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Funding Universal Service: The Effect of Telecommunications Subsidy Programs on Competition and Retail Prices

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Abstract

There is general concern that producer subsidies distort competition. We examine a telecommunications subsidy system that transfers money from low cost regions to high cost regions of the U.S. Even though the system is designed to be competitively neutral, we find evidence that the system, combined with carrier of last resort policies, promotes cream skimming by entrants in low cost areas and less entry in high cost areas, where incumbents are more likely than entrants to receive subsidies. We are unable to rule out the possibility that state regulatory policies favor incumbents in states that are net beneficiaries of the subsidy system.

JEL classification: L52, L96, O11

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1. Introduction

Oftentimes governments subsidize production of products or services. European governments provide funding for Airbus to develop new aircraft. Farmers regularly are provided financial support by national governments. Local governments in the United States frequently provide special tax breaks or other financial considerations to help support a local failing business or to attract a new business to an area; however, such government subsidies distort markets, and distortions ultimately increase costs for consumers. Governments therefore have an incentive to try to make such subsidy programs competitively neutral using additional policy tools and regulations.

In this paper we consider the impact of a particular subsidy program to study its effects on competition in the sector. We focus specifically on the telecommunications industry's Universal Service Fund (USF) in the United States. This is a particularly interesting situation for several reasons. First, industry regulators transformed the program in the 1990s from one designed specifically to subsidize local telephone monopolies to one that would be competitively neutral; however, there is concern among some state telecommunications regulators that the subsidy program unnecessarily and heavily taxes some states (and not others) to provide these subsidies. In other words, competition still is presumed to be distorted. Second, the fund more than doubled in size from 1999 to 2005 – from \$1.7 billion to \$3.8 billion[1] – raising the possibility that any market distortions caused by the subsidy may have grown as well. Finally, the USF has continued to grow and the possibility of its expansion to include broadband services is real.

Using county level telecommunications and demographic data from 1999 through 2002, we consider the high cost support subsidy within the USF program. We find that the high cost support subsidy has effects that run counter to the intended purposes of the fund. Specifically, we find that despite efforts to create a competitively neutral telecommunications support mechanism, the scheme interacts with another regulatory mechanism, the carrier of last resort policy, to distort competition. This occurs because the carrier of last resort policy requires incumbents to serve all customers in broad geographic areas. Entrants, on the other hand, may choose to serve any subset of customers. Ultimately entrants choose to operate in only the most profitable geographic areas.[2] Thus, the carrier of last resort policy opens the door for cream skimming by entrants, and the high cost support mechanism exacerbates the problem by requiring incumbents to pay a portion of their revenues into the high cost fund, which is then used to subsidize telecommunications providers in high cost areas. Although entrants pay into the high cost fund as well, we find that the effects of the policies together are not competitively neutral between incumbents and entrants.

The paper proceeds as follows. Section 2 provides background information and indicates how our research contributes to the existing literature addressing universal service subsidies. Section 3 presents our hypotheses and theoretical model of the effect of high cost support on telecommunications competition. Section 4 presents the data and empirical methodology. The results and policy discussion are presented in Section 5, and Section 6 concludes.

2. Universal service and high cost support

The stated purposes of the U.S. Communications Act of 1934 included "regulating interstate and foreign commerce in communication by wire and radio so as to make available, so far as possible, to all the people of the United States a rapid, efficient, nationwide, and worldwide wire and radio communication service with adequate facilities at reasonable charges."[3] This goal is now commonly referred to as universal service, but subsidies for universal service are a much more recent invention. Indeed the Federal Communications Commission (FCC) did not adopt a policy of telecommunications subsidies until the late 1960s, and it wasn't until the late 1960s and the 1970s – by which time telephone service was already available throughout the country – that the FCC adopted extensive subsidies for rural, high cost telecommunications companies.[4]

The original telephone subsidy policy that the FCC embraced and then extended came under pressure in 1984, as the AT&T monopoly was divided into smaller "Baby-Bells" and competition in long-distance telephone service commenced. The FCC's response to such competition was to create a universal service fund to replace the implicit subsidy system that had been achieved through the regulation of the AT&T monopoly. The new fund assessed competitive interstate long distance carriers to support local telephone monopolies that were required to maintain low prices to promote universal service. The fund allowed special considerations for small companies serving in high cost areas, and helped to provide price discounts to low income consumers.

Then in 1996, the Telecommunications Act opened competition in local markets. This meant that assessing competitive interstate long distance carriers to support local telephone companies (no longer monopolies) could distort market competition. However, the Act preserved the subsidies and extended the dissemination of funds collected to include schools, libraries, and rural health care providers. To address each of these interests the FCC and state utility regulators created a single federal Universal Service Fund (USF) composed of four programs: 1) high cost support; 2) Lifeline and Linkup; 3) schools and libraries; and 4) rural health. The focus of our research is high cost support.

The Telecommunications Act of 1996 mandated that incumbents and entrants contribute a fixed percentage of their interstate and international revenues to the USF, and industry regulators believed that providing USF money to all eligible telecommunications carriers operating in high cost areas could promote efficient competition. By treating incumbents and entrants the same with respect to the USF, the subsidy system should not distort competition. Still, the fund was designed so that while incumbents automatically qualified for high cost support, entrants were required to apply and demonstrate eligibility.[5] Consequently, during the period of our study, few entrants qualified for high cost support.

The USF is now a massive national program under the jurisdiction of the FCC. It disbursed approximately $7.3 billion in 2005, $4.2 billion of which was used to support companies operating in high cost service areas.[6] The high cost support proportion of total USF support has grown in recent years, from 47% in 1998 to 58% in 2005.

As the size of the program has grown, the USF has been increasingly criticized by regulators as well as scholars. In recent years one issue of contention is that the USF, presumed to be a competitively neutral national program, allows the volume of contributions to the USF and receipts from the USF to vary across states, resulting in each state having either a net deficit or net surplus of USF contributions. States with telecommunications companies that contribute significantly to the fund but collect little from it are concerned that such revenue outflows constitute inefficient subsidies and hamper telecommunications development within their states. Some of these states advocate reducing the size of the federal program and promoting state-administered USF programs where fewer contributions would be sent out of state (Clark, 2005). Naturally, states that are net recipients of USF funding are against such proposals.

