data on the number of listed telephone lines per capita to construct a statistical model that predicts the share of wireless-only households within a given geographic area.[70]

31. Figure V displays the estimated state-level wireless-only shares for 2007 through 2012, sorted in ascending order of the 2007 estimate. As seen below, the data indicate that wireless-wireline competition is both widespread and increasing across the United States. As of 2007, the NHIS estimated wireless-only shares ranging from 5.3 percent (Rhode Island) to 21.7 percent (Kentucky). By 2012, the point estimates ranged from 19.4 percent (New Jersey) to 52.3 percent (Idaho). In other words, even the state at the "low" end of the spectrum as of 2012 had roughly the same estimated wireless-only share as the state with the highest wireless-only share in 2007. In fact, the NHIS point estimates have increased for literally every one of the states for which data are available over the sample period shown in Figure V.

70. *See Blumberg et. al. (2013).*

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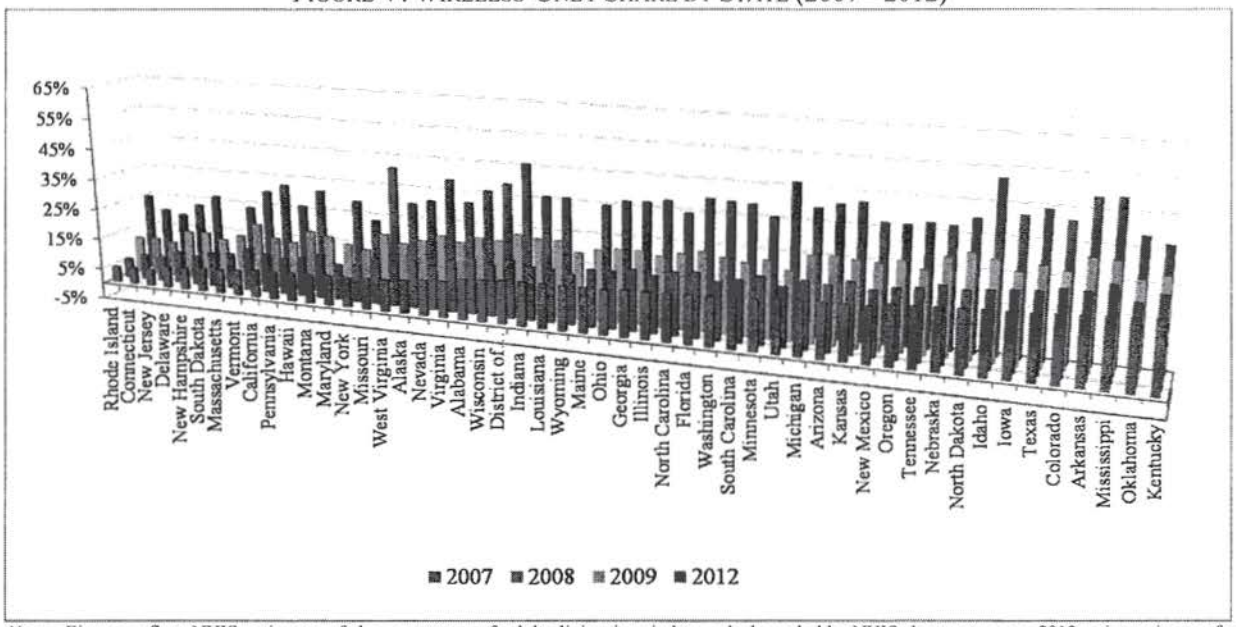
FIGURE V: WIRELESS-ONLY SHARE BY STATE (2007 – 2012)



Notes: Figures reflect NHIS estimates of the percentage of adults living in wireless-only households. NHIS does not report 2012 point estimates for Montana, South Dakota, or Wyoming. Nevertheless, each of these three states registered increases in their point estimates from 2007-2008, and again from 2008-2009.

32. Measured in terms of percentage points, the state with the smallest increase over this five year interval was New York (whose point estimate increased by 13.7 percentage points, from 9.8 percent to 23.5 percent). Idaho registered the largest increase (32.7 percentage points, from 19.6 percent to 52.3 percent). On average, the NHIS state-level wireless-only estimates shown in Figure IV increased by 21.9 percentage points between 2007 and 2012. Finally, for many states, the NHIS also produces estimates for specific counties, or groups of counties. These data, like the state-level estimates, reveal elevated and increasing wireless-only shares.[71]

33. Since 2008, the FCC has published state-level data on the share of residential switched access lines provided by Non-ILECs, defined to include CLECs, cable companies, and interconnected VoIP providers.[72] These data can be combined with the NHIS wireless-only share estimates to obtain a more complete picture of competition at the state level. For example, if 50 percent of households in a given state are wireless-only, and if ILECs account for 50 percent of residential switched access lines, then the ILEC household share can be estimated at 0.5*0.5 = 25 percent, implying that 75 percent of households select competitive alternatives in lieu of traditional ILEC voice service.[73]

34. As seen in Figure VI, these state-level estimates provide further confirmation of widespread competition across the United States. Among states for which complete 2012 data are available, the estimated share of households purchasing competitive alternatives to traditional ILEC voice service ranges from 51 percent (Hawaii) to 73 percent (Utah), with an

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71. *Id.*, Table 1.

72. Federal Communications Commission, *Local Telephone Competition: Status as of December 31, 2008*, at 2.

73. The NHIS state-level wireless-only shares reflect the estimated percentage of wireless-only adults, which consistently falls slightly below the estimated percentage of wireless-only households. *See, e.g., Blumberg & Luke (2013),* at Table 1.

average of 62 percent across all states (up from 38 percent in 2008). Stated differently, as of 2012, the ILEC household share was below 50 percent in every state for which data are available, and below 40 percent on average.

