DESERT PLACES:
COOPERATIVES AS INFRASTRUCTURE PROVIDERS IN MARGINALIZED AREAS

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Abstract

In this study, we examine the comparative advantage of cooperatives relative to for-profit firms in infrastructure provision. We argue that infrastructure projects generate positive local externalities for the communities in which they are located, and that cooperatives, being able to internalize these benefits, may be willing to provide higher quality infrastructure than for-profits, especially in marginalized communities where the costs of provision are high relative to revenues. We test and find support for this argument in US internet broadband provision from 2014 to 2017, showing that cooperatives are more likely to provide internet in communities where for-profits offer poor quality service, with these effects being stronger in rural communities, communities with persistent poverty, and communities with high social cohesion.

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"I think that is the main reason cooperatives have continued to expand their broadband offerings; their local communities are turning to them to provide what the for-profit companies won't."

- Corby Erwin, Plumas-Sierra Telecommunications[1]

The intersection of public and private interests is an area of growing interest to strategy research (Mahoney, McGahan, & Pitelis, 2009; Cabral, Mahoney, McGahan, & Potoski, 2019). While some studies in this area have focused on the role of for-profit firms in addressing grand challenges and solving social issues (George, Howard-Grenville, Joshi, & Tihanyi, 2016; Vakili & McGahan, 2016; Ballesteros, Useem, & Wry, 2017), including through various forms of public-private partnerships (Rangan, Samii, & Wassenhove, 2006; Kivleniece & Quelin, 2012; Bruce, Figueiredo, & Silverman, 2019; Quelin, Cabral, Lazzarini, & Kivleniece, 2019), others have looked to alternate organizational arrangements such as non-profits (Hwang & Powell, 2009; Chatain & Plaksenkova, 2019), social enterprises (Zahra, Gedajlovic, Neubaum, & Shulman, 2009; Dacin, Dacin, & Tracey, 2011; Santos, 2012), cooperatives (Ingram & Simons, 2000; Yue, Luo, & Ingram, 2013; Boone & Ozcan, 2014), community benefit agreements (Dorobantu & Odziemkowska, 2017), and other hybrid forms (Battilana & Lee, 2014; Fosfuri, Giarratana, & Roca, 2016; Luo & Kaul, 2019). This myriad of organizational forms has, in turn, led scholars to advocate a comparative governance approach to addressing social issues, i.e., to study the conditions under which different institutional arrangements may be best at dealing with activities involving the public interest (Kaul & Luo, 2018; Luo & Kaul, 2019; Klein, Mahoney, McGahan, & Pitelis, 2019; Lazzarini, 2019).

[1] Private communication with the author, dated May 9, 2019

In this study, we extend this comparative governance approach to the context of infrastructure provision, asking the question: what are the optimal governance forms for the provision of infrastructure, and under what conditions are these different forms most likely to prevail (Ostrom, Schroeder, & Wynne, 1993)? We contend that infrastructure services have both toll good and public good characteristics (Buchanan, 1965; Ostrom, 2010): while some of the benefits from infrastructure provision are private (and therefore excludable) to those who use the infrastructure, others are public (and therefore non-excludable) in that they impact the entire community. The presence of these locally bounded externalities means that in some cases the comparatively efficient governance form for infrastructure projects will be a local cooperative, since the members of the cooperative will be able to internalize the non-excludable benefits from infrastructure provision in a way that for-profit providers will not (Luo & Kaul, 2019). Specifically, we theorize that cooperatives will be willing to provide higher quality infrastructure than for-profit providers in rural or low-income areas where the private benefits of infrastructure provision are insufficient to cover for-profit costs. We also expect cooperatives to be more successful in communities with greater social cohesion since such communities may be better able to organize for their collective good.

We test our arguments in the context of internet broadband provision in the United States, using uniquely detailed data from the Federal Communications Commission (FCC) that allow us to track internet provision at the census tract level from 2014 to 2017, including not only the identity of internet providers, but also the technology used and the listed speed of provision. We find that cooperatives are more likely to provide internet in communities where for-profit provision is slow, or based on low-speed technologies (primarily DSL or cable). Consistent with our theory, this relationship is stronger in rural communities, as well as in communities with high social cohesion as reflected in low ethnic fragmentation and low immigration rates; it is also stronger in communities with moderate income levels and those with persistent poverty. These results are robust to the inclusion of census tract and year fixed effects, and to the use of a government policy (the Connect America Fund) that incentivized for-profit internet providers to invest in underserved areas as an instrument. Moreover, supplementary analyses show that cooperative entry in response to low quality for-profit provision involves provision of high quality broadband services—measured by both the technologies used and the reported upload speeds—and that these results hold across both new and legacy cooperatives.

Our study makes several contributions to prior literature. By applying a comparative governance lens to infrastructure provision, we extend existing theory on public-private interaction (Cabral et al., 2019; Lazzarini, 2019), showing how the relative balance of public and private benefits from an activity influences how it is best organized. In doing so, we also contribute to research on the role of cooperatives, providing empirical support for recent theoretical work that stresses their ability to deal with locally bounded externalities (Luo & Kaul, 2019), and offering additional insights into the conditions under which they are more likely to prove successful (Yue et al., 2013; Boone & Ozcan, 2014). In addition, our study has important implications for public policy. The provision and maintenance of high quality infrastructure, especially in rural areas, is a central concern for policy makers in general, and the specific issue of digital inequality between prosperous and marginal communities in the United States and elsewhere has received a great deal of recent attention, both in academic circles (DiMaggio, Hargittai, Neuman, & Robinson, 2001; DiMaggio, Hargittai, Celeste, & Shafer, 2004; Greenstein & Prince, 2006; Greenstein, 2019; Skiti, 2020b) and in the popular media[2] (Ali, 2019; Halpern, 2019). Our study offers theoretically driven, systematic evidence for the role of cooperatives in helping to bridge this divide, emphasizing the potential for self-organized community action as a path to economic development.

[2] Including, in June 2019, an entire episode of comedian Hasan Minhaj's Netflix series 'Patriot Act' devoted to the issue of broadband access. Available to view at: https://youtu.be/xw87-zP2VNA.

Cooperatives as infrastructure providers

Private and community benefits of infrastructure

In recent years, strategy scholarship has grown increasingly interested in studying the role of for-profit firms and other private organizations in solving social problems—such as poverty, inequality, disease, pollution, etc.—thus helping to build a sustainable and inclusive global future (Mahoney & McGahan, 2007; Mahoney et al., 2009; George, McGahan, & Prabhu, 2012; George et al., 2016). While these 'grand challenges' were traditionally considered the responsibility of the state (Pigou, 1920), scholars have increasingly come to realize that these problems can be, and often are, solved through the collective action of private actors that organize and cooperate for their common good (Coase, 1974; Ostrom, 1990; 2010). This in turn suggests that we may think of the solution to social issues as a governance problem, i.e., a problem of finding the best institutional arrangement to efficiently and effectively address the issue (Coase, 1960; Klein et al., 2019; Lazzarini, 2019). In particular, it suggests the use of a discriminating alignment approach (Williamson, 1996): matching the attributes of a social issue to the comparatively efficient governance form for addressing it (Luo & Kaul, 2019).

In this study, we apply such a discriminating alignment approach to the problem of infrastructure provision. Infrastructure projects are typically thought of as club or toll goods (Buchanan, 1965; Ostrom & Ostrom, 1971; Ostrom, 2010), in that their benefits, though generally less subtractable[3], are highly excludable. A bridge or a road does not get used up by the people driving on it, so one person's use of it does not preclude its use by another (low subtractability), but it is possible to monitor who uses the bridge or road and to charge a fee for doing so (high excludability). This excludability of infrastructure (and of toll goods more generally) means that we can rely on private for-profit actors to provide such goods, since the

[3] Early work in this area often spoke of goods whose use by one person precluded their use by another as rivalrous. In this paper, we follow Ostrom (Ostrom and Ostrom, 1971; Ostrom, 2010) and speak of such goods as having high subtractability. Infrastructure projects, while not generally subtractable, are subject to congestion (as anyone stuck in rush hour traffic can attest!), which is why we speak of them as low subtractability rather than as non-subtractable.

ability to charge for access, coupled with the natural monopoly that comes from low subtractability, creates the potential for profit. While some level of government intervention may be required to overcome demand uncertainty (Rangan et al., 2006; Klein, Mahoney, McGahan, & Pitelis, 2013), in general, toll goods can be, and are, provided by private for-profit enterprises.

The benefits produced by an infrastructure project are not fully excludable, however. Infrastructure projects do not only produce direct benefits for those who access or use them, they also often produce indirect benefits for the communities in which they are located. Access to better transportation through roads and bridges, for instance, may promote economic development by creating new opportunities for business and exchange (Banerjee, Duflo, & Qian, 2012). Enhanced broadband access may provide several socio-economic benefits to communities (Council of Economic Advisers, 2016; Seamans, 2018), such as improving educational outcomes (Agarwal & Day, 1998), boosting employment opportunities (Forman, Goldfarb, & Greenstein, 2012; Hjort & Poulsen, 2019; Kolko, 2012; Kuhn & Skuterud, 2004), and providing superior access to health care (Finkelstein, Speedie, & Potthoff, 2006). The key point is that these indirect benefits accrue to everyone in the community and are not limited to those who make use of the infrastructure. People who never travel out of their city may still benefit from its greater connectivity; those who do not have a broadband connection may still benefit from neighborhood businesses having one. These indirect benefits of infrastructure are thus externalities—i.e., they are non-excludable—albeit bounded ones, in that they are limited in scope to the local community (Coase, 1974; Ostrom, 1990). We may thus think of infrastructure as partly a toll good (in so far as its direct benefits are excludable) and partly a public good (in so far as its indirect benefits are not).

The role of cooperatives

This dual nature of infrastructure projects has implications for how they are best governed. While toll goods may be well administered by for-profit firms, as already mentioned, the provision of bounded externalities may be better organized through cooperatives (Luo &

Kaul, 2019). A cooperative is defined as "a user-owned and controlled business from which benefits are derived and distributed equitably on the basis of use or as a business owned and controlled by the people who use its services" (USDA, 2011). Cooperatives differ from for-profit firms in that while both seek to realize profit[4], the residual rents of cooperatives are distributed among users rather than among investors, and therefore control rights for the organization reside with the users, generally on a democratic (one-member one-vote) basis (Hansmann, 1996; Hart & Moore, 1996; 1998)[5]. Business cooperatives are active in many areas of the economy (Boone & Ozcan, 2014), including credit unions (Barron, West, & Hannan, 1994), retail cooperatives (Ingram & McEvily, 2007) and agricultural cooperatives (Schneiberg, King, & Smith, 2008), and frequently compete with for-profit firms by offering similar products and services (Chatterji, Luo, & Seamans, 2020).

The key advantage of cooperatives in dealing with activities that produce bounded externalities is that they allow for private ordering (Williamson, 1996; Ahuja & Yayavaram, 2011), placing key organizational decisions in the hands of members of the local community who have both a superior understanding of the magnitude of these externalities, and stronger incentives to be concerned with such externalities (Hansmann, 1996; Hart & Moore, 1996; 1998; Luo & Kaul, 2019). In simple terms, local cooperatives internalize the indirect benefits generated by the infrastructure project, since it is precisely those who benefit from these externalities that are also the owners and—critically—the decision makers of the organization (Hansmann, 1996; Hart & Moore, 1996; 1998). The cooperative's members thus derive two benefits from the infrastructure project: the direct financial returns they receive as owners of the cooperative, and the indirect benefits they receive as members of a community that sees enhanced economic

[4] Comparing for-profit and cooperatives does not mean that the latter are non-profit. Most cooperatives are incorporated as cooperative corporations under various state laws, rather than as tax-exempt non-profits. The key difference between the two being that while non-profits are constrained from distributing their profits, cooperatives can and do distribute profits to their members.

[5] Prior work (Hansmann, 1996; Hart & Moore, 1998) has examined the benefits and costs of cooperative governance relative to traditional for-profit ownership in the context of the provision of private goods. We draw on this work but focus instead on their comparative governance in the case of infrastructure provision.

opportunity from the project[6]. In contrast, the for-profit's shareholders receive only the financial returns from the use of the infrastructure and do not share in the externalities it generates for the community; as such for-profits may undersupply infrastructure relative to the social optimum.

