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Impact of Participation in Technology-Enabled Collaborative Learning and Capacity Building (ECHO) Models on Provider Retention

Final Report

HEALTH CARE & HUMAN SERVICES POLICY, RESEARCH, AND ANALYTICS — WITH REAL-WORLD PERSPECTIVE

Prepared for: **Assistant Secretary for Planning and Evaluation**

Submitted by: **The Lewin Group, Inc.**
Sebastian Negrusa, Paul Hogan and Matt Zhou

December 21, 2018

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Executive Summary

The main focus of this study is to evaluate whether participation in technology-enabled collaborative learning and capacity building models increases provider retention in the sites where these models are present, as well as in high-need areas. More specifically, we test two hypotheses. Our first hypothesis is that ECHO participants have a longer retention than non-ECHO participants in ECHO sites and Health Professionals Shortage Areas (HPSA). The main reason why Project ECHO providers are hypothesized to have a higher retention than non-Project ECHO providers is that through Project ECHO they have stronger professional development, lower professional isolation, and no-fee continuing medical education (CME).

An important caveat is that the current data do not allow us to resolve potential issues of 'reverse causality' when analyzing this hypothesis. Specifically, if providers who join ECHO also have a 'higher predisposition', on average, to working at sites located in areas with provider shortages compared to other providers working in these areas, the results we obtain by comparing the retention of ECHO participants with that of non-ECHO participants may not reflect true retention effects that are directly attributable to ECHO. Rather they may reflect the additional efforts of individuals who want to continue practicing at their current location, regardless of the potential downsides of practicing in these areas, to find ways to improve their skills and access to opportunities to interact with other medical professionals. Although for testing the first hypothesis the non-ECHO participants that we use for retention comparisons are from the same sites where the ECHO participants work (hence reducing the risk of reverse causality), it may still be the case that ECHO participants are more driven than non-ECHO participants to remain in those locations due to other reasons than ECHO participation.

Our second hypothesis is that sites with an ECHO presence may generate synergies that translate into higher levels of professional satisfaction and achievement even for providers who do not participate in ECHO. As ECHO participants become less professionally isolated, they may bring new medical knowledge and practices that can be ultimately adopted by the non-ECHO participants. Having an ECHO presence at a given site will thus foster closer collaboration among providers, improved results in the care being delivered to patients, and an overall more fulfilled sense of accomplishment. If that is the case, then the site-level retention of non-participating providers that work at sites with an ECHO presence may be improved as well.

The data we use for this study come from multiple sources. First, we obtain individual-level information from the University of New Mexico on all providers who participated in ECHO programs over the period between 2006 and 2018. The University of New Mexico data covered only ECHO participants, and only for the duration of their ECHO participation. Second, we merge this information using individual identifiers with Provider360 data (from the 2011-2015 period, and for a subsample of providers, from 2018 as well) to track the location of providers over time more comprehensively. This step allows us to track the location of non-ECHO participants as well. As part of this project we also purchased new 2018 Provider 360 data covering providers who, as of 2015, were still at sites where they were initially observed in any of the years of the 2011-2014 period. Finally, we added local area information from various public datasets, from sources such as the Census Bureau and Bureau of Labor Statistics, including the American Community Survey and the Area Health Resource File. These variables serve two purposes: on the one hand, they allowed us to isolate the impact of local area characteristics on provider retention in the provider-level

retention analysis, while on the other hand they allowed us to construct the comparison group that we used for the site-level retention analysis.

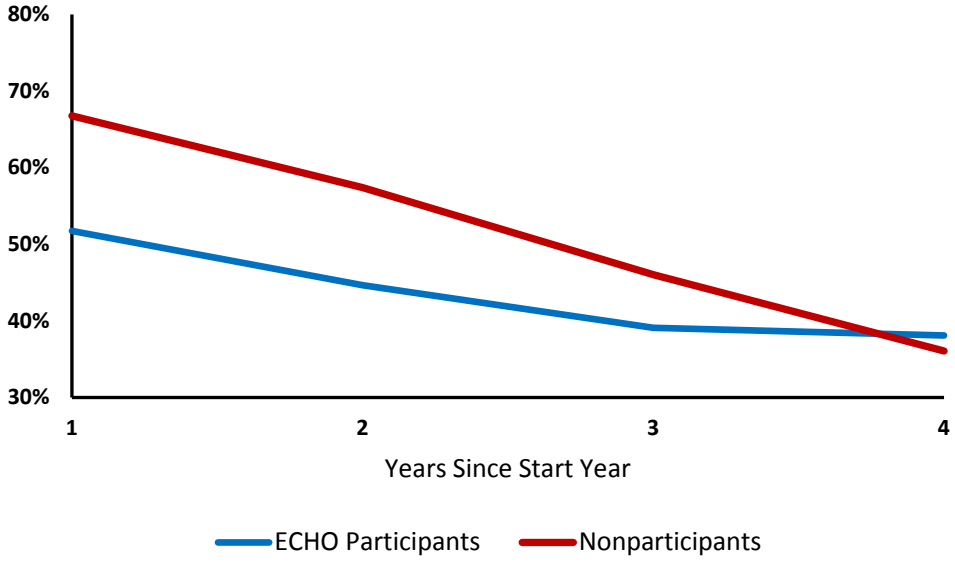
With these datasets, we construct several retention statistics. Consistent with two hypotheses of how ECHO participation can influence retention, we consider retention metrics that are calculated at the provider level (for ECHO sites and HPSAs), and retention metrics that are calculated at the site level. Similar to prior work analyzing retention rates in the National Health Service Corps and Indian Health Service scholarship and loan repayment programs (Lewin 2014; Lewin 2016; or Lewin 2017), we calculate the retention rate of providers as the ratio of providers that are still in a location of interest t years out, from the total number of providers that were in the initial location in the reference year. The retention rates can be anchored to a specific location in which providers were first observed, or to a location type (i.e., practice site located in a HPSA). We consider the following metrics: (i) the 'same ECHO site' retention rate for ECHO sites located in HPSAs; (ii) the 'same ECHO site' retention for all ECHO sites; (iii) the 'same HPSA' retention rate; and (iv) the 'any HPSA' retention rate.

For the site-level analysis, we construct the retention rate as the ratio between the number of providers remaining in a given site t years out, and the number of providers that were observed in the site in the reference year. These site-level retention rates are calculated for ECHO sites, but to be able to determine whether site-level retention is influenced by ECHO one needs to be able to compare these rates with 'counterfactual' retention rates, i.e., retention rates under the scenario in which ECHO never existed. While a perfect comparison group to construct the counterfactual retention rates is not available, we attempt to construct a valid comparison group of sites that closely resemble ECHO sites. The construction of the comparison group of non-ECHO "look-alike" sites was conducted by employing three criteria: geographic location, site size and site type.

