
17	Video Hits One (VH-1)	47.1	1985	37	Home Shopping Network II	13.0	1986
18	QVC Network	44.5	1986	38	Sci-Fi Channel	11.0	1982
19	American Movie Classics (AMC)	43.0	1984	39	Telemundo	10.4	1987
20	WGN	38.1	1978	40	Bravo	10.0	1980

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Source: Waterman & Weiss (1993)

Table 1-2(b). Top 5 Premium Programming Networks
Ranked by Total National Subscribers (in millions)
December, 1992

Rank	Network	Subs (millions)	Launch Date
1	Home Box Office (HBO)	17.5	1972
2	Showtime	7.9	1976
3	The Disney Channel	7.1	1983
4	Cinemax	6.3	1980
5	The Movie Channel	2.9	1979

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Table 1-3. Operating Cable Television Systems and Subscribers
1979 - 1991

Year	Systems	Growth Rate	Growth Rate By Period	Subscribers (000s)	Growth Rate	Growth Rate By Period
1979	4,150	----------		14,100	----------	
1980	4,225	1.81%		16,000	13.48%	
1981	4,375	3.55%		18,300	14.38%	
1982	4,825	10.29%		21,000	14.75%	
1983	5,600	16.06%	8.22%	25,000	19.05%	11.31%
1984	6,200	10.71%	(1979-1991)	29,000	16.00%	(1979-1991)
1985	6,600	6.45%		32,000	10.34%	
1986	7,500	13.64%		37,500	17.19%	
1987	7,900	5.33%		41,000	9.33%	
1988	8,500	7.59%		44,000	7.32%	
1989	9,050	6.47%		47,500	7.95%	
1990	9,575	5.80%		50,000	5.26%	
1991	10,704	11.79%		51,000	2.00%	

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Source : Television and Cable Factbook (1996)

Figure 1-1(a). Natural Impediments to Broadcast Reception: The CATV Solution

At Point A is a television station whose signals go in straight lines as indicated. All homes between the station and Point B on a mountain can get a good signal. however, people in the community at Point C can get no reception because the signals going beyond the mountain are several hundred feet above their homes. By receiving the signals on top of the mountain at Point B, amplifying them, and sending them through the community by cable, the CATV operator can provide homes with good reception.

Figure 1-1(b). Components of a Cable Television System

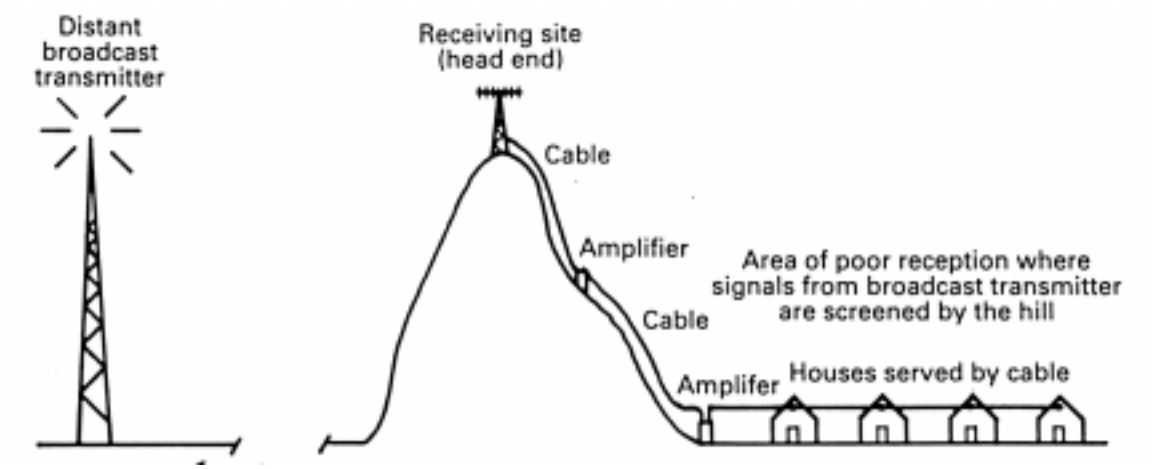
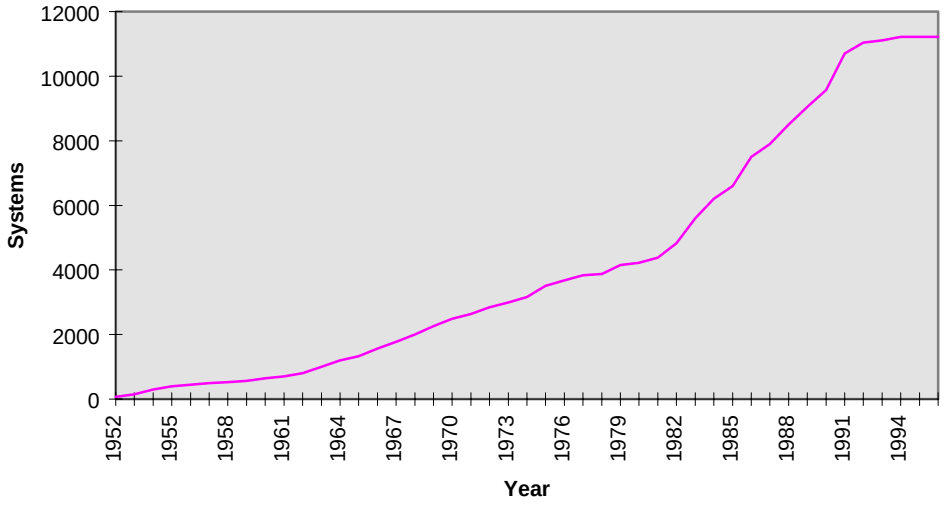


