THE LAW AND ECONOMICS OF UNBUNDLING AND IMPAIRMENT

T. Randolph Beard[*]
Robert B. Ekelund Jr.[**]
George S. Ford[***]

This Essay addresses probably the most critical issue in modern competition policy for the telecommunications industry: the impairment standard by which network components are selected for unbundling. This standard has been defined twice by the Federal Communications Commission ("FCC") and twice remanded by the Supreme Court. We provide an explanation as to why, and propose a more sound definition of impairment based on the statute and economic science.

The Essay also provides a simple theoretical model of impairment and then estimates an econometric model derived from the theory. The econometrics deal with the relationship between the Unbundled Network Element-Platform and the Unbundled Network Element-Loop, which some view as substitute modes of entry. The Unbundled Network Element-Platform—by far the most successful mode of entry in local exchange markets—requires the use of unbundled switching, which the incumbent carriers do not want to provide as an unbundled element. The statistical model determines whether the two are substitutes, and whether impairment exists with respect to unbundled switching. This issue is the most contentious debate at the FCC and state regulatory agencies, and the fifty state proceedings initiated by the FCC's Triennial Review Order will deal exclusively with whether or not unbundled switching should be an unbundled element.

I. INTRODUCTION

Congressional passage of the Telecommunications Act of 1996 ("the Act") was thought to be a watershed event in bringing a large measure of

[*] Professor, Auburn University, Department of Economics.
[**] Lowder Eminent Scholar, Auburn University, Department of Economics.
[***] Chief Economist, Z-Tel Communications, Inc.

competition to communications in the United States.[1] A primary expectation was that the implementation of the Act's provisions by the FCC would bring benefits to local consumers in a manner similar to those produced in long-distance telephone services for the past two decades.[2] But vital problems remain. Of chief concern is the impact of FCC and Court decisions regarding implementation standards relating to entry in local telephony. According to some economists and observers, the primary institutional problem has been that exchange facilities at the local level were, and often still are, regarded as "natural monopolies" or as exhibiting "large scale economies."[3] These are situations where the relation between industry demand and cost structure makes it possible for only one firm to operate facilities or to exist in the industry.[4] But today there are numerous components to the possible supply of local telephone services that may not, due to technological and other considerations, be considered as exhibiting sufficient economies of scale to preclude the relatively free entry of firms.[5] In order to facilitate competition in segments where entry is possible, large incumbent local exchange carriers ("ILECs")—including, but not limited to, the former "Baby Bells"—were directed by the Telecommunications Act to lease their local exchange facilities to competitors who would then use these facilities (Unbundled Network Elements or "UNEs") to enter local telephone markets.[6]

A critical implementation issue for regulators is: What elements of the network are to be unbundled? Since the purpose of unbundling is to facilitate competition, what elements are unbundled is a hotly contested issue, with the ILECs seeking to minimize the list of unbundled

---

1. *See*, *e.g.*, Steven Levy, *Now for the Free-for-All*, NEWSWEEK, Feb 12, 1996, at 55; Howard R. Gold, *Phone Wars*, BARRON'S, Feb. 5, 1996, at 13; Leo Wrobel, *Telecom Reform: For Better Deals, Bundle Up,* DATA COMM., Mar. 1, 1996, at 37.

2. The 1982 Consent Decree that divested AT&T of its local exchange carriers ("LECs") did nothing to increase competition in local exchange telecommunications service (including loop, switching, and transport), which was thought to be a natural monopoly at the time. *See, e.g.,* Verizon Communications Inc. v. FCC, 535 U.S. 467, 475 (2002). *See also* ROBERT B. EKELUND, JR. & ROBERT TOLLISON, ECONOMICS: PRIVATE MARKETS AND PUBLIC CHOICE 184, 232, 408 (Denise J. Clinton ed. 2000). *See also* 2 ALFRED E. KAHN, THE ECONOMICS OF REGULATION 123 (1995) ("[I]t seems clear that local exchange service is a natural monopoly.").

3. The connection between natural monopoly situations and "scale economies" is often made. Only one firm may exist where decreasing long-run average costs exist up to the level of total industry demand. This may create a natural monopoly situation. *See supra* note 2 and accompanying text.

4. *See supra* note 2 and accompanying text.

5. There is little agreement on which segments of the industry are suitable for competition. *See, e.g.,* Gail Hillebrand, *The Application of Antitrust Law to Telecommunications*, 69 CAL. L. REV. 497, 498 (1981); Don Cruickshank, *Telecoms: Ringing the Changes*, CONSUMER POL'Y REV., Mar./Apr. 1998, at 42; Eric Krapf, *The Local Loop: A Natural Monopoly?*, BUS. COMMS. REV., June 2001, at 14; William Sweet, *Battling for Local Phone Customers*, IEEE SPECTRUM, May 1, 1999, at 32. If those portions of the industry that are suitable for multiple firm supply are tied to portions not so suitable (e.g., mandated vertical integration), then the natural monopoly characteristics of the latter are transferred to the former.

6. For a general review of the Act, *see* Thomas G. Krattenmaker, *The Telecommunications Act of 1996*, 49 FED. COMM. L.J. 1 (1996–1997).

elements.[7] On this point, the guidance of Congress appears clear, at least on the face of the matter. Section 251(d)(2)(B) of the Act requires the FCC, in determining what network elements should be made available, to consider, at a minimum, whether "the failure to provide access to such network elements would impair the ability of the telecommunications carrier seeking access to provide the services that it seeks to offer."[8] In other words, the FCC must determine a *standard* for defining how an entrant would be *impaired* from competing where services of the ILEC are bundled or unbundled to a greater or lesser degree. The operational rules used by the FCC in this seemingly transparent directive have created enormous problems and two attempts to define impairment have failed, with the Court remanding both of those attempts.[9] The FCC has yet to establish a defensible paradigm for the most critical component of the Act's competitive framework. Its third attempt to define impairment was not yet finalized as of the writing of this Article, but press releases indicate that the agency will attempt to define impairment in terms of "entry barriers."[10]

The purpose of this Article is threefold. First, we employ statutory language, Court decisions, and basic economic principles to construct an analytical statement of the Act's impairment standard. Based on this analytical framework, we then describe a theoretical model that establishes a framework with which to test for the presence of impairment. Finally, we present the results of an econometric model based on our theory of impairment. The empirical model tests for impairment with regard to unbundled local switching, perhaps the most contested unbundled element.[11] The empirical model also addresses

---

7. *See* Sean Buckley, *Last-Mile Morass: Is UNE-P Really the Lynchpin for Competition?*, TELECOMMS. AM., Nov. 2002, at 8; Peter J. Howe, *Baby Bells, Rivals Spar Over Telecommunications Rules*, BOSTON GLOBE, Oct. 14, 2002, at D5; Johna Till Johnson, *ILECs Are Crying Wolf Over Regulation*, NETWORK WORLD, Oct. 14, 2002, at 38; Shira Levine, *The Unending Debate*, AMERICA'S NETWORK, Sep. 15, 2002, at 14; Mike Martin & Tim Greene, *States, RBOCs Battle Over Regulations*, NETWORK WORLD, Nov. 25, 2002, at 14; *SBC Sees Unbundling Rules 'Devastating' for Broadband*, COMMS. TODAY, July 22, 2002, at 1, *available at* 2002 WL 24214448.

8. 47 U.S.C. § 251(d)(2)(B) (2000). The Act also contains a "necessary standard" in § 251(d)(2)(A)—that is, providing access to any "proprietary" network element must be necessary for the requesting carrier to provide service. In practice, the necessary standard is rarely relevant.

9. Implementation of the Local Competition Provisions of the Telecommunications Act of 1996, 15 F.C.C.R. 3696, 3807–08 (1999) [hereinafter UNE Remand Order]; AT&T Corp. v. Iowa Utils. Bd., 525 U.S. 366, 389–90 (1999) (the following assumptions made by the Commission are not in accord with the ordinary and fair meaning of the terms "necessary" and "impair": (1) that any increase in cost or decrease in quality, imposed by denial of a network element, renders access to that element "necessary"; (2) failure to provide a "necessary" element will "impair" the entrant's ability to furnish the desired services).

10. Press Release, FCC, FCC Adopts New Rules for Network Unbundling Obligations of Incumbent Local Phone Carriers, CC Docket No. 01-338 (Feb. 20, 2003). Barriers to entry may be "natural," such as economies of scale, high fixed costs, high risk, scarce managerial talent, personal technological knowledge, or high capital costs—"artificial"—such as government restrictions; for example, patents, government regulations, licensing, tariffs, quotas, and the like. *See* EKELUND & TOLLISON, *supra* note 2, at 276–77.

