

Oversight and Competition with Heterogeneous Service Providers: The Federal Lifeline Program*

Thomas S. Conkling[†]

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Abstract

Many government benefits and services are provided through private markets. Firms compete to provide services directly to individuals, and the most productive firms survive and serve the market. However, insufficient enforcement of program rules weakens competitive pressures, allowing less productive firms to maintain market share. Exploiting two features of the Lifeline phone subsidy program, state-level variation in regulatory environments and a one-time reform, I test how oversight influences the behavior of heterogeneous firms. Lower productivity firms select into loose-oversight markets, driving the large state-level differences in wasteful program spending. Similar forces may factor into healthcare, education, and consumer finance markets.

JEL Codes: L11, H42, L51, L33

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[†]Office of Research, Consumer Financial Protection Bureau. Email: thomas.conkling@cfpb.gov.

1 Introduction

Many government benefits and services are provided through private markets, either by direct contract or subsidy. This arrangement is motivated by the idea that competition and industry expertise can reduce the costs of provision. Firms compete to provide services to individuals, and under perfect competition the most productive firms survive and serve the market. However, these markets are rarely perfectly competitive, so less productive firms can often maintain market share. Insufficient enforcement of eligibility rules or quality standards further weakens competitive pressures. As a result, the level of oversight will have a selection effect on the types of firms that enter the market.

This paper studies the federal Lifeline program, which subsidizes free cell phone service for low-income households, to empirically demonstrate how oversight influences the composition and post-entry behavior of providers in a market. By law, firms providing these services must adhere to specified rules determining the eligibility of their customers. Although program rules are largely set at the federal level, enforcement is left to state regulators. In practice, enforcement is imperfect and varies widely in intensity across states. Additionally, states have discretion over the approval of new providers. The resulting state-level variation makes Lifeline an ideal test of how regulatory oversight influences program enrollment and waste.

The evidence suggests substantial variation across firms in the propensity to take advantage of lax oversight. This variation across firms is revealed by another unique feature of the data, a one-time federal reform imposing uniform enforcement across states. I estimate a model of consumer demand and firm compliance behavior to quantify the substantial heterogeneity between providers in terms of the quality of service offered and compliance with program eligibility rules. Compliance behavior varies much more across-firm than within-firm. Firms offering low quality and poor compliance select into loose-oversight markets, and their entry drives the large state-level differences in waste and inefficiency. Accounting for firm heterogeneity may be crucial to the design of effective regulatory policy.

When oversight is costly, cost-cutting and non-compliance can reduce the gains of privatization (Hart et al., 1997; Levin and Tadelis, 2010). Providers have an incentive to cut costs on difficult-to-monitor aspects of service. I contribute to previous work by showing empirically how this type of behavior varies across firms and how it affects program outcomes through the entry margin. Why don't all firms cut costs and offer low quality? Competition rewards firms for offering higher quality, which explains some of the story. Additionally, more productive firms have a continued benefit of remaining in the market, since they remain profitable even under more rigorous oversight.¹ As long as these profitable firms perceive

¹This is similar to some of the literature on firm contracts, in which the expected benefit of the continued

some threat of removal or fines for non-compliance with program rules, they will generally adhere to higher standards. This incentive does not hold for less productive firms. For them, removal from the program or strict compliance with regulations both yield zero profits.

When evaluating outcomes, I focus on the efficient use of government funds to achieve program enrollment goals. This is in contrast to the related literature documenting *socially* inefficient levels of entry which arise from the sunk costs of additional entrants (Wolinsky, 1984; Mankiw and Whinston, 1986; Berry and Waldfogel, 1999; Hsieh and Moretti, 2003). In this paper, the decreasing returns from entry come not from sunk costs but from service provided at lower quality and to unintended beneficiaries. The potential benefits of entry depend on the extent to which additional firms expand the market, increasing the total number of eligible households enrolled. Following Berry and Waldfogel (1999), I estimate a nested logit model of demand and present evidence that entry does expand enrollment in the Lifeline market. This is the trade-off of oversight: looser oversight brings more enrollments but also more waste. The balance of the trade-off depends on the compliance and quality offered by the marginal entering firm.

A number of recent empirical papers have addressed aspects of the trade-off between competition and compliance in consumer-facing markets. Polsky et al. (2014) studied state-level entry regulations in the home healthcare market, measuring their effects on market structure and service quality outcomes. Regulated states have more concentrated markets, but service quality does not differ substantially from that in unregulated states. The authors note the possibility that negative outcomes in a few unregulated states with anecdotal evidence of fraud may “cancel out” with any negative effects of reduced competition in regulated states. In a study of a disclosure enforcement change in consumer lending markets, Stango and Zinman (2011) find that looser enforcement led to an increase in price discrimination at the expense of households with biased perceptions of interest rates.² However, the looser enforcement also leads to a drop in the overall level of interest rates, and a net gain for less biased households, potentially due to an increase in supply and lower compliance costs for providers. While not directly consumer-facing, the potential costs of particularly strict oversight have been shown in the realm of charitable foundations: tax reforms aimed at stopping the misuse of funds substantially reduced entry by charitable foundations and genuine gifts to the groups (Marx, 2015). The reform’s effects were larger in states with weaker pre-reform reporting rules, as well as for donors who manage their own charities. All three papers make note of possible heterogeneity in compliance, but cannot observe it

business relationship – the continuation value – is the main deterrent to deviations from contracts (Darby and Karni, 1973; Klein et al., 1978).

²The paper also cites evidence that a small portion of providers did not comply even after being contacted by the regulatory authority.

directly. The institutional characteristics of Lifeline offer a rare opportunity to empirically link compliance and competition. I contribute to this literature by measuring variation in compliance across firms and states, and quantifying its direct influence on competitive forces, entry, and market outcomes.

The patterns highlighted in this paper arise because of the nature of competition and demand. To profitably participate in a market, firms must be able to enroll enough consumers to cover their costs. Competitive forces will require firms to have some minimum productivity or quality to operate, and this threshold falls with product differentiation and search frictions (Syverson, 2004a,b; Hortacsu and Syverson, 2004; Dinlersoz and Yorukoglu, 2012). Search frictions and imperfect information may have important effects on competition in government programs like Lifeline. Consumers are unlikely to have full information about the set of services available, and the lack of out-of-pocket costs could reduce incentives to search for higher quality providers. This can lead to firms seeking out consumers more than consumers are seeking out services. In this context, competition is unlikely to be a substitute for oversight in deterring the entry of low quality or low compliance firms. The empirical evidence from before and after the Lifeline reform suggests that when oversight is lax, firms can cut costs and enroll ineligible households to offset the effects of competition.

The evidence of these dynamics is presented here for the Lifeline program, but this interplay between oversight and entry could be critical in many other markets. The same incentives are likely to exist whenever the government pays the bill, firms compete to enroll customers, quality or prices are imperfectly known, and oversight is costly. In the conclusion, I discuss parallels in markets for healthcare, education, and consumer financial services.

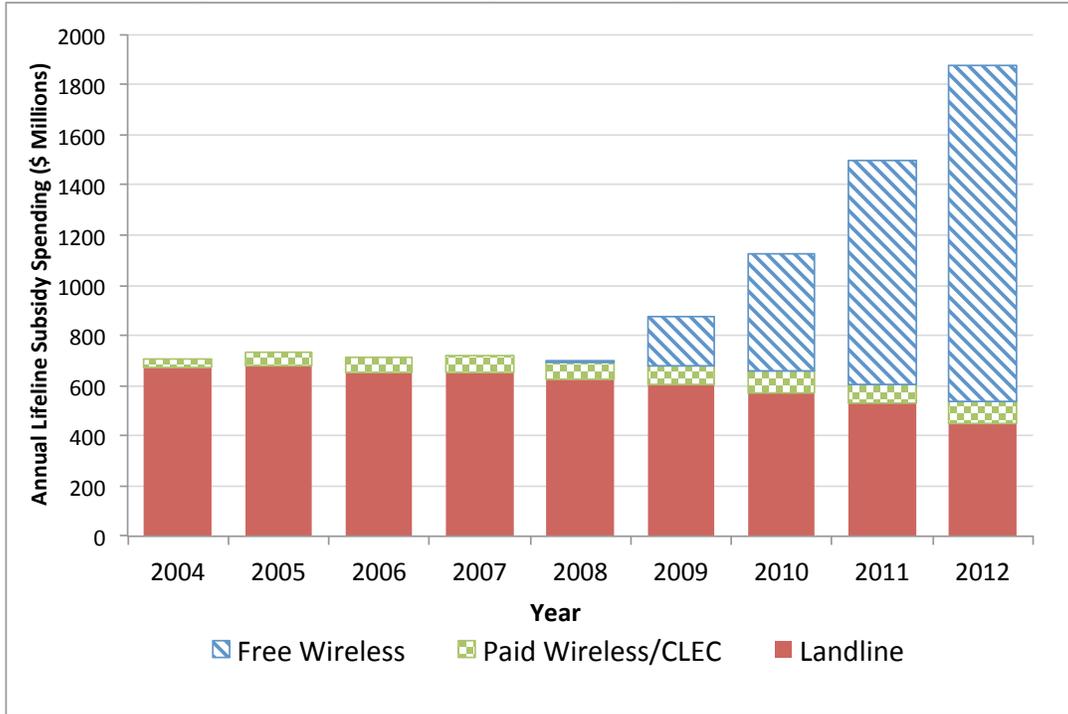
Section 2 describes the Lifeline program and its place within the broader telecom industry. Section 3 describes the data and market definition. Section 4 presents evidence on the importance of firm heterogeneity, as well as preliminary results on the forces driving enrollment and compliance. Based on this evidence, Section 5 presents the model and estimates for firms' enrollment process, and some comparative statics looking at the entry implications of these estimates. Section 6 concludes.

