Pursuing Competition In Local Telephony:
The Law and Economics of Unbundling And Impairment

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I. Introduction

Conflict between the intent of Congress in the 1996 Telecommunications Act, interpretations of vital portions of the Act by the Federal Communications FCC and federal Court decisions have created a critical impasse in providing increased consumer welfare in local telephony. A central problem relates to the access to unbundled network elements ("UNEs") provided by incumbent local exchange carriers ("ILECs") and the sunk costs of entry into local markets, that is, to an economic conflict between ILECs and competitive local exchange carriers ("CLECs"). The guidance of Congress appears clear, at least on the face of the matter. Section 251(d)(2)(B) of the 1996 Telecommunications 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."[1] The FCC has, on two occasions, attempted to apply an "impairment standard" in developing its unbundling policies but the Courts have remanded both those attempts.[2] This problem – a defining one from the perspective of the ultimate provision of competitive retail telephony – stems from the fact that, whereas the plain language of Congress suggests a straightforward definition, the FCC has failed to specify impairment in a useful, analytical way.[3] The FCC's most recent attempt to define impairment by linking it to "entry barriers" has promise, as this paper will show.[4] Certainly, the courts will have there chance to review the new standard in what is expected to be a flurry of appeals.

The purpose of this paper is threefold. In Section II, the implications of the unbundling provisions of the 1996 Telecommunications Act on industry structure for local telecommunications market is discussed. Section III includes an analytical statement of the Act's impairment standard that draws primarily from the text of the Act

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[1] 47 U.S.C. § 251(d)(2)(B). The Telecommunications 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.

[2] *251 Order* and *UNE Remand Order*.

[3] *Iowa* at _____ (the Commission' 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) and *USTA* at _____ ("adding the adjective "material" contributes nothing of any analytical or qualitative characters that would fulfill the Court's demand for a standard "rationally related to the goals of the Act).

[4] FCC Adopts New Rules For Network Unbundling Obligations Of Incumbent Local Phone Carriers, FCC News Release, CC Docket No. 01-338 (Feb. 20, 2003).

and recent court decisions. In Section IV, theoretical and empirical models designed to test for impairment (as it related to unbundled switching) are described, and the results of the empirical analysis summarized. Concluding comments finish the paper.

II. Wholesale-Retail Bifurcation of the Telecommunications Market

The Telecommunications Act of 1996 is an ingenious piece of legislation, incorporating specific mandates that address the underlying economics of the local exchange market into its pro-competition framework[5] for the purpose of "uprooting the monopolies" presently serving that market.[6] For most of the history of telephone service, the local exchange market has been believed to be a natural monopoly and has been treated as such by regulators.[7] Today, it is possible for competition to exist in *some* geographic and product segments of the local exchange market.[8] The unbundling provisions promote competition by addressing the most important factors that impede competitive entry: a) the sunk cost of deploying local exchange facilities and bringing such facilities to operational efficiency; b) pervasive economies of scale, scope, and density; and c) other first-mover advantages possessed by the incumbents.[9]

Industrial economics indicates that equilibrium industry structure is driven fundamentally by market size and the sunk costs of entry.[10] The larger is the market per dollar of sunk entry costs, or, equivalently, the smaller are sunk costs per dollar of market expenditures, the less concentrated is industry structure. Promoting competition by attenuating the influence of sunk costs on market structure lies at the very core of the

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[5] *Verizon* at 1661 (describing "novel rate setting designed to give aspiring competitors every possible incentive to enter local retail telephone markets, short of confiscating the incumbents' property").

[6] *Id.* at 1660.

[7] For example, the 1982 Consent Decree that divested AT&T of its 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., id. At 1654.*

[8] Commenting on implementation of the 1996 Act, Chairman Powell recently observed, "We correctly believed these markets didn't need to be natural monopolies and they could be competitive," Yochi J. Dreazen, "FCC. Faced with Telecom Crisis, Could Let a Bell Buy Worldcom," Wall Street Journal (July 15, 2002). Powell qualified these remarks by noting that "I think we tended to over-exaggerate how quickly and how dramatically it could become competitive."