Table 1 shows the overall net USF contributions ranked across the 50 U.S. states and the District of Columbia.[7] States with high net contributions to the USF, such as California, New York, Florida, and New Jersey, have voiced concern that they contribute much more to the USF than they receive from it, allowing states such as Alaska, Kansas, Arkansas, and Mississippi to receive significant net receipts from the USF. While states with large landmass, low population density, and challenging terrain tend to have relatively more high cost areas, these characteristics do not necessarily predict the overall level of USF net contributions for the state. For example, the extent to which the population is clustered into metropolitan areas (as in the top net contributor states) rather than being spread across many small cities (as in the top net recipient states), is a more accurate indicator of whether a state is a net contributor to or net recipient of the USF.[8] Of further interest is the large difference between net contributor states and net recipient states when comparing the average net contribution by local loop,[9] as shown in Figure 1. In 2004, net contributor states contributed at most $20.56 per local loop (on average), while net recipient states received as much as $182.41 dollars per local loop (on average). Clearly population density, as reflected by the number of local loops, is a critical indicator of net contributions.

[Insert Table 1 here.]

[Insert Figure 1 here.]

Literature addressing the USF generally has been critical of the welfare benefit of the fund to society. Wolak (1996) and Barros et. al. (1999) show that wireline telecommunications penetration rates in the U.S., even in many rural areas, was approaching 100% when their articles were written; further, they cite evidence that few residents would disconnect service as a result of moderately rising prices. Garbacz and Thompson (2002, 2003) support these conclusions, showing demand for telecommunications services to be highly inelastic. These studies indicate that the majority of the population has access to telecommunications services and chooses to subscribe to such services. Thus, the main impetus for the USF (to ensure affordable telecommunications services for the entire population) appears irrelevant.

Specifically addressing high cost support, Rosston and Wimmer (2000) argue that subsidies for high cost areas are inherently discriminatory. High cost areas (in terms of telecommunications provision) can include wealthy estates and remote vacation or secondary homes, while low cost areas are generally more urban and therefore may have a greater number of low income households. In such cases, the high cost fund subsidizes the wealthy rather than low-income households for whom the USF was primarily intended. Rosston and Wimmer argue that reducing high cost support would have no significant effect on universal service, while higher taxes needed to fund the program create costly distortions. Similarly, Cremer et al. (2001) and Chiang and Hada (2007) show that unbalanced rate structures whereby telecommunications prices do not closely reflect their costs cause a costly redistribution of welfare from one segment of the population to another. Eriksson et al. (1998) compare the effectiveness of untargeted subsidies such as the high cost fund and more targeted subsidies such as the Lifeline and Linkup (low income) programs, and find that the latter are significantly more effective in increasing telephone subscriptions. Further, they show that the costs of funding any of these subsidies significantly offset the positive benefits that both untargeted and targeted subsidies aim to achieve. Lastly, Cremer et al. (2001) argues that high cost support is inefficient when the incumbent is not the most efficient operator. In this case, efficient competitors in effect support a less efficient incumbent.

One drawback of the existing literature is that most studies measure the effects of consumer well-being using the level of telephone penetration (i.e., the proportion of total households with access to telecommunications service, or the number of access lines). Yet, with wireline penetration rates about 93%[10] and with increasingly more U.S. households choosing to substitute mobile phones (and more recently, Internet-based telephony) for wireline phones, the use of penetration rate data is no longer an effective means of measuring consumer well-being. Hazlett (2006) points out that while almost all U.S. households have access to a wireline provider, as of the start of 2006, only approximately 89% actually paid to subscribe to wireline service. This may be due to the availability of wireless substitutes that now reach over 95% of U.S. households. In this paper, we measure consumer well-being by the level of wireline telecommunications provider entry as a proxy for competition. We further account for wireless penetration so that any increase in telecommunications services overall is captured within our model.

In this paper, we study how states' net outflows of USF high cost support contributions affect competition. Based on the current national approach to administering the high cost support fund, we estimate the effect of net contributions on competition in a state by analyzing entry data at the county, study area, and state levels for all U.S. states and the District of Columbia for the four-year period from 1999 through 2002.[11] To our knowledge, this research is the first to empirically analyze cross-state effects of high cost support net contributions on the overall level of competition within a state. This is an important issue for policymakers who argue that positive net contributions to the high cost support fund are deleterious to a state's ability to sustain efficient competition. Our main hypotheses follow.

3. Hypotheses and theoretical motivation

Consider an incumbent telecommunications provider that is a net contributor into the high cost fund. Assume the incumbent has both high cost and low cost areas within its study area. Low cost areas are generally urban areas with high customer density and/or relatively easy terrain in which to locate telephone lines. High cost areas are generally rural and sparsely populated, and/or have more challenging terrain. Consider that the incumbent must serve any customer within its study area who requests service. Its rivals do not have to serve the entire study area.

Let A represent the incumbent's average, per customer cost for providing service in the study area.[12] The study area has both high cost and low cost areas. Assume the incumbent's prices to its customers reflect the average cost of providing service in the study area. This practice is called rate averaging and is the traditional pricing practice of regulated utilities. Let L where $L < A$ represent an entrant's cost for serving a customer in a low cost area of the study area. Research indicates entrants typically serve such low cost areas (Hauge et al., 2005). Assume that all else equal, customers prefer lower prices to higher prices, so the market share that the entrant gains in the low cost area is greater the lower its prices are relative to the prices of the incumbent. In other words, assuming that prices reflect underlying costs, the entrant's market share in the low cost area is increasing in $A - L$.