2 Lifeline Background

Establishment, Expansion, and Growth

The federal Lifeline program was established in 1984 with the goal of promoting universal access to telephone service. Telephone carriers submit applications to a state regulator, and once approved can begin enrolling eligible households (more details on this below). For each

Figure 2.1: Annual Program Spending by Carrier Type



Note: Annual subsidy claims to the Universal Service Administrative Company. Excludes Tribal Lifeline claims, and all claims from Oklahoma and Alaska. Free Wireless carriers are defined by author as those carriers offering a wireless service plan at no monthly cost to consumers.

household enrolled, the carrier then claims a monthly subsidy (averaging \$9.25) from the Federal Communications Commission (FCC). Program rules limit each household to only one subsidized phone line, and eligibility is based on income or participation in other benefit programs.³

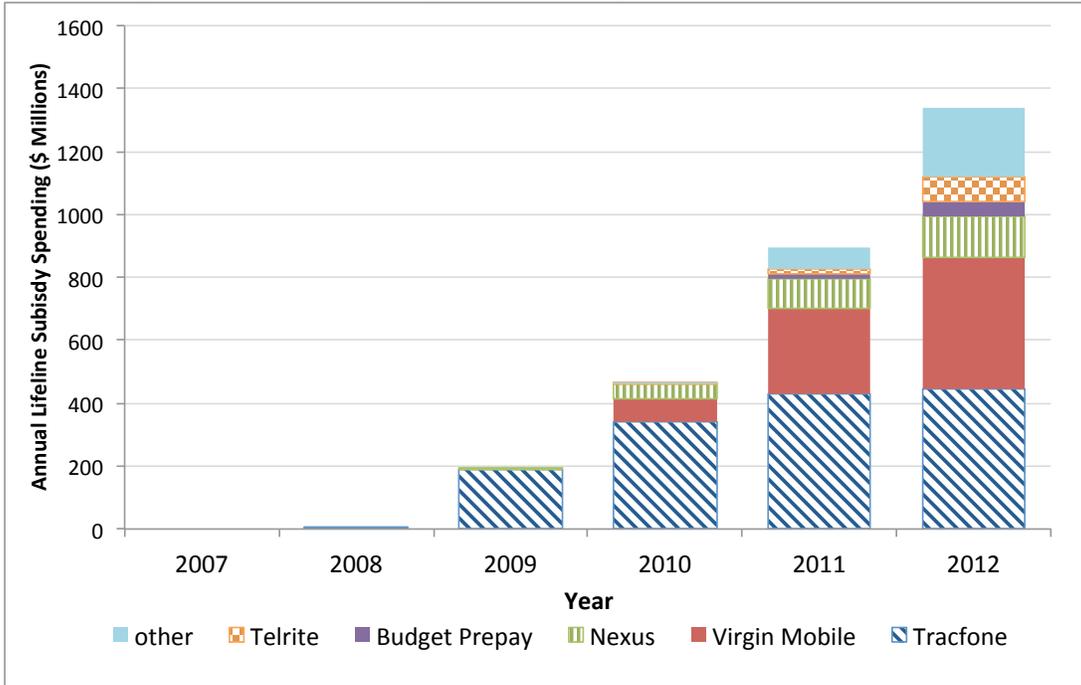
The program was originally restricted to landline and facilities-based wireless carriers, the latter group consisting of firms that own their own networks of towers (AT&T, Verizon, etc.). Prior to 2008, program spending had leveled off to about \$800 million per year. In 2008, the FCC offered the first exemption from the facilities-based requirement to TracFone Wireless, the largest wireless reseller in the United States. As the name implies, resellers pay facilities-based carriers for the use of their networks and resell the services under their own brands.⁴ State regulators quickly followed suit, allowing entry by numerous low-cost wireless resellers.

As seen in Figure 2.1, the entry of these resellers greatly expanded the program. Following

³In most states, a household is eligible if its income is below 135 percent of the federal poverty guidelines or if it is enrolled in Medicaid, SNAP (food stamps), SSI, or one of several other means-tested benefit programs.

⁴This arrangement allows fairly low fixed costs of establishing a new wireless brand.

Figure 2.2: Annual Program Spending by Free Wireless Carriers



Note: Annual subsidy claims to the Universal Service Administrative Company. Excludes Tribal Lifeline claims, and all claims from Oklahoma and Alaska. Free Wireless carriers are defined by author as those carriers offering a wireless service plan at no monthly cost to consumers.

the business model first implemented by TracFone, these carriers offered monthly service at no cost to consumers, usually providing a free handset as well. The free monthly service saved costs on billing, and the steady subsidy reimbursements replaced the typical high-turnover nature of pre-paid wireless services. Figure 2.2 breaks down the growth by carrier in the “free” segment on the industry, with the category “other” encompassing an additional eighteen smaller firms. These free carriers constitute nearly all of the growth in the Lifeline market as a whole and will be the focus of this paper. TracFone and Virgin Mobile are the two largest competitors. By 2012 annual program spending exceeded \$2 billion, and the growth attracted significant attention from legislators and media outlets.⁵

⁵The data in this paper (including Figures 2.1 and 2.2) exclude Oklahoma and Alaska, due to differences in their Lifeline rules and extensive participation in the Tribal Lifeline program. This is why the 2012 subsidy spending number is below \$2 billion in Figure 2.1.

Application Process

Despite being a federal program, many important regulatory decisions are left to state regulators, typically public utilities commissions.⁶ States have latitude to choose criteria like eligibility thresholds, proof-of-eligibility documentation rules, audit requirements, etc.⁷ They also choose which firms to approve. The term oversight is used to encompass states' enforcement of eligibility rules and discretion over provider approval.

Firms first submit their applications to the state regulator, in which they describe their planned Lifeline offering. These applications typically include the number of minutes, texts, or other features included; assurances of the ability to provide a basic level of service; and an appeal to the choice- and competition-enhancing benefit that their entry would bring to the market. The regulator either approves the application (as tends to happen in more lenient states) or requests additional clarifications and assurances, asks for revisions of the offering, seeks out responses from consumer groups, schedules hearings, or other actions along these lines. The more strict the regulator, the more costly and time-consuming these clarifications and revisions tend to be. Relatively few rejections of applications are observed, which I consider evidence that firms know the relative stringency of each state's regulations, and therefore where their applications have a chance of being approved.⁸

The effective result of these regulatory choices leaves some states with as many as fifteen entrant firms, and others with none. As will be shown in Section 4, the stringency of a regulator has a selection effect on the types of firms that enter.

Over-Enrollment and Reform

As numerous firms entered and competed to enroll households in states across the country, anecdotes of households receiving multiple phones began to surface.⁹ In particular, since at the time there was almost no state or federal tracking of enrolled subscribers, firms often could not verify if their customers already had Lifeline phones from another provider. These

⁶An important exception are the eleven states which defer entry and eligibility criteria regulation to the FCC. I will treat these states as a single Federal Group market throughout the paper. The included states are AL, CT, DC, DE, FL, MA, NC, NH, NY, TN, and VA.

⁷The range of eligibility enforcement methods includes (but is not limited to) enrollee self-certification with no documentation requirements (AL, LA, MD), customer provided documentation (MO, NE, PA, SC), some access to state databases on enrollment or eligibility for other programs (FL, TX, WA, WI), and purpose-built Lifeline databases (OR). See FCC (2012) for additional details.

⁸One notable exception is the case of TracFone in California. Though initially scheduled for approval in 2008, TracFone was eventually denied approval over a dispute regarding the remittance of Universal Service Fees. See Conkling (2015) for further details.

⁹"Millions Improperly Claimed U.S. Phone Subsidies," The Wall Street Journal, February 11th, 2013; "Who Gets Rich Off 'Free' Government Phones?" CNN Money, October 26th, 2012.

violations of the program’s one-per-household rule are considered the largest source of over-enrollment or fraud.¹⁰ Although these incidents violate program rules, it can be unclear whether the fault lies with the carrier, the household, or some combination of the two. It’s possible that a) consumers were asked if they had another Lifeline phone and lied, b) consumers didn’t understand the one-per-household requirement, c) consumers volunteered that they had another phone and a firm still enrolled them, or d) firms didn’t ask and consumers didn’t volunteer the information. Cases (a) and (c) can safely be called fraud, while (b) and (d) lie in a gray area, though likely still indicate lax eligibility verification on the part of firms.

Regardless of the mechanism or the assignment of fault, the FCC responded to evidence of these violations with its 2012 Reform Order. This order required a one-time verification of all enrolled subscribers, with firms required to submit full subscriber lists so that the FCC could identify and remove households with multiple phones. In such cases, households were notified by mail or telephone and were allowed to choose which enrollment to keep. In cases of household non-response, all subscriptions were terminated (FCC, 2012). Free Lifeline subscribers fell from a high of 14.35 million in the second quarter of 2012 to 9.28 million in the first quarter of 2013 (I will refer to these quarters as the pre- and post-reform periods, respectively). Given an effective verification and removal process, only eligible subscribers should remain in the post-reform period. The drops in subsidy claims due to the reform then identify how the portions of eligible consumers varied by state and by firm. As will be shown in Section 4, large heterogeneity across firms drives the state-level differences.

Previous Lifeline Literature

A literature exists on the Lifeline program, and more generally on telecom and universal service regulations. Two main threads focus on identifying either the substitution patterns of phone service¹¹ or explaining low take-up rates¹². The findings of modest universal service gains from price subsidies may be explained by the evidence that the price of phone service was not the primary deterrent to phone ownership during this period. The expansion to free wireless service removed the hassle costs of paying monthly bills (which require a stable

¹⁰Cases of ineligible households receiving benefits also occurred but were considered a less urgent priority than cases of duplicative or multiple enrollment (FCC, 2011).

¹¹Rodini et al. (2003) and Ward and Woroch (2010) estimate cross-price elasticities between landline and wireless service from household bill data, with the more recent paper explicitly using the availability of landline Lifeline subsidies as a natural experiment. Akerberg et al. (2003) use local market price data to estimate the effect of Lifeline and Linkup subsidy programs on telephone penetration rates.

¹²Burton et al. (2007) and Hauge et al. (2007, 2008) find that low take-up rates during the landline-only period of Lifeline were due to lack of information, unstable living situations among eligible households, and preference for wireless phones.

billing address) and brought advertising and outreach campaigns from new entrants. As discussed above, this led to huge increases in enrollment.

A few papers have addressed issues of compliance, competition, and entry in landline universal service programs, but these papers consider scenarios where the regulations are a cost imposed on carriers, rather than a profitable business opportunity.¹³

There are only two other papers (to my knowledge) studying the effects of the wireless Lifeline expansion. Ukhaneva (2013) finds that only a small number of households gain access to telephone service as a fraction of the total number of wireless Lifeline enrollments. This raises a question of where these phones are going, and how households are using them. These questions are studied in depth in Conkling (2015), but I briefly address them here before proceeding to the data.