This is not to suggest that cooperatives will always have an advantage in undertaking infrastructure projects. Successful collective action such as that represented by cooperatives is challenging to organize and maintain, given the need for constant assurance and monitoring (Sen, 1967; Sugden, 1984; Ostrom, 1990; 2005), and the potential for internal conflict (Hart & Moore, 1998), so that the bureaucratic costs (Williamson, 1985) of cooperatives are likely to be higher than those of a comparable for-profit. Moreover, the relatively lower-powered incentives in cooperatives may limit the efficiency of their infrastructure provision relative to that of for-profit firms (Williamson, 1985; Luo & Kaul, 2019). Finally, the local nature of cooperatives necessary to internalize the bounded externalities may also limit their scale relative to for-profit providers, resulting in lost scale economies (Luo & Kaul, 2019). Overall, it is thus likely that the costs of infrastructure provision under a cooperative will be higher than those under a comparable for-profit.

Comparative governance of infrastructure

Whether cooperatives or for-profits are to be preferred as infrastructure providers thus depends on the relative importance of the benefits to the local community from bounded externalities. The more important these community benefits, the greater the comparative advantage of cooperatives. Figure 1a demonstrates this argument graphically. It plots the average quality of infrastructure services provided to each user on the horizontal axis, and the marginal cost of providing that quality to each user as well as the direct and total benefits of doing so on the vertical axis. Lines MC_C and MC_F show the marginal increase in cost per user for a unit

[6] While government providers would also value externalities, such providers may be subject to other forms of government failure (Coase, 1964), and will often care about constituencies larger than a single community (Olson, 1986; Luo & Kaul, 2019). In the specific case of internet provision there may also be regulatory barriers to municipal provision (Skiti, 2020b). We therefore focus our theory development on the comparison between for-profits and cooperatives, though we account for the role of municipal providers empirically.

increase in infrastructure quality for cooperatives and for-profits, respectively. As discussed, we expect the costs of cooperative provision to be higher than that for a comparable for-profit, so $MC_C > MC_F$. We also assume that the cost per user increases with the quality of infrastructure provision and does so at an increasing rate. The intuition being that as the quality of provision increases, it becomes more and more challenging to further increase quality, often requiring new innovations or substantial investments in state-of-the-art technologies. In the extreme, beyond a certain point it is no longer possible to further increase infrastructure quality, and the marginal cost curve becomes vertical. In contrast, at low levels of quality, improving service is easy because there are plenty of 'low hanging fruit': minor adjustments or basic improvements through which quality may be improved at a comparatively low cost.

The line MR shows the marginal increase in revenue per user for every unit increase in infrastructure quality. We assume that users have no inherent preferences for either for-profits or cooperatives, they care only about the quality of infrastructure provided to them, so the marginal revenue line for both providers is the same. Clearly, MR is increasing in quality (users will pay more for higher quality provision) and we assume for simplicity that it increases at a constant rate. The line MB plots the marginal increase in total benefits per user from infrastructure provision per unit increase in quality, i.e., it plots the sum of the increase in revenue from users (which measures the direct benefits of infrastructure provisions) and the increase in the indirect benefits to the community as quality increases. The gap between the MR and MB lines thus reflects the externalities generated by infrastructure provision, as a function of its quality.

Insert Figure 1a about here

Figure 1a also shows the quality level chosen by each provider in equilibrium[7]. The for-profit provider chooses quality level Q_F^* at the point where the MC_F line intersects the MR line

[7] Note that we are not modeling competition between multiple providers; Figure 1a simply plots the quality level each provider would choose if it had a monopoly in the market, consistent with the non-subtractable nature of infrastructure provision. We may thus think of the figure as representing the *ex ante* choice of quality each provider would offer if asked to bid for access to the market (Demsetz, 1968).

from below. This is the quality level at which the profit per user is maximized. The cooperative provider chooses quality level Q_C^* at the point where the MC_C line intersects the MB line from below. This is the quality level at which the total benefit to the owners of the cooperative, including both the direct benefits from infrastructure use (paid for as revenue) and the (internalized) indirect benefits to the community, less the cost of provision, are maximized. The key point is that the cooperative internalizes the community benefit, and thus makes its quality decisions based on the overall benefits rather than just the direct (excludable) benefits.

In Figure 1a, $Q_F^* > Q_C^*$, meaning that the for-profit would choose a higher quality of provision than the cooperative. In this case, then, the for-profit is the comparatively advantaged governance form for infrastructure provisions[8]. Figures 1b through 1d then explore the factors that shift the comparative advantage of for-profits relative to cooperatives in infrastructure provision. Figure 1b is similar to Figure 1a, except that we shift the MR and MB curves downward. This is a case where the average user has a lower willingness to pay for infrastructure provision, relative to the average user in Figure 1a. As Figure 1b shows, the downward shift of the MR and MB lines causes the optimal quality levels chosen by both providers to decline (both providers will offer lower quality if users are not willing to pay as much), but the decline is greater for for-profits than for cooperatives, so that Q_C^* is now greater than Q_F^*. In equilibrium, the cooperative provides a higher level of infrastructure quality than the for-profit, and is therefore the comparatively advantaged provider in this scenario. The intuition here is that as the direct benefits to users from infrastructure provision decline, factoring in the externalities generated becomes more critical to the choice of quality. Thus, the lower the user's willingness to pay for infrastructure, the greater the weight of the externalities in determining the comparatively efficient governance form, and the greater the likelihood that it will be a cooperative.

Insert Figures 1b, 1c, and 1d about here

[8] Note that the first best outcome would be for the for-profit to provide the quality level at which MC_F intersect MB, perhaps through the provision of a subsidy by a fully rational social planner. We ignore this hypothetical option here, limiting ourselves to consider the best among feasible alternatives (Williamson, 1996; Luo & Kaul, 2019)

Figure 1c offers a similar argument, except in this case we keep the MB and MR curves as they were in Figure 1a, but shift the cost curves upward. Once again, we see a drop in the equilibrium levels of quality chosen by both providers, but the decline is greater for for-profits than for cooperatives, so that $Q_C^* > Q_F^*$ and cooperatives are now the comparatively advantaged providers. The intuition for this case is very similar to that for the case in Figure 1b: as the cost of infrastructure provision rises, it becomes harder to cover high quality provision (or provision at all) out of revenues from users alone, so it becomes more important to take the externalities generated into account when choosing a quality level. We thus expect that as the cost of infrastructure provision (relative to user's willingness to pay) rises, cooperatives will be increasingly likely to emerge as the comparatively advantaged providers.

While Figure 1c focuses on factors that raise the cost of infrastructure provision for both potential providers (e.g., physical or geographic conditions or technological barriers), Figure 1d considers factors that increase the costs of cooperatives relative to for-profits. Successful cooperation may be easier to maintain where incentives between members are strongly aligned (Hansmann, 1996), when observability of other's actions is high (Holmstrom, 1979; Ostrom, 1990), and when members are embedded in networks of strong social ties (Granovetter, 1985; Jones, Hesterly, & Borgatti, 1997; Yue et al., 2013; Yenkey, 2015; Dorobantu, Kaul, & Zelner, 2017). Where these factors are absent—specifically, where cooperative members are heterogenous in their interests, or where the scope of the cooperative's activities is quite broad—the bureaucratic costs of cooperative governance are likely to be high (Hansmann, 1996; Hart & Moore, 1998), and cooperative governance may thus be relatively inefficient compared to for-profit provision. Figure 1d shows this case, shifting the MC_C line upward, while keeping all else the same as in Figure 1a. Unsurprisingly, an increase in the relative inefficiency of cooperatives lowers the equilibrium quality of cooperative provision, increasing the gap between Q_F^* and Q_C^* and increasing the likelihood that for-profit provision will be comparatively advantaged.

Internet broadband provision

Having proposed a general theory of the comparative advantage of cooperatives vs. for-profits in infrastructure provision, we next develop more specific hypotheses in order to empirically test our theory in the context of fixed internet broadband provision[9]. We believe that this is an excellent setting in which to test our theory for several reasons. First, the provision of broadband internet is a classic example of an infrastructure project, involving large scale investments in physical assets that are largely non-subtractable and thus create natural barriers to entry—especially in the United States, where open access policies[10] are rare—with the result that most households have a choice between relatively few broadband providers (Wallsten & Mallahan, 2013; Greenstein, 2019), often no more than one[11] (Trostle & Mitchell, 2018). Second, broadband provision is a setting where several different governance forms co-exist; specifically, we see substantial provision by cooperatives[12], across most states and regions of the United States, as shown in Figure 2. Third, internet provision has the advantage that the speed of the connection is an unambiguous and universally accepted measure of broadband quality, making comparisons across geography and time easier. Fourth, internet provision is closely monitored, allowing us to track detailed information about the number and identity of providers, as well as quality of provision, at a granular, census-block level (Skiti, 2020b). Such granularity is important, because broadband provision—unlike dial-up access (Downes & Greenstein, 2002)—is tightly bound to local geography, with studies documenting significant variance between quality of provision even within a city (Grubesic & Murray, 2002; Greenstein & Prince, 2006). Moreover, there are a number of different technologies that may be used to provide internet connectivity,

[9] Broadband refers to high-speed internet access that is always on and faster than traditional dial-up access, and is defined as connection speeds of at least 25 Mbps for download and 3 Mbps for upload (Federal Communications Commission, 2018). We focus here on fixed internet provision, and do not consider access via satellite.
[10] Open access policies require existing carriers to lease access to their physical networks to their competitors at a regulated price, and are widely used in many countries, e.g., Sweden, Netherlands. In the U.S., open access policies have generally not been adopted for fear that they may weaken incumbent incentives to invest in new technologies (Benkler, 2010), though recent years have seen voluntary adoption of such policies by some municipal governments, e.g., Public Utility Districts in Washington state.
[11] In our sample (described later), about 30% of census blocks in the country are served by only one for-profit ISP.
[12] In our sample, cooperatives cover 7.79% of all census tracts in the US, while municipal providers cover 3.26%.

allowing us to distinguish between providers of different quality. Finally, as previously mentioned, the issue of 'digital inequality' has received substantial attention in recent years (DiMaggio et al., 2001; DiMaggio et al., 2004), with scholars emphasizing broadband provision as a key driver of inequality in internet access (Augereau & Greenstein, 2001; Greenstein & Prince, 2006; Greenstein, 2019; Skiti, 2020b), and broadband provision being linked to broader community level outcomes (Council of Economic Advisers, 2016; Seamans, 2018; Hjort & Poulsen, 2019) making it an important and timely topic of study.

Insert Figure 2 about here

In order to test our theory of the comparative advantage of cooperatives vs. for-profits in the context of internet provision, we choose to focus on the presence of the former. Given that many communities in the US are served by just one or two broadband providers, we cannot simply compare the performance of cooperative and for-profit providers within communities. Instead, we focus on the question: which markets do cooperative internet providers serve? Our logic for focusing on cooperative presence is that given the basic toll good nature of internet provision, and the empirical fact that almost every community in the US receives at least some for-profit internet provision, though often of very basic quality, we can think of for-profit provision as the baseline for internet service. Cooperatives may only enter a community if they believe they can provide superior service compared to what for-profits provide, i.e., if they believe that they have a comparative advantage in serving the community.

Building on the theoretical arguments in the previous sub-section, our core prediction is that cooperatives will be comparatively advantaged in providing broadband where the revenues from broadband provision for for-profit firms are relatively low compared to their costs. In such communities, for-profits will see little incentive to make the substantial investments in physical infrastructure required to provide high speed broadband access (e.g., fiber), and may prefer to limit themselves to providing basic low-speed internet service (e.g., DSL), if they provide service at all. In contrast, cooperatives, because they will potentially internalize the externalities generated by higher speed broadband access in the local community, may be more willing to invest in superior infrastructure. We therefore expect that cooperatives will be more likely to enter communities where for-profit providers offer poor quality. Our baseline hypothesis is thus:

H1: The greater the average quality of internet provision by for-profit companies in a community, the less likely cooperative providers are to be present in that community.

By itself, a negative association between the quality of for-profit provision and the presence of cooperative providers is not especially probative. While consistent with our theoretical arguments, such an association is susceptible to several alternate explanations: it may be that there are institutional factors (regulatory or cultural) that constrain for-profit broadband provision in some communities (Skiti, 2020b), which is why cooperatives do better there; or it may be that cooperatives are simply substituting for low capability for-profits. To provide stronger evidence for our theory, we would want to see the strength of this negative association vary in ways consistent with our theoretical arguments, which is what we turn to consider next.

First, consistent with Figure 1b, we would expect the negative association between the quality of for-profit provision and cooperative presence to be stronger in low-income communities. Users in such communities will have a limited ability to pay for internet service, so the revenues that for-profit firms can realize in such communities are likely to be lower (Greenstein, 2019). At the same time, low-income communities may see greater externalities from high speed internet provision. Because low-income areas will, by definition, have weaker economic opportunities to start with, high speed internet access is likely to have a greater marginal effect on life in these communities than in communities that are already prosperous. By connecting economically backward communities to richer markets elsewhere, high speed internet provision may give users access to new educational and entrepreneurial opportunities, and these users in turn will boost economic opportunity in the region, through their increased prosperity and job creation, that will benefit even those that are not directly taking advantage of high-speed access. Overall, bounded externalities are likely to make up a larger share of the total benefits of high-speed internet access in low-income communities, so the comparative advantage of cooperative provision should be greater there. Thus:

H2: The negative association between the quality of for-profit internet provision and cooperative presence will be stronger in low income communities than in high income communities.