Now consider the effect of a high cost subsidy system that is funded by a fee assessed against all telecommunications providers (incumbents and entrants) based on a percentage of each firm's revenue.[13] Let α represent the percent of revenue each provider must contribute to the high cost fund, where $1 > \alpha > 0$. The incumbent, in order to pay the fee and cover its costs, must charge a customer at least $\frac{A}{1-\alpha}$. The entrant must charge at least $\frac{L}{1-\alpha}$. The result is that with the subsidy, the entrant's increase in market share is greater than without the subsidy. As Zolnierek et al (2001), Roycroft (2005), and Jamison (2004) show, the more profitable a market is for entrants, the greater the entry in the market.

Now consider a study area that is a net recipient of the high cost fund. This means that the study area has relatively greater area that is high cost than low cost within its boundaries. The incumbent provider is entitled to receive high cost funds for its service within the study area. Qualifying entrants also are entitled to such funds for their service. However, during the period of our study, few entrants had qualified to receive high cost support. The discrepancy makes it possible for incumbents in net recipient study areas to obtain a cost advantage over entrants. Such a case would occur if the subsidy $\hat{S}$, where $\hat{S} \in [\underline{S},\overline{S}]$, allows $A - \hat{S} < L$. This would lower entrants' profitability and in theory lead to less entry.[14] This leads to our first hypothesis, namely:

Hypothesis 1: Under high cost support, competition as measured through entry will be lower in net recipient study areas relative to net contributor study areas.

If we fail to reject Hypothesis 1, we cannot conclude that the fund distorts competition. Net contributor study areas have by definition fewer high cost areas and more low cost areas. Given that most entrants prefer low cost areas, all else equal, we expect more entry in net contributor study areas than in net recipient study areas.

However, we assert that one goal of the subsidy is to make high cost areas more commercially viable so that competition in high cost areas would be equivalent to competition in low cost areas of otherwise similar type. In other words, we should find equivalent entry across study areas of inherently different cost structures but with similar demand and demographic characteristics. We propose two possible reasons equivalent entry might not occur: the structure of the USF program may be flawed, or state regulatory policies that impact the decision-making processes and profitability of both incumbent and new telecommunications providers may disrupt competition. This leads to our second hypothesis, namely:

Hypothesis 2: States that are net contributors to high cost support adopt regulatory policies that encourage competition relative to the regulatory policies of states that are net recipients.

Regulatory policies in states that are net contributors to high cost support may (through a variety of intentional or unintentional means) facilitate more agreeable interconnection agreements with incumbents or may adopt policies that encourage entrants to lease essential facilities from incumbents. Additionally, they may have less stringent requirements for entrants to become classified as providers eligible to receive USF money for operating in high cost areas. To determine whether this is the case, we broaden our analysis to consider whether a state being a net recipient or net contributor affects entry in that state.

We reject our second hypothesis if we find that states' regulatory characteristics and policies are not significant determinants of entry. Additionally, we reject the hypothesis if a state's status of being a net contributor is significantly and negatively correlated with entry. If we fail to reject our first hypothesis (i.e., we find that entry is relatively lower in net recipient study areas), but do reject our second hypothesis (entry is not related to state regulatory characteristics), we can conclude that the high cost fund directly distorts competition.

4. Data and empirical methodology

4.1. Dependent variable

We use a dataset that includes all entrants in the U.S. telecommunications market by city over the four-year period from 1999 through 2002. In the absence of any market distortions, we expect greater customer demand, lower provider costs, and pro-entrant regulatory policies to result in greater entry into a market. Given our goal of estimating the effect of high cost support contributions on entry, our empirical models use the total number of providers per county (and per study area) as dependent variables.[15] Provider data is from the annual CLEC Reports from New Paradigm Resources Group, Inc., and includes both planned and operational voice and data network services provided by entrants. We also include services supplied by municipal providers such as those used for the city's own operations (meter reading, municipal data network, supervisory control and data acquisition, and voice) and those provided to others (cable television, long distance telephone, Internet access, broadband, fiber leasing, and local telephone). Municipal provider data is from the American Public Power Association. Note that while our data includes the existence of entrants by city by year, because our demographic variables are at the county level, we aggregate our city level data to the county level and control for the number of cities per county and the total population.

We also estimate the effect of entry by study area because receipt of high cost support (as well as contributions) is determined by study area. For study area estimates, we match the county level data to study areas. Using detailed incumbent maps from all 50 states and the District of

Columbia, we map each county to the single largest study area within the county borders.[16] For the vast majority of counties, a single study area dominated the county. For the remaining counties, the study area representing the county was selected by either having the greatest physical area in the county or by the number of loops the designated incumbent served within the county. The latter criterion was used to map most of the remaining counties.[17] This gives us a total of 12,536 observations (3,134 observations per year for four years), and represents 99.8 percent of all counties in the U.S. In only 7 counties nationwide were we unable to map a county to a study area due to incomplete data.

4.2. Explanatory Variables

Our explanatory variables can be divided into three categories: costs of operating and the competitive environment; demographic indicators of demand; and regulatory characteristics. We include in our model those factors that have been found to be relevant determinants of entry into local telecommunications markets by prior studies (for example by Alexander and Feinberg, 2004; Greenstein and Mazzeo, 2006; Roycroft, 2005; and Zolnierek et al, 2001). Of primary interest for our analysis are net contributions to the USF. These additional costs of operating are measured in two ways: aggregate net contributions by county and study area (*Net Contributions*) and average net contributions per loop by county and study area (*Net Contributions per Loop*).[18] These variables serve as the key explanatory variables in our regression analyses to estimate the effects of the USF on competitive entry.[19]

To represent the competitive environment we include indicators for incumbents. We do this using state level variables that control for the leading incumbent serving each county and study area. These variables are named for the respective incumbent; for example, the percentage of telecommunications revenue in a state that is attributed to Qwest in a particular year is included as a variable (*Qwest*) in all observations where Qwest has a presence in a state. Additionally, we account for incumbents' direct effects on rivals through unbundled network elements (UNEs). Regulators require incumbents to provide UNEs to rivals.[20] If an incumbent finds it more profitable to provide retail services than to provide unbundled network elements, we would expect the incumbent to try to limit entry. Thus, if incumbents are able to affect entry, we would expect a positive relationship between entrant presence in a market and the ratio of prices of unbundled network elements (UNEs) and comparable retail services. To capture this effect, we include as a variable the incumbent's average price for UNEs per line divided by the comparable retail price per line (*Average UNE Rate*). Following Jamison (2004) we expect this variable to capture the potentially conflicting effects of regulation on incumbent and entrant incentives. We expect service provider costs generally to fall with the amount of urbanization or population density and choose to measure this as population per square mile (*Population*). Lastly, we include the number of cellular telephone providers per county per year (*Cellular Carriers*) to account for the possible substitution effect that may decrease demand for wireline telephone service when more wireless providers are available.