Provider-level Retention

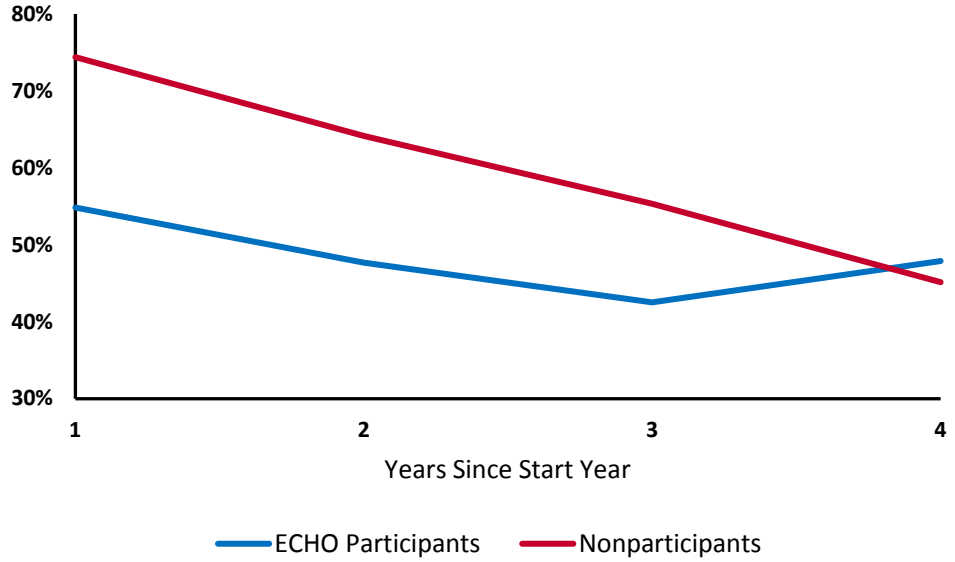
Using the first retention metric, we do not find indication that ECHO increases the retention of providers. As shown in **Figure ES.1**, in the subset of ECHO sites from HPSAs, the retention rate of ECHO participants in the same site where they are first observed is lower than that of providers who do not participate in ECHO.

Figure ES.1. Retention in the Same ECHO Site of ECHO Participants and Non-Participants from HPSA Locations



Similarly, when we look at the same ECHO retention of providers from all locations (HPSAs and non-HPSAs) in **Figure ES.2**, the retention patterns of ECHO participants and non-participants are similar to those from **Figure ES.1**.

Figure ES.2. Retention in the Same ECHO Site of ECHO Participants and Non-Participants

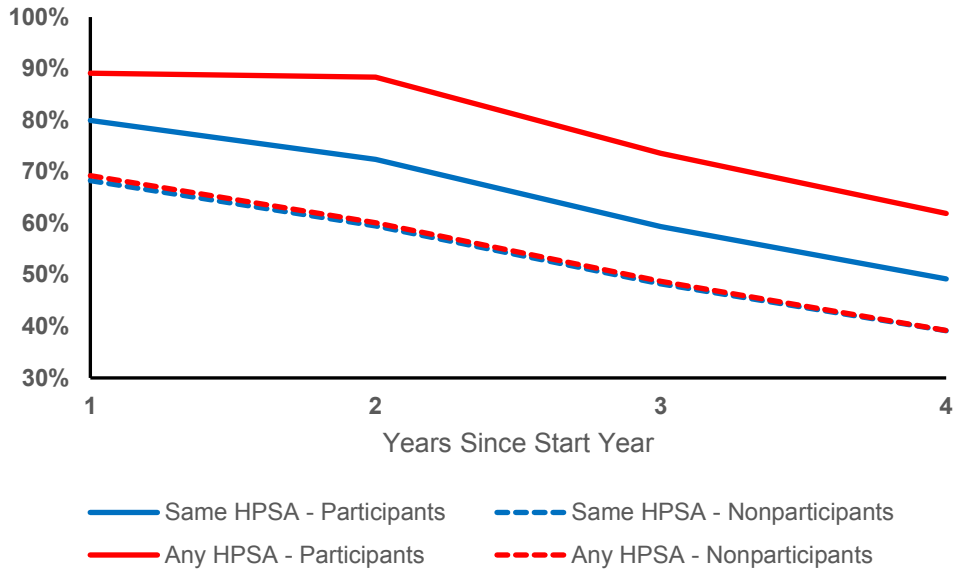


NOTE: The retention rates in the 4th year should be viewed with caution. First, we cannot detect a statistically significant retention differential in year 4, and second, the fourth year retention rates are in fact the fourth year rates of the 2011 cohort (i.e., the only cohort being observed for 4 years in the provider-level analysis).

The participants' retention rate is slightly larger than that of non-participants in the 4th year out, but this reversal in the retention differential should be viewed with caution. First, the difference is small, and the small sample sizes of ECHO participants do not allow for a deeper analysis to determine whether this difference is statistically significant or not. A regression analysis in which we compare the retention of the two groups reveals a non-statistically significant difference in year 4. Second, these combined rates are based on cohorts observed over unequal periods of time, and the cohorts observed for more years dominate the rates corresponding to the further out years. As such, the fourth year retention rates are in fact the fourth year retention rates of the 2011 cohort. Also, the retention rates of all providers appear to be lower in our data after 2011, so a comparison of retention rates across the 2011 cohort and the post-2011 cohorts may not necessarily reveal ECHO vs. non-ECHO differences, but rather inherent different cohort-specific differences. A sub-sample analysis in which we calculate the retention rate of providers in the same ECHO site for sites that are in HPSAs yields similar results as those from **Figure ES.2**.

Keeping in mind the uncertainty around the causal nature of results, our analysis finds a potential relationship between ECHO and retention at the HPSA level. It is important to note that about 85% to 90% of ECHO providers are first observed in HPSA locations. In **Figure ES.3** we present the retention rates of ECHO providers and non-ECHO providers in the same HPSA where they are first observed, and in any other HPSA, respectively.

Figure ES.3. Retention of ECHO Participants and Non-Participants in HPSAs



In brief, we find that:

a) The retention in the same HPSA where the initial ECHO site is located is larger for ECHO providers than the retention of non-ECHO participants by 10 to 12 percentage points in each year – as shown by the difference between the blue curves in **Figure ES.1**.

b) ECHO participants are much more likely to remain in HPSAs (whether at the current site or any other site located within a HPSA) than the non-ECHO participants. The retention differential is between 20 and 28 percentage points in each year since the start year – as shown by the difference between the red curves in **Figure ES.1**.

c) The ECHO participants' expected time is 3.07 years and 3.54 years, in the same HPSA and in any HPSA, respectively (out of a total of 4 years of observation).