A second factor that is likely to moderate the negative association between the quality of for-profit provision and cooperative presence, consistent with Figure 1c, is the population density of the community (Downes & Greenstein, 2002). Since the cost of installing broadband infrastructure increases with the physical distance to be covered, communities where users are more geographically dispersed are likely to have higher costs per user, other things being equal. This means that the cost per user of high-speed internet provision in rural communities—that have lower population density than urban communities—is likely to be higher. Given these higher costs, for-profit providers may find it uneconomical to invest in high quality provision in rural areas, based solely on the revenues they hope to realize (Greenstein & Prince, 2006; Greenstein, 2019). Cooperatives, on the other hand, may be willing to invest in broadband infrastructure in rural communities, despite facing similar high costs, because they can internalize the benefits to the community from better internet connectivity. Therefore:

H3: The negative association between the quality of for-profit internet provision and cooperative presence will be stronger in rural communities than in urban communities.

Finally, consistent with Figure 1d, we also expect the strength of our predicted association to vary with the level of social cohesion within the community. The more tightly-knit the community from which the members of the cooperative are drawn, and the more homogenous their preferences, the more effective the functioning of the cooperative (Hansmann, 1996; Hart & Moore, 1996; 1998). Not only will greater social cohesion mean that the interests of the cooperative's members are naturally aligned, making it easier to ensure cooperation and limit free-riding (Ostrom, 1990; Hart & Moore, 1998), but stronger social ties may enhance trust and mutual reliance between members, further enabling cooperation (Sugden, 1984; Granovetter, 1985; Jones, Hesterly, & Borgatti, 1997; Dorobantu et al., 2017). Conversely, where the members of the community are divided into distinct social groups cooperation between participants may prove more difficult (Yenkey, 2015) and may lead to the exclusion of one group by others, undermining the effectiveness of the cooperative (Yue et el., 2013).

In particular, we expect the effectiveness of cooperative provision to be lower in communities with high ethnic diversity and high rates of (inward) immigration. Prior literature has shown that racial and ethnic fragmentation has a negative effect on social participation within a community (Alesina & La Ferrara, 2000), reducing investments in essential public goods (Alesina, Baqir, & Easterly, 1999), and leaving communities vulnerable to outside exploitation (Alesina, Gennaioli, & Lovo, 2019). In our specific context, we expect that greater ethnic fragmentation within a community will make it more challenging for users within the community to organize as a cooperative. This will raise the cost of cooperative provision relative to for-profit provision, as in Figure 1d. More ethnically fragmented communities may also see lower externalities from broadband provision, both because the indirect benefits from high speed internet access may not be shared equally across the community, and because cooperative members may only care about the gains to members of their own social group rather than the gains to the entire community. Similar problems will apply in the case of communities with high proportion of immigrants. Immigrants may be seen as outsiders to the community and their presence may therefore limit social cohesion. For all these reasons, we predict:

H4: The negative association between the quality of for-profit internet provision and cooperative presence will be stronger in a) less ethnically fragmented communities than in more ethnically fragmented communities; and b) in communities with low immigration rates than those with high immigration rates.

Note that our theoretical arguments also imply that cooperatives are more likely to be present in low-income and rural communities with high social cohesion. While we do not hypothesize a main effect of these variables, choosing to focus instead on their moderating role, we do empirically examine these relationships through our analyses.

Data and methods

Data and variables

We test our arguments in the context of fixed broadband provision in the United States, using uniquely detailed data from the Federal Communications Commission (FCC) that allow us to track internet provision at the census tract level from 2014 to 2017.[13] Specifically, all facilities-based internet providers are required to file the FCC Form 477 biannually (every June and December) at the census block level, as long as the speed of the internet services they provide exceeds 0.2 Megabits per second (Mbps). Note that this cut-off is significantly lower than the 25 Mbps download / 3 Mbps upload speed standard the FCC currently uses to define broadband provision, so that our data include not only broadband providers, but providers of internet services more generally. The FCC data include the name of the Internet Service Providers (ISPs), the technology used, and the listed speed of provision.[14] We extract the December data across four years and aggregate to the census tract level. We conduct our analyses at the census tract level, even though the FCC data are available at the census block level, because our theory is about communities, rather than blocks, and we believe that a census tract—roughly the size of a neighborhood—is a better fit for our theory than a single block. Moreover, some of our predictors and controls are only available at the census tract level.

To collect identity information on the ISPs and to distinguish for-profit providers from cooperative providers as well as municipal governments, we manually search for these ISPs and triangulate across a number of databases, including the University of Wisconsin's Cooperative Census, the Institute for Local Self-Reliance's list of Cooperatives Build Community Networks,

[13] We start the dataset from December 2014, when data filing becomes mandatory and administered centrally by the FCC, and end in December 2017, which was the most recent at the time of the analysis. Prior to our sample period, these data were submitted by state entities to the State Broadband Initiative (SBI) and then to the National Telecommunications & Information Administration (NTIA), which resulted in reporting inconsistencies, especially for cooperatives.

[14] While the FCC data offer the most comprehensive measurement of internet provision in the US available over time, one limitation is that the speeds reported in these data are listed speeds rather than actual speeds. The actual speed may be influenced by idiosyncratic factors such as the end users' hardware and software issues, server-side issues, and the number of users in a house, etc.

and the White House's list of U.S. municipalities with broadband networks[15]. In addition, we visit each ISP's website to confirm that it self-identifies as a cooperative, and visit each municipal government's website to confirm municipal internet service provision. We identify 2,280 unique for-profit firms, 317 cooperatives, and 225 municipal governments as ISPs that operated during this period across the nation. In addition to the FCC data, we also draw on the US census for socio-economic data of the communities. Matching the FCC data to the census database gives us a final sample of 285,320 census tract-year observations across 71,558 unique census tracts.

Dependent variable. We measure *Coop* as a dummy variable indicating whether a cooperative internet service provider is present in a given census tract or not. In robustness analyses, we also differentiate cooperatives by technology type. Specifically, we distinguish between internet provision using technologies that provide relatively high speeds (both upload and download speeds above 150 Mbps, as shown in Appendix 1), which include fixed wireless and fiber, and internet provision using all other technologies, most of which have significantly lower speeds, especially on uploads. *High-tech coop* measures whether a cooperative is present in the given census tract using high-speed technologies, where high-speed technologies are defined as either fixed wireless or fiber[16]. While our main measures include all types of cooperative ISPs, in robustness checks we distinguish between pure-play internet cooperatives and various forms of legacy cooperatives (i.e., cooperatives offering other services that also provide internet), to account for the fact that the latter may face lower costs in the regions they already serve, and may also be subject to different regulations when providing internet services (e.g., easement laws). Results from these robustness checks (Appendix 3) are consistent with our main findings.

Independent variable. For H1, our main measure of the quality of for-profit provision is *for-profit internet mean speed,* measured as the average internet upload speed provided by for-profit ISPs in a

[15] Accessed at https://files.eric.ed.gov/fulltext/ED584128.pdf

[16] A full set of results with a binary measure of high-tech coop presence, as well as with a continuous version of our dependent variable based on the speed of cooperative provision are shown in Appendix 2.

given census tract.[17] As the mean and maximum internet upload speed are 100.4 Mbps and 1000 Mbps (i.e., 1gigabit), we scale the speed measure by 100. While speed of provision is a natural and salient measure of internet service quality, one concern is that speeds listed by the provider may be susceptible to manipulation. We therefore use an alternative technology-based measure of quality, *% covered by high tech for-profit internet*, i.e., the percentage of a given census tract that is covered by high-tech (fiber or fixed wireless) for-profit providers.

Moderating variables. We use a number of additional variables to test our moderating hypotheses, all taken from the census. For H2, which focuses on the differential effects for high- and low-income communities, we measure *log(Median HH income)* for a census tract. For H3, which examines the differential effects for urban and rural communities, we count as *Rural* any census tract that includes an area designated as rural by the US Census. Note that this measure is not time-varying within our sample period. For H4a on the level of social cohesion within the community, we construct a measure for *Ethnic diversity* as an ethnic fractionalization index, following prior literature (Alesina et al., 1999; Alesina et al., 2019; Alesina & La Ferrara, 2000). Specifically, $Ethnic\ diversity = 1 - \sum_i (Race_i)^2$, *where* $i = \{$*White, Black, Hispanic, Asian, Native Americans, and Other*$\}$. For H4b we measure *Immigration* as the percentage of the population in a census tract that has immigrated from outside the US. Data on population ethnicity and migration rates is taken from the census.

Control variables. Most of the analyses we perform include census tract fixed effects and year fixed effects. Additionally, we include several controls at the census tract level for time-varying characteristics that may determine both the quality of for-profit provision as well as cooperative presence, including *log(Population)*, *Unemployment rate, % population above 65*, and *% population with bachelor degree or higher*. We also control for Indian reservations by including *% Native*

[17] For 424 census-tract-year observations (0.14% of the sample) where for-profits do not provide internet service, we code this variable as 0. We focus on upload speeds in results reported here, but analyses using download speeds instead are reported in Appendix 4 and show consistent results.

Americans. In addition, we include a binary variable *Muni gov. coverage* indicating whether the municipal government provides internet service in a given census tract. We also include a variable, *Areas with for-profit business services* to account for the level of business activities in the area. This is measured as the number of census blocks in a census tract that are covered by for-profit internet service towards business (divided by 100 for ease of interpretation). Finally, we also include a measure for the *Number of for-profit providers,* to account for the possibility that cooperatives may be more likely to enter and operate in areas where for-profits face limited competition among themselves (Hart and Moore, 1996; 1998), with users coming together to exert countervailing pressure against monopoly providers (Asmussen, Foss, Foss, and Klein, 2020). Table 1 provides summary statistics and Table 2 provides correlation. While we see a few high correlations, mostly between controls, the mean VIF value is just 1.40, so we see no cause for concern regarding multicollinearity.

Insert Tables 1 and 2 about here

Methodology

Our baseline specification examines the relationship between the quality of for-profit provision in a census tract and cooperative presence in that census tract both in the cross-section (between census tracts) and longitudinally (within census tracts), with the latter specification thus estimating the relationship between changes in the quality of for-profit provision and cooperative entry (or exit[18]) while holding time invariant characteristics of the community constant. We also include year fixed effects in all regressions to account for changes over time, and use robust standard errors clustered at the census tract level. We use a linear probability model in our main models reported below, though results are robust to a variety of other specifications including logit and tobit models (as shown in Appendix 5).

While this baseline specification may provide preliminary evidence as to the relationship

[18] In robustness checks, we focus only on cooperative entry by dropping all census tracts that already have a cooperative ISP at the start of our sample period. Results of this analysis, shown in Appendix 5, are consistent with our main findings.

between the service quality provided by for-profit ISPs and cooperative entry, it may be that the choice of cooperative entry is driven by unobserved and time-varying factors, which also impact the service quality of for-profit provision (i.e., there is a potential omitted variable problem). To deal with this concern, we use an instrumental variable (IV) analysis that exploits a government program, Connect America Fund (CAF) Phase II, that incentivized ISPs to invest in underserved areas. Specifically, in April 2015, CAF Phase II offered subsidies to price cap carriers to deploy and maintain basic voice and internet services in underserved high cost areas. Under the program, ten ISPs—all for-profit providers[19]—received subsidies of over $1.675 billion.

We measure % *CAF funded area*, as the percentage of a given census tract that received subsidies from the CAF fund. We also construct a dummy variable *post year 2015*, coded as 1 for years after 2015 (inclusive) and 0 otherwise, and use % *CAF funded area × post year 2015* as an instrumental variable for mean internet speed provided by for-profit ISPs. The logic for this instrumental variable strategy is as follows. First, the CAF creates an exogenous source of variation in for-profit internet quality across the U.S., starting in 2015 (relevance condition). This is because, given budget and cost considerations, the quality of provision required from ISPs under CAF Phase II is low. To qualify for CAF subsidies, for-profit providers are required to offer 10/1 speeds (that is, a download speed of over 10 Mbps and an upload speed of over 1Mbps)[20]. This speed requirement is much lower than the FCC's standard definition of broadband of 25/3 speeds. It is also far below the sample average of for-profit ISP provision at 100.4 Mbps upload speed. As a result, while large for-profit ISPs have expanded internet service to underserved areas, the resulting service has often ended up satisfying only the minimum requirement, and not meeting broadband speeds. For example, in rural Minnesota, after the implementation of the CAF, only 15% of locations have access to 25/3 Mbps services while

[19] Over 96% of these subsidies went to five large for-profit players: Century Link, AT&T, Frontier Communications, Windstream Communications, and Verizon. In 2018, CAF Phase II was further rolled out through an auction that awarded an additional $ 1.49 billion to 103 bidders, but this was after our study period, which ends in 2017.