[9] *Id.* at 1684 ("The Act, however, proceeds on the understanding that incumbent monopolists and contending competitors are unequal."). The Act's unbundling mandates were not restricted solely to offset entry barriers related to sunk costs, but offered entrants access to the incumbent's network for any reason that would impair the ability of the entrant to provide service. *See* 47 U.S.C. § 251(d)(2)(B). Also *see* T. Randolph Beard, George S. Ford, and Lawrence W. Spiwak, *Why Adco? Why Now? An Economic Exploration into the Future of Industry Structure in Local Telecommunications Markets*, 54 FED. COMM. L. J. 421-59 (2002) (hereinafter "*Beard, Ford, and Spiwak 2002*").

[10] *See*, e.g., John Sutton, SUNK COST AND MARKET STRUCTURE (1991), Ch. 3.

Telecommunications Act of 1996 and, in particular, the unbundling mandates of the Act.[11] By allowing entrants to lease elements of the local exchange, the 1996 Act allows 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 implies, reducing sunk investments allows for more entry, thereby improving the equilibrium industry structure in the provision of retail telephone services (*i.e.*, "uprooting the monopolies"). The unbundling provisions are more important now than ever, as financing for CLECs has all but dried up completely.[12]

Consistency with the Act requires the FCC to consider how its policies, extant and prospective, affect market size and sunk entry costs (along with other practical entry barriers).[13] Successful 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 (*e.g.*, top 50 MSAs, more than 3 access lines, etc.), and such policies should be avoided since they limit competition.[14] 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 Congressional intent of "eliminating the monopolies" in the local exchange markets.[15]

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[11] 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. As Elizabeth Bailey argued, "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" (E.E. Bailey, *Contestability and the Deign of Regulatory and Antitrust Policy*, AMERICAN ECONOMIC REVIEW Vol. 71, at 178-183 (May 1981).

[12] *See*, e.g., *Experts Say Investors Might Not Fund Facilities-Based Competition*, Telecommunications Reports Daily, October 7, 2002 (Financial markets are reluctant to pump more money into the sector, and the Commission may be powerless to jump-start investment).

[13] *AT&T*, 525 U.S. at 388 (rationally related to the goals of the Act); *Verizon*, 122 S. Ct. at 1685 (meant to remove practical barriers to competitive entry into local-exchange markets).

[14] In the UNE Remand Order, 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 (CITATION). Z-Tel Policy Paper No. 3 includes an empirical analysis that estimates the switching restriction reduced competitive entry by 36% (CITATION).

[15] *Verizon Communications, Inc. v. FCC*, 122 S. Ct. 1646, 1654, 1661 (2002).

A. REORGANIZING MARKETS INTO WHOLESALE AND RETAIL COMPONENTS

The unbundling provisions of the Telecommunications Act of 1996 have, in practical effect, split the vertically integrated local exchange industry into retail and wholesale segments.[16] Vertical integration is not prohibited, but neither is it required.[17] By freeing the retail telecommunications and value-added (such as information services) segments of the local exchange from the enormous sunk costs of the wholesale telecommunications segment,[18] 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 distance services, including the Regional Bell Companies (who today rely on market-based unbundled access to interexchange facilities to provide long distance service).[19] All of these retail services were supported by only seven nationwide long distance networks (and some more regional networks).[20] Given that the sunk cost per dollar of market potential in the local exchange market(s) is less favorable to multiple firm supply than in interexchange industry (where traffic is aggregated), an equilibrium industry configuration with numerous CLECs relying exclusively on their own facilities to provide service is improbable.[21] High concentration in the wholesale segment is perhaps inevitable, but monopoly is not.[22]

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

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[16] *Verizon*, 122 S. Ct. at 1661, 1662, 1661 ("Congress aim[ed] to … reorganize markets." "[W]holesale markets for companies engaged in resale, leasing, or interconnection of facilities cannot be created without addressing rates." "The Act…favor[ed]…novel rate setting designed to give aspiring competitors every possible incentive to enter local retail telephone markets.").

[17] This fact also is supported by general antitrust law. *See, e.g., Fishman v. Estate of Wirtz*, 807 F.2d 520 (7th Cir. 1986); and DAVID L. KASERMAN & JOHN W. MAYO, GOVERNMENT AND BUSINESS (1995), Ch. 9.