In interpreting these results, it is important to consider that the relationship between ECHO participation and retention of practitioners at the HPSA level may be more tenuous and subject to a greater degree of uncertainty regarding causality than analyzing retention at the practice site level. Given that a retention effect was not found at the practice site level in this analysis, the observed relationship at the HPSA level may be the result of other unmeasured factors that are also correlated with participation in ECHO. In this analysis, we attempted to investigate whether co-participation in provider incentive programs, such as National Health Service Corps (NHSC) loan repayments, may have served as an alternative explanation for the observed relationship between ECHO participation and HPSA level retention. While this analysis does not provide an explanation for the HPSA retention results, co-participation of providers in many other state-funded incentive programs could potentially explain these patterns. Unfortunately, the data did not allow for a comprehensive analysis of this hypothesis. Still, the HPSA retention results warrant additional research, to the extent that relevant data on other factors are available to rule out competing explanations. After all, retaining practitioners in underserved areas, even if not in the same underserved area throughout a practitioner's career, can be considered an important outcome.

Site-level Retention

For the most part we do not find clear evidence for the second hypothesis in our site-level analysis. In **Table ES.1**, the site-level retention of non-ECHO providers in ECHO sites is sometimes larger than that of providers from comparable non-ECHO sites and sometimes it is smaller.

Table ES.1. Site-level Retention Rates of ECHO and Comparable non-ECHO Sites

	Years	ECHO Sites						Non-ECHO Sites		Difference (percentage points)
		Non-ECHO Providers		ECHO Providers		All				
First Observed in 2011	2011	1,194		166	1,360			7,195		
	2012	1,008	84.42%	147	88.55%	1,155	84.93%	5,904	82.06%	2.37%
	2013	802	67.17%	127	76.51%	929	68.31%	4,718	65.57%	1.60%
	2014	731	61.22%	110	66.27%	841	61.84%	4,292	59.65%	1.57%
	2015	567	47.49%	88	53.01%	655	48.16%	3,690	51.29%	-3.80%
	2018	311	26.05%	21	12.65%	332	24.41%	2,317	32.20%	-6.16%
First Observed in 2012	2012	375		56		431		610		
	2013	246	65.60%	48	85.71%	294	68.21%	458	75.08%	-9.48%
	2014	208	55.47%	39	69.64%	247	57.31%	434	71.15%	-15.68%
	2015	186	49.60%	34	60.71%	220	51.04%	366	60.00%	-10.40%
	2018	83	22.13%	4	7.14%	87	20.19%	216	35.41%	-13.28%
First Observed in 2013	2013	295		42		337		708		
	2014	230	77.97%	37	88.10%	267	79.23%	556	78.53%	-0.56%
	2015	192	65.08%	26	61.90%	218	64.69%	468	66.10%	-1.02%
	2018	100	33.90%	7	16.67%	107	31.75%	260	36.72%	-2.82%
First Observed in 2014	2014	826		96		922		523		
	2015	604	73.12%	75	78.13%	679	73.64%	327	62.52%	10.60%
	2018	240	29.06%	31	32.29%	271	29.39%	171	32.70%	-3.64%

We find that:

a) In the case of sites observed for the first time in 2011, the 1- to 4-year retention of non-ECHO providers in ECHO sites is, respectively, 84.42%, 67.17%, 61.22% and 47.49%. The corresponding site-level retention rates of providers in the comparison non-ECHO sites is about 2 to 3 percentage points lower in the first three years after the start year.

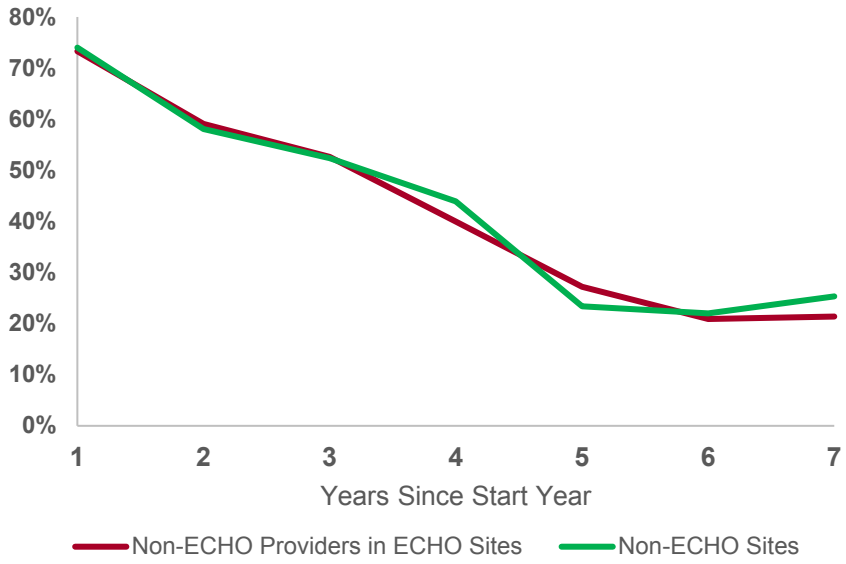
b) However, the 4-year retention differential (defined as the difference between the retention rate of non-ECHO providers in ECHO sites and the retention of providers in comparable, non-ECHO sites) inverses, showing a larger site-level retention of non-ECHO providers (by about 4 percentage points) relative to the retention of non-ECHO providers in ECHO sites. This may indicate that if an ECHO retention effect at the site level exists, it may vanish after a few years. The retention differential becomes even more negative (or smaller) by 2018.

c) The retention rate of non-participants in ECHO sites may be positive (and small, for the most part) in the first years, and this difference reverses (and becomes large and negative in the more recent cohorts) as time goes by. Nonetheless, with the current data we cannot detect clear patterns in the retention differentials patterns of the two groups of interest.

d) Combining in **Figure ES.4** all cohort-specific retention rates from **Table ES.1**, we find no detectable differences between the site-level retention of non-ECHO participants from ECHO sites and the retention of providers in the comparison, non-ECHO sites.

e) We also find no differences when limiting this analysis to sites observed in HPSA locations.

Figure ES.4. Site-Level Retention of ECHO and Comparable non-ECHO Sites



Conducting an analysis in which we break down the site-level retention by whether the site was first observed in a HPSA location yields similar results as the main site-level analysis in **Table ES.1**.

Limitations

In addition to not being able to address reverse causality issues, the results of our study may be affected by a number of additional limitations that could not be addressed with the data that were available to us. Sampling variability, relatively small sample sizes and the likely presence of many unobservable characteristics invite caution when interpreting these results. Another important limitation is that we do not have information on the retention of providers and sites that entered Project ECHO in the last few years. Given that Project ECHO participation has increased tremendously in recent years, a subsequent retention analysis should be performed at a later date to assess whether the retention rates of this intervention change as the platform matures. Stronger tests of our hypotheses, and an updated perspective of provider-level and site-level retention patterns, as well as the formulation of firmer conclusions would require more precise and more up-to-date data, as well as larger sample sizes than currently afforded by our datasets.

I. Introduction

The ECHO Act (PL 114-270) requires the Secretary of HHS to submit a report to Congress with findings from an examination of technology-enabled collaborative learning and capacity building models used by health care providers. The purpose of this project is to conduct an analysis and develop a report that addresses the impact of such models on provider retention. The analysis relies on comparisons between the retention of providers practicing in locations with technology-enabled collaborative learning and capacity building models with the retention of providers who work in similar sites that have not adopted these models.