Overlap with Paid Wireless Market

To address how Lifeline fits into the broader paid wireless market, it is important to understand what products are in the consumer's choice set. If free Lifeline phones are substitutes for paid wireless service, then the expansion of the program should crowd out some of the consumption of paid service. Alternatively, if the Lifeline expansion has little effect on paid consumption, it provides some support for modeling free Lifeline separately from the paid wireless market.

Conkling (2015) addresses these questions by looking at aggregate wireless subscriber counts and household-level data on cell phone service spending. In terms of total wireless subscriptions, the results suggest that the free Lifeline enrollments occurred in addition to the underlying growth of the paid wireless industry rather than in its place.

The household spending results imply a relatively small difference on the extensive margin of any reported spending, but a substantial decrease in the level of total spending. The extensive margin result indicates that few households put off spending entirely due to the availability of free Lifeline phones. Enrollees likely either subscribed to both free Lifeline and paid phone service, or were never in the market for paid wireless service at all. The economically larger effect seems to occur with overall spending. Those households who use a free Lifeline enrollment to supplement their paid service are likely able to save more than the \$9.25 value of the subsidy. This is because Lifeline service tends to offer much higher quality (in terms of minutes, texts, etc.) than equivalently priced non-Lifeline options.

Based on these results, free Lifeline enrollments are unlikely to significantly impact the subscription numbers for paid wireless carriers.¹⁴ The interaction between free Lifeline and

¹³Rosston and Wimmer (1998, 2000); Valletti et al. (2002)

¹⁴There are a number of potential stories to account for these results. Eligible households who highly value

the revenue earned per subscriber may be more of a concern. If households use their Lifeline minutes to decrease their consumption of paid service plans, the large facilities-based carriers like AT&T and Verizon are likely to be worse off. Low-cost prepaid carriers like TracFone and Virgin Mobile, who earn smaller revenues per subscriber and face higher customer turnover, may be more willing to accept these cannibalization effects for the benefits of reliable payment. These incentives could have dictated the response of the larger carriers, who increased their involvement in resale markets, but did not compete by expanding their own prepaid or low cost offerings.

Given this previous work and the lack of data on the contracts between facilities-based carriers and resellers, I focus on modeling competition within free Lifeline. From this point forward in the paper, I largely treat the free Lifeline market as separate from the broader wireless industry, making note where the interrelation may be important.

3 Enrollment Data and Market Definition

The primary enrollment data come from publicly available filings posted by the Universal Service Administrative Company (USAC), which handles the subsidy claims and disbursements for the Lifeline program. The filings document the subsidy dollars received by each firm in each state during each month. The quarter is the time period of choice for this paper, as firms in the data are occasionally delayed in processing their claims, causing the funds to be allocated to the last month of the quarter. The USAC also provides data on the per-subscriber subsidy size by state, firm, and month. There was a small amount of state-by-state variation in subsidy sizes in the earlier years of the program, but these were standardized as part of the 2012 Reform Order. Dividing the total subsidy claims by the subsidy-per-subscriber yields the total number of subscribers. Note that these subscriber claims are three month averages over the quarter. Together this shows the growth of subscribers across states and firms, as well as the effect of the 2012 Reform Order.

Firms are defined as free providers if they offer any wireless plan that has zero monthly cost. This information is gathered from legal documents (applications and compliance plans) and firms' advertisements and press releases. Some firms, such as Budget Prepay and Nexus, were landline Lifeline providers in addition to offering free wireless Lifeline. In such cases, the

wireless service likely already subscribe to paid service. For them, the additional phone and small allotment of minutes has value, but is not sufficient to replace their paid service. It may also provide a second line to keep in touch with a child or other family member. On the other hand, those who previously did not subscribe to wireless service may not have subscribed at all in the absence of free Lifeline. This could include those with low valuations of wireless service, as well as extremely needy populations like the homeless and others whose housing instability prevents their subscription to paid service.

firm is only defined as a free provider in states where it was designated for wireless service, and only once its application was accepted. In states where the firm provided both landline and free wireless Lifeline, only the combined subscriber numbers are observed. Although the number of subscribers with free wireless greatly exceeds the number with landline service for these firms, it is acknowledged that this will introduce some measurement error in the data. Similarly, a few of the smaller companies offer paid plans that require a monthly fee, and any subscribers to these plans would be mixed into the total firm subscriber numbers. These types of plans are not very common, and firms offering no free plan generally did not see anywhere near the type of growth of free providers during this period.¹⁵ In total, the set of free providers includes all such firms that entered at least one market by Q1 2012, when the Reform Order was announced.¹⁶

To estimate the number of eligible households in each market, I use the American Community Survey (ACS), which provides detailed information on income and program participation.¹⁷ The survey does not include participation data on every program used for Lifeline eligibility, but it does include Medicaid, SNAP, and SSI, the three most commonly used programs (FCC, 2012). Additionally, in most states consumers can qualify through income levels, and the cutoff is usually more lenient than for the additional programs not included in the survey.

The data from before and after the Lifeline reform offer a rare, quantifiable look at levels of enrollment and of non-compliance or cost-cutting in a privatized government program.

4 Evidence on Competition, Oversight, and Firm Heterogeneity

The two key sources of variation in the data are differences in where firms enter, and in how many subscribers they retain after the 2012 Reform Order. The correlation between the two can be seen in Figure 4.1. The twenty-three firms in the free Lifeline market are sorted in increasing order of the percentage of subscribers they retained after the reform, across all markets. The remaining columns record which of the firms had entered each state, or market. The states are in decreasing order of the number of total entrants, from left to right. The

¹⁵One exception to this is Cricket Wireless, which offered Lifeline plans with unlimited usage for set monthly fees, and had sizable enrollment. Given the narrow market definition in this paper, households enrolling with Cricket would be observed in the outside option.

¹⁶All free providers of significant size have been accounted for, though it is possible that some very small carriers have been omitted.

¹⁷The FCC uses these Census Bureau datasets for their own estimates of the number of eligible households (GAO, 2010).

Figure 4.1: Enrollee Retention and Entry, Q1 2013

Firm Name	AR	MD	LA	WV	MI	RI	TX	ME	WI	GA	IL	IN	KS	KY	MO	NV	OH	PA	SC	IA	WA	AZ	CO	FED	MS	NJ	UT	NM	CA	ID	OR	SD			
ABC Telecom				1																															
Conexions	1	1			1																														
Assist Wireless	1	1			1																														
Affordable Phone					1																														
Cintex Wireless	1	1			1																														
Absolute Home	1														1																				
Gulf Coast																																			
New Phone																																			
Everycall																																			
Global Connection	1	1	1	1	1		1								1																				
TAG Mobile	1	1	1	1	1		1							1	1																				
Telops	1																																		
US Connect	1	1																																	
Yourtel/Terracom	1	1	1	1	1		1								1																				
Telrite	1	1	1	1	1		1								1																				
PlatinumTel																																			
Nexus	1	1	1	1	1		1								1																				
Budget Prepay	1	1					1								1																				
Cincinnati Bell																																			
Virgin Mobile	1	1	1	1	1		1								1																				
True Wireless	1	1					1																												
Tracfone	1	1	1	1	1		1								1																				
I-Wireless	1	1	1	1	1		1								1																				

Note: States are listed on the horizontal axis, sorted from most entrants to fewest. Firms are sorted in increasing order of the percentage of subscribers retained, which is calculated as the number of subscribers claimed immediately following the implementation of the Lifeline Reform Order (Q1 2013) divided by the number claimed immediately prior (Q2 2012). The shaded 1's indicate that a firm entered a given market. The "FED" state market represents the eleven states (listed in Footnote 6) which deferred to the FCC for the provider approval process.

first key fact from this figure is the huge range of subscriber retention percentages; the firms near the top lost all or nearly all their subscribers, while those at the bottom retain seventy or eighty percent. Second, there is a clear trend: states with fewer entrants are less likely to have the firms with low retention rates (those at the top of the figure). Explaining this pattern requires thinking about the regulatory choices made by the states, and the firms' responses.

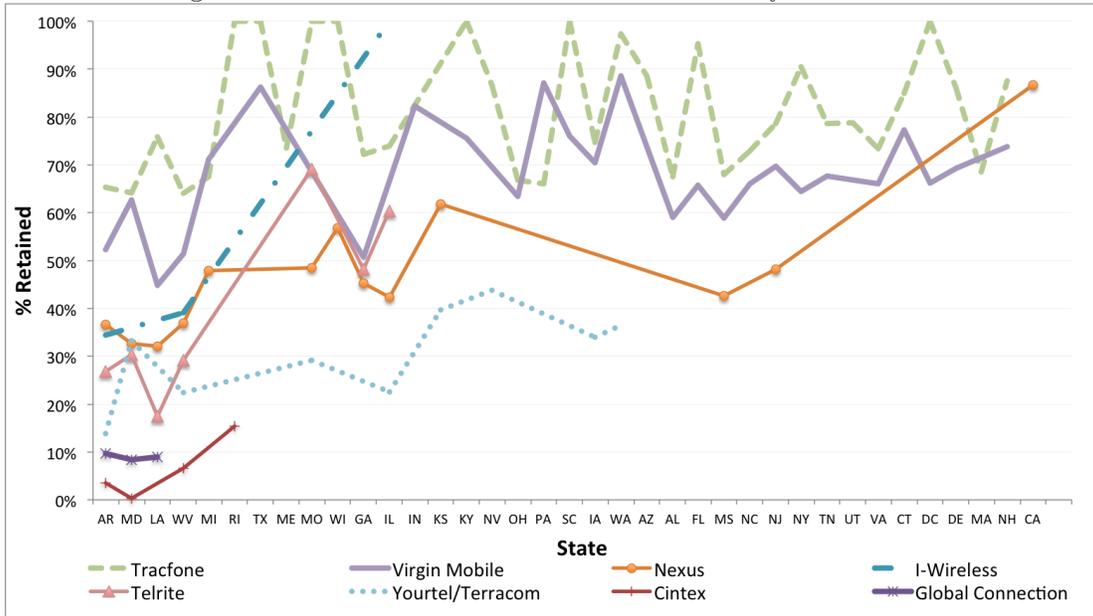
Regulators have numerous choices to make about how Lifeline will function in their state. These include requirements on the intensive margin (proof-of-eligibility rules, state databases, audits) and on the extensive margin (choosing which firms' applications to approve). The intensive margin choices will put real restrictions on the post-entry behavior of firms, while the extensive margin choices will not. However, both types of regulation will screen incoming firms. Stricter intensive margin regulations will impose compliance costs on firms, potentially lowering their expected profits. On the extensive margin, additional requirements will impose legal costs through the application process, or directly exclude firms at the regulator's discretion. Regardless of the mechanism, what is important is that regulators' choices vary the appeal or profitability of their market to potential entrants.