[18] CITATIONS.

[19] *Trends in Telephone Service*, Table 10-4 (May 2002).

[20] *Resellers Rate Wholesale Carriers*, Phone +, September 4, 2000.

[21] *See* Philip Areeda and _____ Hovenkamp, *Antitrust Law*, p. 175 (¶ 772a) (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) and T. Randolph Beard, George S. Ford, and Lawrence W. Spiwak, *Why Adco? Why Now? An Economic Exploration into the Future of Industry Structure in Local Telecommunications Markets*, 54 FED. COMM. L. J. 421-59 (2002) (hereinafter "*Beard, Ford, and Spiwak 2002*").

[22] *See* Beard, Ford, and Spiwak 2002.

impossible. Indeed, the risk of entry at the wholesale level is attenuated by the presence of the non-incumbent demand 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.[23]

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 a 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 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.[24]

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, Global Crossing) do not have a significant retail presence. [25] All of the recently deployed nationwide interexchange networks were deployed by (essentially) non-retail operations to provide data transport and wholesale interexchange services. In 2000, some 800 retailers provided long distance services over about 7 nationwide networks.[26]

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.[27] Vertical integration of retail competitors into the wholesale market has and may

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[23] *See id;* T. R. Beard, D. L. Kaserman, and J. W. Mayo (1998), "The Role of Resale Entry in Promoting Local Exchange Competition," *Telecommunications Policy*, Vol. 22, No. 4/5, pp. 315-326.

[24] See id.

[25] *See* Beard, Ford, and Spiwak (2002) and *Statistical Trends in Telephony* (229 IXCs and 576 resellers), Table 10.4 (May 2002).

[26] *Id*.

[27] 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 inihibit the success of a firm supplying the wholesale markets. See *id*.

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

Besides the network elements that must be unbundled as a requirement of Section 271 of the Act, Section 251(d)(2)(B) of the 1996 Telecommunications Act specifically 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."[28] The plain language of this section indicates at least three components of an impairment standard, including: 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. Each component is discussed in turn.

A. Carrier Specific Nature of Impairment

The plain language of §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 FCC, which can make other elements available on a case-by-case basis;"[29]
- "[t]he 1996 Act…requir[es]…that incumbents provide access to 'any' requesting carrier;"[30]
- "[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

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[28] 47 U.S.C. § 251(d)(2)(B).

[29] *AT&T Corp. v. Iowa Utilities Board*, 525 U.S. 366, 388 (1999) (emphasis added).

[30] *Id*. at 392.

a large competitive carrier such as AT&T or Worldcom [sic]) seeking to gain toeholds in local-exchange markets;"[31] and

- "a policy promoting lower lease prices for expensive facilities unlikely to be duplicated reduces barriers to entry (particularly for smaller competitors).[32]

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.[33] The carrier-specific nature 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*.[34]

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 it seeks to offer*." Clearly, to impair the "ability to provide…service" is best detected in the difference in quantity of service provided (i.e., output) with and without access to the unbundled element.[35]

In its criticism of the FCC's first effort to define impairment, which was 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

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[31] *Verizon*, 122 S. Ct. at 1672

[32] *Id* at 1668.

[33] *Id* at 1672. Judge Antonin Scalia argued that the Section 251(d)(2) of the Telecommunications Act does not mean that the FCC has unlimited authority to order unbundling (Iowa Utilities Board, 119 S. Ct. at 738). While incumbents would favor the "essential facilities doctrine" (established in an early railroad case, *Terminal Railroad Association v. U. S.* 1912) as a boundary, the Court did not invoke it in Iowa. See Jerry A. Hausman and J. Gregory Sidak, "A Consumer-Welfare Approach to the Mandatory Unbundling of Telecommunications Networks," Yale Law Journal, December 1999 at 436.

[34] *See* In re Implementation of the Local Competition Provisions of the Telecommunications Act of 1996, *Third Report & Order & Fourth Further Notice of Proposed Rulemaking*, 15 FCC Rcd 3696, 3726 (¶ 53) (1999) ("*UNE Remand Order*"). 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.* (¶ 54). If the business plans and financial conditions of a group of carriers are sufficiently homogenous, the carriers possibly can 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.