35. Finally, note that certain states such as Rhode Island, New Jersey, Connecticut, and Delaware, with relatively "low" wireless-only shares in 2012 (between 19 and 25 percent), exhibit high rates of customer switching to CLECs, cable companies, and interconnected VoIP providers. The net result is that each of these states exhibits substantial combined switching to competitive alternatives, ranging from 54 percent (Delaware) to 68 percent (Rhode Island).

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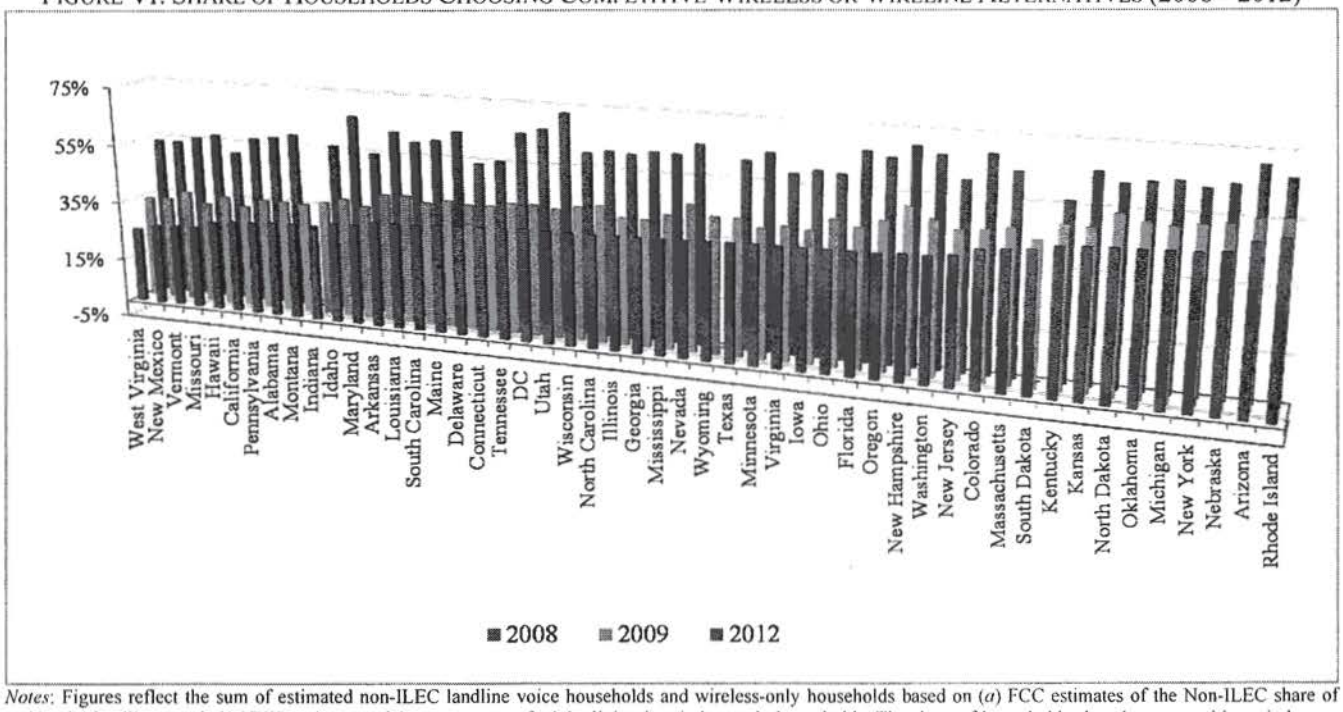
FIGURE VI: SHARE OF HOUSEHOLDS CHOOSING COMPETITIVE WIRELESS OR WIRELINE ALTERNATIVES (2008 – 2012)



Notes: Figures reflect the sum of estimated non-ILEC landline voice households and wireless-only households based on (*a*) FCC estimates of the Non-ILEC share of residential landlines; and (*b*) NHIS estimates of the percentage of adults living in wireless-only households. The share of households choosing competitive wireless or wireline alternatives is estimated as $1-(1-a)*(1-b)$. NHIS does not report 2012 point estimates for Montana, South Dakota, or Wyoming. To maintain firm confidentiality, the FCC does not report the Non-ILEC share for Alaska.

C. Demographic Trends

36. The NHIS data also show that rates of wireless-wireline competition have increased across a range of demographic groups, based on estimates of the wireless-only share by age, ethnicity, income, and other indicators. Figure VII displays the wireless-only share for more than 20 demographic categories tracked by NHIS from 2003 to 2013. As seen below, regardless of whether the sample is divided according to race, age, sex, education, or employment status, the estimated rates of cord-cutting increased substantially over the decade.[74] In 2003, none of the demographic groupings in Figure VII reported wireless-only shares above ten percent. By 2013, the majority of the groups were above 40 percent. Even among adults age 65 and older, cord-cutting had increased substantially by 2013 (from 0.5 percent to more 12.6 percent). Thus, switching away from landline service has increased substantially, even among demographic groups that might have previously seemed disinclined to cut the cord.

74. Analogous patterns are observed when the NHIS sample is disaggregated by household structure, poverty status, geographic region, metropolitan versus not metropolitan, and home ownership status.