From the point of view of a potential entrant, consider the appeal of entering each market.¹⁸ Based on Figure 4.1, it seems clear that not all firms are equal. There must be some heterogeneity in firms, potentially in the appeal of their service or in their costs of provision and compliance. Taking its own characteristics into consideration, the firm evaluates its expected profits from entry into each market. Firms with high costs or low service quality can only profitably enter into states with low regulatory costs and limited oversight. Conversely, a firm with low costs and high quality will be profitable in all markets. A stylized theoretical model combining these ideas is presented in Appendix A.

The remainder of this section will try to identify the key aspects of enrollment and competition in the free Lifeline market. These results are informative in their own right, but focus mainly on market average effects. To take the data a step further, these findings motivate the specification of model with firm heterogeneity in order to quantify the trade-off between eligible enrollments and waste. The results will conclude with some comparative statics highlighting how the estimated heterogeneity would affect enrollment, waste, and firm entry under changes to the level oversight.

¹⁸The implicit assumption here is that the firm is a potential entrant in all markets. This assumption is supported by the evidence in the Lifeline market, but the general idea does not depend on it. As long as there is a similar distribution of potential entrants in each market, the same results will follow.

Figure 4.2: Enrollee Retention at the Firm-by-State Level



Note: States are listed on the horizontal axis, sorted from most entrants to fewest. Each line represents the connected series of state-level subscriber retention percentages for a given firm. The most recent firm-state entries are excluded from the figure.

What factors affect subscriber retention?

A number of factors could affect a firm’s retention of their enrolled subscribers after the reform. A firm’s level of effort in verifying eligibility, keeping records, and maintaining contact with subscribers will naturally be very important. This effort will entail some costs, so firms may have incentives to shirk on these duties if oversight is loose. Conversely, if firms expect a reform, or fear repercussions for rule violations, they may exert higher effort regardless of market differences in regulations. These potential repercussions may vary depending on the size and scope of the firm’s non-Lifeline business operations. As mentioned in Footnote 1, the continuation value of remaining a provider may be the biggest incentive to comply with regulations.

To examine how firms’ behavior or compliance effort responds to the level of oversight, Figure 4.2 charts firm-level retention rates across states. The states on the horizontal axis are again sorted from most entrants to fewest. If firm compliance effort is very responsive to oversight, all firms should retain low percentages in states with looser oversight, and retention rates should rise as they exert more effort in the stricter states. Instead, the trend in firm retention rates is relatively flat (though with significant noise).

The within-firm variation in compliance is small relative to the across-firm variation. Firms seem to operate in a fairly consistent manner across states, potentially due to firm-

level standards of record keeping, employee training, and compliance effort.¹⁹ This will motivate the use of a compliance parameter which is fixed at the firm-level in the model below, though with a functional form that allows for some responsiveness to the oversight level.

What factors affect subscriber enrollment?

Table 1 breaks down how timing and competition influence firm-level subscriber enrollment. The dependent variable is firm enrollment divided by the eligible population of the state. For the first three columns this is enrollment immediately prior to the reform, and immediately after the reform for the last column. These enrollments-per-population are essentially market shares, though given duplicate and ineligible enrollments the interpretation isn't exact for the pre-reform period. Specification (1) shows that later entrants have fewer total subscribers, which is consistent with firms building up a subscriber base over time. To test whether later entrants are in a bad competitive position due to the market already being saturated, specification (2) includes entry order. I find no effects of entry order. This is consistent with switching costs not being important in the Lifeline market.²⁰ It also indicates that preemptive entry strategies are unlikely to hurt later entrants or keep them out. If additional entrants were fighting over the same enrollees, total enrollments should fall with the number of competitors. Specification (3) shows that this is not the case in the pre-reform period. This suggests each additional entrant expands the total number of enrollments. There are two potential explanations, one good and one bad, for program outcomes. New entrants could reach out and enroll previously unenrolled segments of the eligible population. Alternatively, they could be enrolling duplicate and ineligible subscribers, in which case the saturation of the market would not matter. To get at this question, specification (4) looks at market share numbers immediately following the reform. For this post-reform specification, firms have lower market shares in states with more competitors. This is what one would expect in a competitive market.

Comparing (3) and (4) suggests that firms were able to avoid competitive pressures in the pre-reform period by enrolling duplicate or ineligible subscribers. There may be unobserved

¹⁹One concern is that late entering firms could potentially violate the rules by enrolling duplicate households, but then have their phone chosen to be kept at the time of the reform. This would attribute the firm's higher retention to compliance, when it could actually be driven by high quality service. To assess this potential issue, I observe the order of entry into each state market. Similar to the national-level data shown in Figure 2.2, the earliest entrants are almost always those with high retention and large enrollments (TracFone, Virgin Mobile). The smaller firms with low retention tend to be the last entrants. The related issue of potential switching costs or inertia is addressed in the next subsection.

²⁰This is in contrast to the paid wireless industry, where switching costs (whether monetary or hassle based) can be very large (Farrell and Klemperer, 2007; Shi et al., 2006; Franchetti, 2014).

Table 1: Determinants of Subscriber Enrollment at Firm-by-State Level

	Pre-Reform			Post-Reform
	(1)	(2)	(3)	(4)
Entry Date	-0.0179*** (0.0020)	-0.0182*** (0.0028)	-0.0170*** (0.0022)	-0.0079*** (0.0016)
Entry Order		0.0005 (0.0017)		
# Competitors			0.0003 (0.0013)	-0.0041*** (0.0009)
Firm F.E.	Y	Y	Y	Y
State F.E.	Y	Y		
Observations	164	164	164	164
Adjusted R-squared	0.681	0.678	0.520	0.627

*** p<0.01, ** p<0.05, * p<0.1

Note: Robust standard errors in parentheses, with observations clustered by state. Each observation is the enrollment for a firm in a state market divided by the number of households in the state. Columns (1)-(3) use pre-reform enrollments, column (4) uses post-reform enrollments. Estimates come from OLS regression.

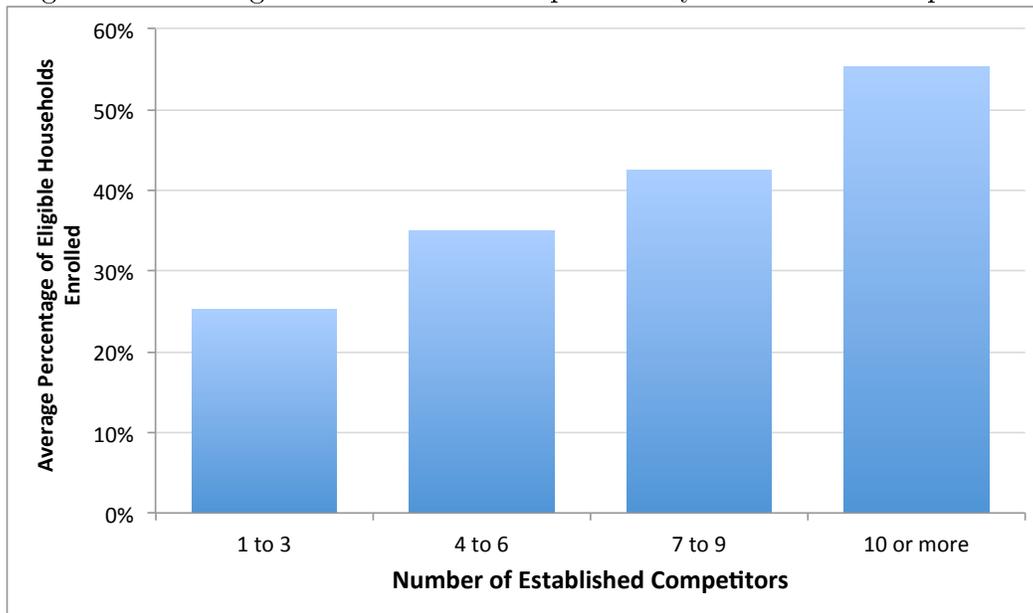
state demand characteristics that are correlated with the number of entrants, which would bias these coefficients upwards. However, this would not explain the differential effect of additional competitors before and after the reform.

While the previous results suggest stronger competitive effects in the post-reform period, the data in Figure 4.3 show that states with more entrants did have higher eligible enrollment, or take-up rates. For example, states with one to three competitors averaged 25% take-up rates, while those with between four and six competitors had 35% take-up. The largest marginal increase in take-up seems to come from the first three competitors, though the rates continue to increase as the number of entrants exceeds ten. The demand model in Section 5 will help discern whether this pattern is driven by competition, firm heterogeneity, or market characteristics.

Note on Plan Quality Competition

Firms in the free Lifeline market compete on numerous margins, but the most visible is plan quality. The dramatic growth in enrollments occurred alongside significant improvements in the number of minutes, texts, and additional features offered by providers. By 2012, Lifeline plans were much more generous than equivalently priced unsubsidized plans. The process of improvements can be described through a timeline of events.

Figure 4.3: Average State-Level Take-Up Rates by Number of Competitors



Note: State-level take-up rates based on Q1 2013 enrollment and population data, excluding any firms active for fewer than four quarters. Averages within bins give equal weight to each state.

In 2008, TracFone obtained approval from the FCC with a plan offering 68 minutes per month. Nexus followed with a similar plan. In early 2010, Virgin Mobile entered into a number of markets offering 200 minutes. Smaller carriers continued to enter in this period, typically still at 68 minutes of service. In August 2010, TracFone increased its own offering to 250 minutes. Virgin Mobile responded a month later by increasing to 250 minutes. During 2011, as more states were approving their first carriers, additional firms entered offering anywhere from 68 to 250 minutes. Some earlier entrants like Nexus increased their plan offerings to 250 minutes as well. By 2012, the Reform Order required all firms to submit compliance plans to the FCC to continue operating as Lifeline providers. Offering a minimum of 250 minutes essentially became an unofficial requirement for approval. By the end of 2012, almost all firms are offering the uniform 250 minutes, and competition begins to expand along the number of text messages included.