[20] https://www.fcc.gov/consumers/guides/connect-america-fund-phase-ii-faqs

most others have access to 10/1 speeds (Blandin Foundation, 2018). Thus, for-profits' expansion into underserved areas post 2015 may be associated with a drop in the average quality of internet access provided by for-profit ISPs. In particular, the CAF would cause the average speed of for-profit provision in the community to drop, both due to the entry of low speed providers to take advantage of government subsidies, and because such entry may cause for-profit ISPs to deprioritize higher quality provision in such areas.

Second, given that all 10 of the ISPs offered subsidies were for-profits, *% CAF funded area × post year 2015* does not directly alter the likelihood of a cooperative's presence in the census tract (exclusion restriction). One potential concern to the exclusion restriction could be that cooperatives were involved in the process of determining the offers made under CAF Phase II. It seems unlikely that cooperatives were involved in the decision-making process, however, seeing as only for-profit ISPs received such offers, and it seems unlikely that cooperatives would have steered subsidies to their potential competitors in areas they planned to enter.

Results

Descriptive statistics

Before we test our main predictions with regression analyses, it is instructive to look at some general patterns of broadband provision in the US during our sample period. Overall, for-profits are the dominant providers of internet services in the US, covering over 99.85% of all census tracts during our sample period[21]. In comparison, the coverage of cooperative providers is just 7.79% (and municipal providers is 3.26%). Table 3a shows the coverage of census tracts in the US by organizational forms and the nature of the community, as well as by type of technology used, and Table 3b shows the average upload speeds.

Insert Tables 3a and 3b about here

Taken together, both tables show a pattern of broadband provision that is broadly

[21] In terms of concentration, the top 10 ISPs accounted for just over 50% of for-profit provision in 2014, with the median for-profit ISP covering just 713 census blocks. Thus, while there are certainly some very large for-profit ISPs in our sample, there are also hundreds of smaller providers that account for this coverage.

consistent with our theory. First, they show that while for-profit providers cover almost every community in the US, the service they provide is often not the highest quality, with less than 90% of census tracts having any high-quality provision, and that number falling to just about 86% in rural and low-income areas. Relatedly, for-profit providers offer the lowest speeds among all three types of providers, with overall average speeds being higher for both cooperative providers and municipal providers. Second, they show that rural and low-income communities, as well as communities with low ethnic diversity and low immigration get (slightly) lower coverage and substantially lower quality from for-profit providers. In particular, the average upload speed of for-profit provision is over 25% lower in low income communities than in high income communities, and over 30% lower in rural communities than in urban communities. In contrast, and consistent with our theoretical predictions, cooperative provision is strongest in precisely those communities where for-profits are weak. Cooperatives have substantially higher coverage rates in low-income, rural, low ethnic diversity, and low immigration communities, with much of that coverage taking the form of high speed (broadband) provision through fiber or fixed wireless technologies. They also offer higher broadband speeds in these communities. In fact, the overall difference between for-profit and cooperative provision in speed of provision comes largely from the substantial difference in the quality of service in rural, low-income, and more socially cohesive communities; in other communities for-profits' generally provide higher speeds than cooperatives. These patterns are entirely consistent with our comparative governance logic, with cooperatives predominantly serving areas where for-profit provision is weak, and providing higher quality service when they do so.

Main findings

Table 4 reports our results for H1. We begin by looking at cooperative provision in the cross-section, with models M1 and M2 showing results from between effects regression. M1 is our baseline regression with a full set of controls, and M2 adds our main predictor *for-profit internet mean speed*. Consistent with our theory, these models show a negative and significant association between the quality of for-profit provision and cooperative presence (β=-0.0104, p<0.001). In terms of economic magnitude, M2 implies that one standard deviation difference in for-profit upload speeds between census tracts is associated with a 1.32 percentage point difference in the probability of cooperative presence between them, which is about 18% of the sample mean. M1 and M2 also show that cooperatives are more likely to be present in rural census tracts with low average incomes and low ethnic fragmentation. While we did not explicitly hypothesize these relationships, they are consistent with our theoretical arguments.

M3 and M4 in Table 4 show our main results, including census tract fixed effects. As with M2, we find a negative and significant coefficient for *for-profit internet mean speed* (p<0.001) in M4. The results in M4 thus strongly confirm a negative association between *for-profit internet mean speed* and *Coop*, with cooperatives being more likely to enter census tracts where speed of for-profit provision is declining, supporting H1. In terms of economic significance, based on the point estimate of M4, a one standard deviation decrease in *for-profit internet mean speed* is associated with a 0.29 percentage point increase in *Coop* (a 51% increase over the average annual increase in *Coop* in a single year of 0.57 percentage points).

Models M5 and M6 report the first and second stage of the IV regressions. Model M5 shows the results of the first stage predicting *for-profit internet mean speed*. It shows a strong and significant relationship between % *CAF funded areas x post year 2015* and *for-profit internet mean speed* (β = -0.9982, p <0.001), confirming the relevance of *CAF funded areas x after 2015* as an instrument. Model M6 then reports the second stage result of our IV specification and shows a negative and significant coefficient for our instrumented measure (β = -0.088, p <0.001). Overall, the results in Table 4 lend strong support to our main hypothesis (H1), showing that the presence of cooperatives is negatively related to the quality of for-profit provision.

Insert Tables 4 and 5 about here

Moderating roles of low-income, rurality, and social cohesion

Next, we turn to consider the factors moderating this main result. We test our moderating hypotheses using a split sample approach since our moderators are either entirely time invariant (e.g., rural vs. urban) or vary little with time (Shaver, 2019). Table 5 shows the results of running our within-effects regressions in split samples corresponding to our hypotheses[22]. Specifically, H2 predicted that the negative association between the quality of for-profit provision and cooperative presence would be stronger in low-income communities. M7a and M7b in Table 5 find a negative and significant coefficient for *for-profit internet mean speed* in both high-income (β=-0.0021, $p<0.001$) and low-income communities (β=-0.0018, $p<0.001$). The p-value of a t-test comparing the coefficients is 0.39, suggesting that the two coefficients are not statistically different from each other. Thus, H2 is not supported.

H3 predicted that the negative association between the quality of for-profit broadband provision and cooperative presence will be stronger in rural communities than in urban communities. While M8a and M8b both show a negative and significant coefficient for *for-profit internet mean speed,* the size of the coefficient is much greater in rural communities (β=-0.0029, $p<0.001$) than in urban communities (β=-0.0009, $p<0.001$), with the p-value of a t-test comparing the coefficients being less than 0.001, offering strong support for H3. The negative relation between declining quality of for-profit provision and cooperative entry in our main analysis is substantially stronger in rural communities.

H4a predicted that the negative association between the quality of for-profit broadband provision and cooperative presence will be stronger in less ethnically fragmented communities than in more ethnically fragmented communities, and H4b predicted a similar relationship for communities with lower immigration than those with higher immigration. M9a and M9b show a negative and significant coefficient for *for-profit internet mean speed* in both high ethnic diversity (β=-0.0014, $p<0.001$) and low ethnic diversity communities (β=-0.0031, $p<0.001$), with the latter being more negative than the former, consistent with H4a, with a significant difference

[22] Samples are split based on the rural/urban designation previously defined, and on median values of *log(Median HH income)*, *Ethnic diversity*, and *Immigration* in the sample.

between the two coefficients ($p<0.001$). M10a and M10b show a similar pattern for high immigration (β=-0.0016, $p<0.001$) and low immigration (β=-0.0028, p=<0.001) communities, with our relationship of interest being significantly stronger in low immigration than in high immigration communities ($p<0.001$), consistent with H4b. These results support our prediction that cooperatives shall be more effective in communities with greater social cohesion[23].

Insert Table 6 about here

Supplementary analyses and robustness

Technology of for-profit provision. We run several supplementary analyses. First, we replace our main independent variable—*for-profit internet mean speed*—with a measure of the technology of for-profit provision, *% covered by high tech for-profit internet*, as an alternative measure of for-profit quality in Table 6. Table 6 provides results quite similar to those in Tables 4 and 5, with our new independent variable showing a negative and significant association with cooperative presence in both within-effects OLS (M11) and instrumental variable (M13) regressions (consistent with H1), and this association being stronger in rural communities than in urban communities (M16a-b, in line with H3), and in communities with low immigration compared to those with high immigration (M18a-b, in line with H4b). In addition, Table 6 also shows results that are directionally in line with H4a, with the coefficient for *% covered by high tech for-profit internet* being more negative in communities with low ethnic fragmentation than those with high ethnic fragmentation (M17a-b), though the difference between the two coefficients is not significant at conventional levels (p=0.1522). Further, models M12 and M14 in Table 6 use an alternative dependent variable *High-tech coop*, which takes the value 1 if a cooperative provides broadband in the community using a high speed technology (fiber or fixed wireless), with M12 showing the results for a fixed effects OLS and M14 showing the second stage of our IV 2SLS specification. As with our main dependent variable, we see a negative and significant association of this

[23] In unreported supplementary analyses we also run a four-way split distinguishing between urban and rural communities with high and low ethnic communities and (separately) high and low immigration levels. Interestingly, we find that the negative association of interest is strongest in rural communities with low ethnic diversity.

measure with high-tech for-profit presence, implying that not only are cooperatives more likely to enter markets where for-profit provision is low quality (primarily DSL or cable), they are likely to do so with higher quality technologies. Appendix 2 reports additional results using this alternative measure, as well as the use of a continuous measure of cooperative quality. These results imply that cooperatives tend to upgrade the quality of internet provision in the communities they enter, providing high speed service using high quality technologies in areas where for-profit provision is basic at best.

Income. To further explore the role of income as a moderating variable (H2), we run supplementary analyses in Table 7. Specifically, we divide the sample by income quartiles and run split sample analysis using the same specification as in Table 5, M7. In models M19a-d and models 21a-d we find that the negative association between both our measures of for-profit internet quality and cooperative entry is stronger for communities with median income levels at 25% -75% of the sample and weaker for communities in the top and bottom income quartiles. While this is not what we hypothesized, the fact that the relationship is weaker in the highest income communities than in those with medium income levels is consistent with our theory. It may be that in the poorest communities even the internalization of the community benefits of broadband by the cooperatives may be insufficient to justify the investment in high speed technologies, so such communities may have to rely on poor quality (for-profit) provision.

Next, we consider an alternative measure of community income: the community's status as a persistent poverty county (PPC)[24]. As Table 2 shows, the correlation between PPC status and median income levels is relatively modest, suggesting that in many communities moderate to high median income levels may mask substantial inequalities in income distribution. We can thus think of PPC status as being a marker of structural inequality in a community, with such communities (or groups within such communities) having the potential to benefit substantially

24 Persistent Poverty Counties (PPCs) are defined as those that have had 20 percent or more of their population living in poverty over the past 30 years (American Recovery and Reinvestment Act of 2009 (ARRA, P.L. 111-5)).

from the bounded externalities of broadband provision. Models 20a-b and 22a-b run split sample analysis based on PPC status using *for-profit internet mean speed* and *% covered by high tech for-profit internet* as the main predictors, respectively. We find that the relationship between the quality of for-profit provision and cooperative presence is more negative for PPCs than non-PPCs, with the difference between the two being strongly significant in M20a-b ($p<0.001$) though not in M22a-b ($p=0.45$). Taken together, we see the results in Table 7 as offering partial support for H2: while cooperatives do not necessarily compensate for low quality for-profit provision in communities with the lowest average household income, they are more likely to do so in communities with moderate rather than high average incomes, and in communities with persistently high poverty rates.

Insert Tables 7 and 8 about here

Municipal providers. While we have focused on the comparative advantage of cooperatives relative to for-profit firms as ISPs, municipal providers are another organizational form providing broadband access, one that might also be expected to care about the non-excludable community benefits from broadband provision. To understand the provision of internet services by municipal governments, we run analyses on municipal provider entry in Table 8. We find some evidence of a negative association between for-profit provision quality and municipal provider presence, though only with our speed-based measure of for-profit quality (Panel A). More interestingly, Table 8 shows strong and consistent evidence for a negative association between for-profit quality and municipal provision in high-income, urban areas with high ethnic fragmentation and high immigration levels, with no evidence of such an association in low-income, rural, or more socially cohesive areas; i.e. the opposite of the pattern of moderations we see with cooperatives. These results suggest a diverging pattern of infrastructure governance, with cooperatives taking up the slack for for-profits in rural and low-income communities, while municipal providers do so in urban and high-income communities, perhaps because that is where municipal governments are strongest, or, in some cases, because regulations prohibit them from entering rural markets[25] (Skiti, 2020b).