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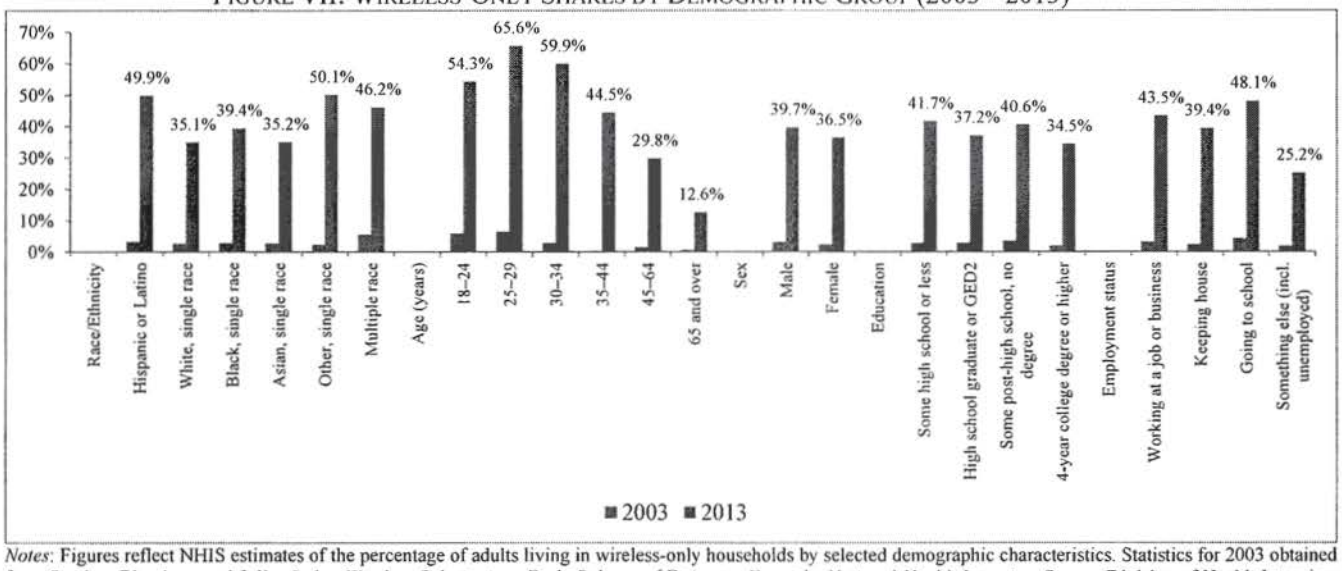
FIGURE VII: WIRELESS-ONLY SHARES BY DEMOGRAPHIC GROUP (2003 – 2013)



Notes: Figures reflect NHIS estimates of the percentage of adults living in wireless-only households by selected demographic characteristics. Statistics for 2003 obtained from Stephen Blumberg and Julian Luke, *Wireless Substitution: Early Release of Estimates From the National Health Interview Survey*, Division of Health Interview Statistics, National Center for Health Statistics, Centers for Disease Control & Prevention (July-December 2006), at Table 2. Estimates for 2013 obtained from *Blumberg & Luke (2013)*, Table 2.

37. As explained in Part IV, because firms choose optimal prices based on the switching behavior of marginal customers (as opposed to inframarginal customers, who could be less price-sensitive), it is not necessary to show that all wireline customers are equally willing to switch to wireless in response to a change in relative prices in order to demonstrate that wireless offerings constrain the price of wireline. Nevertheless, the evidence above belies the notion that certain demographic groups are predisposed to cut the cord, and others are not, as well as the idea that wireless-wireline competition is likely to increase among certain demographic groups but not others. Finally, even if it were the case that (contrary to the available evidence) certain customer subsets were unlikely to ever engage in significant cord-cutting, it is extremely unlikely that an ILEC could profitably engage in targeted price discrimination to particular subsets of price-insensitive customers.[75]

III. ECONOMETRIC STUDIES CONFIRM THAT WIRELINE VOICE COMPETES WITH WIRELESS VOICE

38. As explained in Part IV, the *Phoenix Order* fails to incorporate into its analysis the basic antitrust principle that ILEC pricing power is constrained not by one alternative in isolation, but by the degree of aggregate switching to all competitive alternatives that would take place in response to a hypothetical price increase. As I explain in this Section, even setting this aside, the *Phoenix Order* significantly understates the degree of wireless-wireline competition by implicitly relying on evidence from dated econometric studies, which utilized data from the late 1990s and early 2000s, when customer switching from wireline to wireless had only just begun to emerge.[76] Nevertheless, even these studies provide evidence that, even at

75. See Part IV.A, *infra*.

76. The *Phoenix Order* found insufficient econometric evidence in the record to conclude that wireless had evolved into a competitive alternative for wireline service. *See Phoenix Order*, ¶¶58-60. The *Phoenix Order* relied,

this early stage, wireless and wireline had already begun to compete with one another. Moreover, the authors of these early studies were careful to note the likelihood that mobile and fixed service would evolve into closer competitors over time—as well as the need to adjust current regulatory stances in response to such a development.

39. Subsequent econometric work by myself and other economists (including at least one of the authors of the earlier econometric studies) have confirmed that, when more recent data are analyzed, the cross-price elasticity between wireless and wireline is found to be positive and economically significant.[77] For example, the cross-price effects from my own econometric models indicate that roughly two thirds of landline attrition observed in the United States between 2001 - 2007 can be attributed to the overall decline in the price of wireless service—relative to wireline prices—that occurred over this timeframe.[78] Thus, the persistent trends in cord-cutting observed in the aggregate data are largely a price-driven phenomenon, which can be trigged by a decrease in wireless prices and/or an increase in wireline prices.