Competition for subscribers was an important force pushing these quality improvements, but there was also some regulatory pressure. This would occur at the time of entry, where it is possible that plan quality may affect the probability, cost, or speed of approval.

Quality competition is only briefly discussed here, although it is an important part of the justification for privatization and the entry of additional firms. This paper focuses on the effects of oversight and entry, and utilizes only the immediate pre-reform and post-reform

periods when plans were mostly homogenous. Plan quality changes in large, discrete jumps and is almost always set at the national level, both of which complicate modeling quality choice directly. For this reason, I have only addressed this topic in a qualitative way, and leave a fuller model of quality competition for future research.

Summary and Model Motivation

The evidence in this section separately highlights firm heterogeneity in compliance and entry, as well as the effects of enforcement on competition. To quantify the trade-off between compliance and competition, the next step is to build a cohesive model of consumer demand and firm behavior. The consequences of a regulatory change that induces firm entry may depend heavily on who those entrants are. Firms on the margin of being in or out of a market may be substantially different from the average firm in the population.

5 Model and Estimates

Based on the evidence above, a model of the free Lifeline market should incorporate a few key characteristics. First, firms are heterogeneous, differing in their ability to enroll eligible subscribers and in their ability or willingness to screen duplicate and ineligible subscribers. Second, state markets differ in their appeal to potential entrants, through demand characteristics and regulatory environments. Third, the demand faced by a firm should depend on its competitors in the market but also allow for duplicate enrollments.

The behavior of the regulator will be taken as exogenous. The choices made by state commissions likely depend on demographic and political characteristics, but modeling these explicitly is beyond the scope of this paper.²¹ Instead, I focus on modeling firm behavior in response to regulators' choices and consumers' preferences.

The model includes equations for firms' market shares, enrollments, and profits. The profits are based on enrollments, which are in turn based on market shares. Firm- and market-specific quality, compliance, and oversight parameters are estimated from the data on post-reform market shares, and the enrollment drops due to the reform. The demand model is most similar to Berry and Waldfogel (1999), which uses market share data to estimate the parameters of competition in the radio broadcast industry. The estimates from these regressions are presented first. The simple profit model is then used to illustrate the enrollment, entry, and waste implications of the estimates.

²¹See Garvie and Keeler (1994); Poterba (1994); Besley and Case (1995, 2003); Reed (2006) for examples from the large literature on the determinants of regulations and policy.

Eligible Market Share

The demand for free Lifeline service is modeled at the household level, as per program rules. For now, consider the case in which program rules are completely followed, so each eligible household can only enroll in a single Lifeline subscription, and no ineligible households are enrolled. In practice this is used to model the post-reform choices of consumers. Choosing which plan to enroll in is then a standard discrete choice problem. I first describe the utility functions that generate the logit and nested logit choice models, and then present results for each.

For the logit model, consumer utility is defined following Berry (1994). The utility for consumer i of choosing Lifeline service from firm j in state s is given by

$$u_{ijs} = \delta_j + \mathbf{X}_s \beta + \sum_{q=1}^3 \alpha_q 1_{qjs} + \xi_{js} + \epsilon_{ijs}$$

- δ_j are firm-specific mean utility parameters.
- \mathbf{X}_s are state-level demand shifters, including population density²² and SNAP participation rates.
- α_q are coefficients on indicators 1_{qjs} for whether the observation represents firm j 's first, second, or third quarter (q) active in market s . This accommodates the initial growth in subscribers after entry as observed in the data.
- ξ_{js} is an unobserved firm-market specific demand shock (error term).
- ϵ_{ijs} is an i.i.d. type 1 extreme value error term.

In contrast to most product demand models, there is no price term here, since the market by definition only includes providers offering free monthly service. Since the characteristics \mathbf{X}_s are shared at the state level, they will shift total enrollment relative to the outside share, which is defined as providing a mean utility of zero. Given the structure of the ϵ_{ijs} error terms, firm market shares D_{js} are

$$D_{js} = \frac{e^{d_{js}}}{1 + \sum_{k \in J_s} e^{d_{ks}}}$$

²²I truncate the population density for the District of Columbia, which is ten times larger than the next highest state.

where J_s is the set of firms active in state s , and the 1 in the denominator represents the outside good. The firm's mean utility in the market has been rewritten as

$$d_{js} = \delta_j + \mathbf{X}_s\beta + \sum_{q=1}^3 \alpha_q 1_{qjs} + \xi_{js}$$

Firm heterogeneity is represented by the parameters δ_j , which I will refer to as firm quality. This parameter will pick up differences in the handsets and service plans offered, the amount of advertising, the effectiveness of outreach and recruitment efforts, and the quality of customer service. Firms are assumed to offer the same quality in all markets, and in both the pre- and post-reform periods. As discussed in Section 4, this is almost always true for observable plan characteristics like included minutes and text messages. Any state-level differences in unobservable factors like marketing intensity will be attributed to ξ_{js} .

One key issue to address here is how to define the market size and the outside share. In the post-reform periods, the market size can reasonably be assumed to be the number of eligible households E_s . The outside share is then E_s minus the number of households enrolled with any free Lifeline provider. This outside share includes those who do not enroll in any Lifeline plan, as well as those enrolling in a landline or paid wireless Lifeline plan.²³

The logit model imposes a strong assumption about substitution between goods and the outside option. When new products are added to the choice set, it will largely expand the total number of subscribers, especially when the overall share of the outside good is large. To test whether this model is accurate, I also specify a nested logit model, in which all free Lifeline options are part of the same nest. For the nested logit specification only the error structure is different, with consumer utility defined as

$$u_{ijs} = \delta_j + \mathbf{X}_s\beta + \sum_{q=1}^3 \alpha_q 1_{qjs} + \xi_{js} + v_i(\lambda) + (1 - \lambda)\epsilon_{ijs}$$

- $\lambda \in [0, 1)$ parameterizes the extent to which consumers' choices are driven by their idiosyncratic preferences for each good, ϵ_{ijs} , versus a shared taste for all Lifeline brands $v_i(\lambda)$.
- $v_i(\lambda)$ is consumer i 's utility from choosing the inside good (any free Lifeline brand)

²³The mean utility of the outside option is assumed to equal zero in all markets. This is implicitly assuming that the quality of landline and paid wireless Lifeline options are equal in all states. This should not be an issue for paid wireless Lifeline, as these are typically offered with national plans and pricing. Landlines may be more of a concern, as these can differ in price across states. Additionally, a few states (including California) have automatic enrollment procedures in place for landline Lifeline service. If such policies lower market shares for free wireless providers, it would show up through lower values of ξ_{js} .

which does not vary across brands. It has a unique distribution described in Cardell (1997), which collapses to zero if $\lambda = 0$.

This error structure $v_i(\lambda) + (1 - \lambda)\epsilon_{ijs}$ leads to market shares D_{js} of the form

$$D_{js} = \frac{e^{d_{js}/(1-\lambda)}}{\sum_{k \in J_s} e^{d_{ks}/(1-\lambda)}} \frac{(\sum_{k \in J_s} e^{d_{ks}/(1-\lambda)})^{1-\lambda}}{1 + (\sum_{k \in J_s} e^{d_{ks}/(1-\lambda)})^{1-\lambda}}$$

As $\lambda \Rightarrow 1$, consumers have no idiosyncratic tastes for different goods, and a new entrant will gain subscribers entirely by “stealing” them from incumbent firms, with no change in the total number of Lifeline subscribers. At the other extreme, as $\lambda \Rightarrow 0$, it implies that the uncorrelated errors (tastes) in the logit model are reasonable, and new products will significantly expand total enrollment. This is the same exercise conducted by Berry and Waldfogel (1999), but I am additionally able to observe the same firms operating across multiple markets, and hence account for firm-specific unobservable utility δ_j . This will help establish what roles competition and heterogeneity play in the pattern of increasing enrollments seen in Figure 4.3.²⁴ To highlight how this feature of the data changes the interpretation of competition, I also estimate a third specification with the nested logit model that assumes firms are homogeneous, with $\delta_j = \delta \forall j$.

If enforcement was perfect and firms could only enroll eligible households to a single subscription, this standard discrete choice model would fit the subscriber and entry data well. When enrollment of duplicate and ineligible subscribers is common and varying across firms, as it is in the pre-reform period, this framework may be an inaccurate representation of consumers’ choices and firms’ enrollments. Since entry occurs during the pre-reform period, a model of enrollment with the ability to enroll ineligible subscribers is needed.

Pre-Reform Enrollment

The ability of firms to enroll duplicate subscribers is a way of expanding the market and easing competitive pressures. The relative quality of products in the consumer’s choice set is less important if the consumer can simply take one of each, at a price of zero. This type of behavior is necessary to rationalize the observed entry patterns in which firms with low-quality offerings enter what appear to be fully saturated markets. For the model to fit both pre- and post-reform demand, assumptions must be made on how the forces of competition

²⁴The assumption that firm quality is fixed across markets is important here. If unobservable aspects of quality like advertising increase in response to the entry of additional competitors, it could contribute to expanded total enrollments and a lower estimate of $\hat{\lambda}$. This would not change the fact that entry expands enrollment, but should be considered when thinking about *why* entry expands enrollments.

interact with the ability to enroll these additional subscribers.

I define the number of subscribers enrolled by firm j in state s as:

$$Q_{js} = (1 + \gamma_j \tilde{r}_s) D_{js} E_s \omega_{js}$$

- D_{js} is the eligible market share of firm j (as defined above)
- E_s is the population of eligible households in the state
- γ_j is a firm-specific parameter for the willingness to enroll (or inability to screen) ineligible households. A small value of γ_j represents strict compliance with program rules.
- \tilde{r}_s is a parameter for the laxness of oversight (how many ineligible/duplicate subscribers a firm can enroll). Letting all regulations become fully strict after the reform order, it takes the form

$$\tilde{r}_s = \begin{cases} r_s & \text{in pre-reform period} \\ 0 & \text{in post-reform period} \end{cases}$$

- ω_{js} is an unobserved error term in the size of a firm's potential market, which is assumed to take the form:

$$\omega_{js} = \begin{cases} e^{\varepsilon_{js}} & \text{pre-reform} \\ 1 & \text{post-reform} \end{cases}$$

so that

$$\ln(\omega_{js}) = \begin{cases} \varepsilon_{js} & \text{pre-reform} \\ 0 & \text{post-reform} \end{cases}$$

where ε_{js} is mean zero.