With respect to our second category of variables, demographic indicators of demand, we use those variables that prior studies estimating demand have generally found to be significant.[21] We expect demand to be positively related to household income, and measure this effect using the median annual household income within the county and study area (*Median Household Income*). We also include the percentage of the population that receives government assistance (*Assistance*) and anticipate this to be inversely related to demand. Finally, we include the median age of the population in the county and study area (*Median Age*). While we do not have a strong prediction on the effect of age on competitive entry, a study by Chiang and Hada (2007) showed that younger consumers tend to value choices in providers more than older consumers. If this is accurate, we would predict greater entry in counties with a lower median age.[22]

With respect to the final category of variables, the regulatory environment, we include three variables to estimate the effect of state regulatory conditions on competition. First, we include the binary variable *Flexible Regulation* (with the excluded category all other types of regulation) to distinguish between states that do and do not impose price floors on entrants. Because the imposition of price floors restricts the ability for entrants to compete on price, we expect states that do not impose such restrictions to attract greater entry, and therefore we expect a positive correlation between *Flexible Regulation* and the presence of entrants in a market. Second, we measure whether public service commissioners are appointed rather than elected with the binary variable *PSC Appointed*. We do not have an *a priori* prediction on the possible effects of public service commissioners being appointed rather than elected. It is possible that elected commissioners are more responsive to immediate citizen concerns, but it is unclear whether this means that the commissioners might favor entrants, incumbents, or neither.[23] Lastly, we include a variable that indicates whether a particular state has imposed restrictions on municipal telecommunications entry (*Municipal Ban*). While municipal entry is a small subset of total entry, those states with regulations limiting such entry may have motivations for doing so that also discourage entry by non-municipal entrants.

Summary statistics for all variables are provided in Table 2.

[Insert Table 2 here.]

4.3 *Empirical Methodology*

Our empirical model is based on the theoretical model outlined in Section 3 above. We examine two dependent variables, the number of providers per county, and the number of providers per study area. Our primary interest is to determine whether net contributions to the USF affect entry; however, it is clear that similar factors affect both an entrant's decision to provide telecommunications services in a particular market and the net contributions that ultimately accrue to (or are received from) that market. Therefore, our data is likely to be characterized by endogeneity of the key regressor *Net Contributions* (and *Net Contributions per Loop*). The standard tests for endogenous variables support our concern. By the Wu-Hausman F-test we fail to reject the null hypothesis that the regressor *Net Contributions* is endogenous (P-value = 0.00137). The Durbin-Wu-Hausman chi-sq test has a similar result (P-value = 0.00136). To address this correlation, we employ a two-stage least squares estimation in which we use average revenue per line lagged one year as the instrumental variable for *Net Contributions*. The set of independent variables is as listed in Table 2, and models are specified for dependent variables Entrants per County and Entrants per Study Area both with and without identifying the primary incumbent provider. Additionally, in order to tie the results of the county level estimations to the state level policy analysis this paper addresses, we test simply for the significance of states being net contributors to the USF (*Net Positive*) versus being net recipients of the USF. We consider the variable *Net Positive* at all three levels of observation: county, study area, and state. The results of these estimations appear in Table 3 and are discussed in the next section.

5. Results

The county level and study area level estimates are presented in Table 3.

[Insert Table 3 here.]

We segmented our results to take into account both entrants per county and entrants per study area in order to capture any significant differences since our primary variable of interest (*Net Contributions*) is determined at the study area level. While we address the specifications separately it is important to note that both *Net Contributions* and *Net Contributions per Loop* are positively and statistically significant across all specifications. Using the estimation coefficients in Column 1 of Table 3, the marginal effect of a one standard deviation increase in *Net Contributions* ($6.51 million) is associated with an increase of 0.06 entrants per county, an increase of nearly 8% from the mean. Thus, our first hypothesis is supported in that we find net contributions to correspond with greater entry, while net receipts correspond with less entry. As discussed earlier, this is precisely the pattern of entry we would expect to observe in the absence of the USF. Of interest is to discern why we continue to observe this pattern in the presence of the USF. Prior to addressing this question, we first consider the remaining explanatory variables within the county level specifications.

Across the county level specifications we find that the variables controlling for the incumbent's share of total state revenue are consistently significant indicating that entry is highly influenced by the leading incumbent in a market. Entry in general is higher among all counties where Sprint[24] is the leading incumbent, and lower among counties where Alltel is the leading incumbent. It is beyond the scope of this paper to determine why various incumbents have different effects on entry; we suspect it is related to corporate strategies and other firm-specific variables that are not captured in our model. Consistent with our expectations, we find that *Average UNE Rate* is positively and significantly correlated with entry. This finding suggests that incumbents that can earn higher revenue by leasing their unbundled network elements are less likely to act to limit entry, as the relative gains from serving retail customers are less important. Our variable *Cellular Carriers* has the expected negative sign, which supports our assertion that the availability of wireless substitutes should decrease entry as overall demand for wireline services decline. Finally, we find *Population* to be positively and significantly correlated with entry, as expected.

With respect to our second category of variables (indicators of demand), we find *Median Household Income* to be positively and significantly correlated with entry. *Median Age* is negatively correlated with entry, which supports the notion that younger consumers place higher value in advanced technologies and the availability of new and improved products that result from competition than older consumers. Additionally, the percentage of the population receiving government assistance (*Assistance*) is positively and significantly correlated with entry. We expect that this variable reflects a higher level of urbanization where a greater number of lower-income households may reside.