A. The *Phoenix Order's* Reliance on Dated Econometric Studies

40. In the *Phoenix Order*, the Commission acknowledged that "the increasing number of households that rely solely on mobile wireless services suggests that more consumers may view mobile wireless as a closer substitute for wireline voice service than in the past."[79]

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in part, on a 2008 DOJ report, which concluded that "econometric analyses of the issue have not shown that wireless and landline telephone services are in the same product market, though they may be getting close." *See* U.S. Department Of Justice, *Voice, Video, And Broadband: The Changing Competitive Landscape And Its Impact On Consumers* (2008) (DOJ Voice, Video And Broadband Symposium), [hereafter *Competitive Landscape Report*], at 66. The DOJ's conclusion was based on two econometric studies that analyzed data sets reflecting consumer behavior between 1999 and 2001. *See* Parts III.A.1 – III.A.2, *infra*.

77. *Caves (2011)*; *see also* Jerry Macher, John Mayo, Olga Ukhaneva, and Glenn Woroch, "Demand in a Portfolio-Choice Environment: The Evolution of Telecommunications," Georgetown McDonough School of Business Research Paper No. 2012-19 (August 2012; revised July 2014) [hereafter *Mayo et. al. (2014)*].

78. *Caves (2011)* at 996-97.

79. *Phoenix Order*, ¶60.

Nevertheless, the Commission ultimately concluded that there was "insufficient data in the record to make such a determination"[80] within the confines of the *Phoenix Order*, and noted the absence of econometric estimates showing a significant cross-elasticity of demand between wireline and wireless services.[81]

41. In support of its findings, the Commission implicitly relied upon dated econometric studies, utilizing data sets compiled at the turn of the millennium, when cord-cutting was extremely rare. Specifically, the Commission cited the DOJ's 2007 *Competitive Landscape Report*,[82] according to which "econometric analyses of the issue have not shown that wireless and landline telephone services are in the same product market, though they may be getting close."[83] The *Competitive Landscape Report*, in turn, cited two econometric studies—a paper published in *Telecommunications Policy* in 2003, and a working paper released in 2004.[84]

1. Rodini, Ward, and Woroch (2003)

42. In the first study, Mark Rodini, Michael Ward, and Glenn Woroch utilized a US bill-harvesting dataset spanning 2000-2001 to estimate an econometric model of the determinants of consumers' decisions to subscribe to (1) second landlines; and (2) mobile service.[85] A consumer's decision to subscribe (or not to subscribe) to each type of service is

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80. *Id.* ¶60.
81. *Id.* ¶58.
82. *Id.* ¶¶57-59 (citing *Competitive Landscape Report*).
83. *Competitive Landscape Report* at 66.
84. *Id.* at 66, n. 364, citing Mark Rodini, Michael Ward, & Glenn Woroch, *Going Mobile: Substitutability between Fixed and Mobile Access*, 27 TELECOMMUNICATIONS POLICY 457-476 (2003) [hereafter *Rodini et. al. (2003)*]; and, Michael Ward & Glenn Woroch, "Usage Substitution between Mobile Telephone and Fixed line in the U.S.," Center for Research on Telecomm. Policy Working Paper (May 2004) [hereafter *Ward & Woroch (2004)*].
85. *Rodini et. al. (2003)* at 462 ("The main source of data in our analysis are the Bill Harvesting data from TNS Telecoms ReQuest Market Monitors along with its survey responses. This quarterly sample of US household consumption of various telecommunications services is derived from a large national panel. Participating households are asked to submit one set each of their original bills for local, long distance, cable TV, cellular and Internet services. Besides summary information, the data set extracts detailed call information from each

modeled as a binary choice using logistic regressions.[86] The authors found some evidence of competition between wireless and wireline: The cross-price elasticity of mobile access with respect to the wireline price is found to be positive and statistically significant, ranging from 0.13-0.18.[87] (In other words, a one percent increase in the price of landline service was found to increase the demand for wireless service by 0.13 to 0.18 percent). However, the authors were unable to detect a statistically significant relationship between mobile prices and the demand for second landlines. (The point estimates suggest moderate cross-price elasticities, ranging from 0.22-0.26).[88]

43. Significantly, because wireless-only households were rare in the early 2000s—only about one to two percent of the authors' data sample did not subscribe to fixed line service—the authors found it statistically impracticable to directly model the decision to abandon wireline service altogether, and were therefore unable to obtain an econometric estimate of the cross-price elasticity of wireline demand with respect to the price of wireless.[89] Instead, they were obliged to impute an indirect estimate based on restrictions on the cross-elasticities implied by economic theory, which suggested that a one percent increase in the price of wireless would lead wireline demand to increase by approximately 0.06 – 0.08 percent.[90]

44. In reviewing their results, Rodini, Ward, and Woroch concluded that wireless offerings represented a "moderate substitute" for landline telephony, but that it would be "premature…to infer from these estimates that mobile service currently constrains local

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"harvested" phone bill. While these data were first collected in 1995, this paper uses data from the 2-year period January 2000–December 2001 during which a uniform sampling method and survey instrument were employed.")

86. *Id.* at 468.

87. *Id.* at 470.

88. *Id.*

89. *Id.* ("Our data are not rich enough to estimate the cross-elastic effect from wireless price changes on the decision to subscribe to any fixed line. Only about 1–2% of our sample does not subscribe to fixed line service.")