Specifically, the main focus of this study is to evaluate whether participation in the University of New Mexico's technology-enabled collaborative learning and capacity building model, called Project ECHO, increases provider retention in the sites where these models have been present. Project ECHO stands for Extension for Community Healthcare Outcomes. We test whether providers serving in the Project ECHO sites have a higher retention than providers who serve at sites that are not part of Project ECHO. While there are a number of ECHO-like projects, in this study we exclusively focus on those projects that are connected to the University of New Mexico's ECHO Institute.

The main reason why Project ECHO providers are hypothesized to have a higher retention than non-Project ECHO providers is that through Project ECHO they have enhanced professional development, less professional isolation, and no-fee continuing medical education (CME). Moreover, the presence of providers who participate in Project ECHO in a given site may generate synergies that translate into higher levels of professional satisfaction and achievement even for providers who do not participate in ECHO. If that is the case, then the retention of non-participating providers who work at sites with an ECHO presence may be improved as well.

It is also important to note that there may be opportunity costs associated with ECHO participation. Providers who become ECHO participants may have less time to deliver care to patients because of time spent attending ECHO sessions. This in turn may result in lower revenue, all else constant. If the opportunity cost is large, providers or practices may decide against ECHO participation. At the same time, ECHO participants may acquire knowledge through ECHO sessions that may make them good hires in hospitals or practices located in urban areas. If that is the case, ECHO participation may also be associated with a lower retention rate. Unfortunately, the data we have for this study do not permit us to disentangle these potential effects. The empirical analysis we conduct in this study will necessarily reflect a combination of these (and perhaps other) effects on provider retention.

The data we use for this study come from multiple sources. First, we obtained individual-level information from the University of New Mexico on all providers who participated in ECHO-branded programs over the period between 2006 and 2018. Second, we merge this information using individual identifiers with Provider 360 data (covering the 2011-2015 period) to track the location of providers over time more comprehensively. This step allows us to track the location of non-ECHO participants as well, since the University of New Mexico data covered only ECHO participants, and only for the duration of their ECHO participation. We also purchased new Provider 360 data to ascertain the 2018 location of the providers who as of 2015 were still in the sites where they were initially observed in any of the years of the 2011-2014 period. Finally, we

add local area information from various public datasets from sources such as the Census Bureau, and Bureau of Labor Statistics, including the American Community Survey and also the Area Health Resource File from the Health Resources and Services Administration. On one hand, these variables allow us to isolate the impact of local area characteristics on provider retention in the provider-level retention analysis, while on the other hand they also allow us construct the comparison group that we use for the site-level retention analysis.

Using the data described above, we construct several retention statistics. Consistent with the two hypotheses of how ECHO participation can influence retention, we consider retention metrics that are calculated at the provider level, and also those calculated at the site level. As with previous studies of retention in the National Health Service Corps and Indian Health Service service-obligated scholarship and loan-forgiveness programs (Lewin 2014; Lewin 2016; or Lewin 2017), we calculate the retention rate of providers as the ratio of providers who are still in a location of interest t years out after a start year, from the total number of providers that were in the initial location in the start year. The retention rates can be anchored to the specific location in which providers were first observed, or to a location type. In our case, the former measure would be the retention rate in ECHO sites where the providers were first observed, while the latter would be the retention rate in HPSAs.

For the site-level analysis, we construct the retention rate as the ratio between the number of providers remaining in a given site t years out, and the number of providers that were observed in the site in the reference year. These site-level retention rates are calculated for ECHO sites, but to be able to determine whether site-level retention is influenced by ECHO one needs to be able to compare these rates with 'counterfactual' retention rates, i.e., retention rates under the scenario in which ECHO never existed. While a perfect comparison group in which to construct the counterfactual retention rates is not available, we attempt to construct a valid comparison group of sites that closely resemble ECHO sites. The construction of the comparison group of non-ECHO "look-alike" sites was conducted by employing three criteria: geographic location, site size and site type.

II. ECHO Participation and Provider Retention

In this study we evaluate whether participation in technology-enabled collaborative learning and capacity building models increases provider retention in the sites where these models are present. More specifically, we test whether providers practicing in Project ECHO sites in areas where there are provider shortages have a higher retention than providers who practice at sites that are not part of Project ECHO. The main reason why Project ECHO providers are hypothesized to have a higher retention than non-Project ECHO providers is that through Project ECHO providers in more remote areas will have enhanced professional development, less professional isolation, and no-fee continuing medical education (CME). Moreover, the presence of providers who participate in Project ECHO in a given site may generate synergies that translate into higher levels of professional satisfaction and achievement even for providers who do not participate in ECHO. If that is the case, then the retention of non-participating providers that work at sites with an ECHO presence may be improved as well.

A. Provider Retention

In general, at any point in time, providers make choices with respect to various location types, such as rural or urban areas. The value (or utility) of each location has three components. The first component is the value that the individual places on the non-pecuniary factors associated with living in the location, such as preference for that location, climate, environment, local amenities, schools or other factors. The second component accounts for the pecuniary value of the location, which includes the provider's current wage, as well as the discounted value of expected future utility if the provider chooses the location in period t+1. The third component consists of a completely random, period-specific location shock, such as a parent or sibling living elsewhere getting ill, which is unrelated to the individual's preference for the location. This location-specific shock accounts for the net impact of unobservable factors that might induce individuals to choose a location they dislike or leave a location they like.[1]

From the perspective of a dynamic economic model of provider's location choice, in equilibrium providers will 'sort' themselves into all available locations as a function of their preferences, availability of positions, compensation and the distribution of the random shocks. When additional incentives associated with a given location (say, sites in remote rural areas) become available, they have the effect of increasing the value of moving to that area, all else constant. Some providers place a low value for serving in a rural area relative to the value associated with serving in a non-rural area. If, all else is constant, and the value of an incentive is sufficiently generous to compensate for the negative preference for rural areas, then some providers may be induced to serve in rural areas. Moreover, once they serve in those areas they may be more likely to remain there for longer periods of time.[2] In addition, providers who prefer to serve in rural areas even in the absence of additional incentives, may be inclined to stay longer in rural areas once the additional incentive becomes available. The additional incentive may take the form of monetary compensation (e.g., supplemental payments, loan repayment programs, loan forgiveness programs,

[1] This structural approach conceptualization is similar to dynamic programming problems, such as those in Keane and Wolpin (1994) or Asch and Warner (2001).

[2] It is important to note that providers who 'at the margin' are induced to move to locations they do prefer in the absence of the incentive may have a lower retention than providers who serve in those locations without the additional incentive (Lewin, 2014).

tax credits, insurance subsides, or scholarships), or non-pecuniary forms, such as the opportunity to interact with other medical professionals offered by an intervention such as Project ECHO. Theoretically, as participation in Project ECHO may increase the providers' sense of professional fulfillment, the value (or utility) of serving at such a site would increase. This would then translate into an increase in the probability of such providers practicing longer at those sites. However, participation in Project ECHO may also involve an opportunity cost since providers who participate in ECHO may have less time to deliver care to patients while attending ECHO sessions. This in turn may result in lower revenue, ultimately making ECHO participation less desirable.