With respect to the final category of variables, the regulatory environment, we find that *Flexible Regulation* is associated with lower likelihood of the presence of entrants in a market. It is possible that this result, which is counter to our initial expectation, reflects a response by regulators to satisfy incumbents by incorporating other rules that might deter competitive entry. We find that whether the public service commissioners are appointed or elected is not significant, nor is the presence of restrictions on municipal entry. We conclude then with respect to our second hypothesis that state regulatory policy does not appear to drive our results.

Turning to the study area level results presented in Table 3, note that the same estimations were performed after aggregating the county level variables to the corresponding study area. While the majority of results are qualitatively similar to the county level specifications, coefficients for key variables are strengthened, including those for *Net*

*Contribution*s and *Average UNE Rat*e. Note that the variables controlling for incumbent's share of total state revenue all are insignificant, which is likely due to the study area level specification (in which each study area represents just one incumbent). Similarly, *Flexible Regulation* is not significant in the study area estimates.

The results of the initial estimates as presented above provide us with the foundation for testing our first hypothesis. Namely, we find that certain cost, environment, demographic, and regulatory factors are relevant to entry decisions. Some of these factors differ by county (i.e., population); some differ by state (i.e., election of public utility commissioners); still others differ by study area (i.e., incumbent status). Our goal, however, is to determine which of these effects most directly drive our results. Our primary concern is how *Net Contributions* affect the competitive environment. Therefore, we attempt to further clarify the effect of USF contributions on entry between net contributors and net recipients through the indicator variable *Net Positive. Net Positive* takes the value of 1 if the area (county, study area or state) is a net contributor to the high cost fund, and 0 otherwise. The results of these estimates appear in Table 4.

[Insert Table 4 here.]

Our county level estimates are inconclusive. At the county level, the average number of entrants is 1.203 in counties that are net contributors to the fund and 1.740 in counties that are net recipients of the fund. This is not a statistically significant difference. We assert that this result is due to the large number of counties without any entrants during the years of study. Of 12,536 total observations, only 2,028 had entry and of those counties, 1,697 were net contributors (average entry 5.56 per county) and 331 were net recipients (average entry 2.46 per county). Overall among those counties with any entrants during the years of the study, the average number of entrants per county was 5.05. To account for these characteristics of the data, we estimated the county level specifications using those counties that had a positive number of entrants per county during any of the years of the study. Even doing so, these results were not significant. We believe this supports the dominance of study area level and state level results. We would expect that to the extent the USF influences policies and decisions, it would do so at the study area or state level since funds are determined at the study area level. The county level effects that we expect to be the greatest are those indicating the demographic (demand) conditions. Our estimations support these assertions.

With respect to the study area level results, we find that net contributions are positively and significantly correlated with the number of entrants. To add clarity to this finding, note that the average number of entrants is 22.40 in net contributor study areas and 0.15 in net recipient study areas. Similar to our findings with respect to counties, a substantial number of study areas had no entrant participation. Therefore, it is useful to compare study areas that have at least one entrant. In such cases there are 281 net contributor study areas with an average of 33.57 entrants, and 199 net recipient study areas with an average of 4.10 entrants.

This result also applies at the state level, where in fact we find a positive and statistically significant difference in entry between states that are net contributors to the USF and states that are net recipients of the USF. Specifically, the average number of entrants is 52.19 in net contributor states and 47.94 in net recipient states. Our results indicate a statistically significant, positive relationship at the state level between entry and whether a state is a net contributor to the USF.

6. The effects of net contributions on competition

There are at least two potential negative effects on competition created by the high cost support. First, entrants are negatively affected by their contributions paid to the USF given that they qualify for the subsidy less frequently than do incumbents. The more significant issue, however, is whether the fund distorts competition. In other words, is efficient entry discouraged by the high cost system? We assert that this is the case. While contributions to the USF affect the profitability of all operators, it is the USF funding system that gives entrants a possible advantage over an incumbent when the incumbent is a net contributor. Because an incumbent is forced to serve the high cost areas it is unable to effectively compete in the low cost areas. Instead, it earns revenue based on its average cost of providing service, which allows prices to be higher in the low cost study areas thereby encouraging inefficient entry. The more low cost areas a state has, the more disadvantaged the incumbents are expected to be. Simultaneously, states with many high cost areas have less entry due simply to costs, and we find that being a net recipient of USF subsidies does not encourage efficient entry. In fact, contrary to the intentions of policymakers, being a net recipient might discourage efficient competition.

For future work, relevant questions remain. First, how might entrants respond if the USF were abolished altogether? In this case, we would be interested in the level of entry that would occur relative to the level of entry in net contributing states under the USF. Alternatively, how might entrants response if a state-administered USF were implemented? We also might consider the role of specific incumbents on entry. This would require incorporating firm-specific data on pricing, policies, and costs. Despite these lingering questions, our key finding remains that increased entry is correlated with positive net USF contributions – precisely the result we expect to see in the absence of the USF but not in its presence. This adds a new dimension to the ongoing debate.

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Footnotes

1. Figures provided by the Federal Communications Commission (http://www.fcc.gov).

2. The term incumbent refers to the carrier that prior to the Telecommunications Act of 1996 provided local telephone service in an area. An entrant is a carrier that provides some or all of the local telephone service in an area that was not operating prior to the Act.

3. Communications Act of 1934, obtained from the University of Southern California website http://www.usc.edu/~douglast/202/lecture20/1934act.html, downloaded March 3, 2007.

4. For detailed information on the establishment and progression of the universal service fund, see Gabel (1967), Mueller (1993), and Jamison (2002).

5. An entrant must first be designated as a competitive eligible telecommunications carrier before qualifying for high cost support.

6. The remainder was disbursed for telecommunications assistance to low income households, schools and libraries, and rural health centers.