11. *See, e.g., CompTel Turns Up UNE-P Heat*, COMMS. TODAY, Jan. 17, 2003, at 1; Levine, *supra* note 7 at 1; *Competition and Bell Company Investment in Telecommunications Plant: The Effects of*

alternate entry modes—that is, unbundled loop-switching combinations versus unbundled loops combined with self-supplied switching. These alternate modes of entry are not found to be substitutes, and our empirical model provides strong evidence of impairment with regard to unbundled switching.

In order to appreciate fully how important the implications of the unbundling provisions of the Act are for providing consumer benefits in the local telephone provision, it is first necessary to understand the manner in which the local market is organized and the background of the impairment problem. This background information is provided in Section II.

II. INDUSTRIAL ORGANIZATION OF THE LOCAL TELEPHONE MARKET: BACKGROUND TO THE IMPAIRMENT ISSUE

Industrial economics indicates that equilibrium industry structure is determined fundamentally by market size and by the sunk costs of entry.[12] The larger the market per dollar of sunk entry costs or, equivalently, the smaller sunk costs per dollar of market expenditures, the less concentrated the industry structure. Promoting competition by attenuating the influence of sunk costs on market structure lies at the very core of the Act and, in particular, the unbundling mandates contained therein.[13] By allowing entrants to lease elements of the local exchange, the Act allows a firm to enter that market more freely and to sustain that entry by avoiding the entry-deterring sunk investments otherwise required to provide service. As the economics of entry imply, reducing sunk investments allows for more entry, thereby improving the equilibrium industry structure in the provision of retail telephone services— "uprooting the monopolies." The unbundling provisions are now more important than ever, as financing for Competitive Local Exchange Carriers ("CLECs") has all but dried up.[14]

Consistency with the Act requires the FCC to consider how its policies, both extant and prospective, affect market size and sunk entry costs, along with other practical entry barriers.[15] Successful

UNE-P, PHOENIX CTR. POL'Y BULL. NO. 5, July 9, 2003, at 1.

12. *See, e.g.,* JOHN SUTTON, SUNK COSTS AND MARKET STRUCTURE: PRICE COMPETITION, ADVERTISING & THE EVOLUTION OF CONCENTRATION 45–83 (1991).

13. Policies designed to promote competition in markets that have traditionally been characterized by natural monopoly or high concentration must address either market size or sunk costs (or other entry barriers), and, in most cases, sunk cost is more readily affected by policy. *See* Elizabeth E. Bailey, *Contestability and the Design of Regulatory and Antitrust Policy*, 71 AM. ECON. REV. 178, 179 (1981) ("The single most important element in the design of public policy for monopoly should be the design of arrangements which render benign the exercise of power associated with operating sunk facilities.").

14. *See, e.g.,* Tom Leithauser, *'Facilities-Based' Competition Won't Be Easy, Analysts Tell Commission*, 68 TELECOMM. REPS. 1 (2002) ("Financial markets are reluctant to pump more money into the sector, and the Commission may be powerless to jump-start investment.").

15. *See generally* AT&T Corp. v. Iowa Utils. Bd., 525 U.S. 366, 386–90 (1999) (relating rationally

implementation of the Act by the FCC requires the reduction of sunk costs, and entry barriers generally, and the expansion of the potential market available to entrants whenever feasible. Conversely, limiting market size or increasing sunk costs reduces entry, thereby reducing competition and extending the need to regulate local exchange services. Limited access to unbundled elements in arbitrarily defined geographic and product markets unambiguously reduces market size (for example, top fifty Metropolitian Statistical Areas ("MSAs"), more than three access lines, etc.); such policies should be avoided since they limit competition.[16] Requiring competitors to self-provide critical inputs where production requires sunk investments further rigs the system against competitive entry, denying consumers the benefits of competition and thwarting the Congressional intent of "eliminating the monopolies" in the local exchange markets.[17]

A. Reorganizing Markets into Wholesale and Retail Components

The unbundling provisions of the Act that are already in force have, in practical effect, split the vertically integrated local exchange industry into retail and wholesale segments.[18] The wholesale markets resell, lease, or interconnect facilities at given rates to retail purchasers of these facilities who then sell services to the public. Vertical integration is not prohibited, but neither is it required.[19] By freeing the retail telecommunications and value-added segments of the local exchange from the enormous sunk costs of the wholesale telecommunications segment, unbundling directly promotes competition in retail services, increasing consumer welfare.

Differentiation of retail and wholesale segments of the local exchange market mirrors the current market structure in the interexchange industry. In 2001, more than 900 firms sold retail long-

---

to the goals of the Act). S*ee also* Verizon Communications Inc. v. FCC, 535 U.S. 467, 535 (2002) (removing practical barriers to competitive entry into local-exchange markets).

16. In the UNE Remand Order, *supra* note 9, the FCC restricted access to unbundled local switching for locations with more than three access lines located in the most dense portions of the largest fifty metropolitan statistical areas (MSAs). A recent study by Beard, Ford, and Koutsky finds that this restriction reduced the deployment of switching equipment in the restricted areas, contrary to the intent of the restriction. T. Randolph Beard et al., *Mandated Access and the Make-or-Buy Decision: The Case of Local Telecommunications Competition*, *at* http://www.telepolicy.com/BFKfinal.pdf (last visited Apr. 7, 2004) (including an empirical analysis that estimates the switching restriction reduced competitive entry by 36%). *See* Z-TEL COMMUNICATONS, INC., AN EMPIRICAL EXPLORATION OF THE UNBUNDLED LOCAL SWITCHING RESTRICTIONS (2002), *at* http://www.telepolicy.com/zpp3.pdf [hereinafter Z-TEL, EXPLORATION].

17. *Verizon*, 535 U.S. at 488.

18. *See id.* at 489 ("Congress [aimed] . . . to reorganize markets." "The Act . . . favor[ed] . . . novel ratesetting designed to give aspiring competitors every possible incentive to enter local retail telephone markets . . ."); *cf. id.* at 492 ("[W]holesale markets for companies engaged in resale, leasing, or interconnection of facilities cannot be created without addressing rates.").

19. This fact is also supported by general antitrust law. *See, e.g.,* Fishman v. Estate of Wirtz, 807 F.2d 520, 534 (7th Cir. 1986). *See also* DAVID L. KASERMAN & JOHN W. MAYO, GOVERNMENT AND BUSINESS: THE ECONOMICS OF ANTITRUST AND REGULATION 297–331 (1995).

distance services, including the Regional Bell Companies, who today rely on market-based unbundled access to interexchange facilities to provide long-distance services.[20] All of these retail services were supported by only seven nationwide long-distance networks, and some more regional networks.[21] Given that the sunk cost per dollar of market potential in the local exchange market is less favorable to multiple firm supply than in the interexchange industry, where traffic is aggregated, an equilibrium industry configuration with numerous CLECs relying exclusively on their own facilities to provide service is improbable.[22] High concentration in the wholesale segment is perhaps inevitable, but monopoly may not be.[23]

B. Sunk Cost and the Feasibility of Vertical Disintegration

The economic and financial infeasibility of all CLECs deploying their own facilities does not suggest that facilities-based competition in the wholesale segment is impossible. Indeed, the risk of entry at the wholesale level is attenuated by the presence of the non-incumbent demand—that is, demand for wholesale facilities by retail sellers of services unaffiliated with the ILECs—for network infrastructure held by entrants using unbundled elements in the retail segment. Until CLECs have substantial numbers of retail customers, there is effectively no demand for competitive telecommunications facilities. End users do not directly demand facilities. Retail telecommunications carriers do. Thus, generating effective demand for facilities by promoting retail competition stimulates entry in the wholesale segment of the local exchange.[24]

Given the likelihood that very few firms can exist in equilibrium in the wholesale segment, this non-incumbent demand for facilities, held by numerous retail competitors, can be consolidated by one or a few wholesale entrants. More simply, the derived demand for facilities of *any particular* CLEC likely will not be sufficient to warrant duplication of costly network facilities. However, the consolidation of the derived demands of *multiple* CLECs may be sufficiently large to justify the sunk

---

20. FCC, TRENDS IN TELEPHONE SERVICE, at 10-10 tbl. 10.4 (May 2002) *at* http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/IAD/trend502.pdf [hereinafter FCC, TRENDS].

21. Judy Reed Smith & Taher Bouzayen, *Resellers Rate Wholesale Carriers*, PHONE+ (Apr. 2000), *at* http://www.phoneplusmag.com/articles/041resl1.html.

22. *See* PHILIP AREEDA & HEBERT HOVENKAMP, ANTITRUST LAW: AN ANALYSIS OF ANTITRUST PRINCIPLES AND THEIR APPLICATION 178 (1996) (pointing out that whether or not local "hard-wired" telephone service is best delivered by a monopoly, it would be unwise to allow that monopoly to obstruct free competition in long-distance services or telephone instruments, where competition is clearly possible). S*ee generally* T. Randolph Beard et al., *Why Adco? Why Now? An Economic Exploration into the Future of Industry Structure in Local Telecommunications Markets*, 54 FED. COMM. L.J. 421, 430 (2002) [hereinafter Beard, *Why Adco?*].