Discussion

Our study sheds new light on the role of cooperatives in providing infrastructure to marginalized communities. We find that cooperatives are more likely to enter communities that are underserved by for-profit providers, in the sense that for-profit internet provision in these communities is relatively slow and based on lower speed technologies, and that this association is stronger in rural communities and in communities with moderate income levels, and weaker in communities with high ethnic diversity or high immigration rates. These results are robust to the use of an instrumental variable approach to improve identification, and supplementary analyses suggest that when cooperatives enter communities with low quality for-profit provision they tend to do so with more advanced technologies (fixed wireless or fiber) and offer higher speeds, thus raising the quality of internet access in communities that receive only basic service from for-profit ISPs. Supplementary analyses also suggest that these patterns are distinct from those for municipal internet providers, who may also serve communities with weak for-profit provision, but do so primarily in high-income or urban communities, potentially with lower social cohesion.

These findings contribute to our understanding of firm strategy at the intersection of public and private interests (Mahoney et al., 2009; Cabral et al., 2019). Recent work in this area has stressed the need for a comparative governance approach to dealing with societal 'grand challenges', arguing that we need to systematically examine the institutional arrangements that are most effective and efficient at dealing with these challenges (Kaul & Luo, 2018; Luo & Kaul, 2019; Klein et al., 2019; Lazzarini, 2019). Our study complements and extends this work by examining the benefits and costs of two distinct governance arrangements—cooperatives and for-profits—in infrastructure provision. We make a theoretical contribution by clearly delineating the nature of

[25] In recent years, around 20 states have passed regulation limiting municipal providers from providing broadband services outside their city jurisdictions, often modeled on a draft bill created by the American Legislative Exchange Council (ALEC). Further, a recent federal court ruling (State of Tennessee et al. vs. FCC et al., 2016) upheld the state's rights to limit municipal provision in this way.

infrastructure provision as an economic activity, linking the characteristics of this activity to the governance forms best suited to handling it, and developing a general theory for the conditions under which either cooperatives or for-profits will be the comparatively efficient organizational form for providing infrastructure (Luo & Kaul, 2019). We also make an empirical contribution by testing our theoretical predictions in the context of internet broadband provision. Not only do we provide large sample evidence in support of our theory, we also offer one of the first empirical studies looking at public-private interests from a comparative governance lens, thus complementing a stream of hitherto theoretical work in this area (Luo & Kaul, 2019; Klein et al., 2019; Lazzarini, 2019). In doing so, we also offer new insights into the role of cooperatives, moving past the factors that make cooperatives successful—such as external community level influences (Ingram & Simons, 2000; Simons & Ingram, 2003; Boone & Ozcan, 2014) or internal tensions (Yue et al., 2013)—to develop a theoretical account of the comparative advantage of cooperatives as an organizational form (Hansmann, 1996; Hart & Moore, 1996; 1998; Luo & Kaul, 2019).

Our theory and findings also speak to an ongoing policy debate about infrastructure provision. While the critical role of infrastructure in enabling economic development is well understood, there remains considerable disagreement as to how that objective is best accomplished. While some favor large investments by the state, others believe that the provision of infrastructure is best entrusted to the private sector. Our study highlights the existence of a third option: the use of local cooperatives (Ostrom, 1990). More specifically, it suggests that cooperatives may be especially effective in driving high quality infrastructure provision in marginalized (often rural) areas, where the gains from infrastructure provision come primarily from the positive externalities generated for the local community, and where for-profit firms may therefore have limited incentive to invest. This is especially important because it is precisely the divide between such marginalized communities and more prosperous ones that is often the focus of concern, especially in the context of digital inequality (DiMaggio et al., 2001; Council of Economic Advisers, 2016; Seamans, 2018; Greenstein, 2019).

As with any study, our work has several limitations. First, while we believe the FCC data we use to test our theoretical arguments offer the most comprehensive measurement of internet provision in the US available over time, we recognize and acknowledge that these data are far from perfect. The speeds reported in these data are listed speeds rather than actual speeds, and the FCC counts a census block as 'covered' if even one household in the block receives service. Our data thus suffer from substantial measurement error, which makes our results potentially noisy, though we see no reason why it would bias in favor of our predictions. Second, our empirical analyses focus primarily on cooperative presence (as well as their choice of technology); we do not examine how for-profits react to cooperative presence (Seamans, 2012; Skiti, 2020a) or the evolving nature of competition between them: questions worth exploring in future work. Future work could also look further into the role of regulatory and normative institutions (Skiti, 2020b) in driving heterogeneity of cooperative presence across regions.

To conclude, we take a comparative governance approach to infrastructure provision and ask: when are cooperatives better at providing infrastructure than for-profit firms? We argue that this is the case when the direct revenues from infrastructure provision are relatively low compared to costs, so for-profit firms have little incentive to invest in high quality provision. In such cases, cooperatives may be more willing to provide high quality infrastructure because, being owned and controlled by users, they are able to internalize the externalities generated for the community by high quality infrastructure. We test these arguments in the context of internet broadband provision, showing that cooperatives are more likely to enter communities where the existing for-profits offer low quality internet access, with this relationship being stronger for rural communities and for communities with low social cohesion, and being robust to accounting for the endogeneity of low quality for-profit provision. Our study thus contributes to a growing body of work on strategies at the intersection of public and private interests, highlighting the potential role of cooperatives in effectively providing high quality infrastructure in otherwise marginalized areas.

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Figure 1a: For-profit vs. Cooperative Infrastructure Provision