B. Does ECHO Participation Increase Retention?

A clear distinction of all recruiting and retention effects potentially generated by Project ECHO is beyond the scope of this study. Without directly estimating the providers' probability to move to remote sites and practice there for longer periods, we can nonetheless – using the insights from the conceptual framework sketched above – articulate two straightforward hypotheses that we test with the data available for this study.

Hypothesis #1

The first hypothesis is that ECHO participants have a longer tenure than non-ECHO participants due to the professional development afforded by ECHO. Under the assumption that providers who work at sites with an ECHO presence are similar in terms of preferences, compensation and other characteristics, a comparison between the group of ECHO providers and the group of non-participating providers may potentially allow for the identification of this hypothesized ECHO-induced retention effect. We operationalize this hypothesis in several ways, by analyzing the retention of ECHO and non-ECHO providers at the ECHO sites where they are first observed, but also analyzing their retention in HPSAs.

Hypothesis #2

The second hypothesis is that sites with an ECHO presence have a larger overall site-level retention because ECHO participants have a beneficial professional influence on the non-ECHO providers in ECHO sites. As ECHO participants become less professionally isolated, they may not only become more enthusiastic about their work, but as a result of attending ECHO sessions and making presentations during ECHO sessions they may bring to the site new medical knowledge and practices that can be ultimately adopted by the non-ECHO participants. Having an ECHO presence in a given site will thus foster closer collaboration among providers, improved results in the care being delivered to patients, and an overall fulfilled sense of accomplishment. This dynamic may then translate into higher levels of utility for all providers practicing in those sites or for a large number of them. If that is the case, then provider turnover is reduced.

However, testing this hypothesis entails the construction of a valid comparison group of non-ECHO sites that will have a similar distribution of characteristics as the ECHO sites. Next, comparing the site-level retention rates of ECHO sites with the site-level retention of comparable, non-ECHO sites will provide insights into whether ECHO sites have larger retention rates than non-ECHO sites.

It is important to note that the site-level retention in ECHO sites is a blend of the retention rate of ECHO participants and non-ECHO participants. If the first hypothesis is true, then the overall

ECHO site retention may be larger simply because ECHO participants have a larger retention. The appropriate way to test the second hypothesis is to compare the retention of non-ECHO participants from ECHO sites with the retention rate in non-ECHO sites. If the retention rate of the former group is larger than the retention rate of the latter, then we can interpret this differential as consistent with the second hypothesis, of positive spillovers from the ECHO model to the retention of non-ECHO participants.

III. Data and Methodology

The data we used for this study come from multiple sources. First, we obtained individual-level information from the University of New Mexico on all providers who participated in ECHO-branded programs over the period between 2006 and 2018. Second, we merge this information using individual identifiers with Provider360 data (from the 2011-2015 period, and for a subsample of providers, from 2018 as well) to track the location of providers over time more comprehensively. This step allowed us to track the location of non-ECHO participants as well, since the University of New Mexico data covered only ECHO participants, and only for the duration of their ECHO participation. Finally, we added local area information from various public datasets from sources such as the Census Bureau and Bureau of Labor Statistics including the American Community Survey and HRSA's Area Health Resource File. On one hand, these variables allowed us to isolate the impact of local area characteristics on provider retention in the provider-level retention analysis, while on the other hand they allowed us construct the comparison group that we used for the site-level retention analysis.

In this chapter we discuss the data sources in more detail, explain the steps we took to link the data sets, present a number of descriptive statistics, and then describe our methodology for the two analyses: provider-level retention and site-level retention.

A. Data

1. University of New Mexico's (UNM) Data on ECHO Participants

The data we received from the University of New Mexico included 2,477 unique individual providers. This number includes providers who over the entire period between 2006 and 2018 participated in at least 15 ECHO presentations. This criterion was used by the University of New Mexico to define a minimum level of ECHO participation. These providers were observed in 868 unique sites over the 2006-2018 period. Throughout the entire study, a site is considered to be an ECHO site if in a given year there is at least one Project ECHO participating provider in that site. Given that the minimum of 15 visits may be reached over multiple years, it is likely that in recent years, the proportion of ECHO participants that is included in our data may be lower than in previous years – since in previous years providers had more time to reach the minimum of 15 visits. However, the impact of this limitation is potentially reduced if providers in more recent years have a more intense ECHO participation, thus reaching 15 visits faster than their counterparts from the earlier time of the program.

In **Table III.1**, we present the number of unique ECHO participants in each year of the 2006-2016 timeframe, along with the number of unique sites where these providers were observed in each year.[3] The annual number of providers and sites represent "stock" measures, reflecting the number of individuals or sites that continued in ECHO, as well the inflows and outflows in each year. As can be noticed, the volume of ECHO participation increased substantially over the last few years. Between 2006 and 2009, ECHO participation was below 100 providers; it then abruptly increased every year from 253 in 2010 to a maximum of 1,565 in 2016. This increase in the stock of

[3] Since 2017 and 2018 data is incomplete, we exclude from all tables in this section information pertaining to those years.

participants may be the result of: (i) an increase in the average duration of ECHO participation; and/or (ii) disproportionately large numbers of net new entrants in the program.

Table III.1. Volume of ECHO Providers and ECHO Sites by Year (UNM's Data)

Year	ECHO Providers	ECHO Sites	Average ECHO Participants
2006	26	23	1.1
2007	60	44	1.4
2008	57	40	1.4
2009	72	46	1.6
2010	253	112	2.3
2011	354	160	2.2
2012	465	199	2.3
2013	558	211	2.6
2014	787	296	2.7
2015	1,247	485	2.6
2016	1,565	659	2.4

The average number of ECHO participants per site increases over the same period, which is consistent with the possibility of large entries into the program in recent years. In fact, as shown in **Table III.2**, the number of new providers who entered Project ECHO increased substantially in the years when the volume of ECHO participation increased. It is also important to note that there is some variation in the length of time and intensity with which a provider participates in Project ECHO. Some providers may attend a few sessions and then end their participation, while others may attend large number of sessions over a longer period of time. The inclusion restriction of a minimum of 15 attended sessions reduces in part the heterogeneity of ECHO participation in our data. However, even if ECHO participation is homogeneous in terms of sessions attended, the length of time over which providers are observed to participate is truncated, in particular for the most recent entrants. In our empirical analysis we attempt to account for this issue.