23. *See* Beard, *Why Adco?*, *supra* note 22, at 431.

24. *See id.* at 435. *See generally* T. Randolph Beard et al., *The Role of Resale Entry in Promoting Local Exchange Competition*, 22 TELECOMM. POL'Y 315 (1998).

investments by allowing the wholesaler to quickly and assuredly realize minimum efficient scale. Further, the ability to establish long-term contracts with extant demand reduces the lag between the occurrence of sunk investments and the realization of revenues, thereby facilitating entry into the wholesale market by reducing risk.[25]

The interexchange telecommunications industry is a good example of the relationship between retail competition and wholesale entry. While long-distance retailers AT&T, MCI, and Sprint operate their own interexchange networks, the other operators of nationwide interexchange networks—Qwest, Williams, and Global Crossing—do not have a significant retail presence.[26] All of the recently deployed nationwide interexchange networks were put into place by essentially non-retail operations to provide data transport and wholesale interexchange services. In 2000, some 800 retailers provided long-distance services over about seven nationwide networks.[27]

Unbundling therefore promotes the evolution of competition in the wholesale local exchange market by targeting the source of industry concentration: the risk accompanying sunk entry costs and other entry barriers. Entrants in the retail segment, however, are not necessarily the same firm or firms that enter the wholesale segment.[28] Vertical integration of retail competitors into the wholesale market may continue to occur on a limited basis, but likely will be restricted to specific product and/or geographic markets where the entry conditions are suitable. For these reasons, the whole question of how and under what conditions unbundling should occur is critical to providing retail competition in local telephony. But prior to the determination of what is unbundled and where, clear principles of impairment must be established.

III. UNBUNDLING AND THE IMPAIRMENT STANDARD: FOUNDATIONS OF AN ANALYTICAL MODEL

Besides the network elements that must be unbundled as a requirement of Section 271 of the Act, Section 251(d)(2)(B) of the Act specifically requires the FCC, when determining what network elements should be made available, to consider whether "the failure to provide access to such network elements would impair the ability of the telecommunications carrier seeking access to provide the services that it seeks to offer."[29] The plain language of this section indicates that there

25. *See generally* Beard, *Why Adco?*, *supra* note 22.

26. *See id.* at 451–52; FCC, TRENDS, *supra* note 20.

27. FCC, TRENDS, *supra* note 20.

28. As with long distance, vertical integration into the downstream retail market by upstream wholesalers is possible. As scale or density economies become more prevalent, vertical integration can inhibit the success of a firm supplying the wholesale markets. *See generally* Beard, *Why Adco?*, *supra* note 22.

29. 47 U.S.C. § 251(d)(2)(B) (2000).

are at least three components to an impairment standard: (1) impairment is *carrier specific*; (2) impairment is detected in the relative *output* of the requesting carrier with and without access to the element; and (3) impairment includes some notion of *significance* and should be non-transitory. We shall consider each component in turn as well as the reasons for the Court's previous rejections of FCC impairment criteria.

A. Carrier-Specific Nature of Impairment

The plain language of Section 251(d)(2)(b) indicates that the impairment standard is *carrier specific,* describing "*the* telecommunications carrier" and the services "*it* seeks to offer." In fact, given the different business plans (including target markets), financial resources, and retail products of the various CLECs, it is difficult to imagine how impairment could not be carrier-specific. The Supreme Court recognized the carrier-specific nature of the impairment standard, observing that:

- "[i]f *a* requesting carrier wants access to additional elements, *it* may petition the state commission, which can make other elements available on a case-by-case basis;"[30]
- "[t]he 1996 Act . . . requir[es] . . . that incumbents provide access to 'any' requesting carrier;"[31]
- "[C]ompetition as to 'unshared' elements may, in many cases, only be possible if incumbents simultaneously share with entrants some costly-to-duplicate elements jointly necessary to provide a desired telecommunications service. Such is the reality faced by the hundreds of smaller entrants (without the resources of a large competitive carrier such as AT&T or Worldcom [sic]) seeking to gain toeholds in local-exchange markets;"[32] and
- "a policy promoting lower lease prices for expensive facilities unlikely to be duplicated reduces barriers to entry (particularly for smaller competitors)."[33]

Clearly, the Court recognized that the condition of impairment may vary among CLECs, and further observed that financial "resources" and basic "inefficiency" may be legitimate sources of such variation.[34] The nature

30. AT&T Corp. v. Iowa Utils. Bd., 525 U.S. 366, 388 (1999) (emphasis added).
31. *Id*. at 392.
32. Verizon Communications Inc. v. FCC, 535 U.S. 467, 510 n.27 (2002).
33. *Id*. at 503 n.20.
34. *Id.* at 509. In *AT&T Corp.*, Justice Antonin Scalia argued that § 251(d)(2) of the Telecommunications Act does not mean that the FCC has unlimited authority to order unbundling. *AT&T Corp.*, 525 U.S. at 395–97. While incumbents would favor the "essential facilities doctrine" (established in an early railroad case, U.S. v. Terminal R.R. Ass'n of St. Louis, 224 U.S. 383 (1912)) as a boundary, the Court did not invoke it in *AT&T Corp*. *See* Jerry A. Hausman & J. Gregory Sidak, *A Consumer-Welfare Approach to the Mandatory Unbundling of Telecommunications Networks*, 109 YALE L.J. 417, 436 (1999).

of impairment is echoed throughout Section 251(c) and also in Section 257 of the Act. The FCC recognized that impairment is a carrier-specific phenomenon in the UNE Remand Order.[35]

B. Output-Based Nature of Impairment

A second component of impairment is that it is *output-based* for a specific carrier. That is, impairment is satisfied if a lack of access to an element impairs the ability of the requesting carrier "to provide the services that it seeks to offer."[36] Impairment of the "ability to provide . . . service" is best detected in the difference in quantity[37] of service provided—i.e., output—with and without access to the unbundled element.[38]

In its criticism of the FCC's first effort to define impairment using a cost-based standard, the Supreme Court observed the output-based nature of impairment:

> [T]he [FCC's] assumption that *any* increase in cost (or decrease in quality) imposed by denial of a network element renders access to that element "necessary," and causes the failure to provide that element to "impair" the entrant's ability to furnish its desired services, is simply not in accord with the ordinary and fair meaning of those terms.[39]

The Court did recognize, however, that "[i]n a world of perfect competition . . . the Commission's total equating of increased cost or decreased quality with 'necessity 'and 'impairment' might be reasonable."[40] The Supreme Court here links impairment to the output of the requesting carrier. Indeed, in a world of perfect competition or Bertrand-style oligopolistic competition with homogeneous products, any cost disadvantage translates into zero output for the high-cost firm.[41] As competition moves away from textbook models of intense price

35. *See* UNE Remand Order, *supra* note 9, at 3725–26 ¶ 53. While carrier-specific, the FCC's analysis also noted that the administrative costs of a case-by-case analysis may be prohibitively expensive. *See id.* at 3726 ¶ 54. If the business plans and financial conditions of a group of carriers are sufficiently homogenous, the carriers could possibly be grouped for an impairment analysis without violating carrier specificity. The administrative costs also imply that impairment analysis is perhaps better left to the state regulatory commission.

36. 47 U.S.C. § 251(d)(2)(B) (2000).

37. Here, the quality of service is assumed constant.

38. *AT&T Corp.*, 525 U.S. at 390 (emphasis added). The FCC's failure to specify impairment in terms of output is the source of most of its judicial trouble with the standard. In the UNE Remand Order, *supra* note 9, at 3705, the FCC appeared to adopt an output standard (focusing on timeliness, ubiquity, etc.), but failed to specify directly the standard in terms of output. Once the output distinction is made clear, the impairment analysis becomes considerably easier to describe and implement.

39. *AT&T Corp.*, 525 U.S. at 389–90.