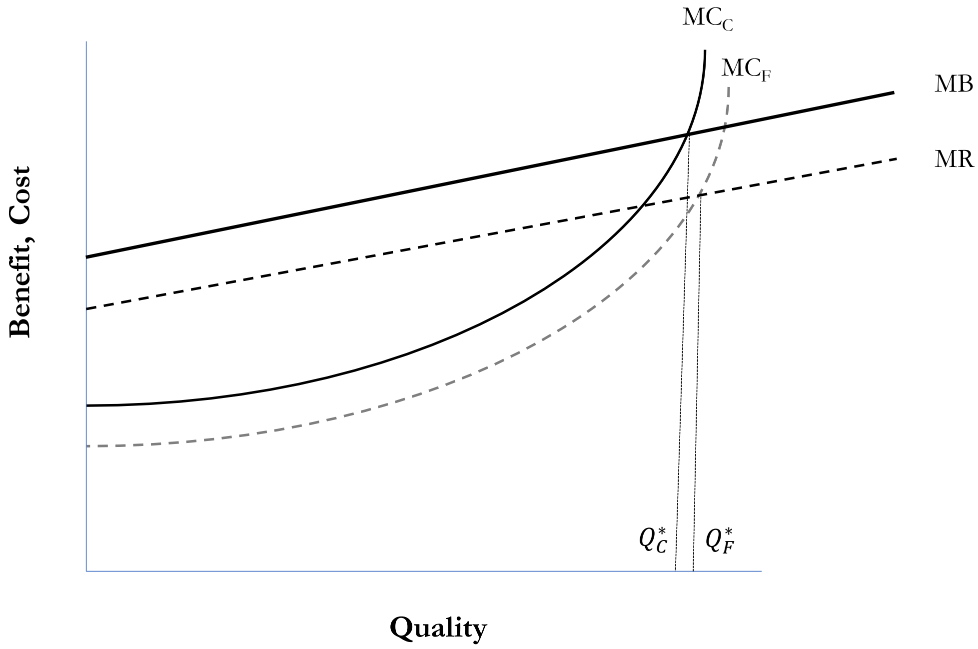


Figure 1b: Moderating Effect of Willingness to Pay

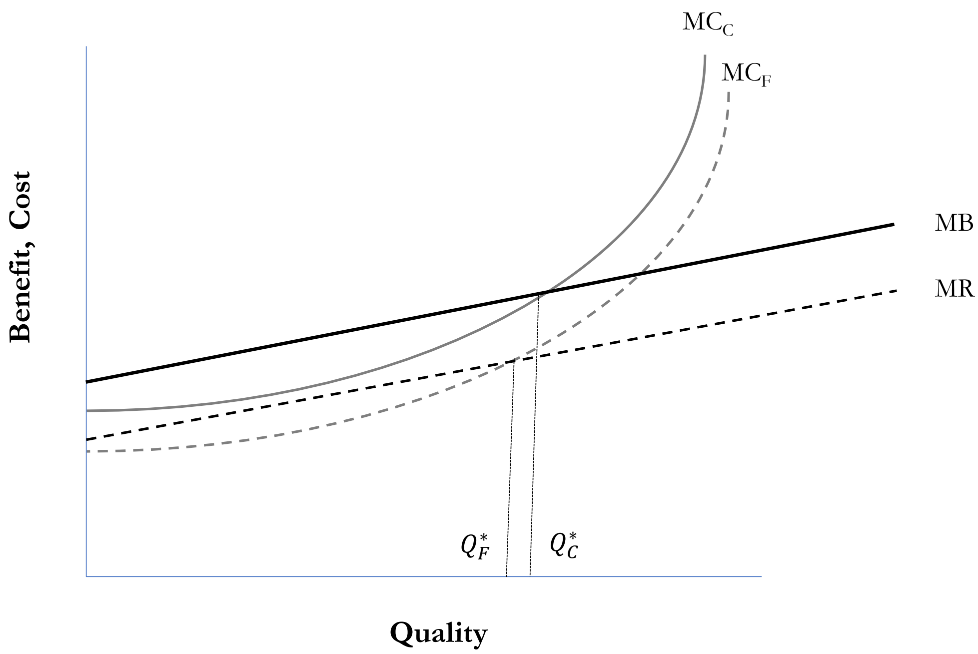


Figure 1c: Moderating Effect of Cost of Provision

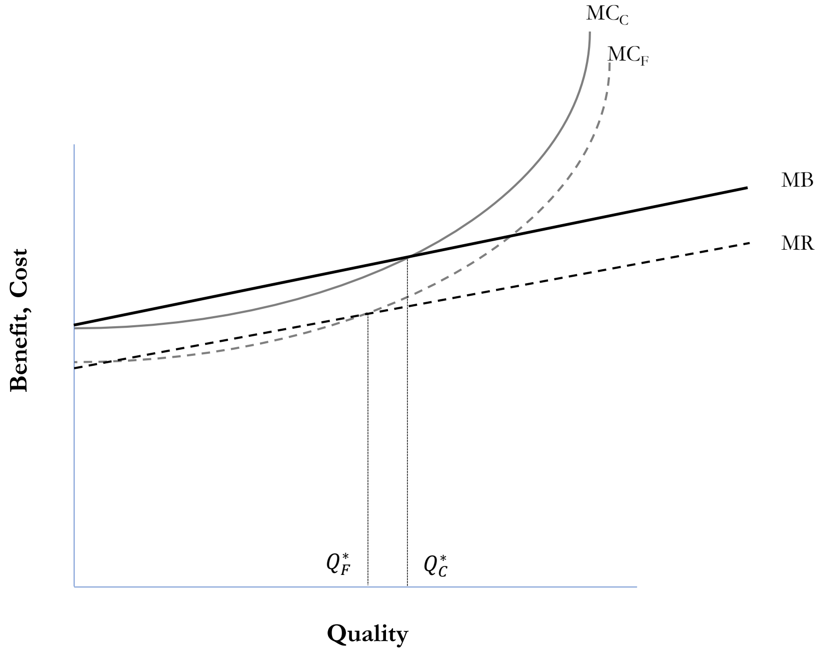


Figure 1d: Moderating Effect of Cost of Cooperative Governance

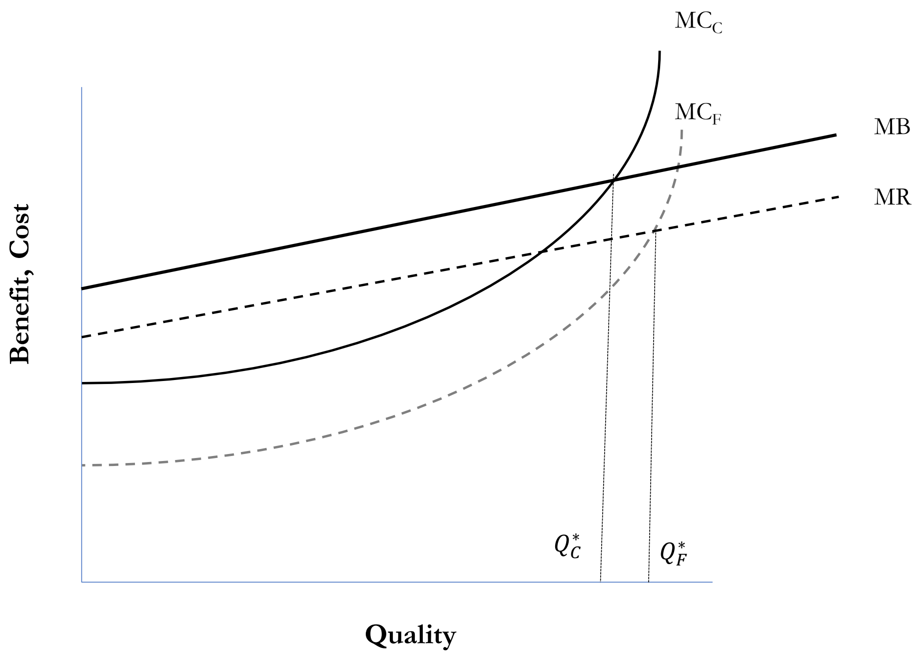
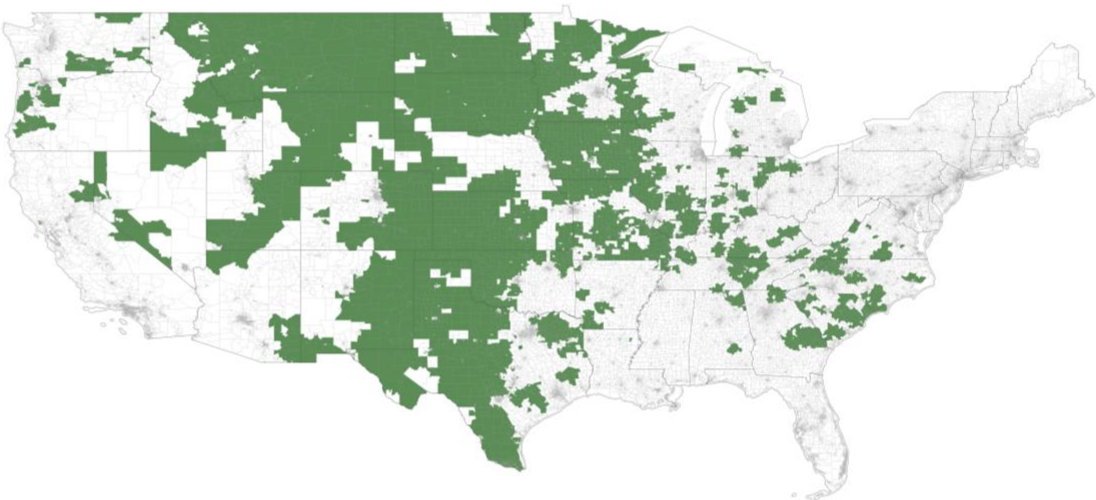


Figure 2. Census Tracts where Cooperatives Provide Internet Service in 2017



Notes: Generated using QGIS with December 2017 FCC broadband availability data (aggregated at census tract level).

Table 1. Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Coop	0.0727	0.2597	0	1
For-profit internet mean speed	1.0047	1.2737	0	10
log(Median HH income)	10.9409	0.4770	8.0388	12.4292
Rural	0.3770	0.4846	0	1
Ethnic diversity	0.3872	0.2038	0	0.8265
Immigration	0.0060	0.0119	0	0.3750
log(Population)	8.2795	0.4894	2.8332	11.0903
Unemployment rate	0.0513	0.0313	0	0.7410
% population above 65	0.1360	0.0838	0	0.9330
% population with bachelor degree or higher	0.2879	0.1862	0	1
% Native Americans	0.0084	0.0440	0	1
Muni. gov.	0.0326	0.1775	0	1
The number of for-profit providers	5.9604	2.7706	0	32
Areas with for-profit business services	1.1262	1.2782	0	22.84
IV: CAF funded areas x after 2015	0.0129	0.0485	0	0.6944
% covered by high tech for-profit internet	0.5794	0.4253	0	1
High tech coop	0.0631	0.2432	0	1
Persistent Poverty Counties (PPC)	0.0718	0.2581	0	1
Coop internet mean speed	1.4753	3.0811	0	10

Notes: N=285,320.

Table 2. Correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1 Coop	1																		
2 For-profit internet mean speed	-0.0717	1																	
3 log(Median HH income)	-0.0593	0.1619	1																
4 Rural	0.2738	-0.1406	0.0251	1															
5 Ethnic diversity	-0.1655	0.0707	-0.0449	-0.38	1														
6 Immigration	-0.0658	0.0687	0.0115	-0.1892	0.2513	1													
7 log(Population)	-0.0371	-0.0134	0.2015	0.0737	0.1236	0.0272	1												
8 Unemployment rate	-0.1084	-0.0565	-0.495	-0.1941	0.1637	-0.0131	-0.0944	1											
9 % population above 65	0.0585	-0.033	0.0209	0.1472	-0.2761	-0.106	-0.1601	-0.1902	1										
10 % population with bachelor degree or higher	-0.1265	0.1464	0.7078	-0.1967	0.0687	0.2351	0.0827	-0.3829	0.0547	1									
11 % Native Americans	0.0631	-0.0445	-0.0732	0.0913	0.0577	-0.0202	-0.0391	0.0724	-0.0329	-0.0838	1								
12 Muni. gov.	0.0356	-0.0352	-0.0436	0.0765	-0.0217	-0.0146	0.0337	-0.0161	0.002	-0.0271	0.0061	1							
13 The number of for-profit providers	-0.0887	0.1386	0.1083	-0.1621	0.1695	0.1407	0.1867	-0.0653	-0.085	0.2194	-0.0732	-0.0107	1						
14 Areas with for-profit business services	0.2624	-0.0129	-0.0337	0.4634	-0.2474	-0.1255	0.1328	-0.1367	0.1009	-0.1721	0.1218	0.0454	0.0726	1					
15 IV: CAF funded areas x after 2015	0.0349	-0.068	-0.0403	0.3099	-0.1535	-0.0756	-0.0232	-0.057	0.0423	-0.1371	0.0335	0.045	-0.0903	0.1585	1				
16 % covered by high tech for-profit internet	-0.0777	0.4552	0.1466	-0.2281	0.1229	0.0555	0.0335	-0.0519	-0.0811	0.1288	-0.0326	-0.0716	0.3246	0.0717	-0.0957	1			
17 High tech coop	0.926	-0.062	-0.0532	0.2498	-0.1563	-0.0586	-0.0343	-0.108	0.0549	-0.115	0.0528	0.0308	-0.0811	0.2434	0.0289	-0.0709	1		
18 Persistent Poverty Counties (PPC)	0.0586	-0.0012	-0.1935	0.0395	0.0021	0.0028	-0.0583	0.0974	-0.0429	-0.1009	0.1062	0.0135	-0.1145	-0.0091	0.0862	-0.0352	0.06	1	
19 Coop internet mean speed	0.4676	-0.0415	-0.0307	0.1417	-0.0901	-0.0343	0.0019	-0.0498	0.0404	-0.0601	0.0213	0.0294	-0.0445	0.0984	0.0656	-0.0549	0.4981	0.0265	1

Table 3a. Broadband Coverage by Organizational Forms

	For-profit		Cooperatives		Muni. gov.		Total
	All	High tech	All	High tech	All	High tech	census tracts
High-income	99.90%	92.61%	5.65%	5.02%	2.53%	2.12%	142,664
Low-income	99.81%	86.56%	9.94%	8.71%	3.98%	2.96%	142,656
Urban	100.00%	91.56%	2.06%	1.89%	2.20%	1.87%	177,746
Rural	99.61%	86.32%	17.27%	15.09%	5.00%	3.65%	107,574
High-ethnic diversity	99.94%	90.86%	4.32%	3.74%	2.91%	1.89%	142,659
Low-ethnic diversity	99.77%	88.31%	11.27%	9.99%	3.60%	3.19%	142,661
High-immigration	99.94%	91.53%	5.24%	4.69%	3.05%	2.37%	138,475
Low-immigration	99.77%	87.75%	10.20%	8.92%	3.45%	2.70%	146,845
Total	99.85%	89.59%	7.79%	6.87%	3.26%	2.54%	285,320

Notes: Table shows internet coverage by organizational forms at the census-tract level. Specifically, the cells report for each subsample, the percentage of census tracts with any tech type of internet coverage (All) and high tech internet coverage (High tech) by at least one provider of the focal organizational form. High tech is defined as Terrestrial wireless and Fiber-to-the-end-user (see Appendix 1).

Table 3b. Broadband Speed by Organizational Forms

	For-profit	Cooperative	Muni.gov.
High-income	115.68	122.60	401.27
Low-income	85.24	161.72	323.77
Urban	114.25	107.55	479.37
Rural	77.61	155.39	262.75
High-ethnic diversity	105.80	125.10	333.50
Low-ethnic diversity	95.13	156.13	370.46
High-immigration	109.66	130.11	400.02
Low-immigration	91.79	155.96	315.50
All	100.47	147.53	353.93

Notes: Table shows the quality of broadband coverage by organizational forms at the census-tract level. Specifically, the cells report for each subsample, the average upload speed (in Mbps) provided by the focal organizational form.

Table 4. Main Results

	DV: Coop				DV: For-profit internet mean speed	DV: Coop
	OLS Between M1	OLS Between M2	OLS Within M3	OLS Within M4	2SLS 1st stage M5	2SLS 2nd stage M6
For-profit internet mean speed		-0.0104		-0.0023		-0.0880
		(0.0000)		(0.0000)		(0.0000)
log(Median HH income)	-0.0434	-0.0391	0.0163	0.0175	0.5270	0.0626
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.000)	(0.0000)
Rural	0.0743	0.0714				
	(0.0000)	(0.0000)				
Ethnic diversity	-0.0559	-0.0565	-0.0009	-0.0001	0.3238	0.0285
	(0.0000)	(0.0000)	(0.8565)	(0.9787)	(0.000)	(0.0008)
Immigration	0.2377	0.2730	-0.0012	-0.0020	-0.3615	-0.0321
	(0.0068)	(0.0019)	(0.9576)	(0.9296)	(0.398)	(0.4613)
log(Population)	-0.0275	-0.0295	-0.0099	-0.0103	-0.1651	-0.0232
	(0.0000)	(0.0000)	(0.0058)	(0.0043)	(0.001)	(0.0001)
Unemployment rate	-1.1459	-1.1295	0.0581	0.0635	2.3596	0.2645
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.000)	(0.0000)
% population above 65	-0.1015	-0.1162	0.0201	0.0239	1.6787	0.1681
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.000)	(0.0000)
% population with bachelor degree or higher	-0.0587	-0.0581	-0.0356	-0.0352	0.1402	-0.0217
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.158)	(0.0504)
% Native Americans	0.1418	0.1337	0.0757	0.0763	0.2627	0.0964
	(0.0000)	(0.0000)	(0.0654)	(0.0635)	(0.474)	(0.0637)
Muni. gov.	0.0158	0.0143	0.0074	0.0072	-0.0882	-0.0009
	(0.0023)	(0.0059)	(0.0792)	(0.0888)	(0.016)	(0.8766)
The number of for-profit providers	-0.0058	-0.0053	0.0016	0.0018	0.0840	0.0089
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.000)	(0.0000)
Areas with for-profit business services	0.0363	0.0367	0.0013	0.0025	0.4962	0.0442
`	(0.0000)	(0.0000)	(0.2400)	(0.0370)	(0.000)	(0.0000)
IV: % CAF funded area * post year 2015					-0.9982	
					(0.000)	
Constant	0.8936	0.8677	-0.0224	-0.0328		
	(0.0000)	(0.0000)	(0.5273)	(0.3562)		
Observations	285,320	285,320	285,320	285,320	285,197	285,197
Number of censustractid	71,558	71,558	71,558	71,558	71,435	71,435
R-squared(between)	0.130	0.131	0.0099	0.0203		
R-squared(overall)	0.110	0.110	0.0084	0.0163		
Kleibergen-Paap rk Wald F-statistic					313.64	
Cragg-Donald Wald F statistic					199.98	
Endogeneity test of endogenous regressors[P-val]					64.474[0.0000]	

Notes: Robust standard errors are clustered at the census tract level. P-values are shown in parentheses. Stock-Yogo weak ID test critical value at 10% maximal IV size is 16.38.