This error specification allows for estimation based on the post-reform drop in enrollments. This is done by comparing the data on the portion of subscribers retained after the reform to the model predictions:

$$\frac{Q_{js}^{\text{post-reform data}}}{Q_{js}^{\text{pre-reform data}}} = \frac{D_{js} E_s}{(1 + \gamma_j r_s) D_{js} E_s \omega_{js}}$$

which, after simplifying, can be rewritten as

$$\varepsilon_{js} = \ln \left(\frac{1}{1 + \gamma_j r_s} \right) - \ln \left(\frac{Q_{js}^{\text{post-reform data}}}{Q_{js}^{\text{pre-reform data}}} \right)$$

This term does not depend on the market shares D_{js} . Note that there is assumed to be an unobserved error term only in the pre-reform market sizes. Also, based on the evidence presented in Section 4, the model for total enrollment uses the strong assumption that firm compliance behavior is essentially fixed across markets. More specifically, if $r_s E_s$ is the number of ineligible or duplicate households firms can potentially enroll, then firm j enrolls the same fraction γ_j in every market.

Identification

Firm-specific mean utility δ_j is identified by each firm's post-reform market shares across multiple markets. The quarters-active indicators α_q are identified from differences in enrollments for newly entered versus developed markets. β is identified by total enrollment relative to the outside share across states with differing observable characteristics. In the nested logit model, the correlation of idiosyncratic tastes λ is identified by the total size of the inside share across states with different sets of entrants, after controlling for firm-quality and state characteristics.

The drop in enrollments from the pre-reform period to the post-reform period identifies firm compliance, γ_j , and state regulatory laxness, r_s . The separate identification of γ_j depends on the differences in enrollment drops between firms within each state. Identification of r_s depends on the differences in enrollment drops within firms across states.

Note that because there are no market characteristics or fixed effects in the enrollment equation, any differences across states in pre-reform enrollment figures not explained by competition or firm quality will be attributed to ineligible enrollments. I use the term oversight to describe r_s , but the parameter will also absorb the effects of other state characteristics that influence the number of ineligible enrollments.

Utility, Compliance, and Oversight Estimates

The functional forms of the logit choice model allow estimation by OLS regression. Estimation of the nested logit models requires an instrument for a firm's own share of the total inside share. Typical instruments consist of some function of the characteristics or number of competing products in the market. I use the number of competing free Lifeline providers. The demand estimates are shown in Table 2. In the nested logit specification with firm heterogeneity, $\hat{\lambda}$ is essentially zero. Thus the nested logit model collapses to the logit, explaining why the remaining parameters are nearly identical across the two specifications. This is important for program outcomes, as it indicates that allowing additional providers to enter does expand total enrollment. The third specification shows how the interpreta-

tion of competition differs if firms’ heterogeneity is ignored. Here, $\hat{\lambda} = 0.57$ implies a much stronger “business stealing” effect from additional entrants, meaning that new entrants cause sizable reductions in incumbents’ market shares. This effect is identified by the diminishing increases in total enrollment for markets with more and more competitors. However, the nested logit specification with firm heterogeneity demonstrates that this effect is not due to business stealing, but rather to the diminishing quality of marginal entrants.

Since these products all have a price of zero, the firm quality parameters are negative to rationalize the number of potential subscribers choosing the outside option. The nine firms which retain below 20% of subscribers in all markets they enter have been grouped²⁵ (δ_{low}), as have the four firms which have higher retention rates but enter only a few markets²⁶ (δ_{medium}). The relationship between quality and compliance will be shown below. Population density and the take-up rate for SNAP benefits are both positively correlated with the total free Lifeline enrollment at the state level. The indicators for quarters active (α_1 , α_2 , and α_3) take on negative values, which converge towards zero as the number of quarters active in the market increases.

There is some reason for concern about selection into the sample, since market shares and enrollment drops are only observed for firm-market combinations where entry occurred in the data. In cases with few observations for a given state or firm, the model could attribute large market shares and pre-reform enrollments to $\hat{\delta}_j$, $\hat{\gamma}_j$, and \hat{r}_s when they may be driven by high draws of ξ_{js} or ε_{js} . In unreported results, I estimate an additional logit specification which controls for selection on unobservables (based on Heckman (1979) generally, and Iaria (2014) in the context of firm entry) by using the estimates of oversight \hat{r}_s in the selection equation. The parameter estimates are robust to this test, suggesting that the firm quality estimates are not driven by selection on unobservable shocks at the firm-market level.

The parameters for firm compliance, γ_j , and state oversight, r_s , are estimated by non-linear least squares, where the dependent variable is the portion of subscribers retained at the firm-by-state level. The full table of estimates and standard errors are in Appendix B and are presented visually in Figures 5.1 and 5.2. Figure 5.1 plots the relationship between firm quality $\hat{\delta}_j$ and compliance $\hat{\gamma}_j$, with each point representing a firm. There is a negative correlation between γ and δ overall, but significant variation at the firm level. Firms that enroll many eligible subscribers also retain a higher portion of their subscribers after the reform. There is a significant gap between the 9 Low Group firms and the others, in both compliance and quality. Even excluding the Low Group, the variation across firms is sizable.

²⁵For the few firm-market combinations with a zero percent retention rate, I assume the firm retained 1% of subscribers, since estimation requires taking the log of market share.

²⁶Telops, US Connect, Platinumtel, and Cincinnati Bell

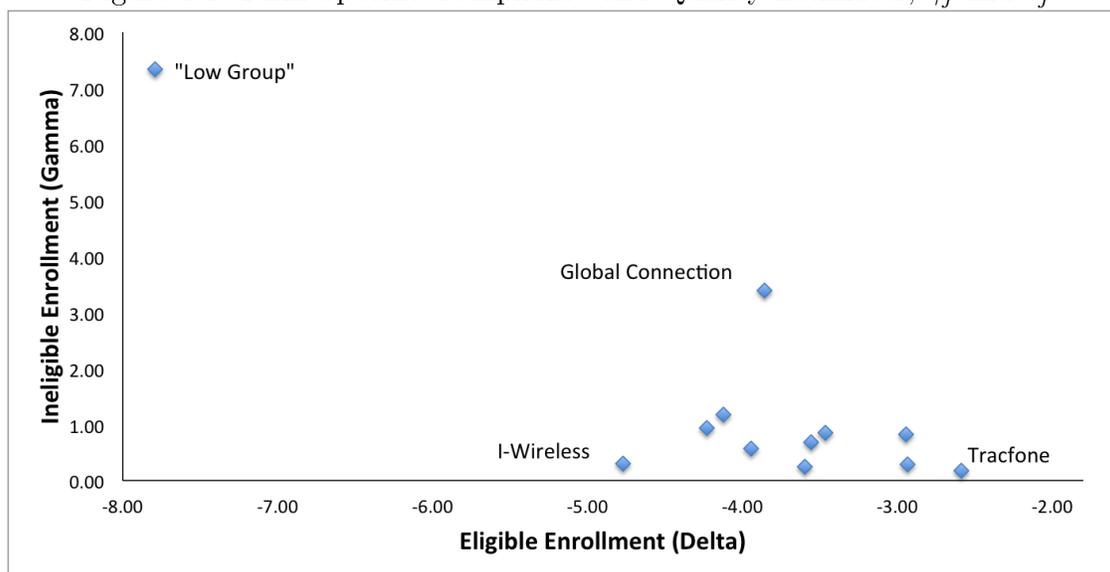
Table 2: Utility Parameter Estimates

	Logit	Nested Logit	Nested Logit, Homogeneous Firms
Correlation of firm logit unobservables (λ)	-	0.0009 (0.248)	0.5733*** (0.096)
Firm Qualities (δ_j):			
Homogeneous Quality (δ)	-	-	-2.570*** (0.500)
Budget Prepay	-3.597*** (0.694)	-3.595*** (0.828)	-
Global Connection	-3.858*** (0.751)	-3.855*** (1.020)	-
I-Wireless	-4.768*** (0.637)	-4.765*** (1.031)	-
Nexus	-3.558*** (0.646)	-3.557*** (0.764)	-
Tag Mobile	-3.467*** (0.727)	-3.465*** (0.922)	-
Telrite	-2.943*** (0.728)	-2.942*** (0.830)	-
TracFone	-2.585*** (0.606)	-2.585*** (0.607)	-
True Wireless	-4.228*** (0.952)	-4.226*** (1.128)	-
Virgin Mobile	-2.932*** (0.605)	-2.931*** (0.622)	-
Yourtel/Terracom	-4.124*** (0.635)	-4.122*** (0.871)	-
Low Group	-7.788*** (0.679)	-7.784*** (1.485)	-
Medium Group	-3.946*** (0.797)	-3.943*** (1.027)	-
State Characteristics (β_s):			
Population Density	0.109*** (0.0418)	0.109*** (0.0401)	0.127*** (0.0346)
SNAP Takeup Rate	3.403 (2.832)	3.404 (2.739)	3.711 (2.357)
Indicators for Quarters Active:			
α_1	-2.812*** (0.433)	-2.811*** (0.568)	-1.520*** (0.367)
α_2	-1.049** (0.458)	-1.049** (0.441)	-0.745** (0.348)
α_3	-0.612 (0.485)	-0.612 (0.466)	-0.598 (0.381)
Observations	216	216	216

*** p<0.01, ** p<0.05, * p<0.1

Note: Standard errors in parentheses. Dependent variable is the difference between log market shares for firm j in state s , and the log of the outside share. For nested logit specifications, the number of competitors is used as the instrument for own share of the inside good.

Figure 5.1: Firm-Specific Compliance and Quality Estimates, $\hat{\gamma}_j$ and $\hat{\delta}_j$



Note: Firm-specific compliance and quality parameter estimates, identified by post-reform market shares and enrollment drops due to the Lifeline Reform Order. The number of eligible subscribers a firm enrolls is increasing along the horizontal axis, and the number of ineligible subscribers is increasing along the vertical axis. Model is detailed in Section 5. Firms with very few observations are grouped.