40. *Id.*

41. Firms choose price in Bertrand competition, quantities in Cournot competition. *See, e.g.*, JAMES W. FRIEDMAN, OLIGOPOLY THEORY 50–77 (1983). If products are homogeneous, Bertrand competition renders the competitive equilibrium (price equals marginal cost) with only two firms. *Id.* With product differentiation, the differences in Bertrand and Cournot outcomes are less divergent. *Id.*

competition, the Court recognized, cost disadvantages are not so punishing to the output of rival firms.[42] For example, in Cournot-style oligopolistic competition, firms with different levels of marginal cost can coexist, although low-cost firms have higher output levels.[43] By linking cost changes to output by reference to the intensity of price competition, the Court observed that output was the relevant index of impairment, and rebuked the FCC for not incorporating this fact into their impairment analysis.[44]

The Supreme Court decision in *Verizon Communications Inc. v. FCC*[45] further supports the output component of impairment. In its *Verizon* decision, the Court described a "reasonable reading" of the unbundling and interconnection provisions of the Act (i.e., Section 251(c)) to be that they are "meant to remove practical barriers to competitive entry into local-exchange markets."[46] Under an output-based test for impairment, any "practical barrier[s] to . . . entry"[47] will be revealed in the reduced output of the entrant. These "practical barriers" include the more traditional, economic concept of *barriers to entry*, as well as any other factor that attenuates competitive entry in a practical sense, such as access to financial resources and the relative inefficiency of entrants.[48] Indeed, any factor that attenuates competitive entry impedes the attainment of the Act's fundamental goals, including: "uprooting the monopolies . . ., reorganiz[ing] markets . . . [and] giv[ing] aspiring competitors every possible incentive to enter local retail telephone markets."[49]

Because impairment is an output-based standard, the FCC's focus on cost differences in the UNE Remand Order was lacking given that the order failed to provide some direct link between cost and output.[50] Thus,

---

42. *AT&T Corp.*, 525 U.S. at 390.

43. *See* STEPHEN MARTIN, ADVANCED INDUSTRIAL ECONOMICS 20 (1993) ("In equilibrium the lower-cost firm enjoys greater sales."). Cournot competition assumes that rival firms select their chosen level of output and the market price is such that the entire industry output is sold. Industry output and price approach the competitive level as the number of firms increase.

44. *AT & T Corp.*, 525 U.S. at 390–92.

45. Verizon Communications Inc. v. FCC, 535 U.S. 467 (2002).

46. *Id.* at 535.

47. *Id.*

48. Barriers to entry relate to the ease or difficulty of entry. Joe Bain defined entry barriers as "advantages which established firms in an industry have over unestablished entrant firms." *See generally* Implementation of § 19 of the Cable Television Consumer Protection & Competition Act of 1992, 9 F.C.C.R. 7442 at 7604 (1994) (first report). George Stigler, similarly, defines entry barriers as "a cost of producing (at some or every rate of output) which must be borne by a firm which seeks to enter an industry but is not borne by firms already in the industry." *Id.* Von Weizsacker adds to the Stiglerian definition the requirement that the barrier lead to a suboptimal allocation of resources. *Id.*; *see also* MARTIN, *supra* note 43, at 5–7, 172–91.

49. *Verizon*, 535 U.S. at 488–89.

50. Section 251 of the Telecommunications Act also instructs the FCC to consider whether "access to such network elements as are proprietary in nature is necessary" and whether "the failure to provide access to such network elements would impair the ability of the telecommunications carrier seeking access to provide the services that it seeks to offer." 47 U.S.C. § 251(d)(2) (2000). According to Hausman and Sidak,

it is important to establish some theoretical relationship of output to cost because cost differences will often be the focus of attention in a *practical* analysis of impairment. Such an exercise has been performed before; it is not repeated here.[51] Nevertheless, it is worth observing that output is very sensitive to cost changes even under competitive interactions much less severe than perfect competition (e.g., Cournot competition).

C. The Significance Component

Impairment focuses on the reduction in output experienced by an individual carrier if the carrier is not given access to an unbundled element. But how much of a reduction does the Act allow before impairment is deemed to exist? Because the dictionary definition of "impair" is "to damage or make worse by or as if by diminishing in some material respect,"[52] it seems reasonable that to constitute a statutorily cognizable impairment, there must be a small, but significant and non-transitory decrease in the requesting carrier's output. The Act offers no guidance on what "significant" is, but it seems sensible that significance be "rationally related to the goals of the Act,"[53] which include the promotion of competition ("uprooting the monopolies") and deregulation.[54] The reduction in output also should not be a transitory disability, but one that cannot be quickly and easily overcome.[55]

In the *Verizon* case, the Supreme Court observed that the Act was "designed to give aspiring competitors every possible incentive to enter local retail telephone markets."[56] Given that the Court stated that even

---

> neither § 251(d)(2) nor any other section of the Telecommunications Act of 1996 defines "proprietary" for purposes of the ILEC's duty to unbundle network elements. In practice, the "necessary" standard of § 251(d)(2) may ultimately prove to have less frequent application than the "impair" standard if, under whatever legal definition is adopted, an ILEC is deemed to have few or no network elements that are "proprietary in nature."

Hausman & Sidak, *supra* note 34, at 434. Because "impairment" is the more relevant standard, our own focus in this Article is to develop an "impairment" standard analytically and suitable for empirical testing.

51. *See* Z-TEL COMMUNICATIONS, INC., SOME THOUGHTS ON IMPAIRMENT: AN ECONOMIC ANALYSIS OF THE IMPAIRMENT STANDARD OF THE 1996 TELECOMMUNICATIONS ACT (2003), *at* http://www.telepolicy.com/zpp5.pdf; Declaration of George S. Ford on behalf of Z-Tel Communications, Inc., Review of the § 251 Unbundling Obligations of Incumbent Local Exchange Carriers (No. 01-338) (2002), *available at* http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6513282337.

52. *See* MERRIAM-WEBSTER'S COLLEGIATE DICTIONARY 581 (10th ed. 1999).

53. AT&T Corp. v. Iowa Utils. Bd., 525 U.S. 366, 388 (1999).

54. In *AT&T Corp.*, Justice Scalia entertained the element of significance in the context of impairment. 525 U.S. at 388. Obviously, not every diminution in quality or increase in cost significantly impairs an entrant and its return on investment. *Id.* "Significance" is therefore undefined in this Court decision. *Id.* If small price increases (or differentials) bar entry by a competitor, they are definitionally significant. *Id.* Significance is included in the model developed in Parts IV and V of this Article.

55. *See generally,* U.S. DEP'T OF JUSTICE & FTC, HORIZONTAL MERGER GUIDELINES (1997), *available at* http://www.ftc.gov/bc/docs/horizmer.htm (reflecting the April 8, 1997 revisions to Section 4 on Efficiencies).

56. *Verizon,* 535 U.S. at 489.

small price increases of an unbundled element may reduce incentives to enter local retail telephone markets, small degrees of impairment necessarily must be significant.[57]

D. An Analytical Statement of the Impairment Condition

The legal intent of impairment, as we have established above, is an output standard of which "significance" is a necessary part. To be useful, these requirements must be developed into a conceptual framework with which issues may be identified and analyzed in empirical terms. In order to provide analytical specificity to the impairment condition, consider the following simple model. Let Q^U be the quantity of services sold by the CLEC when it has access to the unbundled element, and let Q^F represent the quantity of services sold without access to the unbundled element. Services sold with the unbundled element (Q^U) may contain services provided with and without the element in question, but services sold without the element (Q^F) are provided solely without the element.[58] For now, let m be a particular percentage reduction in the quantity of service sold that is "significant."

Consistent with the discussion above, the impairment standard is satisfied for firm i if the following is true:

$$Q_i^{UI} - Q_i^F > mQ_i^{UI}, \tag{1}$$

where the condition simply states that impairment exists if the reduction in the quantity of services sold ($Q^U - Q^F$) exceeds a significant reduction in services sold (mQ^U) when the unbundled element is taken away.[59] For example, say that a 10% reduction in the quantity of services sold is significant ($m = 0.10$). With access to the unbundled element, CLEC i sells 100 units. Without access to the element, alternately, CLEC i sells only 30 units. Because 70 units (100 - 30) exceeds 10 units ($0.10 \cdot 100$), the impairment condition is satisfied. In this example, if the CLEC output falls by more (less) than 10 units, the impairment condition is (is not)

57. *See id.* at 509 ("[T]he difference between such a higher rate and the TELRIC rate could be the difference that keeps a potential competitor from entering the market."); *id.* at 515–16 ("[H]igh lease rates for these elements would be the rates most likely to deter market entry."). It is certainly possible to conclude that a significant difference is something perhaps akin to the 5-10% price increase of merger analysis. Econometric studies indicate that the own-price elasticities of demand for unbundled elements are in the elastic region of demand. *See, e.g.*, Robert B. Ekelund, Jr. & George S. Ford, *Preliminary Evidence on Unbundled Elements Demand in Local Telephony*, 2002 ATL. ECON. J. 443 (estimating own-price elasticity of demand for unbundled element combinations to be •2.7).

58. The quantity of service provided using the unbundled element (Q^U) is that quantity provided at "cost[-based]" rates and on "non-discriminatory" terms and conditions, consistent with § 252(d). Today, prices are based on total long-run incremental cost ("TELRIC"), and the Supreme Court recently upheld that pricing standard in *Verizon*, 535 U.S. at 502–23, as being the most reasonable interpretation of the Act's requirements among proffered alternatives.