Table 5. Moderation Results

	DV: coop							
	High income	Low income	Urban	Rural	High ethnic diversity	Low ethnic diversity	High immigration	Low immigration
	M7a	M7b	M8a	M8b	M9a	M9b	M10a	M10b
For-profit internet mean speed	-0.0021	-0.0018	-0.0009	-0.0029	-0.0014	-0.0031	-0.0016	-0.0028
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
log(Median HH income)			0.0059	0.0466	0.0109	0.0223	0.0126	0.0233
			(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Ethnic diversity	0.0008	-0.0001	0.0010	0.0067			-0.0000	-0.0003
	(0.9048)	(0.9844)	(0.7772)	(0.5920)			(0.9964)	(0.9728)
Immigration	-0.0125	-0.0038	0.0234	-0.0500	-0.0234	0.0784		
	(0.6628)	(0.9145)	(0.2450)	(0.5805)	(0.3163)	(0.1762)		
log(Population)	-0.0038	-0.0079	-0.0079	-0.0080	-0.0107	-0.0012	-0.0040	-0.0115
	(0.5122)	(0.0858)	(0.0021)	(0.3605)	(0.0049)	(0.8615)	(0.3677)	(0.0416)
Unemployment rate	0.1003	0.0544	0.0158	0.0827	0.0460	0.0630	0.0442	0.0820
	(0.0000)	(0.0009)	(0.0907)	(0.0319)	(0.0018)	(0.0059)	(0.0071)	(0.0000)
% population above 65	0.0147	0.0176	0.0078	0.0505	-0.0011	0.0446	0.0129	0.0357
	(0.0000)	(0.0017)	(0.0001)	(0.0000)	(0.8349)	(0.0000)	(0.0013)	(0.0000)
% population with bachelor degree or higher	-0.0118	-0.0295	-0.0130	-0.0695	-0.0243	-0.0474	-0.0294	-0.0371
	(0.1731)	(0.0078)	(0.0119)	(0.0005)	(0.0008)	(0.0003)	(0.0004)	(0.0021)
% Native Americans	0.0209	0.1070	0.0296	0.0958			0.0709	0.0760
	(0.7498)	(0.0429)	(0.3261)	(0.2569)			(0.1985)	(0.2079)
Muni. gov.	0.0079	0.0062	0.0026	0.0076	0.0007	0.0120	0.0050	0.0091
	(0.0841)	(0.3596)	(0.2761)	(0.2927)	(0.8136)	(0.0837)	(0.4018)	(0.1324)
The number of for-profit providers	0.0019	0.0015	0.0006	0.0012	0.0009	0.0026	0.0015	0.0018
	(0.0000)	(0.0000)	(0.0000)	(0.0080)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Areas with for-profit business services	-0.0016	0.0043	0.0007	0.0001	0.0020	0.0023	0.0002	0.0030
	(0.4653)	(0.0009)	(0.7320)	(0.9549)	(0.0668)	(0.1749)	(0.9336)	(0.0391)
Test of differences across split samples[P-val]:	0.74[0.3904]		38.56[0.0000]		36.84[0.0000]		17.28[0.0000]	
Constant	0.0833	0.1545	0.0195	-0.2671	0.0156	-0.1299	-0.0522	-0.0652
	(0.0874)	(0.0000)	(0.4629)	(0.0038)	(0.6666)	(0.0497)	(0.2553)	(0.2307)
Observations	142,664	142,656	177,746	107,574	142,659	142,661	138,475	146,845
Number of censustractid	35,710	35,848	44,623	26,935	35,698	35,860	34,746	36,812
R-squared(overall)	0.0015	0.0167	0.0001	0.0003	0.0106	0.0081	0.0029	0.0136

Notes: OLS fixed effects regression. Year fixed effects and census tract fixed effects are included. Robust standard errors are clustered at the census tract level. P-values are shown in parentheses.

Table 6. Supplementary Analyses on Technology Choice

	DV: Coop	DV: High tech coop	DV: Coop	DV: High tech coop	DV: Coop							
	Full sample analyses				Subsample analyses using OLS fixed effects							
	OLS Within	OLS Within	2SLS 2nd stage	2SLS 2nd stage	High income	Low income	Urban	Rural	High ethnic diversity	Low ethnic diversity	High immigration	Low immigration
	M11	M12	M13	M14	M15a	M15b	M16a	M16b	M17a	M17b	M18a	M18b
% covered by high tech for-profit internet	-0.0056	-0.0073	-0.8051	-0.8106	-0.0047	-0.0055	-0.0013	-0.0105	-0.0047	-0.0069	-0.0038	-0.0070
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0280)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
Test of differences across split samples[P-val]:					0.24[0.6275]		20.47[0.0000]		2.05[0.1522]		4.10[0.0429]	
Constant	-0.0208	-0.0188			0.0734	0.1558	0.0247	-0.2625	0.0229	-0.1150	-0.0461	-0.0486
	(0.5570)	(0.6792)			(0.1320)	(0.0000)	(0.3521)	(0.0044)	(0.5278)	(0.0816)	(0.3162)	(0.3698)
Observations	285,320	285,320	285,197	285,197	142,664	142,656	177,746	107,574	142,659	142,661	138,475	146,845
Number of censustractid	71,558	71,558	71,435	71,435	35,710	35,848	44,623	26,935	35,698	35,860	34,746	36,812
R-squared(overall)	0.0183	0.0173			0.0032	0.0185	0.000001	0.0004	0.0161	0.0073	0.0039	0.0151
Cragg-Donald Wald F statistic			43.44									
Kleibergen-Paap Wald rk F statistic			49.73									
Endogeneity test of endogenous regressors[P-val]			66.989[0.0000]	64.549[0.0000]								

Notes: All control variables are included. Year fixed effects and census tract fixed effects are included. Robust standard errors are clustered at the census tract level. P-values are shown in parentheses. Stock-Yogo weak ID test: critical value at 10% maximal IV size is 16.38.

Table 7. Supplementary Analyses on Income

	DV: Coop											
	Median HH income				Non-PPC	PPC	Median HH income				Non-PPC	PPC
	(1): >75%	(2): 50-75%	(3): 25-50%	(4) : <25%			(1): >75%	(2): 50-75%	(3): 25-50%	(4) : <25%		
	M19a	M19b	M19c	M19d	M20a	M20b	M21a	M21b	M21c	M21d	M22a	M22b
For-profit internet mean speed	-0.0008	-0.0026	-0.0028	-0.0008	-0.0020	-0.0041						
	(0.0210)	(0.0000)	(0.0000)	(0.0079)	(0.0000)	(0.0000)						
% covered by high tech for-profit internet							-0.0001	-0.0074	-0.0099	-0.0015	-0.0053	-0.0082
							(0.9583)	(0.0000)	(0.0000)	(0.2562)	(0.0000)	(0.0254)
Test of differences across split samples[P-val]:												
(1)&(2)		17.27[0.0000]			13.21[0.0003]			8.12[0.0044]			0.57[0.4500]	
(2)&(3)		0.19[0.6649]						1.13[0.2875]				
(3)&(4)		22.36[0.0000]						14.27[0.0002]				
(1)&(3)		18.55[0.0000]						12.32[0.0004]				
(1)&(4)		0.00[0.9548]						0.31[0.5802]				
(2)&(4)		21.37[0.0000]						9.29[0.0023]				
Constant	0.1734	0.1385	0.1397	-0.0533	0.1372	0.1637	0.1747	0.1354	0.1336	-0.0631	0.1362	0.1884
	(0.0000)	(0.0532)	(0.0704)	(0.3282)	(0.0000)	(0.0359)	(0.0000)	(0.0590)	(0.0838)	(0.2486)	(0.0000)	(0.0152)
Observations	71,332	71,332	71,332	71,324	264,846	20,474	71,332	71,332	71,332	71,324	264,846	20,474
Number of censustractid	17,864	17,846	17,859	17,989	66,413	5,145	17,864	17,846	17,859	17,989	66,413	5,145
R-squared(overall)	0.00006	0.0477	0.00005	0.0402	0.0149	0.0504	0.00005	0.0527	0.00007	0.0427	0.0161	0.0451

Notes: OLS fixed effects regressions. All control variables are included. Year fixed effects and census tract fixed effects are included. Robust standard errors are clustered at the census tract level. P-values are shown in parentheses. PPC refers to Persistent Poverty Counties and are defined as any county that has had 20 percent or more of its population living in poverty over the past 30 years.

Table 8. Supplementary Analyses on Municipal Government Provision

	DV: Muni. gov.								
	Panel A								
	Full sample	Subsample analyses using OLS fixed effects							
	OLS within	High income	Low income	Urban	Rural	High ethnic diversity	Low ethnic diversity	High immigration	Low immigration
	M23	M24a	M24b	M25a	M25b	M26a	M26b	M27a	M27b
For-profit internet mean speed	-0.0003	-0.0007	0.0004	-0.0007	0.0006	-0.0007	-0.000002	-0.0006	-0.0001
	(0.0123)	(0.0000)	(0.1302)	(0.0000)	(0.0317)	(0.0000)	(0.9910)	(0.0003)	(0.7754)
Test of differences across split samples[P-val]:		13.83[0.0002]		18.51[0.0000]		7.02[0.0081]		4.61[0.0318]	
Constant	0.0049	-0.0607	0.0248	-0.0246	0.0870	-0.0168	0.0305	-0.0129	0.0226
	(0.8495)	(0.1092)	(0.3505)	(0.4174)	(0.0688)	(0.6552)	(0.3529)	(0.7375)	(0.5019)
Observations	285,320	142,664	142,656	177,746	107,574	142,659	142,661	138,475	146,845
Number of censustractid	71,558	35,710	35,848	44,623	26,935	35,698	35,860	34,746	36,812
R-squared(overall)	0.0040	0.0023	0.0021	0.000006	0.0033	0.0016	0.0017	0.0031	0.0026
	Panel B								
	Full sample	Subsample analyses using OLS fixed effects							
	OLS within	High income	Low income	Urban	Rural	High ethnic diversity	Low ethnic diversity	High immigration	Low immigration
	M28	M29a	M29b	M30a	M30b	M31a	M31b	M32a	M32b
% covered by high tech for-profit internet	-0.0008	-0.0010	-0.0002	-0.0016	0.0030	-0.0026	0.0011	-0.0024	0.0007
	(0.1923)	(0.1977)	(0.7893)	(0.0045)	(0.0242)	(0.0001)	(0.2487)	(0.0045)	(0.4043)
Test of differences across split samples[P-val]:		0.47[0.4943]		10.17[0.0014]		10.33[0.0013]		6.67[0.0093]	
Constant	0.0066	-0.0650	0.0243	-0.0205	0.0866	-0.0131	0.0304	-0.0099	0.0230
	(0.7970)	(0.0859)	(0.3604)	(0.5001)	(0.0701)	(0.7284)	(0.3565)	(0.7959)	(0.4954)
Observations	285,320	142,664	142,656	177,746	107,574	142,659	142,661	138,475	146,845
Number of censustractid	71,558	35,710	35,848	44,623	26,935	35,698	35,860	34,746	36,812
R-squared(overall)	0.0044	0.0024	0.0025	0.0001	0.0024	0.0035	0.0014	0.0045	0.0021

Notes: All control variables are included. Year fixed effects and census tract fixed effects are included. Robust standard errors are clustered at the census tract level. P-values are shown in parentheses.

Appendix 1. Technology Breakdown and Average Speed

Technology type	Avg. upload speed(Mbps)	Avg. download speed(Mbps)	% of the sample
ADSL2, ADSL2+	0.98	10.03	11.25
Asymmetric xDSL	1.27	7.08	13.8
VDSL	5.65	34.82	6.25
Cable Modem – DOCSIS 1, 1.1 or 2.0	8.39	38.21	0.89
Cable Modem – DOCSIS 3.0	13.66	122.51	22.28
Cable Modem – DOCSIS 3.1	18.73	484.77	2.16
Cable Modem other than DOCSIS 1, 1.1, 2.0, 3.0, or 3.1	23.16	194.23	0.36
Symmetric xDSL*	40.21	40.49	0.74
Other Copper Wireline (all copper-wire based technologies other than xDSL; Ethernet over copper and T-1 are examples)	48.09	50.14	2.05
Terrestrial Fixed Wireless	183.90	192.48	29.67
Optical Carrier / Fiber to the end user (Fiber to the home or business end user, does not include "fiber to the curb")	513.21	555.08	10.52

Notes: Other technology accounts for 0.03%. In our main analyses we classify Terrestrial wireless and Fiber-to-the-end-user as 'high tech', since they provide significantly higher symmetrical speeds than other technologies.