Figure 1-2. Operating Cable Television Systems 1952-1996



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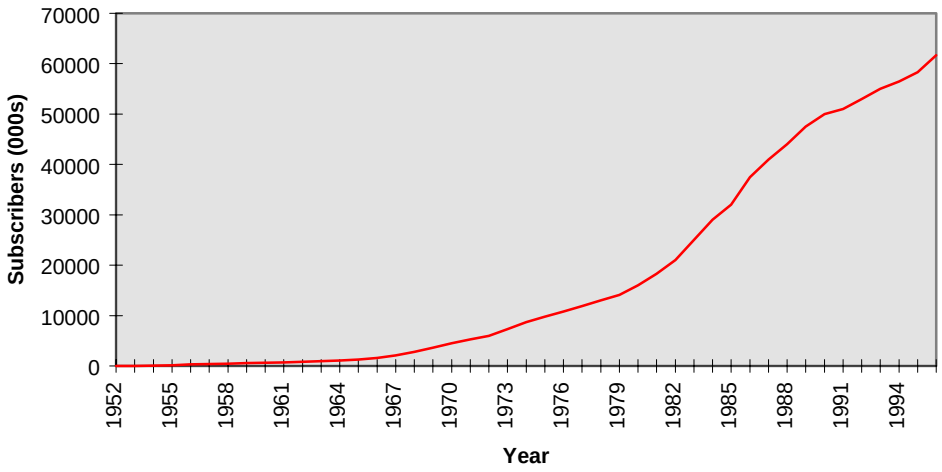
Source : Television & Cable Factbook (1996)

Figure 1-3. Total Cable Television Subscribers 1952-1996



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Source : Television & Cable Factbook (1996)

Figure 1-4(a). Allocation of Programming to Services
In the Cable Television Industry
1952-1979

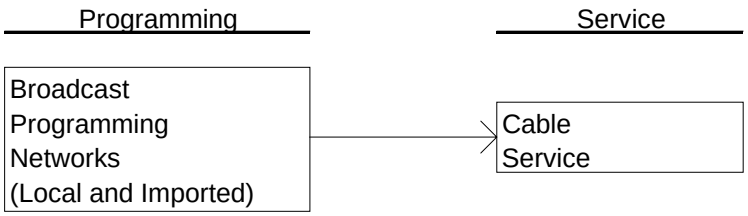


Figure 1-4(b). Allocation of Programming to Services
In the Cable Television Industry
1979-1991

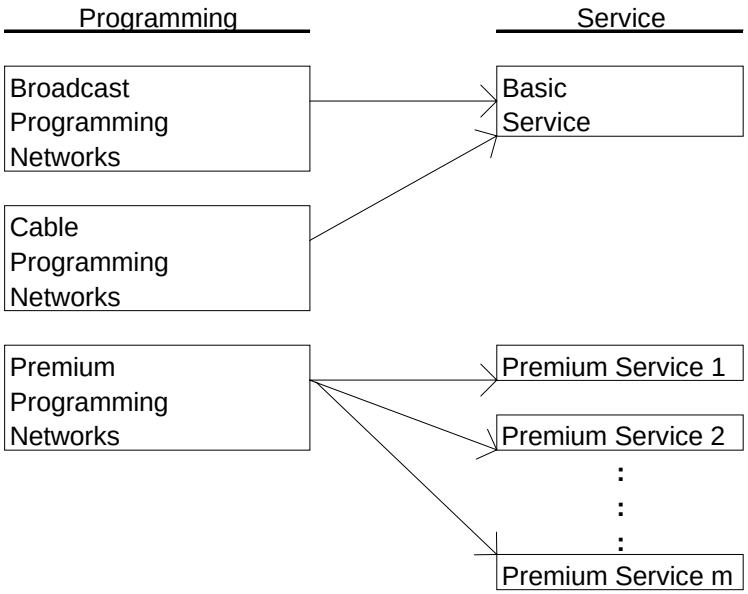


Figure 1-4(c). Allocation of Programming to Services
In the Cable Television Industry