59. Quality of services is assumed constant—as part of the *ceteris paribus* assumption—for purposes of the present simple model.

satisfied. Equation (2) is a simple, direct analytical re-statement of § 251(d)(2)(B). Obviously, the difference in CLEC output across the two regimes is a function of a number of factors, including the cost differences of self-provisioning the element and the availability of elements from a competitive wholesale provider.[60]

This analytical statement suggests a straightforward empirical test of impairment for which multiple regression and other statistical procedures may prove useful. In general, the analysis proceeds as follows: Let Q be the output of a "requesting carrier," and this output is a function of the availability (or price) of some network element (i.e., $Q(A)$, where A is zero if the element is unavailable).[61] A finding of impairment is supported if reductions in availability (or increases in price of the element above cost), reduce output by an amount sufficiently large to qualify as "significant" (i.e., $Q(A) - Q(0) > mQ(A)$).

1. Geographic Markets and Time

It may be the case that the impairment test described by Equation (2) renders different results across geographic and product markets.[62] While not explicitly stated in § 251(d)(2)(B), it is perhaps reasonable to incorporate a geographic/product component into the condition, particularly in light of the recent *USTA v. FCC* decision.[63] Further, output must be measured at some specific point in time or over a time interval. Thus, the impairment standard for firm i in market g is:

$$Q^{U}_{i,g,t} - Q^{F}_{i,g,t} > mQ^{U}_{i,g,t}, \qquad (2)$$

where the quantities are measured in period t. Consideration of impairment over some time interval ensures that a reduction in output that is merely transitory does not constitute impairment. However, a reduction in output is not transitory if there is a permanent lag which reduces output permanently below the levels that would exist in the absence of the condition that creates the lag. This is consistent with prior FCC interpretations of impairment. Geographic differences in impairment were considered with respect to unbundled switching in the FCC's UNE Remand Order.[64] While the switching restriction of that Order has been detrimental to competition and facilities deployment, the restriction was useful in that it did generate some variation across markets in element availability so the effects of unbundling or the lack

60. AT&T Corp. v. Iowa Utils. Bd, 525 U.S. 366, 388 (1999).

61. Prices are relevant to impairment because price is just another index of availability (at some price, the effective demand is zero).

62. A granular, geographic-specific analysis of impairment was called for in *United States Telecom Ass'n v. FCC,* 290 F.3d 415, 422 (D.C. Cir. 2002).

63. *Id*.

64. *See* UNE Remand Order, *supra* note 9, at 3804–32.

thereof could be measured empirically.[65] In that same Order, the FCC also considered "timeliness" as a relevant factor for impairment, which enters the analysis via *t*.[66]

Using our analytical form, Section 251(d)(2)(B) can be rewritten as "the failure to provide access to such network elements would [reduce] the [output] in time *t* of the telecommunications carrier [*i*] seeking access [in market *g* by *m* percent]." This analytical restatement of the impairment standard of the Act exactly reflects the plain language of the Act and the apparent intent of Congress as interpreted by the Supreme Court. In practical terms, the final impairment condition (Equation (2)) can be stated as a question: Without access to the unbundled element, will the requesting carrier's output in market *g* fall by more than *m* percent over some relevant time period?

2. Impairment and the Triennial Review

While it remains to be seen what the FCC's decision in the Triennial Review will exactly entail in practice, the definition of the impairment standard is broadly consistent with the analytical approach summarized above. Specifically, the FCC now defines the impairment standard as:

A requesting carrier is impaired when lack of access to an incumbent LEC network element poses a barrier or barriers to entry, including operational and economic barriers, which are likely to make entry into a market uneconomic. Such barriers include scale economies, sunk costs, first-mover advantages, and barriers within the control of the incumbent LEC. The Commission's unbundling analysis specifically considers market-specific variations, including considerations of customer class, geography, and service.[67]

Economists have many definitions of entry barriers, but generally an "entry barrier can be thought of as something that makes entry more costly or more difficult."[68] Importantly, an entry barrier need not preclude entry; it need only weaken it. Since the primary symptom of "difficult entry" is a reduction in the output of the entrant, the entry barriers definition of impairment could be entirely compatible with the analytical approach summarized in Equation (2). However, the devil is always in the details, and the details have troubled the FCC throughout its implementation of the Act. Also, beginning with a sensible

65. *See* Z-TEL, EXPLORATION, *supra* note 16; Z-TEL COMMUNICATIONS, INC., DOES UNBUNDLING REALLY DISCOURAGE FACILITIES-BASED ENTRY? AN ECONOMETRIC EXAMINATION OF THE UNBUNDLED SWITCHING RESTRICTION (2002), *available at* http://www.telepolicy.com/zpp4.pdf; T. Randolph Beard et al., Facilities-Based Entry in Local Telecommunications: An Empirical Investigation (June 2002), *available at* http://www.telepolicy.com/bfkswitch.pdf [hereinafter Beard, *Entry*].

66. UNE Remand Order, *supra* note 9, at 3704–09 (discussing timelines in the executive summary).

67. FCC, Press Release, *supra* note 10.

68. W. KIP VISCUSI ET AL., ECONOMICS OF REGULATION AND ANTITRUST 60 (2d ed. 1995).

framework does not imply ending with one, so it is unclear whether or not the full treatment of entry barriers will be compatible with our framework or consistent with general economic principles.

E. Specific Causes and Elimination of Impairment

The decline in the CLEC's output related to a lack of access to an unbundled element is a consequence of the inability to find an adequate substitute for the element.[69] In cases where a perfect substitute for the UNE can be self-supplied or purchased from a third-party, then the output of the CLEC would not be expected to fall so that $Q^U = Q^F$. Thus, an important fact relevant to the determination of impairment is the measurement of the substitution effect between a UNE and alternative sources of supply. In measuring this substitution effect, it is vital to measure the full cost of alternative sources of supply. For example, with respect to unbundled local switching, the manual intervention required to physically connect an unbundled loop to a CLEC's equipment (a "hot cut") prohibits both self- and third-party supply of the switching element.[70] The manual process of connecting an incumbent's loop to an entrant's equipment is extremely costly, subject to malfunction, and deters retail and wholesale entry. All entry is prohibited by this requirement since an intermediary would face similar problems.

The output effect is related to the substitution effect. If perfect substitutes for the UNE are unavailable, then the output of the CLEC will decline without access to the UNE because only higher cost alternatives will be available. Depending on the relative full costs of self- or third-party supplied elements to the UNE, this *output effect* may be large or small. A non-zero output effect implies $Q^U > Q^F$, and the question of impairment becomes relevant. Obviously, there is a direct relationship between the substitution effect and the output effect. If perfect substitutes for the UNE are readily available, then the substitution effect is large and the output effect is small. Alternately, if good substitutes are unavailable, the substitution effect is small and the

---

69. AT&T Corp. v. Iowa Utils. Bd., 525 U.S. 366, 391–92 (1999).

> Section 251(d)(2) . . . requires the Commission to determine on a rational basis *which* network elements must be made available, taking into account the objectives of the Act and giving some substance to the "necessary" and "impair" requirements. The latter is not achieved by disregarding entirely the availability of elements outside the network . . . .

Id.

70. *See generally,* Comments of Z-Tel Communications Inc., Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers (2002) (No. 01-338), *available at* http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6513086660 [hereinafter Z-Tel, Comments]; Reply Comments of Z-Tel Communications, Inc., Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers (2002) (No. 01-338), *available at* http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6513282336 [hereinafter Z-Tel, Reply Comments]. *See also* Comments of New York State Department of Public Service, Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers (2002), *available at* http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6513086084.

output effect is large. Empirical measurements of the substitution and output effects are, consequently, important to the evaluation of impairment.

Due to the supply-side characteristics of the local telecommunications market (e.g., scale economies and sunk costs), self-supply by a large number of firms is not feasible.[71] Thus, as element prices rise or as availability is restricted, the output effect dominates the substitution effect and output declines, potentially satisfying the impairment condition. Thus, for network elements that exhibit characteristics unfavorable to easy self-supply (i.e., free entry), the only condition under which output remains relatively unchanged despite an unbundled element price increase is if there is a competitive wholesale market producing a near perfect substitute for the element. Only when there is a wholesale market providing a near perfect substitute available at a comparable price will the absence of an unbundled element have little to no impact on any given potential entrant. Thus, a *general* finding of impairment (that is, one that implicates *all* potential entrants) must be based on the presence of a competitive wholesale market for the element. Absent a wholesale market, even an efficient entrant may be hindered in its ability to provide service without the element—clear evidence of impairment.