Appendix 2. Alternative DVs

DV: High tech coop

Panel A

	Full sample	Subsample analyses using OLS fixed effects							
	OLS within	High income	Low income	Urban	Rural	High ethnic diversity	Low ethnic diversity	High immigration	Low immigration
	M33	M34a	M34b	M35a	M35b	M36a	M36b	M37a	M37b
For-profit internet mean speed	-0.0029	-0.0025	-0.0023	-0.0009	-0.0037	-0.0018	-0.0038	-0.0019	-0.0035
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Test of differences across split samples[P-val]:		0.32[0.5732]		60.70[0.0000]		34.15[0.0000]		25.81[0.0000]	
Constant	-0.0338	0.0229	0.2358	0.0103	-0.2889	0.0400	-0.1669	-0.0478	-0.0902
	(0.4578)	(0.7037)	(0.0000)	(0.6957)	(0.0198)	(0.3665)	(0.0545)	(0.3305)	(0.2464)
Observations	285,320	142,664	142,656	177,746	107,574	142,659	142,661	138,475	146,845
Number of censustractid	71,558	35,710	35,848	44,623	26,935	35,698	35,860	34,746	36,812
R-squared(overall)	0.0151	0.0000002	0.0090	0.00002	0.0013	0.0122	0.0065	0.0081	0.0106

Panel B

	Full sample	Subsample analyses using OLS fixed effects							
	OLS within	High income	Low income	Urban	Rural	High ethnic diversity	Low ethnic diversity	High immigration	Low immigration
	M38	M39a	M39b	M40a	M40b	M41a	M41b	M42a	M42b
% covered by high tech for-profit internet	-0.0073	-0.0064	-0.0071	-0.0011	-0.0146	-0.0061	-0.0090	-0.0055	-0.0088
	(0.0000)	(0.0000)	(0.0000)	(0.0515)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Test of differences across split samples[P-val]:		0.17[0.6817]		39.09[0.0000]		3.23[0.0724]		4.31[0.0389]	
Constant	-0.0188	0.0116	0.2374	0.0152	-0.2835	0.0495	-0.1487	-0.0400	-0.0689
	(0.6792)	(0.8465)	(0.0000)	(0.5636)	(0.0222)	(0.2634)	(0.0863)	(0.4159)	(0.3744)
Observations	285,320	142,664	142,656	177,746	107,574	142,659	142,661	138,475	146,845
Number of censustractid	71,558	35,710	35,848	44,623	26,935	35,698	35,860	34,746	36,812
R-squared(overall)	0.0173	0.00002	0.0101	0.00004	0.0018	0.0169	0.0064	0.0114	0.0118

	DV: Coop internet mean speed								
	Panel C								
	Full sample	Subsample analyses using OLS fixed effects							
	OLS within	High income	Low income	Urban	Rural	High ethnic diversity	Low ethnic diversity	High immigration	Low immigration
	M43	M44a	M44b	M45a	M45b	M46a	M46b	M47a	M47b
For-profit internet mean speed	-0.0155	-0.0107	-0.0132	-0.0032	-0.0209	-0.0064	-0.0238	-0.0089	-0.0200
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Test of differences across split samples[P-val]:		1.23[0.2674]		53.92[0.0000]		68.75[0.0000]		27.75[0.0000]	
Constant	-0.9073	0.0823	0.7291	-0.4297	-2.9268	0.2308	-2.5326	-0.7538	-1.5903
	(0.0007)	(0.7778)	(0.0201)	(0.0193)	(0.0001)	(0.3951)	(0.0000)	(0.0232)	(0.0002)
Observations	285,320	142,664	142,656	177,746	107,574	142,659	142,661	138,475	146,845
Number of censustractid	71,558	35,710	35,848	44,623	26,935	35,698	35,860	34,746	36,812
R-squared(overall)	0.0042	0.0016	0.0040	0.0002	0.0005	0.0019	0.0037	0.0003	0.0040
	Panel D								
	Full sample	Subsample analyses using OLS fixed effects							
	OLS within	High income	Low income	Urban	Rural	High ethnic diversity	Low ethnic diversity	High immigration	Low immigration
	M48	M49a	M49b	M50a	M50b	M51a	M51b	M52a	M52b
% covered by high tech for-profit internet	-0.0301	-0.0297	-0.0236	0.0059	-0.0723	-0.0114	-0.0523	-0.0019	-0.0536
	(0.0000)	(0.0000)	(0.0108)	(0.1392)	(0.0000)	(0.0613)	(0.0000)	(0.7659)	(0.0000)
Test of differences across split samples[P-val]:		0.30[0.5815]		27.23[0.0000]		13.89[0.0002]		22.24[0.0000]	
Constant	-0.8287	0.0366	0.7409	-0.4126	-2.8893	0.2591	-2.4180	-0.7318	-1.4707
	(0.0020)	(0.9002)	(0.0183)	(0.0246)	(0.0001)	(0.3404)	(0.0000)	(0.0279)	(0.0005)
Observations	285,320	142,664	142,656	177,746	107,574	142,659	142,661	138,475	146,845
Number of censustractid	71,558	35,710	35,848	44,623	26,935	35,698	35,860	34,746	36,812
R-squared(overall)	0.0042	0.0020	0.0038	0.000004	0.0006	0.0019	0.0037	0.00006	0.0044

Notes: All control variables are included. Year fixed effects and census tract fixed effects are included. Robust standard errors are clustered at the census tract level. P-values are shown in parentheses.

Appendix 3. Analyses by Cooperative Type

Panel A

	DV: Telecom coop	DV: Electric coop	DV: Other coop	DV: All legacy coop	DV: Internet coop
	M53	M54	M55	M56	M57
For-profit internet mean speed	-0.0013	-0.0009	0.0001	-0.0023	-0.0001
	(0.0000)	(0.0000)	(0.0060)	(0.0000)	(0.0017)
Constant	0.0513	-0.0834	0.0233	-0.0417	-0.0022
	(0.0396)	(0.0003)	(0.1448)	(0.2312)	(0.8016)
Observations	285,320	285,320	285,320	285,320	285,320
Number of censustractid	71,558	71,558	71,558	71,558	71,558
R-squared(overall)	0.00005	0.0034	0.0004	0.0129	0.0008

Panel B

	DV: Telecom coop	DV: Electric coop	DV: Other coop	DV: All legacy coop	DV: Internet coop
	M58	M59	M60	M61	M62
% covered by high tech for-profit internet	-0.0034	-0.0022	0.0002	-0.0054	-0.0003
	(0.0000)	(0.0000)	(0.4283)	(0.0000)	(0.1949)
Constant	0.0582	-0.0786	0.0226	-0.0300	-0.0017
	(0.0191)	(0.0006)	(0.1568)	(0.3886)	(0.8520)
Observations	285,320	285,320	285,320	285,320	285,320
Number of censustractid	71,558	71,558	71,558	71,558	71,558
R-squared(overall)	0.0002	0.0034	0.0004	0.0145	0.0008

Notes: OLS fixed effects regression. All control variables are included. Year fixed effects and census tract fixed effects are included. Robust standard errors are clustered at the census tract level. P-values are shown in parentheses. Coops are categorized based on the service type that a coop is established to provide - telecommunication, electricity, internet, or others (cable, energy, and etc.) *All legacy coop* includes all coops except internet coops.

Appendix 4. Supplementary Analyses on Download Speed

	DV: Coop	DV: High tech coop	DV: Coop	DV: High tech coop	DV: Coop							
	Full sample analyses				Subsample analyses using OLS fixed effects							
	OLS Within	OLS Within	2SLS 2nd stage	2SLS 2nd stage	High income	Low income	Urban	Rural	High ethnic diversity	Low ethnic diveristy	High immigration	Low immigration
	M63	M64	M65	M66	M67a	M67b	M68a	M68b	M69a	M69b	M70a	M70b
For-profit internet mean speed	-0.0023	-0.0028	-0.0583	-0.0587	-0.0020	-0.0019	-0.0008	-0.0029	-0.0013	-0.0031	-0.0015	-0.0029
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Test of differences across split samples[P-val]:					0.09[0.7642]		47.36[0.0000]		43.25[0.0000]		26.28[0.0000]	
Constant	-0.0335	-0.0347			0.0838	0.1547	0.0209	-0.2732	0.0160	-0.1331	-0.0513	-0.0689
	(0.3451)	(0.4459)			(0.0857)	(0.0000)	(0.4328)	(0.0031)	(0.6580)	(0.0443)	(0.2641)	(0.2052)
Observations	285,320	285,320	285,197	285,197	142,664	142,656	177,746	107,574	142,659	142,661	138,475	146,845
Number of censustractid	71,558	71,558	71,435	71,435	35,710	35,848	44,623	26,935	35,698	35,860	34,746	36,812
R-squared(overall)	0.0169	0.0155			0.0018	0.0181	0.000001	0.0003	0.0104	0.0090	0.0026	0.0147
Cragg-Donald Wald F statistic			397.74									
Kleibergen-Paap Wald rk F statistic			674.83									
Endogeneity test of endogenous regressors[P-val]			62.881[0.0000]	59.723[0.0000]								

Notes: All control variables are included. Year fixed effects and census tract fixed effects are included. Robust standard errors are clustered at the census tract level. P-values are shown in parentheses. Stock-Yogo weak ID test: critical value at 10% maximal IV size is 16.38.

Appendix 5. Alternative Specifications

	DV: Coop							
	Logit		Tobit		OLS Within	2SLS 2nd stage	OLS Within	2SLS 2nd stage
	M71	M72	M73	M74	M75	M76	M77	M78
For-profit internet mean speed	-0.5763		-0.0038		-0.0027	-0.0820		
	(0.0000)		(0.0000)		(0.0000)	(0.0000)		
% covered by high tech for-profit internet		-3.3871		-0.0148			-0.0064	-0.6156
		(0.0000)		(0.0000)			(0.0000)	(0.0000)
log(Median HH income)	0.2094	0.7063	0.0157	0.0142	0.0191	0.0627	0.0177	0.0197
	(0.3005)	(0.0009)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Ethnic diversity	-16.3073	-16.5110	-0.0848	-0.0847	-0.0002	0.0290	-0.0013	-0.0078
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.9705)	(0.0007)	(0.8113)	(0.4815)
Immigration	-10.7951	-15.2956	-0.0174	-0.0159	-0.0043	-0.0433	-0.0025	0.0436
	(0.0747)	(0.0204)	(0.5386)	(0.5743)	(0.8563)	(0.3080)	(0.9165)	(0.5064)
log(Population)	-0.0333	-0.3282	-0.0176	-0.0176	-0.0123	-0.0250	-0.0120	-0.0261
	(0.8009)	(0.0111)	(0.0000)	(0.0000)	(0.0015)	(0.0000)	(0.0019)	(0.0038)
Unemployment rate	-71.4360	-82.3079	-0.0639	-0.0718	0.0755	0.2836	0.0691	0.1385
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
% population above 65	4.9219	4.6399	0.0288	0.0244	0.0255	0.1688	0.0216	0.1081
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
% population with bachelor degree or higher	-24.5411	-22.6670	-0.1293	-0.1282	-0.0387	-0.0281	-0.0393	-0.0602
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0104)	(0.0000)	(0.0003)
% Native Americans	16.5947	21.0584	0.2547	0.2516	0.0856	0.1069	0.0838	-0.0139
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0542)	(0.0489)	(0.0593)	(0.8542)
Muni. gov.	1.9798	1.8413	0.0156	0.0155	0.0083	-0.0042	0.0087	0.0010
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0746)	(0.4798)	(0.0633)	(0.8993)
The number of for-profit providers	-0.2873	-0.1459	0.0004	0.0007	0.0020	0.0091	0.0020	0.0270
	(0.0000)	(0.0000)	(0.0090)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Areas with for-profit business services	1.4927	1.5820	0.0186	0.0196	0.0038	0.0514	0.0037	0.1457
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0187)	(0.0000)	(0.0277)	(0.0000)
Constant	-7.9287	-11.7626	0.1122	0.1298	-0.0988		-0.0837	
	(0.0006)	(0.0000)	(0.0000)	(0.0000)	(0.0093)		(0.0271)	
Year fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Census tract fixed	No	No	No	No	Yes	Yes	Yes	Yes
Observations	285,320	285,320	285,320	285,320	267,067	266,947	267,067	266,947
Number of censustractid	71,558	71,558	71,558	71,558	66,989	66,869	66,989	66,869
R-squared(overall)					0.0091		0.0086	
Cragg-Donald Wald F statistic						246.95		78.25
Kleibergen-Paap Wald rk F statistic						325.33		75.92
Endogeneity test of endogenous regressors[P-val]						62.791[0.0000]		65.710[0.0000]

Notes: All models include census tract random effects. Standard errors are clustered at the census tract level for logit models. Models M75 to M78 exclude the census tracts where a cooperative ISP was present at the start of our sample period. P-values are shown in parentheses. Stock-Yogo weak ID test critical value at 10% maximal IV size is 16.38.