90. *Id.* at 470-72.

telephone service market power to any economically significant degree over the 2000–2001 period."[91] Nevertheless, they also noted that "[e]volving usage patterns suggest that mobile and fixed service will become greater substitutes over time,"[92] and that "discrepancies between the two services are fading."[93]

2. Ward and Woroch (2004)

45. In the second study cited in the *Competitive Landscape Report*, Michael Ward and Glenn Woroch analyze a similar bill harvesting dataset spanning 1999 – 2001 to measure usage switching patterns between wireless and fixed line service.[94] The authors use an Almost Ideal Demand System framework[95] to model the share of minutes that customers allocate between wireless usage and wireline usage. The authors "find significant positive cross-price elasticities between mobile and wireline usage."[96] Further, the authors estimate that changes in relative prices over their (relatively short) sample period lead to substantial changes in usage patterns, noting that "[b]ecause mobile usage prices fell dramatically over this period, we estimate that wireline usage may have been about 50% higher had mobile prices not fallen."[97]

46. Ward and Woroch conclude that, although mobile service appears to be a "moderate substitute" for wireline usage, it would be "premature…to infer from these estimates that mobile service currently constrains local telephone service market power to any

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91. *Id.* at 475.
92. *Id.*
93. *Id.*
94. *Ward & Woroch (2004)* at 5.
95. Angus Deaton and John Muellbauer, *An Almost Ideal Demand System*, 70(3) AMERICAN ECONOMIC REVIEW 312-326 (1980).
96. *Ward & Woroch (2004)* at Abstract.
97. *Id.*

economically significant degree."[98] Nevertheless, the authors (writing more than ten years ago) were careful to note the potential for fundamental change in the "near future":

> Substitutability may increase over time due to continued price declines and feature improvements of mobile services outpacing those of wireline service. At some point in the near future, it is possible that mobile telephone service will be able to significantly constrain wireline providers' exercise of market power. When this does occur, it will be appropriate to modify many of the current regulatory stances toward telecommunications provision.[99]

B. Econometric Studies of More Relevant Time Periods

47. More recently, both my own econometric work and that of other economists have incorporated data from more relevant time periods, yielding results confirming that wireless and wireline compete with one another. In addition to producing positive and statistically significant estimates of the cross-price elasticity between wireless and wireline, these studies have also shown that the cross-price effects are economically significant: A substantial fraction of the observed increase in demand for wireless service in recent years—and the concomitant decrease in demand for wireline service—can be attributed to the observed decline in the relative price of wireless voice service.

1. Caves (2011)

48. In a paper published in *Telecommunications Policy* in 2011, I compiled a state-level panel dataset from a relatively recent time period (2001-2007) and estimated a structural demand system yielding econometric estimates of the own-price, cross-price, and income elasticities of demand for wireless and wireline telephony in the United States.[100] The study utilizes standard econometric techniques to estimate a demand system for wireless and wireline

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98. *Id.* at 12.
99. *Id.*
100. *Caves (2011)*. A copy of the published paper is attached as Exhibit B.

telephony. Demand systems are econometric tools commonly applied in economics and antitrust to capture customer switching patterns among a group of differentiated products. The two-equation demand system is reproduced below in (0.1) and (0.2):

$$q_{st}^{w} = \alpha_0 + \alpha_1 p_t^{w} + \alpha_2 p_{st}^{l} + \alpha_3 i_{st} + \sum_{k=1}^{K} \lambda^k X_{st}^k + \sum_{j=1}^{J} \theta^j D_s^j + \varepsilon_{st} \tag{0.1}$$

$$q_{st}^{l} = \beta_0 + \beta_1 p_{st}^{l} + \beta_2 p_{st}^{w} + \beta_3 i_{st} + \sum_{k=1}^{K} \gamma^k X_{st}^k + \sum_{j=1}^{J} \phi^j D_s^j + \mu_{st} \tag{0.2}$$

49. Above, q_{st}^{w} is the natural log of the quantity of wireless subscribers in state s in year t, while q_{st}^{l} is the natural log of the quantity of ILEC residential billable access lines in state s in year t, as reported by the FCC.[101] Similarly, p_{st}^{l} and p_{st}^{w} give the natural log of the price of landline and wireless service by state and year, also reported by the FCC.[102] Consistent with the increasingly obsolete distinction between local and long distance calling, the FCC's wireless price data do not vary by state. However, there is considerable cross-state variation in the tax rates on wireless service in the United States. Therefore, p_{st}^{w} is adjusted to reflect this variation using state-specific wireless tax data.

50. The remaining variables control for other factors that may shift the demand for wireless and/or wireline service. The variable i_{st} denotes real median income by state and year. Additional covariates, denoted X_{st}^k, include controls for population density, cellular tower density, average commute times, and various demographic controls.[103] In addition, the D_s^j (with $D_s^j = 1$ if $j = s$, and $D_s^j = 0$ otherwise) denote state fixed effects, which control for all state-

101. *Id.* at 989-991.
102. *Id.*
103. *Id.* at 990.

specific factors that are invariant over time. Finally, ε_{st} and μ_{st} are random error terms, driven by unobserved demand shocks and/or measurement error in the dependent variable of each equation.

51. As is commonly the case in demand system estimation, there exists the potential for endogeneity in the price variables. For example, in equation (0.1), both p_{st}^{w} and p_{st}^{l} are potentially correlated with unobserved demand shocks in ε_{st}. With respect to p_{st}^{w}, over the sample period there were significant advances in the quality and versatility of wireless technology along several dimensions (handset size, battery life, sound quality, etc.). As a consequence, there have likely been positive unobserved shocks to wireless demand. Holding other factors constant, these shifts in demand may be correlated with wireless prices.

52. More generally, there is also reason to suspect that p_{st}^{l} and p_{st}^{w} may both be correlated with ε_{st} and μ_{st}. Although landline prices in the US remain constrained by regulation, which may mitigate endogeneity problems,[104] it is also the case that some states have begun to deregulate wireline prices, or at least to allow for additional pricing flexibility. Given the expansion of intermodal alternatives during the sample period, it is likely that unobserved shocks to ILEC wireline demand have occurred over the sample period, suggesting that p_{st}^{l} may be correlated with μ_{st}. Moreover, if wireless and wireline are competitors, then unobserved positive shocks to wireless demand should generally be correlated with unobserved negative shocks to wireline demand. For example, an improvement in the sound quality of wireless calls would be expected to increase the demand for wireless service, while decreasing fixed line

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104. Laurits Christensen & William Greene, *Economies of Scale in U.S. Electric Power Generation* 84 JOURNAL OF POLITICAL ECONOMY, 655–676 (1976).

demand. This suggests that p_{st}^{l} may be correlated with ε_{st}, and that p_{st}^{w} may be correlated with μ_{st}.