F. Caveat

The purpose of analytically defining the impairment standard is not necessarily to produce some formula that actually can be calculated directly.[72] Rather, the purpose of the analysis is to create a conceptual framework for considering impairment so that relevant empirical and theoretical questions may be posed and answered. The use of an analytical approach to impairment assists in providing a framework for evaluating the many empirical questions that are extremely important for competition policy in local telecommunications markets. Given the ambiguity of economic theory on many of the policy-relevant issues (e.g.,

71. JERRY B. DUVALL & GEORGE S. FORD, PHOENIX CTR. FOR THE ADVANCED LEGAL & ECON. PUB. POLICY STUDIES, CHANGING INDUSTRY STRUCTURE: THE ECONOMICS OF ENTRY AND PRICE COMPETITION (POLICY PAPER NO. 10) (2001), *available at* http://www.phoenix-center.org/pcpp/PCPPOPFinal.pdf.

72. The current lack of experience and information implies that in many cases an impairment analysis will require a plethora of rough guesses and empirical extrapolation. This reality is unproblematic, however, since regulatory agencies frequently operate under such conditions and constraints. Merger analysis under the Merger Guidelines is one example of decisions based on theoretical conjecture and available empirical evidence. Importantly, the Texas Public Service FCC recently performed an impairment analysis entirely consistent with the impairment condition of Equation (3). *See* Petition of MCImetro Access Transmission Services LLC for Arbitration of an Interconnection Agreement with Southwestern Bell Telephone Company Under the Telecommunications Act of 1996, Pub. Util. Comm'n of Tex. (2002) (No. 24542), *available at* http://interchange.puc.tx.us/WebApp/Interchange/documents/319570.doc.

unbundling and its effect on investment), the need for quality empirical analysis to guide policy cannot be overstated.[73]

IV. THEORETICAL AND EMPIRICAL MODEL OF IMPAIRMENT

We have just described two important empirical relationships relevant to the determination of impairment: the substitution and output effects. These two effects can be described in more detail with a simple theoretical model that captures the essence of competition resulting from the unbundling provisions of the Act. Consider a scenario where there are two firms—Firm 1, the ILEC, and Firm 2, the CLEC—producing a homogeneous output produced with a fixed proportion technology (i.e., each unit of output requires one unit of input, e.g., loops and switching). The end-user outputs of the two firms are q_1 and q_2, and the industry equilibrium price is $p(q_1 + q_2)$. The firms act as Cournot competitors, choosing their respective outputs simultaneously and selling at the market-clearing price.

Firm 1 (the ILEC) self-supplies all of its own inputs to produce its output. Firm 2 (the CLEC) may either self-supply inputs at cost $c(x)$, lease units of input (the UNE) from its rival firm at regulated price r, or both (the latter being the most interesting case).[74] Units of input purchased by Firm 2 from Firm 1 equal $(q_2 - x)$. When Firm 1 sells a unit of x to Firm 2, it incurs a cost w per unit sold, whereas units sold to consumers require cost k per unit.[75] Because Firm 2 can either make or buy the input, it must select both its output q_2 and how much of its input to make or buy. Assume, for present purposes, that self-supplied and leased inputs are identical in all respects—i.e., perfect substitutes.[76]

The profit functions of the two firms are:

$$\pi_1 = pq_1 + (q_2 - x)(r - w) - kq_1, \text{ and} \tag{3}$$

$$\pi_2 = pq_2 - c(x) - r(q_2 - x). \tag{4}$$

73. *See* Beard, *Entry*, *supra* note 65, at 3–8 (illustrating the theoretical ambiguity of the relationship between unbundling and CEC investment).

74. For an interior solution, assume c' > 0 and c" > 0. The second condition is true for any firm in the short run.

75. For an illustration of the differences between retail and wholesale costs, see Letter from Robert Curtis, President, Z-Tel Network Services, & Thomas Koutsky, Vice President, Law and Public Policy, to Michael Powell, Chairman, FCC (Feb. 23, 2002), *available at* http://gullfoss2.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6513292609; GEORGE S. FORD & T. RANDOLPH BEARD, PHOENIX CTR. FOR THE ADVANCED LEGAL & ECON. PUB. POLICY STUDIES, WHAT DETERMINES WHOLESALE PRICES FOR NETWORK ELEMENTS IN TELEPHONY? AN ECONOMETRIC EVALUATION 23 (Sept. 2002), *at* http://www.phoenix-center.org/pcpp/PCPP16.pdf (estimating cost differences of about $5-6 per line, per month).

76. This is a heroic assumption, and one that would call for less, not more, unbundling.

The first-order conditions for the profit functions are conventional, except that Firm 2 has the additional condition for the choice of x: $c'(x) - r = 0$. By equating the marginal costs of each firm to the common marginal revenue, the equilibrium output levels q_1* and q_2* are found.

The additional first-order condition of Firm 2 yields the demand for x that is $x^*(r)$. This first-order condition implies that Firm 2 makes the input x until the marginal cost of x equals r, and then buys the remaining units of x (up to q_2) at price r. In the case where Firm 2 makes and buys its inputs, the firm's marginal cost at equilibrium is always r, regardless of how many units of input are self-supplied at equilibrium (x*) as long as self-supplied units are less than Firm 2's output ($x^* < q_2$).

The fact that Firm 2's marginal cost equals r is theoretically significant. Because Firm 2's marginal cost is equal to r (in the case where some units of x are purchased), the effect of an increase in r on the output of Firm 2 is consistent with the conventional result in Cournot competition: *a Cournot firm with higher marginal costs produces less output than its low-cost rivals*. Thus, an increase in the input price r reduces the output of Firm 2. This effect is the "output effect," reflecting the effect of changes in r on the output q_2 ($\partial q_2/\partial r < 0$). But, as the price r rises, Firm 2 substitutes self-supply for input purchases. This effect is the "substitution effect," reflecting the increase in the amount of input x "made" as the price of x increases ($\partial x/\partial r > 0$).

Importantly, in an equilibrium where units of x (the UNE) are purchased, *the output effect is always negative*—an increase in the price of r (the price of the UNE) reduces the output of Firm 2 (the CLEC) because it increases the marginal cost of Firm 2. Thus, any claim that increases in the price or the reduction in the availability of "used" UNEs will not affect the output of CLECs should be viewed with skepticism. The remaining empirical question is whether the *substitution effect* is large enough to make the *output effect* so small that it is insignificant and transitory (i.e., less than m percent in time period t). Econometric estimates of the size of the two effects, obviously, are very useful to such an evaluation.

A. Empirical Evidence

The most successful, fastest growing, and most geographically ubiquitous model of competitive entry in the local exchange markets today is the UNE-Platform.[77] The UNE-Platform is the combination of unbundling loop, switching, and transport.[78] In effect, the UNE-Platform

77. UNE-P FACT REPORT, PACE COALITION (July 2003), *available at* http://www.telepolicy.com/pacejuly2003.pdf.

78. All components of the UNE Platform must be unbundled under § 271 of the Act. Nevertheless, the ILECs continue to call for the elimination of unbundling obligations for unbundled switching under § 251(d)(2)(B). *See* Z-Tel, Comments, *supra* note 70, at 22–34; Z-Tel, Reply Comments, *supra* note 70, at 102–11.

allows the CLEC to provide traditional local exchange telecommunications services as if it were the ILEC, and it allows the CLEC to integrate its own technology and software with the ILEC's network. Unbundled loops can be combined with self-supplied switching, and this arrangement is called UNE-Loop.

The success of the UNE-Platform has made it the ILECs' prime target for elimination under the impairment standard, with a focus on eliminating the switching element of the UNE combination.[79] It is therefore sensible to consider empirically the substitution and output effects as they relate to unbundled loops purchased with and without unbundled switching. Unbundled loops must be combined with switching to provide local exchange service. As in the theoretical model, switching is either self-provisioned by the CLEC or purchased on an unbundled basis from the ILEC. In the context of the theoretical model, self-provisioned switching is indicated as x, whereas the quantity of unbundled switching purchased is $q_2 - x$. Total CLEC output (using unbundled loops) is q_2. We only have aggregate data, so the aggregate is treated as representative of Firm 2. If impairment is found to exist for the aggregate of CLECs, then it plainly exists for some components of the aggregate.

Unbundled switching is "available" in all states. Thus, we must treat availability in terms of price. The theoretical model evaluates impairment in terms of an increase in r (or price of unbundled switching for these empirics). Accordingly, to estimate the output and substitution effects, we estimate the following ordinary demand equations:

$$\ln(x) = \alpha_0 + \alpha_1 \ln r + \sum_{j=3}^{n} \alpha_j Z + \varepsilon_L \tag{5}$$

$$\ln(q_2 - x) = \beta_0 + \beta_1 \ln r + \sum_{j=3}^{n} \beta_j Z + \varepsilon_S , \tag{6}$$

where r is the price for unbundled switching, the vector Z represents n other demand-relevant factors that influence the demand for loops of both types, and ε_L and ε_S are econometric error terms that measure the unobserved determinates of loop demand. All variables are measured at the state level, and only the Bell Companies are represented in the sample.[80] Descriptive statistics and variable descriptions and sources are provided in Table 1.