Table III.2. Providers Flows into and out of ECHO by Year (UNM's Data)

Year	ECHO Entrants	ECHO Separatees
2006	26	1
2007	36	4
2008	15	5
2009	29	3
2010	180	36
2011	146	48
2012	178	79
2013	192	103
2014	370	139
2015	562	249
2016	549	372

Another noteworthy feature of **Table III.1** is that the number of ECHO sites where ECHO participants practice increases dramatically in recent years as well. Given that the increase in the volume of ECHO providers is to a large extent the result of net new entrants, it follows that these new entrants start participation in new sites, rather than at sites that already had an ECHO presence. Consistent with this observation, the average number of ECHO providers in ECHO sites (from the last column of **Table III.1**) tends to remain low even when the volume of ECHO participation increases substantially. In other words, ECHO volume increased extensively, rather than intensively.

The UNM data included a number of other relevant data elements, such as the number of sessions attended by ECHO participants, and the number of sessions in which ECHO participants had a presentation. **Table III.3** presents the average number of ECHO sessions attended and the average number of presentations in ECHO sessions in each year. With some variability, in each year after 2010 the average number of sessions attended varies between 9 and 11, and the number of presentations varies between 1.4 and 3.3. During the 2007-2009 period, the average number of presentations was about the same as the average number of sessions attended, which is consistent with the notion that in the beginning ECHO was a model that focused on infectious and chronic diseases, such as Hepatitis C (Arora et al., 2011). It is important to note that the number of ECHO sessions is truncated for providers entering ECHO in the more recent years, since the period over which they are observed attending sessions or presenting is shorter relative to providers who entered ECHO at the beginning of our timeframe.

Table III.3. Average Number of Sessions Attended and Average Number of Presentations by ECHO Providers, by Year (UNM's Data)

Year	Sessions Attended	Presentations
2006	6.65	11.31
2007	13.15	14.98
2008	11.78	12.44
2009	8.34	8.71
2010	9.21	3.26
2011	9.19	2.50
2012	7.74	1.79
2013	10.90	2.18
2014	11.51	2.26
2015	9.29	1.84
2016	10.00	1.60

In fact, as **Table III.4** indicates, in the 2006-2009 period most Project ECHO interventions addressed infectious diseases (mainly Hepatitis C and HIV) and to some extent chronic diseases. While participation in ECHO projects addressing those conditions remained strong and even increased in more recent years, the ECHO model spread to mental and behavioral health conditions as well, such as addiction, autism, ADHD, dementia, or substance abuse. The chronic diseases treated by ECHO providers include asthma, cardiac conditions, chronic pain, diabetes, hypertension, obesity, rheumatism, or sickle cell disease, while the category of "Other" includes for instance cancer, Native American care, LGBT care, or training for community care workers.

Table III.4. ECHO Participants by Medical Condition Addressed

Year	Chronic Disease	Mental Health	Infectious Disease	Other
2006	2	0	24	0
2007	5	1	55	0
2008	12	1	50	0
2009	25	1	52	0
2010	147	42	104	3
2011	190	82	147	5
2012	245	109	200	1
2013	266	169	213	0
2014	367	216	285	16
2015	529	298	412	127
2016	599	423	514	279

In **Table III.5** we present the distribution of ECHO participants in each year by their provider type. While initially ECHO participation was mainly limited to physicians, nurse practitioners (NP) and physician assistants (PA) started participating in larger numbers in the more recent years. In the UNM data, a large category of individuals includes additional types of workers including community workers, social workers, or non-medical providers (such as prison guards). Also, there is no information on provider type for many participants. These providers are included in the "Other" category along with other medical providers and non-medical providers. The type of about half of the providers in the "Other" category is unknown.

Table III.5. ECHO Participants by Provider Type

Year	MD	NP	PA	Other
2006	10	1	4	11
2007	24	6	7	23
2008	25	3	7	22
2009	24	8	11	29
2010	69	17	21	146
2011	102	25	27	200
2012	140	35	33	257
2013	147	39	37	335
2014	201	71	44	472
2015	259	113	64	814
2016	324	136	80	1,027

Finally, the UNM data includes information on sites belonging to a list of 21 ECHO hubs. A complete list of these hubs is available in **Table A.1** in the Appendix. Most of the hub data we received from UNM includes information on providers working at sites associated with the University of New Mexico hospital. The information presented here on providers working at sites associated with other hubs received from the University of New Mexico is incomplete.

2. Provider 360

Provider 360 is a dataset that offers a comprehensive overview of the population of medical providers in the nation at a given point in time. It is updated at relatively regular intervals, such that although it is not meant to be a truly longitudinal dataset, it allows one to track most providers over time from one extract to another. For the purposes of this study we use six extracts that were available to us, one from each year in the 2011-2015 period, and one from 2018. Provider 360 represents the main source of data for our retention analyses, as it provides information on the location of: (i) ECHO providers; (ii) non-ECHO providers working in ECHO sites; and (iii) non-ECHO providers working in comparable, non-ECHO sites.

An important limitation is that we cannot track the retention of providers continuously (or year-by-year) beyond 2015. As such, we cannot construct longer term retention statistics for the ECHO providers entering the program in recent years. Longer term retention patterns of the many new entrants that joined ECHO especially after 2014 can be the focus of future studies, so long as data on their subsequent location is available. We attempt to take a first step in this direction by acquiring new Provider 360 data (from the most recent extract, i.e., July 2018). These new data help us provide a number of initial insights into the longer term retention patterns of providers entering ECHO in more recent years.

Using National Provider Identifier (NPI) information, as well as first and last names — available in both UNM data and Provider 360 —, we were able to identify in P360 a number of 1,656 unique providers from the total of 2,477 providers from the UNM data. The remaining providers could not be identified in Provider 360. Most of them (732 providers) had no NPI, and could not be identified in Provider 360 by name. A smaller number of ECHO participants (89 providers) had NPI information in the UNM data, but that information was not matched with the NPI information in Provider 360 and we were not able to identify them in Provider 360 by name.

The UNM data included information on the address where the ECHO participant first entered in an ECHO program. In some cases, this address was updated if the provider moved to another (ECHO or non-ECHO) location, but in many cases the new address was not updated in the UNM data. We therefore gave priority to the address we found in Provider 360. In a large majority of cases, if the first ECHO address was recorded in the UNM data between 2011 and 2015, it coincided with the address from Provider 360.

3. Other Datasets

Several other factors could influence provider retention, even in the absence of ECHO participation. These characteristics include the site type where providers practice — such as Federally Qualified Health Centers (FQHC), Rural Health Clinics (RHC), Indian Health sites, or private practices —, or local area characteristics, such as the unemployment rate, health infrastructure, rates of health insurance, median income, levels of education and so on. We used public information on Indian Health Service "Indian, Tribal and Urban" (I/T/U) sites to determine whether ECHO participants practiced in an I/T/U site[4] and added other site type information from the administrative National Health Service Corps (NHSC) files (up to 2015). Finally, to account for local area characteristics, we collected additional information at the county level from public

[4] Available at: https://www.ihs.gov/locations/.

datasets (Census Bureau, Bureau of Labor Statistics, American Community Survey, or the Area Health Resource File).