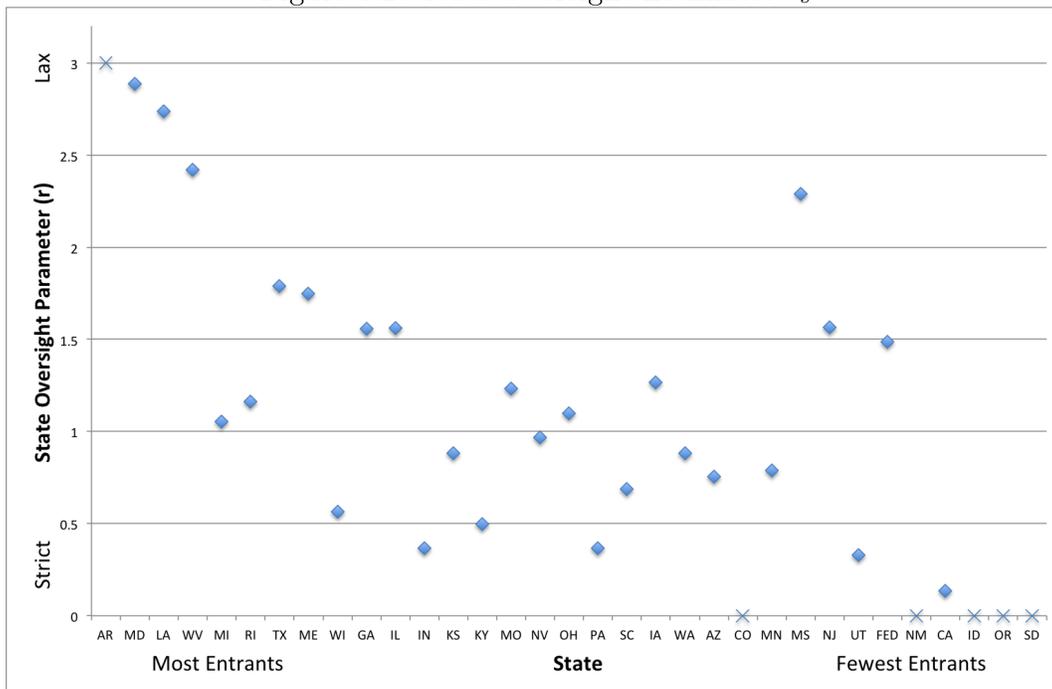
For example, the estimates predict that Telrite enrolls a roughly equal number of eligible subscribers as Virgin Mobile, but more than double the number of ineligible subscribers, all else equal.

Figure 5.2 plots the estimated \hat{r}_s for each state, sorted again from most entrants to fewest. States with fewer entrants have stricter oversight (lower \hat{r}_s), but the relationship is not completely monotonic. These estimates are based only on the intensive margin of oversight. The high estimates of \hat{r}_s in markets like New Jersey, Mississippi, and the Federal Group (described in Footnote 6) would be consistent with a policy of restricting entry on the extensive margin, but with less policing of firms' post-entry behavior.

Notably, market size E_s has little correlation with \hat{r}_s or the number of entrants. Rhode Island (117,000 eligible households) has the same number of providers as Texas (2.71 million eligible households). This is not unheard of in the literature on entry decisions in competitive markets, but many of the usual explanations do not apply here.²⁷ Price competition is not a factor in this market, as the per-subscriber subsidy is fixed by program rules. Though firms compete on plan quality, these terms are set nationally so the marginal cost of serving a subscriber should be largely fixed for a given firm. The estimate of strong market-expanding

²⁷See Bresnahan and Reiss (1991); Berry (1992); Mazzeo (2002); Ciliberto and Tamer (2009).

Figure 5.2: State Oversight Estimates \hat{r}_s



Note: State-specific oversight parameter estimates. Identified by within-firm variation in post-reform retention rates across states. Model is detailed in Section 5. Higher values indicate more ineligible enrollments. Values that are assigned, rather than estimated, are marked with an X.

effects of entry ($\hat{\lambda} \approx 0$) indicates that even lower-quality additional entrants can carve out a reasonable share of the market. The data show that firms have much higher total revenues in large markets. To explain the lack of correlation, there must either be cost differences across states or substantial extensive margin entry restrictions imposed by regulators in large markets.

Given that free Lifeline providers are reselling wireless services from the same national facilities-based carriers, I argue that the cost differences (and hence entry differences) across markets are driven by compliance costs. The estimated distribution of oversight \hat{r}_s is consistent with the qualitative evidence in the state-level legal filings: the states estimated to be strict do place additional requirements on carriers in the form of procedures like proof-of-eligibility rules, audits, and enrollment databases.²⁸

The results so far have shown that firm entry increases both eligible and ineligible levels of enrollment, with the tradeoff depending on the quality and compliance characteristics of the entering firm. The final step here is to specify a simple profit function to illustrate the

²⁸Seminar participants from the telecommunications industry have also noted that larger states tend to have larger public utility commission staffs, which may allow for stricter oversight.

implications of oversight on entry, competition, enrollment, and waste.

Profit Function and Comparative Statics

Given the model of enrollments specified above, firm costs are the final piece to be modeled. Let the per-month profits of firm j in state s be defined as:

$$\pi_{js} = (p - c_{js})Q_{js} - F_{js}$$

- p is the per-subscriber subsidy.
- c_{js} is a per-subscriber marginal cost, assumed to be a function of firm characteristics and state oversight r_s .
- Q_{js} is the number of pre-reform subscribers, which is a function of the demand and enrollment estimates above.
- F_{js} represents per-period fixed costs, also assumed to be a function of r_s .

The basic idea is that firms enter a market if they can earn positive profits. Stricter oversight (low r_s) not only decreases the number of ineligible subscribers a firm can enroll, but also increases the costs of operation through added requirements of record-keeping, auditing, compliance filings, employee training, etc. The terms c_{js} and F_{js} thus represent the combination of regulatory and non-regulatory costs. Oversight can also have indirect effects on the number of eligible subscribers a firm enrolls by changing the number of participating firms.

For simplicity, this model assumes that firms make separate entry decisions for each state. Having a presence in one state does not change costs or revenues in any other state.

Firm Response to Changing Oversight

The purpose of laying out the model above is to demonstrate how market structures will vary with the level oversight. If the regulator in a given state loosens oversight (increases r_s), the impact on profits can be described by

$$\frac{\partial \pi_{js}}{\partial r_s} = \underbrace{(p - c_{js}) \frac{\partial Q_{js}}{\partial r_s}}_{\text{Change in Revenue}} - \underbrace{\left(Q_{js} \frac{\partial c_{js}}{\partial r_s} + \frac{\partial F_{js}}{\partial r_s} \right)}_{\text{Change in Costs}}$$

where looser oversight is assumed to weakly lower costs ($\frac{\partial c_{js}}{\partial r_s} \leq 0$ and $\frac{\partial F_{js}}{\partial r_s} \leq 0$). The effect on enrollments is a bit more involved. Ignoring the error terms used for estimation, recall that

$$Q_{js} = (1 + \gamma_j r_s) D_{js} E_s$$

which yields

$$\frac{\partial Q_{js}}{\partial r_s} = \underbrace{(1 + \gamma_j r_s) E_s \frac{\partial D_{js}}{\partial r_s}}_{\text{Change in enrollments due to competitor entry/exit}} + \underbrace{\gamma_j E_s D_{js}}_{\text{Change in ineligible enrollments}}$$

As oversight becomes looser, firms ineligible enrollments increase, raising revenue. Combined with falling costs, there is likely to be additional entry into the market. This in turn will lower eligible market shares for all firms due to competitive effects specified by the nested logit demand model ($\frac{\partial D_{js}}{\partial r_s} < 0$). Given the limited business stealing effects implied by the nested logit estimates ($\hat{\lambda} \approx 0$), these negative competitive effects will be far outweighed by the increased enrollment of ineligible households.²⁹ The nested logit results also imply that although each individual firm enrolls fewer eligible subscribers as entry increases, the overall level of eligible enrollment increases.

With very loose oversight, nearly all firms can find it profitable to enter a given market. This is the example seen in the data for states like Arkansas, Louisiana, Maryland, and West Virginia. If stricter oversight is imposed (r_s lowered), the largest drops in ineligible enrollments will occur for firms with low compliance (high γ_j). Given the inverse relationship between compliance and quality shown in Figure 5.1, these firms tend to enroll the fewest eligible subscribers as well. If their profits fall below zero, they exit, removing large numbers of ineligible subscribers, but also some eligible subscribers. This is the downside of tighter oversight: additional entrants expand the level of eligible enrollment, and stricter rules lead some providers to exit. However, because the first firms to exit are those with the lowest quality (and compliance), the “marginal cost” to eligible enrollment goals will be low.

As oversight tightens, higher quality firms do increase their eligible market share as their competitors exit, though they also pay higher compliance costs. This fits with the legal arguments made by these firms, who have advocated for stricter oversight but with more of the cost burden falling on the regulator.³⁰ How these compliance costs will be shared between regulators and providers remains a point of debate in the ongoing (as of 2015) implementation of the National Lifeline Accountability Database.³¹ The degree to which firms should bear

²⁹In unreported entry and enrollment simulations at the estimated parameter values, looser oversight leads to increased total enrollments for all firms.

³⁰See “Comments of Sprint Nextel Corporation” and “Comments of TracFone Wireless Inc.,” FCC Docket No. 11-42, April 21st, 2011.

³¹See “Second Further Notice of Proposed Rulemaking,” FCC Docket No. 11-42, June 22nd, 2015.

the cost of instituting the new database depends on the program enrollment goals of the regulator and the substitutability of rival carriers. The results presented in this paper suggest that entry expands total eligible enrollment, as long as the marginal carriers have at least moderate quality level. If eligibility rules can be effectively enforced, the regulator may find it beneficial to lower compliance costs for firms, encouraging additional entry and enrollments.

6 Conclusion

This paper is the first empirical study of competition and firm behavior in the Lifeline program. The program outcomes depend on a number of interacting factors. The data provide clear evidence of heterogeneous firms, differing in quality and compliance. Oversight affects where each type of firm chooses to enter. Additional entry expands total enrollments, but a sizeable portion of these enrollees are ineligible. After entry, compliance behavior varies much more across firms than within firms. Additionally, looser oversight mitigates competitive pressures. All of these findings are identifiable because of a unique feature of the Lifeline data: I observe the same firm's behavior across multiple state markets, each varying in oversight intensity. As such, these results do not rely on strong modeling assumptions.