[35] *AT&T*, 525 U.S. at 388, 375 (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*, the FCC appeared to adopt an output standard (focusing on timeliness, ubiquity, etc.), *see id.* at 3705, but failed to directly specify the standard in terms of output. Once the output distinction is made clear, the impairment analysis becomes considerably easier to describe and implement.

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."[36] The Court did recognize, however, that "In a world of perfect competition … the FCC's total equating of increased cost (or decreased quality) with "necessity and "impairment" might be reasonable."[37] Clearly, the Supreme Court is linking 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.[38] As competition moves away from textbook models of intense price competition, as the Court recognized, cost disadvantages are not so punishing to the output of rival firms.[39] For example, in Cournot-style oligopolistic competition, firms with different levels of marginal cost can co-exist, although low-cost firms have higher output levels.[40] By linking cost changes to output by reference to the intensity of price competition, the Court clearly observed that output was the relevant index of impairment, and rebuked the FCC for not incorporating this fact into their impairment analysis.

The Supreme Court decision in *Verizon v. FCC* further supports the output component of impairment. In that decision, the Court describes a "reasonable reading" of the unbundling and interconnection provisions of the Act (*i.e.*, section 251(c)) is that they are "meant to remove practical barriers to competitive entry into local-exchange markets."[41] Under an output-based test for impairment, any "practical barrier[] to … entry"[42] will reveal itself 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

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[36] *AT&T*, 525 U.S. at 389-90.

[37] *Id.* at 390.

[38] Firms choose price in Bertrand competition, quantities in Cournot competition. If products are homogeneous, Bertrand competition renders the competitive equilibrium (price equals marginal cost) with only two firms. With product differentiation, the differences in Bertrand and Cournot outcomes are less divergent. See, e.g., James Friedman, OLIGOPOLY THEORY (1983).

[39] *AT&T*, at __ (In a world of perfect competition, in which all carriers are providing their service at marginal cost, the Commission' s total equating of increased cost (or decreased quality) with "necessity" and "impairment" might be reasonable; but it has not established the existence of such an ideal world).

[40] STEPHEN MARTIN, ADVANCED INDUSTRIAL ECONOMICS (1993), at 19-21 ("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.

[41] *Verizon*, 122 S. Ct. at 1685.

[42] *Id.*

resources and the relative inefficiency of entrants.[43] 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."[44]

Because impairment is an output-based standard, the FCC's focus on cost-differences in the *UNE Remand Order* was lacking, given that it failed to provide some direct link between cost and output.[45] Thus, 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.[46] 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," it seems reasonable that to constitute a statutorily cognizable

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[43] 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 established entrant firms." 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." von Weizsacker adds to the Stiglerian definition the requirement that the barrier lead to a suboptimal allocation of resources. *See* MARTIN, *supra* n. 42, at 5-7, 172-191; In re Implementation of Section 19 of the Cable Television Consumer Protection & Competition Act of 1992; Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming, *First Report*, 9 FCC Rcd 7442, at App. H: Economic Concepts for Assessing the Extent of Competition in Video Programming Distribution Markets (1994).

[44] *Verizon,* 122 S. Ct. at 1660-61.

[45] Section 251 of the Telecommunications Act also instruct 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" (251(d)(2)). According to Hausman and Sidak, "neither 251(d)(2) not any other section of the Telecommunications Act of 1996 defines "proprietary" for purposes of the ILEC's duty to unbundled 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"" (see Jerry A. Hausman and J. Gregory Sidak, supra note 25 at 434). Because "impairment" is the more relevant standard, our own focus in this paper is to develop an "impairment" standard analytically and suitable for empirical testing.