B. Retention Measures

Using the analytic dataset described above, we construct several retention statistics. Consistent with the two hypotheses of how ECHO participation can influence retention (described in Chapter II), we consider retention metrics that are calculated at the provider level, and retention metrics that are calculated at the site level.

1. Provider-level Retention

As in our previous studies of retention of service obligated loan and scholarship participants in the scholarship and loan repayment programs of National Health Service Corps and Indian Health Service (Lewin 2014; Lewin 2016; or Lewin 2017), we calculate the retention rate of providers as the ratio of providers that are still in a location of interest *t* years out, from the total number of providers that were at the initial location in the reference year. The retention rates can be anchored to the specific location in which providers were first observed, or to a location type.

The two retention rates are 'unadjusted' retention rates, since they do not take into account other factors, unrelated to ECHO, that may affect provider retention. To obtain adjusted retention rate, we propose an econometric approach that will allow us to determine how much of the retention differential between participants and non-participants is due to the program, and how much due to other characteristics. Specifically, we estimated regression models in which we controlled for observable characteristics on each individual provider ($\mathbf{X}_i$), local area characteristics ($\mathbf{Z}_j$) and an indicator for ECHO participation ($ECHO_i$):

$$y_{ij} = \alpha_0 + \alpha \cdot ECHO_i + \boldsymbol{X}_i' \cdot \beta + \boldsymbol{Z}_j' \cdot \delta + \varepsilon_i \quad (1)$$

Model (1) can be estimated using as dependent variables indicators taking the value of 1 if the participating provider serves at the location of interest (e.g., ECHO sites) in any of the years after providers are first observed, and 0 otherwise. These models are based on data on ECHO participants and non-participants who work in ECHO sites to determine whether program participants have a longer or a shorter retention in ECHO sites than non-participating providers.

The coefficient of interest, α, indicates the impact of program participation on the number of years served in a location of interest. The $\boldsymbol{X}$ vector included individual-level characteristics like age and gender, while the $\boldsymbol{Z}$ vector included county level variables and local area characteristics, such as: family income, poverty rate, insurance rates by insurer type, percent White, percent Black, education level and percent of the population over the age of 65. Model (1) can be estimated using a logit specification, separately by the number of years elapsed since entering ECHO (for participants) and by the number of years since start year in ECHO sites (for non-participants).

2. Site-level Retention

For the site-level analysis, we construct the retention rate as the ratio between the number of providers remaining in a given site *t* years out, and the number of providers that were observed at the site in the reference (or 'start') year. One problem that arises in this context is that some ECHO sites may cease to exist from one year to the next, in which case providers observed at a site in the

previous year do not appear in the retention rate calculation in the current year. This suggests that the site-level retention rate may be artificially low. To avoid this problem, we construct an alternative retention rate that includes only sites that are observed continuously over the entire period of analysis.

These site-level retention rates are calculated for ECHO sites, but to be able to determine whether site-level retention is influenced by ECHO one needs to be able to compare these rates with 'counterfactual' retention rates, i.e., retention rates under the scenario in which ECHO never existed. While a perfect comparison group in which to construct the counterfactual retention rates is not available, we attempt to construct a valid comparison group of sites that closely resemble ECHO sites. As before, a site is considered to be an ECHO site in a given year if it has at least one ECHO participant in that year. Since this analysis is at the site-level, once a site is considered an ECHO site in a given year, it is considered an ECHO site in all subsequent years.

The construction of the comparison group of non-ECHO "look-alike" sites was conducted using three criteria:

1) Geographic location
2) Site size
3) Site type

Using Provider 360 data, we first choose all sites that are located in the proximity of each ECHO site. Since some ECHO sites located in urban or semi-urban locations may have a lot of potential comparison sites around them, we only choose the sites from the ECHO site's 5-digit zip code. In the case of ECHO sites in rural locations, we select sites within the ECHO site's county. Next, we keep only the local sites that have a similar number of providers as the ECHO sites.[5] Finally, we keep as comparison sites those non-ECHO sites that are local, approximately equal in size and are of the same type as the ECHO sites. We considered the following site types: rural health clinics (RHC), federally-qualified health centers/community health centers (FQHC/CHC), American Native and Indian, Tribal and Urban sites (I/T/U), community outpatient facilities, correctional facilities, private practices and other facilities.[6] As shown in **Table III.6**, we identify on average 4.3 to 6.9 comparison sites per ECHO site.[7]

[5] For most site sizes we chose comparison sites that have exactly the same site size as the ECHO site. For small comparison sites (1-4 providers) where we cannot identify a comparison site having the same exact site size as the ECHO site we choose a comparison site that has any size between 1 and 4. For site sites above 20, unless we find sites of exact size as the ECHO site, we choose as comparison site any site with more than 20 providers.

[6] This is akin to coarsened exact matching (CEM). Other methods to construct valid comparison groups include Mahalanobis distance, propensity score matching, propensity scores weighting, entropy balancing and others. We prefer the CEM method because all of the variables on which the matching is to be done are binary, and because it is easy to implement and interpret in this context. Methods like propensity score matching are applicable when there is a large number of continuous variables. These methods also work in the "asymptotics", which means that in the presence of small samples, they may not produce reliable comparison groups.

[7] A potential limitation may come from the differing size of counties. In other words, in larger counties there may be more potential comparison sites than in smaller counties. However, this is unlikely to be a serious limitation, since in virtually all counties we considered, we found a sufficiently large number of potential comparison sites.

Table III.6. Number of ECHO Sites and Comparison Non-ECHO Sites

Year	ECHO sites	Non-ECHO sites	Average Non-ECHO Sites per ECHO Site	ECHO Participants
2011	137	950	6.93	161
2012	173	1,074	6.21	211
2013	191	1,209	6.33	229
2014	263	1,267	4.82	309
2015	285	1,225	4.30	343

The values in **Table III.6** are obtained by excluding those sites that are not observed continuously over the 2011-2015 period. In the last column of **Table III.6** we present the number of unique ECHO providers practicing in ECHO sites in each year of the 2011-2015 period. These numbers are lower than the numbers in **Table III.1** because of the merge between UNM data and Provider 360 and because of the restriction to sites that are observed continuously over time. This also points to a potential limitation of the site-level analysis, since many ECHO sites may have a short duration of operation as ECHO sites. About 75%-78% of the ECHO sites from **Table III.6** are located in HPSAs.

IV. Results

In this section we present our main results. We start with provider-level retention rates and then present site-level retention rates. These results correspond to the main hypotheses considered in this study. In brief, the first hypothesis is that ECHO participants have a longer tenure at sites than non-ECHO participants due to the professional development afforded by ECHO, while the second hypothesis is that sites with an ECHO presence have a larger overall site-level retention because ECHO participants have a beneficial professional influence on the non-ECHO providers in ECHO sites. The provider-level retention analysis corresponds to the first hypothesis, and the site-level retention rates corresponds to the second hypothesis.