53. To ensure that the estimated own- and cross-price elasticities reflect the responsiveness of demand to prices alone, holding non-price factors constant, it is important to correct for potential endogeneity bias. Accordingly, I estimated the system using iterated three-stage least squares (I-3SLS), which combines the techniques used in Seemingly Unrelated Regression (SUR) and two stage least squares (2SLS).[105] This requires instrumental variables, which are correlated with the (potentially endogenous) price variables, but uncorrelated with the error terms. The instruments utilized in the study include state-specific taxes on wireless and wireline service, which provide exogenous price variation across states and over time. In addition, because the wireless industry has undergone significant technical change, an index of wireless telecommunications productivity is included as a third instrument, to capture shifts in the industry cost curve over time.

54. According to my econometric estimates of the cross-price elasticity between wireless and wireline, a one percent decrease in the price of wireless service would decrease the demand for fixed-line service by approximately 1.2 to 1.3 percent.[106] Because these results substantially exceed prior econometric estimates from the empirical literature (which the study reviews in detail), they indicate that wireless voice service had evolved into a strong competitive alternative to traditional landline service. To illustrate the economic significance of

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105. 3SLS yields instrumental variable estimates, taking into account the covariances across equation disturbances. The objective function for three stage least squares is the sum of squared transformed fitted residuals. *See, e.g.,* ROBERT PINDYCK & DANIEL RUBINFELD, ECONOMETRIC MODELS & ECONOMIC FORECASTS (McGraw Hill 3rd ed. 1991), at 310-311.

106. The estimated cross-price elasticities are statistically significant at the one percent level or better. *See Caves (2011)* at 995.

these results, I also showed that the parameter estimates from the demand system imply that roughly two thirds of observed landline attrition in the United States over the sample period is attributable to the observed decline in the relative price of wireless service over that same timeframe. The study concludes as follows:

> Because a wireline incumbent attempting to increase prices above competitive levels will lose customers to wireless competitors at significant rate if and only if the cross-price elasticity is positive and economically significant, these results support the view that regulators should take wireless competition into account when assessing the degree of market power that wireline incumbents would be able to exercise, absent regulatory pricing constraints. Specifically, the empirical results suggest that wireless offerings should be included among the set of intermodal alternatives capable of imposing price discipline on wireline incumbents, and that wireless substitution contributes substantially to the aggregate price-disciplining effect imposed by the full suite of intermodal alternatives to landline telephony. The continued erosion of the landline business since the time period analyzed here, combined with increasing rates of wireless substitution, lend additional credence to this perspective.[107]

2. Mayo et. al. (2014)

55. Professor John Mayo and his co-authors have recently released a working paper utilizing household-level data to empirically estimate discrete choice models of the consumer demand for telecommunications services.[108] The paper provides important corroboration of my own work: Despite utilizing a very different set of data and econometric techniques, Mayo et. al. conclude that their empirical analysis "provides strong evidence that wireless telephony has become a close substitute for wireline telephony over the 2003-2010 period."[109]

56. Professor Mayo and his co-authors were granted access to the individual household-level data that comprise the NHIS, including confidential data not released to the general public. Their database is therefore much more detailed and granular than the aggregated

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107. *Id.* at 997.
108. *Mayo et. al. (2014).*
109. *Id.* at 3.

NHIS statistics on cord-cutting that appear in standard CDC publications. Instead of simply observing the overall proportion of surveyed households that were wireless-only at a given point in time, the authors of the study are able to observe whether or not each individual household surveyed was wireless-only, as well as household-specific characteristics such as age, educational attainment, employment status, and the geographic location of the surveyed household. Using the household's location, the authors were able to link the individual survey responses with location-specific data from a variety of public data sources. The resulting data set measures a large number of variables that may influence the demand for wireless and wireline service, including price, income, local population density and topography, local cell tower coverage, and various demographic variables.[110]

57. Mayo et. al. estimate a simultaneous equation bivariate probit model of the demand for wireless and wireline service. The model captures the fact that a given household may, in theory, subscribe to (1) wireline service only; (2) wireless service only; (3) both wireless and wireline; or (4) neither wireless nor wireline. The model can be summarized as follows:

$$y_{it}^{*} = \alpha_l p_{it}^{l} + \alpha_w p_{it}^{w} + \sum_{k=1}^{K} \lambda^k X_{it}^k + \varepsilon_{it} \tag{0.3}$$

$$\tilde{y}_{it}^{*} = \beta_l p_{it}^{l} + \beta_w p_{it}^{w} + \sum_{k=1}^{K} \delta^k X_{it}^k + \tilde{\varepsilon}_{it} \tag{0.4}$$

58. As is standard in discrete choice econometric models, y_{it}^{*} is defined as a continuous variable; household i will subscribe to wireline service at time t if y_{it}^{*} exceeds a critical threshold c. Similarly, household i will subscribe to wireless service at time t if $\tilde{y}_{it}^{*}$

110. *Id.* at 9-16.

exceeds another critical threshold, denoted $\tilde{c}$. The variables p_{it}^{l} and p_{it}^{w} denote the price of wireline and wireless service faced by household i at time t, while the X_{it}^{k} denote control variables such as income, demographics, employment status, population density, and cell site deployment.[111]