Based on these findings, I impose additional structure to quantify the level of heterogeneity across firms, and the role of entry in expanding eligible enrollment. The results suggest that entry substantially increases eligible enrollment, but the size of the effect depends on firm quality. Given the inverse relationship between estimated firm quality and compliance, the initial gains from a minimum oversight level will be greatest: firms with few eligible and many ineligible subscribers will be removed. Additional tightening of oversight would lead to higher retention, but at a cost of exit by medium-quality firms and the eligible enrollments they generate. Given a welfare function which places relative value on eligible and ineligible enrollments, one could calculate an optimal level of oversight to balance this trade-off.

The overarching result is that firm heterogeneity matters. From a policy-maker's point of view, there should be particular attention placed on the lowest quality providers, who represent the low-hanging fruit for possible reductions in waste. But this is not a group that will be removed from the market without some regulatory influence. Competition in subsidized markets is sometimes seen as a replacement for oversight, with the reasoning that market forces will eliminate any low-quality providers. One interpretation of the limited business-stealing effect found in the Lifeline market is that consumers have imperfect information about the set of products available, and the lack of out-of-pocket costs reduces incentives to search for higher quality providers.³² Firms seek out consumers more than consumers seek

³²The importance of zero out-of-pocket costs requires either a population segment with low valuations of

out products. When coupled with imperfect oversight, even the lowest quality firms can maintain market share.

These dynamics are likely to appear in a number of other markets. Fraud and abuse are a consistent concern in healthcare provision, with recent estimates putting losses at hundreds of billions of dollars each year.³³ Though this encompasses a wide range of issues, programs which provide care or devices to individuals outside of the hospital system may be particularly susceptible.³⁴ Outside of healthcare, there is evidence of excessive fees being extracted from Earned Income Tax Credit beneficiaries by their tax preparers.³⁵ For-profit colleges have also seen charges of wasting federal student loan dollars³⁶, and there is the potential for problems in new programs funding early childhood education or pre-K³⁷. In all of these cases, the waste stems from a small segment of providers taking advantage of insufficient oversight of quality, prices, or eligibility. Broadly, there should be more focus and research on how regulations screen heterogeneous potential providers. The selection effects could determine the efficiency of any program where the government pays the bill, firms compete to enroll customers, quality or prices are imperfectly known, and oversight is costly.

service relative to search costs, or a more behavioral explanation based on consumer psychology.

³³“The \$272 billion swindle,” *The Economist*, May 31, 2014.

³⁴“Medicaid Shift Fuels Rush for Profitable Clients,” *The New York Times*, May 8th, 2014.

³⁵“Tax Preparers Targeting Poor With High Fees,” *The New York Times*, April 7th, 2014.

³⁶“Senate Committee Report on For-Profit Colleges Condemns Costs and Practices,” *The New York Times*, July 29th, 2012.

³⁷“Undercover Testing Finds Fraud and Abuse at Selected Head Start Centers,” *Government Accountability Office*, May 18th, 2010.

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Appendix A - Optimal Cost Cutting

Here, I lay out a stylized model in which firms receive a draw of their own marginal costs, and must decide what level of cost-cutting to engage in. The modeled trade-off between current profits and the continuation value is in the spirit of Darby and Karni (1973). Let profits be defined as

$$\pi = (P - \gamma c_j)S_j + (1 - H(\gamma))V$$

P is the price or marginal revenue per subscriber. The marginal cost per subscriber is c_j which can be scaled down by engaging in cost-cutting activities, through the choice of $\gamma \in (0, 1)$. V is the continuation value of providing government services in future periods, where there is some probability of being banned from the program given by $H(\gamma)$. S_j reflects the number of subscribers that a firm can enroll, which would be a function of the firm's service quality, but as shown below this will not factor into the optimal choice of γ . Assuming firms discount future profits with some discount rate $\delta < 1$, expected total value of current and future profits can be written as

$$\begin{aligned} \pi &= \sum_{t=0}^{\infty} \delta^t (1 - H(\gamma))^t (P - \gamma c_j) S_j \\ &= (P - \gamma c_j) S_j \sum_{t=0}^{\infty} \delta^t (1 - H(\gamma))^t \\ &= (P - \gamma c_j) S_j \frac{1}{1 - \delta(1 - H(\gamma))} \end{aligned}$$

To find the optimal choice of γ , take the derivative and set it equal to zero:

$$\frac{\partial \pi}{\partial \gamma} = S_j \left[-c_j \frac{1}{1 - \delta(1 - H(\gamma))} + (P - \gamma c_j) \frac{1}{(1 - \delta(1 - H(\gamma)))^2} \frac{\partial(\delta(1 - H(\gamma)))}{\partial \gamma} \right] = 0$$

which after simplification leads to

$$\gamma^* = \frac{P}{c_j} - \frac{1 - \delta(1 - H(\gamma^*))}{-\delta H'(\gamma^*)}$$

First, the optimal amount of cost-cutting does not depend on the size of the firm or the number of subscribers S_j , since revenues and costs have constant returns to scale. All else equal, γ^* is decreasing in own costs c_j . Firms with higher marginal costs have lower expected future profits, so the lost benefits from being banned are smaller. As expected, γ^* is increasing in δ , since an increased valuation of future profits gives more incentive to remain as a provider.

The function $H(\gamma)$ represents the effective enforcement level of the regulator. If some basic constraints are imposed, such that $H(0) = 1$, $H(1) = 0$, $H'(\gamma) < 0$, and $H''(\gamma) > 0$, then this convex enforcement function will ensure interior solutions for the firm's optimal γ^* . One implication of this model is that no matter how high a firm's costs c_j , they can still earn some positive profit by picking low enough γ . If fixed entry costs or regulatory costs were added to the model it would put some upper bound \bar{c} on the c_j that could profitably enter.³⁸ This upper bound cost \bar{c} , which is essentially a productivity threshold for entry, will then depend on the level of enforcement $H(\gamma)$. Stricter enforcement imposes a higher optimal γ^* for all active firms, and leads to lower per-period profits and a tighter entry threshold \bar{c} . The overall effect on cost-cutting or waste will depend on the cost distribution of potential entrants, their relative size in the market, and the current or baseline level of enforcement.

So far enforcement has been discussed as a single function $H(\gamma)$. However the unique characteristic of the Lifeline market is that each state has its own regulations and enforcement. This could be modeled as having state specific functions $H_s(\gamma)$. If the potential repercussions of cost-cutting were totally separate across states, it would imply that each firm chooses an optimal γ_s^* for each state. In reality, there tends to be a good deal of communication between state regulators, and allegations of waste at the state-level draw the attention of the FCC.³⁹ Given complete inter-state ties in repercussions, the appropriate $H(\gamma)$ would be that of the strictest state a firm operates in. In such an environment, firms would choose γ based on enforcement level defined by

$$\bar{H}(\gamma) = \max_{s \in M_j} \{H_s(\gamma)\}$$

where M_j is the set of states (markets) entered by j . This would lead to a single optimal γ^* based solely on the level of enforcement in the strictest state. Given an array of potential markets, firms should have a profit-maximizing upper threshold strictness of a state they are willing to enter. They would then solve for γ^* based on this. This would help explain why a firm would enter all markets up to a given strictness threshold level, but none above, and adhere to the standards of the strictest one.

The previous paragraph has essentially laid out the two extreme endpoints for the possible structure of enforcement across multiple markets. In reality, things are messier and exist somewhere in between. The data provide information on this through the percentage of

³⁸This would also reintroduce S_j into the entry decision.

³⁹In conversations, state regulators have mentioned their use of a shared email group for gathering background on potential entrants. In this way firms that have generated concerns in one state are likely to face much closer inspection in other states as well. Additionally, the FCC has levied fines on firms for state-level infractions across the country ("FCC Proposes Nearly \$44 Million in Fines Against 3 Lifeline Providers," FCC Unofficial Announcement, December 11th, 2013).

subscribers retained, which should be correlated with γ .

Broadly, loose oversight allows providers to cut costs and loosens the entry threshold in the market. This is in addition to the effects coming from product differentiation and search costs described by Syverson (2004a) and Hortacsu and Syverson (2004). The effect runs counter to the idea that less government interference will lead to more competitive markets for the benefits, eliminating inefficient providers. If a sufficiently strict level of oversight is too costly, some policy of entry restrictions may increase program efficiency.

Appendix B - Compliance and Oversight Estimates

Firm Enrollment of Ineligibles γ_j		State Oversight Laxness r_s			
Budget Prepay	0.246*** (0.0787)	Arizona	0.754*** (0.168)	New Jersey	1.565*** (0.273)
Global Connection	3.389*** (0.549)	Georgia	1.557*** (0.498)	Ohio	1.099*** (0.392)
I-Wireless	0.296*** (0.101)	Illinois	1.563*** (0.486)	Pennsylvania	0.365 (0.415)
Nexus	0.676*** (0.113)	Indiana	0.368*** (0.142)	Rhode Island	1.163*** (0.308)
Tag Mobile	0.847*** (0.320)	Iowa	1.265*** (0.373)	South Carolina	0.686*** (0.265)
Telrite	0.822*** (0.172)	Kansas	0.882*** (0.309)	Texas	1.789 (2.049)
TracFone	0.172*** (0.0382)	Kentucky	0.498** (0.250)	Utah	0.331 (0.333)
True Wireless	0.942 (0.820)	Louisiana	2.738*** (0.732)	Washington	0.883** (0.428)
Virgin Mobile	0.286*** (0.0616)	Maine	1.749*** (0.479)	West Virginia	2.421*** (0.528)
Yourtel/Terracom	1.181*** (0.343)	Maryland	2.886*** (0.844)	Wisconsin	0.564 (0.348)
Low Group	7.336*** (1.526)	Michigan	1.055** (0.440)	Federal Group	1.486*** (0.335)
Medium Group	0.567*** (0.198)	Mississippi	2.290*** (0.439)	Minnesota	0.788*** (0.165)
		Missouri	1.232*** (0.313)	California	0.135*** (0.0227)
		Nevada	0.968*** (0.212)		
Observations	989				

*** p<0.01, ** p<0.05, * p<0.1

Note: Standard errors in parentheses. All coefficients are from a single non-linear least squares regression. The model is described in Section 5. The dependent variable is the portion of subscribers retained after the Lifeline reform by firm j in state s .