[46] See Z-Tel Policy Paper No. 5 and Rebuttal Testimony of George S. Ford on Behalf of Z-Tel Communications, CC Docket No. 01-338 (DATE).

impairment, there must be a small, but significant and non-transitory decrease in the requesting carrier's output.[47] The Act offers no guidance on what "significant" is, but it seems sensible that significance be "rationally related to the goals of the Act,"[48] which include the promotion of competition ("uprooting the monopolies") and deregulation.[49] The reduction in output also should not be a transitory disability, but one that cannot be quickly and easily overcome.[50]

In *Verizon v. FCC*, the Supreme Court observed that the Act was "designed to give aspiring competitors every possible incentive to enter local retail telephone markets."[51] Given that the Court stated that even small price increases of an unbundled element may reduce incentives to enter local retail telephone markets, small degrees of impairment necessarily must be significant.[52]

D. AN ANALYTICAL STATEMENT OF THE IMPAIRMENT CONDITION

The legal intent of impairment, as we have established above, is an output standard to which "significance" is a necessary part. To be useful, these requirements must be developed into a conceptual framework around which issues may be identified and analyzed in empirical terms. In order to provide analytical specificity to the impairment condition, consider the following simply 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

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[47] *See* Merriam-Webster Dictionary Online (www.m-w.com).

[48] *AT&T*, 525 U.S. at 388.

[49] Justice Scalia (in ATT&T Corp. v. Iowa Utilities Board, 119 S. Ct. at 735) entertained the element of significance in the context of impairment. Obviously not every diminution in quality or increase in cost significantly impairs an entrant and its return on investment. But "significance" is therefore undefined in the Iowa Utilities decision. If small price increases (or differentials) bar entry by a competitor they are definitionally significant. Significance is included in the model develop in Parts IV and V of this paper.

[50] The concept of a more permanent, non-transitory change is consistent with the Merger Guidelines (CITATION).

[51] *Verizon*, 122 S. Ct. at 1661.

[52] *Id.* at 1672 ("[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 1675 ("[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. and George S. Ford, "Preliminary Estimates of the Demand for Unbundled Network Elements in Telephony, *Atlantic Economic Journal* (Forthcoming December 2002) (estimating own-price elasticity of demand for unbundled element combinations to be –2.7).

without the element.[53] For now, let the significance component be a particular percentage reduction (m) 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:

$$Q_i^U - Q_i^F > mQ_i^U, \quad (1)$$

where the condition simply states that impairment exists if the reduction in the quantity of service sold ($Q^U - Q^F$) exceeds a significant reduction in service sold (mQ^U) when the unbundled element is taken away. For example, say that a 10% reduction in the quantity of service 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 (0.10·100), 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) satisfied. Equation (2) is a simple, direct analytical re-statement of section 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.[54]

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).[55] 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., $Q(A) - Q(0) > mQ_E(A)$].

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.[56] While not stated explicitly in

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[53] 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 section 252(d). Today, prices are based on total long-run incremental cost ("TELRIC"), and the Supreme Court recently upheld that pricing standard in *Verizon*, 122 S. Ct. at 1668-79, as being the most reasonable interpretation of the Act's requirements among proffered alternatives.

[54] *AT&T*, 525 U.S. at 389.

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

[56] A granular, geographic-specific analysis of impairment was called for in *USTA v. FCC* (CITE).

§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.[57] Further, output must be measured at some specific point in time or over some 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*.[58] 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 thereof could be measured empirically.[59] In that same *Order*, the FCC also considered "timeliness" as a relevant factor for impairment, which enters the analysis via *t*.[60]

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 carriers 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 exactly what the FCC's decision in the Triennial Review will 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:

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[57] *Id*.

[58] *See UNE Remand Order*, 15 FCC Rcd at 3804-32 (¶¶ 241-99).

[59] See Z-TEL Policy Papers Nos. 3 and 4, and T. Randolph Beard, George S. Ford, & Thomas W. Koutsky, Facilities-Based Entry in Local Telecommunications: An Empirical Investigation (unpublished manuscript, June 2002).

[60] *See id.* at 3704-09 (Executive Summary).

> 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.[61]

Economists have many definitions of entry barriers, but most generally an "entry barrier can be thought of as something that makes entry more costly or more difficult."[62] Since the primary symptom of "difficult entry" is a reduction in the output of the entrant, the entry barriers definition of impairment is entirely compatible with the analytical approach summarized in Equation (2). An entry barrier need not preclude entry, it only need attenuate it.