79. Eliminating switching as an element would require CLECs to deploy their own switching equipment, including the complementary colocation and transport facilities. Approximately 40% of CLEC-deployed switching equipment is in bankruptcy. *See* Ford, Declaration on Behalf of Z-Tel, *supra* note 51.

80. For all practical purposes, only the Bell Companies have effectively been made to unbundle their network at prices that provide an opportunity for competitive entry.

1. Substitution and Output Effects

The price of unbundled switching r is included in both demand equations. The substitution effect, or $\partial x/\partial r$, is measured by coefficient α_1 in Equation (5). Due to the log-log specification of the model, the estimated coefficient α_1 measures the substitution effect in elasticity form, or the percentage change in output x given a percentage change in price r. In the theoretical model, the substitution effect indicated that $\partial x/\partial r > 0$ (as r rises, less of x is purchased and more of x is "made") and, by implication, $\partial(q_2 - x)/\partial r < 0$ (the demand for switching slopes downward). The own-price elasticity of demand for switching is measured by the coefficient β_1.

The output effect measures the influence of price r on the total output of the firm (q_2), so this effect is computed using coefficients α_1 and β_1 in Equations (5, 6). Specifically, the output effect is calculated as:

$$\partial q_2/\partial r = \alpha_1(x/q_2) + \beta_1(1 - x/q_2), \tag{7}$$

which is simply a weighted average of the two coefficients α_1 and β_1. The theoretical model suggests that the output effect is negative. The size of the output effect measures impairment. Observe that the output effect is equal to the difference of the reduction in the quantity of x "made" and the quantity of x "bought."

2. Other Variables

Another variable in the demand equation (making up the vector **Z**) is the price for unbundled loops (P_L). Higher prices for loops raise the cost of the CLEC and, consequently, should reduce the quantity demanded of both modes of competitive entry. Because the estimated demand curves are derived demands (demand for inputs, not the final output), the total demand for the final good (local service), measured as the total local service revenues of the Bell Company in the state (*SIZE*), is included as a regressor.[81] The *a priori* expectation is that demand is positively related to market size. Typically, UNE-Loop is viewed as a business-only entry strategy, whereas UNE-Platform is more frequently used to serve residential customers. Thus, we include a measure of the residential-business mix of access lines, measured as the percentage of residential to total access lines in the state (*RESSHR*). A positive relationship between *RESSHR* and UNE-Platform is expected, and a negative relationship between *RESSHR* and UNE-Loop is expected.

In both New York and Texas public services, the FCC has exhibited leadership in promoting competition, and competitor penetration in

81. *See* P.R.G. LAYARD & A.A. WALTERS, MICROECONOMIC THEORY 123–69 (1978).

these two states that is considerably higher than average.[82] Thus, a dummy variable that equals one for New York and Texas (*DNYTX*), zero otherwise, is included in the model. New York and Texas are the leaders in promoting competition via unbundled elements, so positive signs are expected on *DNYTX*.

The Bells' ability to provide long-distance telecommunications service may influence demand, so we include a dummy variable for states in which the Bell Companies have received Section 271 approval (*D271*).[83] Both New York and Texas have Section 271 approval, so the Section 271 dummy variable measures the influence of Section 271 approval absent the leadership effect of these two states. No *a priori* expectation is made about Section 271 status, and it is important to keep in mind that the dummy variable *D271* measures the effect of Section 271 approval once the "leadership effect" of New York and Texas is taken into account.

Dummy variables indicating states with high non-recurring charges (*DNRC*) and the state's population density (*METPOP*) are both included as additional regressors.[84] The variable *METPOP* is measured as the percent of a state's population living in metropolitan areas. Non-recurring charges are sunk costs and consequently deter entry, so a negative sign on *DNRC* is expected. *METPOP* may positively affect demand for unbundled loops purchased without switching due to density economies for self-supplied switching, but no *a priori* expectation is made with respect to the variable's effect on loop-switching combinations.[85]

Finally, since the data used were collected in June and December of 2001, a dummy variable indicating the "as of" date of the data (*DSAMPLE*) is included as a regressor. A positive (or negative) and statistically significant coefficient indicates that, on average, demand increased (or decreased) over the six-month period between June 2001 and December 2001.

---

82. The loop penetration rates (total loops divided by total access lines) in New York and Texas are much higher than average (about 19% for these two states, compared with an average of 5% for the others), and this difference is statistically significant (*t* statistic = 7.56).

83. While most ILECs are subject to the Act's unbundling provisions, the Bell companies, as a result of the § 271 process, have different incentives to comply. Section 271 of the Act would allow Bell companies to offer long-distance services in their regions if they comply with a competitive checklist.

84. For every unbundled loop or loop-switching combination leased from the incumbent LEC, the CLEC must pay the ILEC a non-recurring charge ("NRC") to cover the labor costs of the migration (ordering and provisioning). A high NRC is defined to be an NRC exceeding $50 (for the UNE-Platform, migrating customers rather than new installations).

85. UNE Remand Order, *supra* note 9, at 3823–26 ¶¶ 279–283.

B. Empirical Results

The two equations are estimated by both ordinary least squares ("OLS").[86] Results are summarized in Table 2. Due to limitations on the availability of data for prices and quantities, the final sample consists of sixty-seven observations for each equation. The Adjusted R^2 of Equation (5) is about 0.85 and Equation (6) is 0.70, indicating that a large amount (83% and 70%) of the variation of loop demand of both types is explained by the regressions.[87] Cross-sectional data often has low R^2 values, so these results are very good with respect to how well they fit.[88]

Econometric specification errors such as omitted variables, endogenous explanatory variables, errors in measurement, and an incorrect functional form can each cause least-squares estimates to be biased, inconsistent, and inefficient. The Regression Specification Error Test ("RESET test") is a rather general test of specification error, and is capable of detecting all of the specification problems listed above, but the test is particularly sensitive to omitted variables and incorrect functional form.[89] The null hypothesis for RESET is "no specification error," so specification error is indicated if the null hypothesis is rejected. The RESET F-statistics are provided in Table 2, and neither test statistic is statistically significant even at the 10% level, so there is no evidence of specification error (i.e., null hypothesis of "no specification error" cannot be rejected at standard significance levels). Accordingly, we can be reasonably certain that our model does not suffer from these important specification errors.

Heteroscedasticity exists when the error term (ε) does not have constant variance.[90] The consequence of heteroscedastic disturbances is inefficient estimates, implying the standard errors are inefficient, and consequently the *t*-statistics are either too small or too large.[91] For both equations, the White test rejects the null hypothesis of homoscedastic disturbances, so the reported *t*-statistics are computed using White's robust standard errors.[92]

---

86. Because the two equations are identical in regressors, there is nothing to gain from estimating the equations jointly using Seemingly Unrelated Regressions ("SUR"). For a discussion of SUR, see ROBERT PINDYCK & DANIEL L. RUBINFIELD, ECONOMETRIC MODELS & ECONOMIC FORECASTS 308–11 (3d ed. 1991).

87. DAMODAR GUJARATI, BASIC ECONOMETRICS 207–08 (3d ed. 1995).

88. A.H. STUDENMUND, USING ECONOMETRICS: A PRACTICAL GUIDE 47 (2d ed. 1992).

89. *See, e.g.,* James B. Ramsey & Richard O. Gilbert, *A Monte Carlo Study of Some Small Sample Properties of Tests for Specification Error*, 67 J. AM. STAT. ASS'N, 180, 181 (1972). The RESET Test is valid only for least-squares regressions and is performed by including as regressors the powers of the predicted values of the regression. The joint significance of these additional regressors is evaluated, and the null hypothesis of "no specification error" is rejected if the RESET F-Statistic exceeds the critical value (i.e., the test of the joint restriction that all of the additional coefficients equal zero is statistically significant). *See id.* at 183–84. *See generally* ADRIAN C. DARNELL, A DICTIONARY OF ECONOMETRICS 346–48 (1994).

90. GUJARATI, *supra* note 87, at 61–63.

91. *Id*. at 359–62.

92. *Id*. at 379–83.

1. Estimates of the Substitution and Output Effects

As previously mentioned, the substitution effect is measured by the coefficient α_1 ($= \partial x/\partial r$) in Equation (5). From the econometric model, it is not possible to reject the hypothesis that *the substitution effect is zero*. While the estimated coefficient is positive (0.114), the estimated coefficient is very close to zero and not statistically different from zero (the *t*-statistic is only 0.91). As the price of unbundled switching rises, CLECs do not purchase more loops to be used with their own switching facilities or the switching facilities of third-party suppliers. Given a zero substitution effect, the effect of higher unbundled switching prices is only reflected in the output effect.