7. Table 1 uses 2004 contribution data.

8. Formally, a high cost area is defined by the local loop price with respect to the national average loop price. The local loop price is the price an entrant must pay the incumbent provider to lease the line needed to provide service to the consumer.

9. A loop is essentially a local telephone line.

10. Subscribership has fallen due to cell phones, but this does not affect wireline penetration, which is the ability to subscribe. This is clarified by the Hazlett (2006) reference.

11. A study area is an area defined by the FCC, that represents the geographic area within a state that was traditionally served by a particular incumbent. Incumbents that operate in more than one state will have a distinct study area for each state in which they operate. In some instances an incumbent may have more than one study area in a state if, for example, the company merged with another company in the state. Study areas cannot overlap, though more than one study area can appear in a single county.

12. The cost of operating in an area is based on a forward-looking cost model of building and operating the network.

13. Per the current USF arrangement, contributions are collected from all telecommunications carriers providing interstate service. There is a universal service exception for *de minimis* (non-common carrier) telecommunications carriers whose estimated contributions would be less than $10,000. All carriers that provide service in rural or urban high cost areas receive support. This includes entrants that are designated as a competitive eligible telecommunications carrier. A

rural area is primarily defined as a study area in which less than 15 percent of access lines are in cities of more than 50,000 (http://www.fcc.gov). High cost areas are defined with respect to the five components of high cost services, and are based on costs greater than 135% of the national average cost per line ($27.51 in 2002). For defined high cost areas with fewer than 200,000 working loops, the carrier receives $1 in subsidies for each $1 of loop costs above 150 percent of the national average loop cost. For defined high cost areas with more than 200,000 working loops, the carrier receives subsidies between 10 percent and 75 percent of costs, depending on how much the cost is above the national average.

14. The theoretical motivation is shown formally in the Appendix.

15. Our initial research included using the number of access lines as a dependent variable to measure investment. These specifications resulted in poor models with insignificant results. We submit that this is due to the fact that access lines are frequently leased by entrants; therefore it is possible to have entry of one or more entrants without any increase in access lines at all.

16. Incumbent maps were obtained from each state for which a map was available. In six states, incumbent maps were not necessary since only one incumbent serves the entire state. In three other states, complete incumbent listings by county were obtained in lieu of maps. Maps were provided by the Telephone Association or the Public Service Commission from each state. Specific documentation of sources is available upon request.

17. The first criterion was used in cases in which two or more study areas were served by large incumbents (e.g., SBC and Verizon). This is because it is not possible to determine the number of loops an incumbent serves within a county when it serves multiple counties in a state.

18. At the state level, a comparison of these variables in 2004 appears in Table 1 and Figure 1, respectively.

19. While the FCC makes available data on receipts from the USF (and specifically on high cost support), contributions to the USF are not directly provided. However, contributions can be calculated by multiplying the appropriate contribution factor (fixed across all states) by the respective time period's revenues for each state. Contribution factors change each quarter; thus, contributions must be calculated on a quarterly basis, and then summed for the annual totals. Next, these contributions include funding for all four USF programs. In order to narrow the contributions to the high cost portion, all of the contributions are multiplied by the percentage of total contributions appropriated to high cost support. This varies from year to year, and ranges from 53% to 58%. Receipts are then subtracted from contributions to calculate net contributions.

20. Leasing portions of an incumbent's network is called purchasing unbundled network elements. For example, an entrant could lease a local telephone line from the incumbent provider. The line would connect to the incumbent's building. It could then connect to the incumbent's switch or the entrant's switch, depending on how the entrant wishes to use the incumbent's facilities. Our variable is a state-wide average rate based on the loop, port and switching rates per month.

21. Because penetration rates for telecommunications services are high within the U.S., it is difficult to predict the factors that potential competitors would consider when deciding if there is enough demand to support their entry. For more detailed consideration, see Garbacz and Thompson (2002 and 2003), and Grzybowski (2005), or Alexander and Feinberg (2004) who provide a review of telecommunications entry literature.

22. We considered additional population characteristics such as race and ethnicity, language, and education, and other measures of population density such as urban classification, and various demographic indicators such as the employment growth rate and personal bankruptcy rate. These variables proved to be insignificant and did not affect results, therefore they were excluded from the model.

23. We generically refer to state regulatory agencies as public service commissions. Some states elect their commissioners. In other states they are appointed. The appointment processes vary across states, but the processes generally involve both the governor and the legislatures.