Since Equation (2) is based on a rather straightforward reading of the statute, the FCC's newest impairment standard probably has legs. That said, the devil is always in the details, and one relevant detail is how the various state regulatory agencies implement the new standard. Even if the definition survives scrutiny, the implementation may not.

3. *The Specific Causes 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.[63] 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 move an unbundled loop from the ILEC's switch to a CLEC's colocation prohibits both self- and third-party supply of the switching element.[64]

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[61] FCC Adopts New Rules For Network Unbundling Obligations Of Incumbent Local Phone Carriers, FCC News Release, CC Docket No. 01-338 (Feb. 20, 2003).

[62] W. K. Viscusi, J. M Vernon, and J. E. Harrington Jr., Economics of Regulation and Antitrust, 2nd Ed. (1995), p. 60.

[63] AT&T, at _____ (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 …).

[64] *See* Z-Tel Comments and Reply Comments in CC Docket No. 01-338 (CITATION); also see Comments of the New York State Public Service Commission in CC Docket No. 01-338 (CITATION).

Related to the substitution effect is the output effect. If perfect substitutes for the UNE are unavailable, then the output of the CLEC will decline without access to the UNE. 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 output effect is large. Empirical measurements of the substitution and output effects are, consequently, important to the evaluation of impairment.

4. Caveat

The purpose of defining analytically the impairment standard is not necessarily to produce some formula that actually can be calculated directly.[65] 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., unbundling and its effect on investment), the need for quality empirical analysis to guide policy cannot be understated.[66]

IV. A Theoretical and Empirical Model of Impairment

Just described are 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, 1 and 2 (i.e., the ILEC and 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 $p(q_1 + q_2)$. Firms act as Cournot competitors,

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[65] 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 Arbitration Award, *Petition of MCIMetro*, Texas PUC Docket No. 24542 (May 1, 2002)).

[66] The theoretical ambiguity of the relationship between unbundling and CLEC investment is illustrated by Beard, Ford, and Koutsky (2002).

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 1 at regulated price r, or both (the latter being the most interesting case).[67] 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 of w per unit sold, whereas units sold to consumers require cost k per unit.[68] Because firm 2 can either make or buy the input, firm 2 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).[69]

The profit functions of the two firms are

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

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

The first-order conditions for the profit functions are conventional, except 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 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

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

[68] For an illustration of the differences between retail and wholesale costs, see Letter to FCC Chairman Michael Powell from Robert Curtis and Thomas Koutsky (CITATION) and Phoenix-Center Policy Paper No. 16 (estimating cost differences of about $5-6 per line, per month).

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

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 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 effect the output of CLECs should be viewed with skepticism. The remaining empirical question is, therefore, is the *substitution effect* 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, most geographically ubiquitous model of competitive entry in the local exchange markets today is the UNE-Platform. The UNE-Platform is the combination of unbundling loop, switching, and transport.[70] In effect, the UNE-Platform 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.

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.[71] It is sensible, therefore, 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

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[70] All components of the UNE Platform must be unbundled under Section 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 Comments and Reply Comments of Z-Tel Communications, CC Docket No. 01-338 (_____ and July 16, 2002).

[71] Eliminating switching as an element would require CLECs to deploy their own switching equipment, including the complementary colocation and transport facilities. Approximately 40 percent of CLEC deployed switching equipment is in bankruptcy. See Rebuttal Testimony of George S. Ford on Behalf of Z-Tel Communications, CC Docket No. 01-338 (July 16, 2002).

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 well-behaved 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.[72] Descriptive statistics and variable descriptions and sources are provided in Table 1.

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

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

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

which is simply a weighed 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

Other variables in the demand equation (making up the vector **Z**) include the price for unbundled loops (P_L). Clearly, 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.[73] A priori expectations are that demand is positively related to market size.

Both the New York and Texas public service FCCs have exhibited leadership in promoting competition, and competitor penetration in these two states is considerably higher than average.[74] 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 271 approval (*D271*). [75]Both New York and Texas have 271 approval, so the 271 dummy variable measures the influence of 271 approval absent the leadership effect of these two states. No a priori expectation is made about 271 status (*D271*), and it is important to keep in mind that the dummy variable *D271* measures the effect of 271 approval once the "leadership effect" of New York and Texas (both 271 approved states) is taken into account.