Equation (6) shows the calculation for the output effect. Using the estimated coefficients and the sample average value for x/q_2 (= 0.50), the output effect is 0.50. So, a 10% increase in the switching price reduces CLEC aggregate output (using unbundled loops) by 5.0%. This output effect (elasticity) is statistically different from zero at better than the 1% significance level ($\chi^2 = 17.95$, Prob. < 0.01).[93]

It is worth observing that the own-price elasticity of demand for unbundled switching is about •1.10 (measured as β_1), which indicates that a 10% change in price produces an 11% change in quantity demanded for loop-switching combinations (i.e., the UNE-Platform). The estimated elasticity is statistically significant at better than the 1% level. Because UNE-Platform accounts for half of all unbundled loops, the total output effect is smaller than the reduction of output for the UNE-Platform alone.

If a 10% increase in the price of unbundled switching reduces CLEC output by 5%, then it is clear that the complete removal of unbundled switching will substantially reduce CLEC output. The empirical evidence, assuming that the significance component of impairment is not arbitrarily large, supports impairment with respect to unbundled switching. Assuming the estimated elasticities are valid for large price increases, a doubling of switching charges essentially cuts CLEC total output in half.

2. Other Variables

Given the model specification, the own-price elasticities of demand for loops are estimated. As expected, the demand curves for unbundled loops of both types slope downward, with an elasticity of about -1.1 for x (loops purchased without switching) and -2.2 for $(q_2 - x)$ (loops purchased with unbundled switching). Both elasticities are in the elastic

93. This joint test of significance is distributed χ^2 with m degrees of freedom (where m is the number of constraints). *See generally* THE MIT DICTIONARY OF MODERN ECONOMICS 124 (David W. Pearce ed., 4th ed. 1992).

region of demand, indicating that quantity demanded responds more than proportionately to any given percentage change in price. A 10% increase in the loop price will decrease quantity demanded for each type of loop by about 11% and 22%, respectively.

The effects of prices on the total quantity of competitive services provided using unbundled loops can be computed from the estimated coefficients of the demand equations. The own-price demand elasticity for total loops (q_2) is simply the weighted average of the two elasticities measured by α_2 and β_2, because in our sample, x/q_2 is roughly equal to 0.50. The simple average of the two own-price elasticities is -1.7. This value measures the total, own-price elasticity of demand for unbundled loops of both types. Across loops of all types, a 10% increase in the price of an unbundled loop alone will decrease the quantity of loops sold by about 17%, all else being equal.

While the point estimates of the elasticities of demand for loops and switching are different, it is not possible to reject the hypothesis that a $1 increase in the price of either the loop or switching has an equal effect on quantity. This result is sensible, since in loop-switching combinations both elements are purchased jointly.[94] The Wald test on the equality restriction (evaluated at the sample means) has the statistic $\chi^2 = 3.55$, which is not statistically significant at the 5% level.[95] So the null hypothesis of equality (a $1 change renders an identical reduction in quantity) cannot be rejected at this level of statistical significance.

Market size (*SIZE*), which measures total expenditures for local service, increases the demand for loops of both types. The coefficients are less than 1.00, so the increase in demand is less than proportionate to the increase in market size.[96] As expected, a richer mix of residential lines leads to more loop-switching combinations (UNE-Platform), whereas more business lines positively affects loop-only entry (UNE-Loop). New York and Texas, the two leading states in the promotion of competition in local exchange markets, have a higher demand for loops leased with and without unbundled switching, but these effects are statistically significant only in Equation (6).

Once the higher demand levels in New York and Texas are taken into account, approval for Bell Company entry into long distance under Section 271 of the 1996 Act (*D271*) is not an important determinant of the demand for loop-switching combinations. Section 271 approval has no statistically significant effect on demand. High non-recurring charges reduce demand for both types of loops (*DNRC*), and both estimated coefficients are statistically significant at better than the 10% level.

94. An alternative specification would be to impose this constraint on the coefficients. However, doing so is complicated by the non-linear transformation of the regressors (i.e., levels to natural logs).

95. The test is $\beta_2/w = \beta_1/(1 - w)$, where w is $P_L/(P_L + P_S)$.

96. Statistically, we cannot reject the hypothesis that the coefficients on *SIZE* are equal across equations ($\chi^2 = 0.38$, Prob 0.54).

Population density (*METPOP*) increases the demand for loops purchased without switching, but the variable does not exhibit statistical significance for loop-switching combinations.

V. CONCLUSIONS

A central problem in the establishment of competition in local telephony has been the mechanism through which entry might be achieved. Congress, through the 1996 Telecommunications Act, offered guidance to the FCC by creating standards on which unbundling of critical elements by ILECs could take place. Chief among the principles regulating unbundling by ILECs is the potential impairment of entrants seeking to provide services to local consumers. The "impairment standard" as identified by the FCC has lacked the specificity necessary to be accepted by the courts.

This Article surveys the impairment standard of Section 251(d)(2)(B) of the Telecommunications Act of 1996 and its content as it has been interpreted by both the FCC and the courts. The Congressional standard relating to unbundling clearly pointed to its impact on each CLEC's output, and relevant court decisions have repeatedly upheld this view. We develop a formal theoretical model of impairment that relates element availability to CLEC output. This theoretical model is then subjected to empirical tests.

From this theory, it is shown that impairment is evaluated by estimating an output effect—the reduction in a CLEC's output when an element is made less available—and a substitution effect. The substitution effect measures the shift from unbundled elements to self-supply (or third-party supply) given a change in wholesale price. For unbundled switching, the empirical model revealed a sizable and statistically significant output effect: a 10% increase in switching price reduces CLEC output by 4.4%. The substitution effect, or the shift in inputs "made" from those "bought," is found to be zero. These estimates, made possible with the model developed in this Article, reveal the necessity for establishing standards for unbundling and, ultimately, for competitive entry in local telephony.

Table 1. Variable Definitions, Sources, and Descriptive Statistics				
Name	Description	Mean	St. Dev.	Source
x	Quantity of unbundled loops sold on a stand-alone basis.	84,469	103,695	(1)
$q_2 - x$	Quantity of unbundled loops sold with unbundled switching.	148,580	359,948	(1)
q_2	Total unbundled loops sold: $Q_L + Q_S$.	233,049	419,107	(1)
x/q_2	Share of stand-alone unbundled loops to total loops.	0.502	. . .	. . .
P_L	Index of average price of an unbundled loop (mean-centered index).	15.95	4.73	(2)
r	Index of average price for unbundled switching (i.e., non-loop costs, indexed by average loop price).	14.60	7.22	(2)
SIZE	Size of the market measured as retail revenues for local services.	1.3M	1.2M	(3)
RESSHR	Percentage of total analog access lines that serve residential customers.	0.726	. . .	(3)
DNYTX	Dummy variable that equals 1 if state is New York or Texas, 0 otherwise.	0.060	. . .	. . .
D271	Dummy variable for states granted § 271 approval by the FCC: New York, Texas, Oklahoma, Kansas, Arkansas, Missouri, Massachusetts, and Pennsylvania.	0.179	. . .	. . .
DNRC	Dummy variable that equals 1 for states with loop-switching non-recurring charges exceeding $50.	0.045	. . .	(2)
METPOP	Percent of state population living in metropolitan areas.	0.715	. . .	(4)
DSAMPLE	Dummy variable that equals 1 for data as of Dec. 2001, 0 for data as of June 2001.	0.537	. . .	. . .

(1) FCC Data acquired by Freedom of Information Act request made by the Promoting Active Competition Everywhere ("PACE") Coalition.
(2) Provided by Z-Tel Communications.
(3) ARMIS data (www.fcc.gov/wcb/armis).
(4) www.census.gov.

Table 2. Summary of Results		
	Ordinary Least Squares	
Equation	No. (5)	No. (6)
Dep. Variable	$\ln Q_L$	$\ln Q_S$
	Coef. (White's *t*-stat)	Coef. (White's *t*-stat)
Constant (α_0, β_0)	5.497 (2.48)*	1.691 (0.28)
r (α_1, β_1)	0.114 (0.91)	-1.104 (-4.71)*
P_L (α_2, β_2)	-1.124 (-3.89)*	-2.209 (-4.64)*
SIZE (α_3, β_3)	0.655 (5.91)*	0.873 (2.62)*
RESSHR (α_4, β_4)	-4.357 (-2.48)*	8.964 (2.83)*
DNYTX (α_5, β_5)	0.520 (1.51)	1.979 (3.62)*
D271 (α_6, β_6)	-0.391 (-1.33)	0.340 (1.23)
DNRC (α_7, β_7)	-0.567 (-2.46)*	-1.519 (-3.30)*
METPOP (α_8, β_8)	2.710 (5.77)*	-1.461 (-1.32)
DSAMPLE (α_9, β_9)	0.259 (1.89)**	0.195 (0.88)
Adj. R^2	0.83	0.70
RESET F	1.40	1.23
White χ^2	27.70*	37.48*
Observations	67	67
*Statistically significant at the 5% level or better. ** Statistically significant at the 10% level or better.		