24. The incumbent local exchange company Sprint became Embarq subsequent to this study.

Table 1. Rank of net contributions into the Universal Service Fund, by state

Rank	State	2004 Net	2003 Net	2002 Net	2001 Net
1	California	$266,002	$245,677	$211,070	$161,039
2	New York	$170,352	$155,401	$136,693	$110,964
3	Florida	$142,908	$132,688	$104,909	$83,115
4	New Jersey	$125,693	$117,060	$116,018	$99,130
5	Pennsylvania	$87,788	$78,072	$73,295	$69,462
6	Illinois	$83,183	$71,868	$75,951	$72,009
7	Massachusetts	$80,355	$75,113	$73,991	$67,425
8	Ohio	$77,174	$69,475	$62,861	$56,913
9	Maryland	$73,800	$68,214	$61,806	$52,470
10	Michigan	$50,130	$47,480	$38,452	$30,459
11	Connecticut	$49,234	$45,855	$42,682	$38,238
12	North Carolina	$22,976	$23,767	$23,228	$32,827
13	Virginia	$22,394	$18,321	$17,179	$12,059
14	D. Columbia	$16,900	$15,801	$15,322	$14,149
15	Delaware	$12,233	$11,365	$10,875	$9,406
16	Rhode Island	$12,052	$11,274	$11,232	$10,678
17	Tennessee	$9,440	$7,628	$4,943	$5,991
18	Indiana	$8,633	$6,144	$7,484	$4,052
19	New Hampshire	$6,390	$5,651	$5,677	$6,222
20	Nevada	$5,855	$1,569	$3,339	$658
21	Utah	$2,440	-$586	$3,081	$4,954
22	Hawaii	$1,953	$3,945	$3,554	$4,511
23	Georgia	-$3,269	-$9,524	-$19,051	-$9,633
24	Texas	-$9,538	-$5,860	-$20,889	-$27,264
25	Arizona	-$13,096	-$7,102	-$4,941	-$391
26	Washington	-$15,024	-$10,684	-$19,451	-$21,216
27	Maine	-$15,404	-$15,942	-$16,438	-$16,952
28	Colorado	-$21,074	-$17,253	-$9,898	-$11,982
29	Vermont	-$22,752	-$19,900	-$17,960	-$15,709
30	Missouri	-$24,019	-$30,386	-$33,291	-$37,460
31	South Carolina	-$26,801	-$33,467	-$35,846	-$19,688
32	Nebraska	-$27,278	-$25,885	-$15,198	-$11,202
33	New Mexico	-$28,231	-$29,280	-$26,429	-$26,675
34	Oregon	-$29,126	-$31,228	-$30,750	-$27,802
35	Kentucky	-$30,018	-$21,432	-$20,843	-$3,015
36	Idaho	-$37,183	-$36,187	-$34,624	-$30,612
37	Minnesota	-$40,146	-$28,919	-$23,322	-$7,202
38	Wisconsin	-$46,417	-$37,623	-$22,112	-$20,117
39	West Virginia	-$46,900	-$58,322	-$63,568	-$57,682
40	North Dakota	-$47,132	-$43,850	-$26,466	-$20,488
41	Wyoming	-$48,060	-$41,090	-$35,366	-$30,196
42	South Dakota	-$48,253	-$40,823	-$25,663	-$16,473
43	Iowa	-$49,541	-$40,239	-$15,744	-$12,155
44	Alabama	-$50,456	-$46,404	-$57,792	-$61,119
45	Louisiana	-$57,706	-$47,250	-$48,967	-$46,735
46	Montana	-$62,850	-$54,872	-$53,437	-$43,073
47	Oklahoma	-$63,913	-$70,645	-$56,037	-$50,272
48	Alaska	-$84,716	-$80,099	-$73,278	-$71,528
49	Kansas	-$97,509	-$83,112	-$67,221	-$57,763
50	Arkansas	-$107,380	-$86,135	-$69,254	-$57,959
51	Mississippi	-$157,193	-$142,470	-$144,482	-$120,223

Note: Monetary figures represent thousands of U.S. Dollars

Table 2. Summary statistics, by county (1999 – 2002); 12,536 observations

Variable	Mean	Std. Dev.	Min	Max
Number of Entrants per County (actual numbers)	0.818	3.561	0	80
Net Contributions (in millions)	1.390	6.514	-25.350	109.298
Net Contributions per Loop (in thousands)	-0.215	0.475	-14.152	10.060
Average Revenue per Line (in tens)	3.524	0.465	2.528	4.588
UNE Average Loop Rate (actual numbers)	16.053	4.325	7.014	28.295
Alltel (market share)	0.029	0.054	0	1
BellSouth (market share)	0.204	0.359	0	1
SBC (market share)	0.195	0.336	0	1
Sprint (market share)	0.041	0.085	0	1
Qwest (market share)	0.204	0.374	0	1
Verizon (market share)	0.186	0.309	0	1
Small Carriers (market share)	0.141	0.320	0	1
Cellular Carriers (actual numbers)	10.042	3.152	4	18
Population per Square Mile (in thousands)	0.216	1.430	0.001	52.419
Median Household Income (in thousands)	35.328	8.852	9.333	82.929
Median Age (actual numbers)	37.354	4.004	20.125	58.686
Assistance (Percent of Households)	2.963	1.960	0	49.013
Flexible Regulation (= 1 if Yes; 0 if No)	0.508	0.500	0	1
PSC Appointed (= 1 if Yes; 0 if No)	0.695	0.461	0	1
Municipal Ban (=1 if Restrictions; 0 otherwise)	0.050	0.217	0	1

Table 3. Two-stage least squares estimates for entry per county and per study area

Regression Number	1	2	3	4	5	6
Dependant Variable	Entrants per County			Entrants per Study Area		
Net Contributions	0.247***	0.531***		0.990***	1.06***	
	(0.08)	(0.01)		(0.26)	(0.28)	
Net Contributions per Loop			0.020***			0.036**
			(0.01)			(0.02)
Average UNE Rate	0.091***	0.147***	0.131***	0.258***	0.320***	0.487***
	(0.02)	(0.02)	(0.02)	(0.09)	(0.10)	(0.18)
Alltel		-3.146***			-6.705	-7.905
		(0.69)			(5.03)	(7.73)
BellSouth		-0.720	3.745***		2.283	-4.916
		(0.52)	(0.77)		(3.72)	(5.40)
SBC		-1.640**	5.068***		1.635	7.656
		(0.52)	(0.94)		(3.33)	(5.31)
Sprint			2.839***			
			(0.79)			
Qwest		-1.916***	5.455***		-0.175	1.634
		(0.51)	(1.07)		(3.25)	(4.98)
Verizon		-2.400***	3.541***		1.833	-5.725
		(0.58)	(0.73)		(3.84)	(5.05)
Small Carriers		-1.104**	4.343***		0.696	1.574
		(0.48)	(0.87)		(3.44)	(5.25)
Cellular Carriers	-0.026	-0.159***	0.025			
	(0.03)	(0.04)	(0.02)			
Population per Square Mile	0.518***	0.449***	0.609***	10.850***	7.908***	43.907***
	(0.03)	(0.03)	(0.03)	(0.87)	(1.02)	(2.24)
Median Household Income	0.009***	0.479***	0.474***	13.357**	9.840	4.180***
	(0.001)	(0.09)	(0.11)	(6.56)	(7.64)	(1.53)
Median Age	-0.042***	-0.029***	-0.024*	-0.057	-0.050	-0.247
	(0.01)	(0.01)	(0.02)	(0.10)	(0.10)	(0.15)
Assistance	0.142***	0.121***	0.195***			
	(0.028)	(0.028)	(0.03)			
Flexible Regulation	-0.086	-0.251***	-0.473***	0.164	0.003	0.470
	(0.06)	(0.10)	(0.14)	(0.62)	(0.73)	(1.04)
PSC Appointed	-0.060	-0.038	0.078	-0.234	-0.231	-1.002
	(0.09)	(0.11)	(0.12)	(0.72)	(0.79)	(1.23)
Muniban	0.004	0.290*	-0.004*	-0.042	-0.024	-0.096**
	(0.14)	(0.161)	(0.01)	(0.03)	(0.03)	(0.04)
Number of Observations	11,900	11,900	11,873	2,002	2,002	1,999