A dummy variable indicating states with high non-recurring charges (*DNRC*), and the percent of the state's population density (*METPOP*), are both included as additional regressors.[76] The variable *METPOP* is measured as the percent of a state's population

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[73] See P.R.G. Layard and A.A. Walters, MICROECONOMIC THEORY (1978), Ch. 5.

[74] 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 to the average of 5% for the others), and this difference is statistically significant (t statistic = 7.56).

[75] While most ILECs are subject to the Telecommunication 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.

[76] 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

living in metropolitan areas. Non-recurring charges are sunk costs and, consequently, deter entry, so a negative sign on *DNRC* is expected. Population density (*METPOP*) may be 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.[77]

Finally, since the data used was 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 (negative) and statistically significant coefficient indicates that, on average, demand increased (decreased) over the six-month period between June 2001 and December 2001.

B. EMPIRICAL RESULTS

The two equations are estimated (as a system) by weighted least squares.[78] Results are summarized in Table 2. Due to limitations on the availability of data for prices and quantities, the final sample consists of 134 system observations, or 67 (balanced) observations for each equation. The R^2 of Equation (5) is about 0.85 and Equation (6) is 0.66, indicating that a large amount (85% and 66%) of the variation of loop demand of both types is explained by the regressions. Cross sectional data often has low R^2s, so the results are very good with respect to goodness of fit.[79]

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.[80] The RESET test is a rather general test of specification error, and is capable of detecting all of the specification problems listed above (Ramsey 1969), but the test is particularly sensitive to omitted

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provisioning). A high NRC is defined to be an NRC (for the UNE-Platform, migrating customers rather than new installations) exceeding $50.

[77] *UNE Remand Order*, at ¶¶ 279-283..

[78] By estimating as a system using weighted least squares, the estimates are more efficient relative to ordinary least squares estimates of the individual equations because the procedure increasesthe degrees of freedom and corrects for heteroskedastic disturbances. *See* Robert PINDYCK, AND DANIEL L. RUBINFIELD, ECONOMETRIC MODELS & ECONOMIC FORECASTS (3rd ed. 1991). Because there are no cross-equation restrictions, the estimated parameters are identical to single-equation ordinary least squares estimation. However, the standard errors of the two procedures are not the same.

[79] A. H. Studenmund, USING ECONOMETRICS (1992) at p. 47.

[80] This class of error violates the least squares assumption of a null mean for the theoretical disturbance vector. The RESET Test is valid only for least-squares regressions. Ramsey's RESET Test 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).

variables and incorrect functional form.[81] 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.

Heteroskedasticity exists when the error term (ε) does not have constant variance. The consequence of heteroscedastic disturbances is inefficient estimates, implying the standard errors are too large and, consequently, the t-statistics are too small. The White test fails to reject the null-hypothesis of homoscedastic disturbances, so heteroscedasticity is not influencing the reported t-statistics.

1. *Estimates of the Substitution and Output Effects*

As previously mentioned, the substitution effect is measured by the coefficient α_1 (= $\partial x/\partial r$). From the econometric model, it is not possible to reject the hypothesis that *the substitution effect is zero*. While the estimated coefficient is positive (0.12), the estimated coefficient is not statistically different from zero (the t-statistic is only 0.29). As the price of unbundled switching rises, CLECs do not deploy more switching facilities or purchase switching from third-party suppliers. Given a zero substitution effect, the effect of higher unbundled switching prices is only reflected in the output effect.

Equation (7) 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 0.44. So, a 10% increase in the switching price reduces CLEC aggregate output (using unbundled loops) by 4.4%. This output effect (elasticity) is statistically different from zero at better than the 1% significance level ($\chi^2 = 8.27$).[82]

It is worth observing that the own-price elasticity of demand for unbundled switching is about –1.00 (measured as β_1), which indicates that a 10% change in price produces a 10% 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 (t statistic –3.79). Because UNE-Platform accounts for half of unbundled loops, the total output effect is smaller than the reduction of output for the UNE-Platform alone.