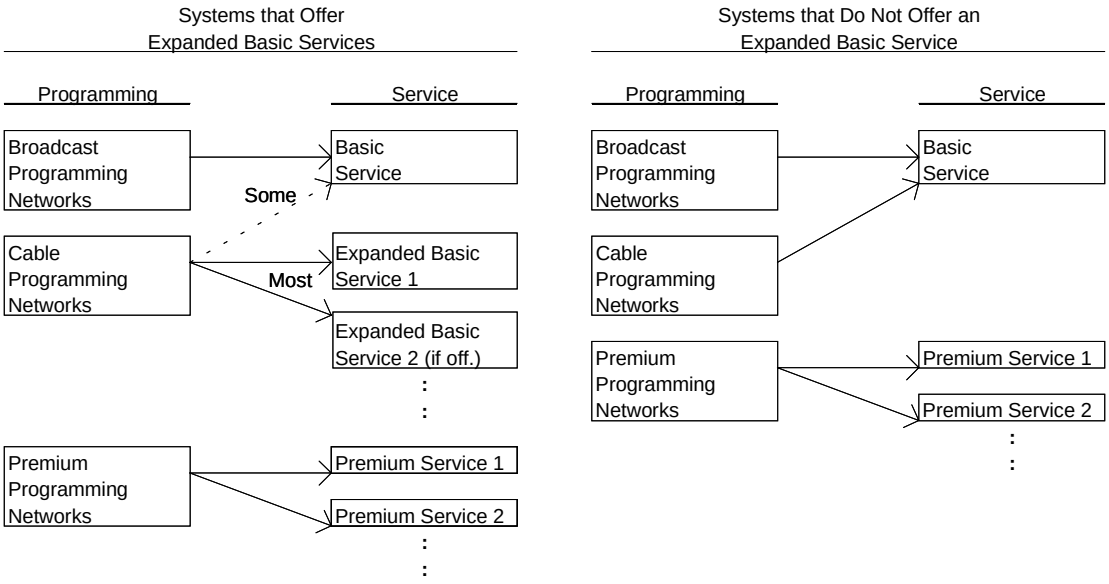
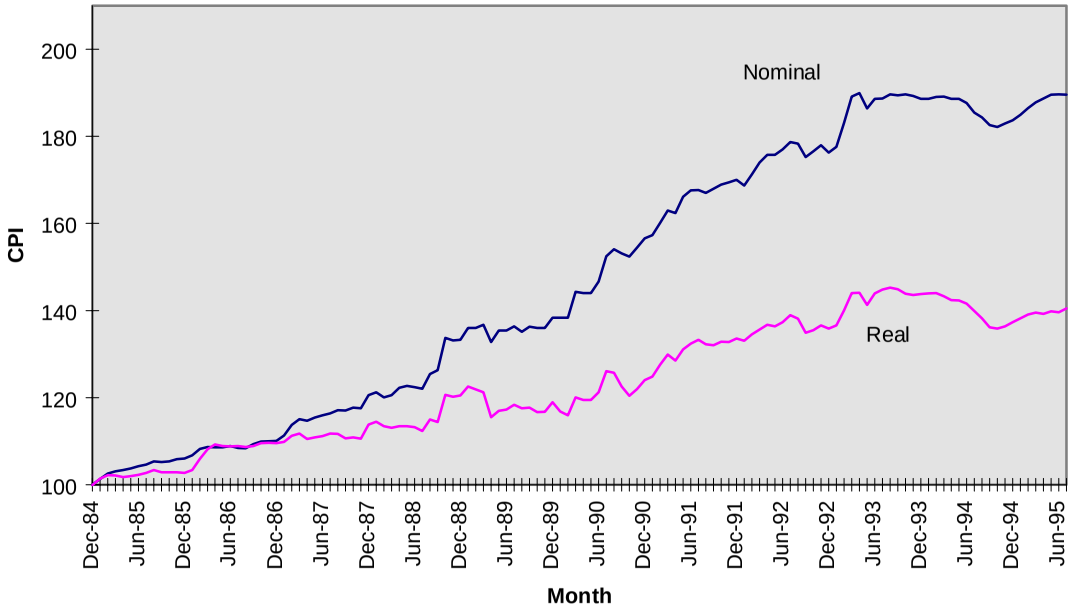


Figure 1-5. Consumer Price Index
Cable Television Service
December, 1984 to July, 1995



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Source: Consumer Price Index