59. Mayo et. al. use their econometric estimates to compute marginal effects, including the cross-price effects that define wireless-wireline competition. Just as in my own work, they find, all else equal, that an increase in the price of wireline service has a positive and statistically significant effect on the demand for wireless service. Likewise, an increase in the wireless price leads to an increase in the demand for wireline service.[112] In addition, Mayo et. al. are able to decompose household-level responses to an increase in the wireline price into (1) those that drop their wireline service and become wireless-only households; and (2) those that keep their wireline service but also purchase wireless service. During the early portion of their sample (2003 – 2006), the authors estimated that roughly half wireline-only households would respond to an increase in wireline prices by transitioning to wireless-only status. By the later portion of their data sample (2007 – 2010), more than three quarters of wireline-only households were estimated to respond in this manner. Thus, the authors find that the marginal propensity to cut the cord has increased substantially over their sample period.[113]

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111. *Id.* at 17-20. Similar to my own work, Mayo et. al. use a two-stage procedure designed to correct for endogeneity in their price variables. *Id.* at 14.

112. *Id.* at 21.

113. *Id.* at 22. The authors estimate alternative models, which confirm the robustness of their key conclusions. *Id.* at 23.

IV. THE *PHOENIX ORDER'S* ANALYTICAL FRAMEWORK IS INCONSISTENT WITH FUNDAMENTAL PRINCIPLES OF ECONOMICS AND ANTITRUST

60. Although the *Phoenix Order* explicitly endorses the standard principles of antitrust analysis practiced by DOJ and other agencies,[114] certain aspects of the *Phoenix Order's* analytical framework are inconsistent with fundamental principles of economics and antitrust. As explained below, the *Phoenix Order's* first major error is to disregard the basic economic principle that competition occurs, and prices are set, at the margin—i.e., by the most price-sensitive customers in the marketplace. This leads the Commission to err in its analysis by (1) drawing invalid inferences based on the behavior of inframarginal customers; and (2) giving undue weight to a non-standard economic theory, which asserts that ILECs would have less pricing power if they did not face any competition from intermodal alternatives such as wireless voice service. (As explained below, this theory is tailored to special circumstances surrounding generic competition in the pharmaceutical industry, and is not relevant to telecommunications markets).

61. These analytical flaws are compounded by the *Phoenix Order's* unjustified (and unstated) assumption that current, regulated wireline prices have been accurately calibrated to competitive levels. The source of this error appears to be a misinterpretation of the DOJ/FTC *Merger Guidelines*, which often (but not always) evaluate the potential for a post-merger exercise of market power based on the ability of the merged firm to implement a small but significant and non-transitory increase in price ("SSNIP")—relative to the *unregulated* pre-merger price level.[115] By equating regulated ILEC wireline prices with the unregulated profit-

114. *Phoenix Order*, ¶1.

115. *Merger Guidelines*, §4.1.1. ("The hypothetical monopolist test requires that a product market contain enough substitute products so that it could be subject to post-merger exercise of market power significantly

maximizing prices of two merging firms, the *Phoenix Order* proceeds under the assumption that any increase in wireline prices above current levels would be anticompetitive. This assumption is fundamentally flawed because economists have long recognized that the regulatory process cannot be expected to replicate competitive pricing outcomes. Furthermore, there is direct empirical evidence that regulation has artificially suppressed telecommunications prices below competitive levels, which implies that the *Phoenix Order's* framework will systematically generate improperly narrow product market definitions and incorrect inferences of market power.

62. Finally, in attempting to determine whether wireless voice service should be included in the relevant product market, the *Phoenix Order* fails to recognize that antitrust product markets are delineated based on the extent of aggregate switching towards all products outside of the candidate market. The *Phoenix Order* instead poses the inapposite question of whether wireless voice service is capable of single-handedly defeating a hypothetical price increase. This ignores the basic principle that, when contemplating a price increase, a hypothetical monopolist over wireline services would need to consider the potential for customers to switch not only to wireless services, but also to other competitive alternatives such as Cable VoIP or CLEC offerings. Formally, this is due to the fact that the own-price elasticity of demand for any service is a share-weighted average of the cross-price elasticities for all competitive alternatives. The greater the aggregate effect of the cross-price elasticities, the greater is the own-price elasticity, and the less pricing power the firm will possess. Therefore, a

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exceeding that existing absent the merger. Specifically, the test requires that a hypothetical profit-maximizing firm, not subject to price regulation, that was the only present and future seller of those products ("hypothetical monopolist") likely would impose at least a small but significant and non-transitory increase in price ("SSNIP") on at least one product in the market, including at least one product sold by one of the merging firms.")

framework that considers switching towards only one competitive alternative at a time will tend to overstate ILEC pricing power.

A. The *Phoenix Order* Disregards the Fact That Prices Are Set At The Margin

63. A fundamental principle of economics is that a profit-maximizing firm sets prices by equating marginal revenue to marginal cost. The demand curve faced by a firm gives the maximum price that can be charged in order to sell a given quantity of output, which, in turn, is determined by the maximum willingness-to-pay of the firm's marginal customers (i.e., those willing to pay exactly that price, but nothing higher). If the firm raises its price above that level, then some marginal customers will drop out of the market, and the firm will sell less output; if the firm lowers the price, it can draw in more marginal customers, and sell a higher quantity. In light of this tradeoff, a profit-maximizing firm adjusts its price until the revenue earned on the marginal customer is just equal to the marginal cost of serving that customer.[116]

64. Accordingly, a firm's optimal pricing strategy depends on the price sensitivity of its marginal customers. The centrality of price sensitivity at the margin is illustrated by the fundamental concept of the elasticity of demand, which summarizes the price-responsiveness of a firm's marginal customers to a change in price.[117] It is also evident from the definition of competitive alternatives, which, as noted above, is defined by the willingness of marginal customers to increase their consumption of one good in response to an increase in the price of the other.