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[81] See, e.g., J. Ramsey and R. Gilbert, A Monte Carlo Study of Some Small Sample Properties of Tests for Specification Error, Journal of the American Statistical Association, Vo. 67, 198-86, 1972.

[82] This joint test of significance is distributed χ^2 with m degrees of freedom (where m is the number of constraints). See Adrian C. Darnell, A DICTIONARY OF ECONOMETRICS (1994).

If a 10% increase in the price of unbundled switching reduces CLEC output by 4.4%, then it is clear that the removal altogether of unbundled switching will substantially reduce CLEC output. The empirical evidence, assuming 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 using unbundled loops 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 -1.7 for both x and $(q_2 - x)$. Both elasticities are in the elastic 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 17%. We cannot reject the hypothesis that the two elasticities are equal using the Wald Test ($\chi^2 = 0.05$).[83] Thus, our estimates suggest that it is reasonable to conclude that an increase or decrease in the loop rate for unbundled elements has an equivalent effect on all forms of loop purchases, and that the percentage quantity response of both quantities will exceed the percentage price change.

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. In fact, 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 approximately equal to 0.50. The simple average of the two own-price elasticities is –1.7, and 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 (Eq. 6) 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 for loop-switching combinations both elements are purchased jointly. The Wald test on the equality restriction has the statistic $\chi^2 = 1.17$, so the null hypothesis of equality (a $1 change renders an identical reduction in quantity) cannot be rejected.

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

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83 *Id.*

demand is less than proportionate to the increase in market size.[84] New York and Texas, two leading states in the promotion of competition in local exchange markets, have a higher demand for loops leased with and without unbundled switching, and these effects are statistically significant, though statistical significance is much higher 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 (Eq. 6). With respect to the demand for loops purchased without switching (Eq. 5), Section 271 approval negatively affects demand, and this result is statistically significant (t statistic = -1.99).[85] High non-recurring charges reduce demand for both types of loops (*DNRC*), and both estimated coefficients are statistically significance at better than the 10% level. Population density (*METPOP*) increases the demand for loops purchased without switching, but has no statistically significant effect on the demand for loop-switching combinations.

VI. 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 demanders. The "impairment standard" as identified by the FCC has, however, lacked specificity to be accepted by the courts.

This paper 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 the 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 percent increase in switching price reduces CLEC output by 4.4 percent. The

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[84] Statistically, we cannot reject the hypothesis that the coefficients on *SIZE* are equal across equations.

[85] Both Verizon in New York and SBC in Texas have 271 authority.

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 paper, 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 standalone 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 standalone unbundled loops to total loops.	0.502	…	…
P_L	Index of average price of an unbundled loop (mean-centered index).	1.00	0.30	(2)
r	Index of average price for unbundled switching (i.e., non-loop costs, indexed by average loop price).	0.915	0.45	(2)
SIZE	Size of the market measured as average monthly retail rate for local services multiplied by total access lines.	113M	107M	(1, 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 PACE coalition.
(2) Provided by Z-Tel Communications.
(3) Gregg (2001).
(4) www.census.gov.

Table 2. Summary of Regression Results

Variable	Equation (5)	Equation (6)
Constant (α_0, β_0)	2.126 (2.39)*	6.108 (3.72)*
r (α_1, β_1)	0.118 (0.83)	-0.995 (-3.79)*
P_L (α_2, β_2)	-1.627 (-5.57)*	-1.763 (-3.27)*
SIZE (α_3, β_3)	0.555 (6.00)*	0.389 (2.27)*
DNYTX (α_4, β_4)	0.557 (1.65)**	2.563 (4.11)*
D271 (α_5, β_5)	-0.420 (-2.05)*	0.411 (1.09)
DNRC (α_6, β_6)	-0.792 (2.14)*	-1.451 (2.12)*
METPOP (α_7, β_7)	2.939 (-5.82)*	-0.657 (-0.70)
PERIOD (α_8, β_8)	0.274 (2.14)*	0.142 (0.60)
R^2	0.85	0.66
RESET F	0.78	1.19

* Statistically-significant at the 5% level or better.
** Statistically-significant at the 10% level or better.