Notes: Standard errors in parentheses. Significance of coefficients at the 10%, 5%, and 1% levels are shown by *, **, and ***, respectively.

Table 4. Fixed-effect estimates for entry

Regression Number	(1)	(2)	(3)
Net Positive Indicator (by County)	-1.288	-10.863	-26.261
(2,028 Observations)	(2.39)	(18.59)	(203.78)
Net Positive Indicator (by Study Area)	4.522	3.898	13.902***
(2,002 Observations)	(4.57)	(3.85)	(3.06)
Net Positive Indicator (by State)	30.404***	23.587*	23.087
(190 Observations)	(11.81)	(15.70)	(21.20)

Notes: Standard errors in parentheses. Significance of coefficients at the 10%, 5%, and 1% levels are shown by *, **, and ***, respectively.

Specification 1 uses *Net Contributions* and does not include incumbents; specification 2 uses *Net Contributions* and includes incumbents; specification 3 uses *Net Contributions per Loop* and includes incumbents.

Appendix

The model is a homogenous good duopoly competition model in which telecommunications providers simultaneously and independently choose whether to operate in a particular geographic area. For simplicity, suppose there are two areas, a low cost area (L) and a high cost area (H). There are two potential providers, an incumbent (I) and an entrant (E). Providers are assumed to be equal in operating costs so that $C_I^k(\theta) = C_E^k(\theta)\ \forall\ \theta, k \in \{L, H\}$. Then $C(\theta_i^k) = [\beta + c_i q_i^k(\theta_i^k)]$ where $c_i q_i^k > 0$ is provider i's marginal cost of serving q_i^k customers θ_i^k for all $k \in \{L, H\}$ and all $i \in \{I, E\}$. β is the fixed cost of operating in an area. Providers compete for customers through price only. The total number of potential customers providers compete for in each county k is given by $n^k = (q_i^k + q_j^k)$, $k \in \{L, H\}$. All potential customers enroll with one (and only one) provider, and choose the low-price provider. Each provider contributes a portion of its revenue to a universal service fund. The incumbent provider receives a subsidy for operating in a high cost area. For simplicity, assume the entrant does not receive a subsidy (this assumption mirrors the majority of cases in the US; without it, the dilemma disappears as both providers are essentially equal). The subsidy $\hat{S} \in [\underline{S}, S]$ is a payment from the USF to the incumbent operating in a high cost area. In addition to the subsidy, providers earn revenue as indicated in Section 3 of the paper. Let R_i^k be the exogenously determined revenue to provider i, $i = \in \{I, E\}$ in area k, $k \in \{L, H\}$.

Lemma 1: The incumbent will earn zero profit if the entrant operates in the low cost area (i.e., $q_I^L = 0$ and $q_E^L = n^L$; and $q_I^H = n^H$ and $q_E^H = 0$) without the USF.

Without the USF, $[R_I^L - C_I^L(\theta)]n^L = 0$ since $R_I^L n^L = \frac{A}{1-\alpha} n^L$ and $\frac{A}{1-\alpha} > \frac{L}{1-\alpha}$. At the same time, $[R_I^H - C_I^H(\theta)]n^H = 0$, since $R_I^k = \frac{A}{1-\alpha}$ which by definition just covers cost. The incumbent therefore has no incentive to operate without the USF, but is required to do so by the carrier of last resort obligations.

Lemma 2: An appropriate subsidy will incorporate funds to offset the cost of competition in the low cost area in addition to offsetting the cost of operating in the high cost area.

With the USF, the incumbent faces the following profit condition:
$[R_I^L\beta \hat{S} - C_I^L(\theta)]\frac{1}{2}n^L + [R_I^H(1-\beta)\hat{S} - C_I^H(\theta)]n^H \geq 0$. This allows the incumbent to earn non-negative profit operating in both the low and high cost areas while the entrant operates in the low cost area. Hypothesis 1 indicates that there will be less entry in high-cost dominated study areas; however, under the USF this should not be the case. By definition, the subsidy should make operating in the high cost area commercially viable,[1] and should ensure the policy is competitively neutral for the incumbent and entrant given that most entrants operate only in low cost areas. This implies that if Ŝ is optimal the following condition applies:

$$\Pi_I^{L,H} = [R_I^L\beta \hat{S} - C_I^L(\theta)]\tfrac{1}{2}n^L + [R_I^H(1-\beta)\hat{S} - C_I^H(\theta)]n^H = [R_E^L - C_E^L(\theta)]\tfrac{1}{2}n^L = \Pi_E^L \qquad (1)$$

Solving for Ŝ we find:

$$\hat{S} = \frac{C_I^H}{R_I^H(1-\beta)} \qquad (2)$$

[1] If we assume that the subsidy is appropriately determined, then the entrant has an incentive to apply for eligible telecommunications carrier status that enables it to receive the high-cost subsidy too. In reality most entrants do not apply for ETC status; we rely on revealed preference theory to assert that the subsidy must not be enough to make entry commercially viable.

For the subsidy to establish a neutral competitive study area, it must be set based on the incumbent's cost of operating in the high cost area given the revenue received in that area and the portion of the subsidy that must be transferred to compete in the low cost area.

Figure 1. Net contributions by local loop into the Universal Service Fund, by state, 2004