65. Price sensitivity of marginal consumers is an important component of standard antitrust analysis. The standard SSNIP test articulated in the DOJ/FTC *Merger Guidelines* asks

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116. *Katz & Rosen* at 209-212.
117. *Id.* at 73-77.

whether "a hypothetical profit-maximizing firm, not subject to price regulation...likely would impose at least a small but significant and non-transitory increase in price."[118] The profitability of such hypothetical price increase (or lack thereof) hinges on the responses of the firm's marginal customers.

66. It bears emphasis that it is extremely unlikely that an ILEC could profitably engage in targeted price discrimination to particular subsets of price-insensitive customers. It is true that regulators have, historically, sometimes required that monopoly telecommunications providers engage in certain forms of price discrimination or cross-subsidization. However, implementing a strategy of profitable price discrimination becomes highly problematic under competitive conditions, particularly in industries such as telecommunications, which are characterized by large fixed costs and low marginal costs. Economists have shown that firms in such industries would need to accurately target price-sensitive customers approximately 95 percent of the time in order for a strategy of price discrimination to be profitable—yet it is unlikely that ILECs would possess sufficiently detailed, customer-specific information to achieve this degree of accuracy,[119] and there appear to be no instances in which ILECs have engaged in targeted price discrimination (unless mandated by regulation to do so). The ability to price discriminate is further constrained by the fact that competing communications providers offer uniform services not tailored to particular demographic niches, including VoIP providers offering flat-rate nationwide plans, wireless providers offering uniform access to nationwide

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118. *Merger Guidelines* §4.1.1.

119. *See, e.g.,* Jerry Hausman and J. Gregory Sidak, "Telecommunications Regulation: Current Approaches with the End in Sight," *in Economic Regulation And Its Reform: What Have We Learned?* (Nancy L. Rose editor, National Bureau of Economic Research & University of Chicago Press 2014), at 400-401; *see also* Jerry Hausman, Gregory Leonard, and Christopher Vellturo, "Market Definition Under Price Discrimination," 64(2) *Antitrust Law Journal*, 367-386 (1996).

networks, and converged alternatives offering video, voice, and text-based communications wherever an Internet connection is available. Finally, I understand that Section 202 of the Communications Act explicitly forbids these forms of price discrimination.[120]

1. The *Phoenix Order* Draws Incorrect Inferences Based on the Behavior of Inframarginal Customers

67. Although the *Phoenix Order* recognizes the importance of the SSNIP test,[121] the *Phoenix Order* improperly relies on evidence of the behavior of inframarginal customers[122] in the course of its competitive analysis. In analyzing whether mobile wireless services belong in the same relevant product markets as fixed wireline service, the *Phoenix Order* observes that:

> Although a growing number of mass market customers subscribe exclusively to mobile wireless service, the majority of households continue to subscribe to both a wireline and a mobile wireless telephone service, and the proportion of households subscribing to both services has not substantially changed since the first half of 2006.[123]

The *Phoenix Order* also claims that:

> [S]everal classes of customers appear unlikely to drop wireline service in response to a significant price increase, including those who: (a) value the reliability and safety of wireline service; (b) value a single point of contact for multiple household members; (c) live in a household with poor wireless coverage; (d) operate a business out of their home and believe that wireline service offers better reliability and sound quality; or (e) desire a service that is more economically purchased when bundled with a local service (e.g., wireline broadband Internet service, or a video service).[124]

68. The Commission goes on to conclude that "because the record reflects that the majority of residential customers continue to subscribe to both mobile wireless and wireline services, it appears that most mass market consumers use mobile wireless service to supplement

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120. 47 U.S.C. §202; *see also* Hausman and Sidak, *supra*.

121. *Phoenix Order*, ¶56.

122. A firm's inframarginal units are those which do not respond when a firm changes its price by a given amount. *See Katz & Rosen* at 414-416.

123. *Phoenix Order*, ¶55.

124. *Id.* ¶59.

their wireline service rather than as a substitute for their wireline service."[125] As it happens, this statistic declined significantly in subsequent years: As of early 2013, approximately 49.5 percent of households purchased both wireline and wireless service, down from approximately 58.1 percent as of early 2010.[126] But the fundamental problem with the *Phoenix Order's* analysis is that it assumes incorrectly two goods do not compete with for one another merely because some customers purchase them simultaneously. This is false, and is contradicted by elementary economic principles, which define competition in terms of customer willingness to switch from one good to the other in the face of a change in relative prices.[127] For example, the fact that some families may own both a Toyota sedans and a Honda clearly does not imply that consumers view a Toyota as a complement for a Honda. Likewise, the fact that some inframarginal customers purchase both wireless and wireline services does not capture switching at the margin, and is not the relevant statistic for competitive analysis. To illustrate, note that, while the Commission is correct in observing that the proportion of households purchasing both wireline and wireless service remained relatively stable in the years leading up to the *Phoenix Order*, (hovering in the neighborhood of 55 to 60 percent from 2007-2010, before declining to approximately 48 percent in subsequent years),[128] it is also true that, from 2007-2010, the proportion of wireless-only households nearly doubled (from 13.6 percent to

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125. *Id.*
126. *Blumberg & Luke (2013)*, Table 1.
127. *Katz & Rosen* at 60.
128. *See* Stephen Blumberg and Julian Luke, *Wireless Substitution: Early Release of Estimates From the National Health Interview Survey*, Division of Health Interview Statistics, National Center for Health Statistics, Centers for Disease Control & Prevention (January - December 2010), at Table 1. *See also Blumberg & Luke (2013b)*, Table 1.