A. Provider-level Retention

For the provider-level analysis we consider retention metrics tied to ECHO sites, and retention metrics tied to HPSAs. Using only HPSA locations, we define a 'same ECHO in HPSA' retention rate for sites in HPSA locations, calculated as the fraction of providers that remain at the same ECHO site every year elapsed after a first year of observation. A second retention metric is the 'same ECHO' retention rate, for all ECHO sites (HPSA and non-HPSA). Also, in the calculation of these retention metrics we consider as "stayers" those providers who remain at the same site even if they cease to be ECHO participants over time.[8] Regarding HPSAs, we define a 'same HPSA' as the fraction of providers that remain at the same HPSA as the one when they are first observed in an ECHO site. We also define an 'any HPSA' retention rate, as the fraction of providers that remain in HPSAs (the same, or any other HPSA) after being first observed in an ECHO site.

In **Table IV.1** we present the retention rates of providers in the same ECHO site where they are first observed, by limiting the analysis to sites located in HPSAs. We find that of the 63 initial ECHO participants that enter ECHO in a HPSA location in 2011, 43 (68.3%) continue to practice in that site one year later. By the fourth year since the start year of 2011, the 'same ECHO in HPSA' retention drops to 38.1%. i.e., 24 providers of the initial 63 participants are at the same site in 2015. In contrast, the corresponding retention rate for non-ECHO providers in ECHO sites tends to be larger than that of ECHO participants in almost all years.

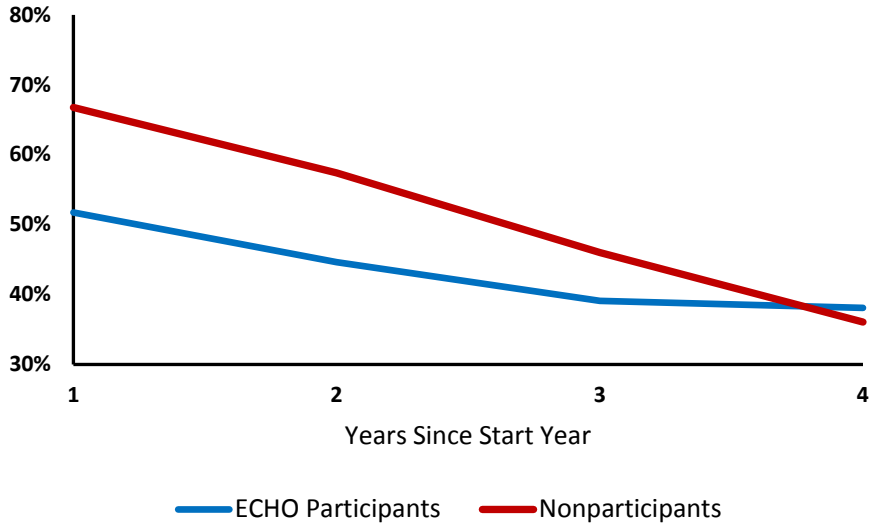
[8] There is a small number of ECHO participants that the UNM data flags as starting their participation in a given year that do not appear in Provider 360 data in that same year, but only at a later time. We exclude these providers from the calculation of the retention metrics in Table IV.1, since including them in the denominator artificially deflates the retention rates of participants, especially if the lag with which these ECHO participants appear in Provider 360 data is larger.

Table IV.1. Provider-level 'Same-ECHO' Retention Rates in HPSAs

Years		Same Site - HPSA locations only			
		ECHO providers		Non-ECHO providers	
First Observed in 2011	2011	63		9,210	
	2012	43	68.3%	7,473	81.1%
	2013	38	60.3%	6,355	69.0%
	2014	36	57.1%	5,515	59.9%
	2015	24	38.1%	3,322	36.1%
First Observed in 2012	2012	93		7,827	
	2013	47	50.5%	5,942	75.9%
	2014	44	47.3%	4,835	61.8%
	2015	25	26.9%	2,324	29.7%
First Observed in 2013	2013	77		8,898	
	2014	42	54.5%	6,832	76.8%
	2015	22	28.6%	3,699	41.6%
First Observed in 2014	2014	169		11,512	
	2015	76	45.0%	4,754	41.3%

Combining all cohorts from **Table IV.1**, in **Figure IV.1** we plot the two retention rates for each of the two groups of providers. We find that the participants' rates are: 51.7%, 44.6%, 39.1%, and 38.1%, while the non-participants' rates are: 66.8%, 57.4%, 46.0% and 36.1%.

Figure IV.1. Retention in the Same ECHO Site of ECHO Participants and Non-Participants from HPSA Locations



There are a number of points worth emphasizing here. The retention rates from **Figure IV.1** are larger for non-participants in the first three years after the start year. Also, the difference between the rates of participants and non-participants is continuously narrowing in the first three years (i.e., the difference between the two curves). This flattening out of the retention of ECHO

participants is consistent with the possibility that over time ECHO participants are more attached to ECHO sites than non-ECHO providers. This is similar to our previous findings on NHSC providers, that over time their migration rate out of Health Professional Shortage Areas (HPSA) decreases relative to that of non-NHSC participants working in HPSAs (which remains the same) (Lewin, 2014; Lewin 2016).

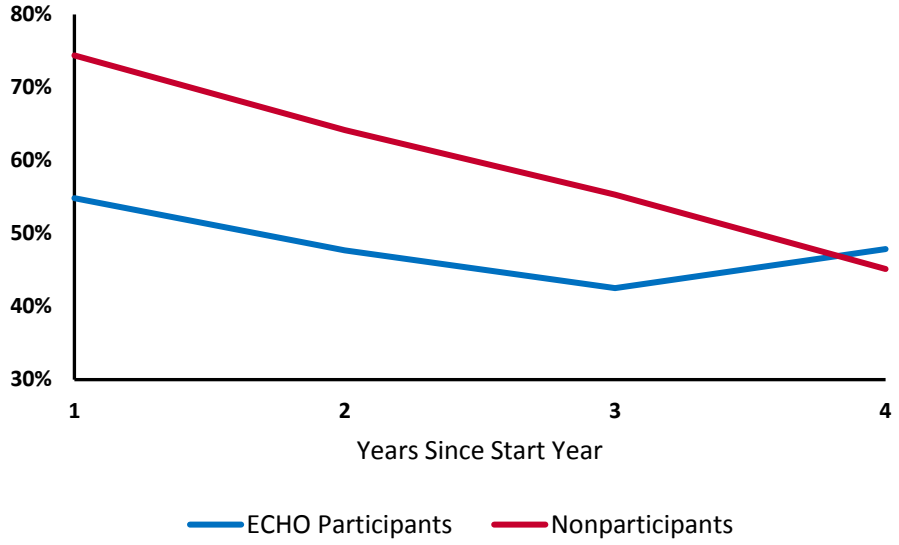
Also, the participants' retention rate is slightly larger than that of non-participants' rate in the 4th year out, but this reversal in the retention differential should be viewed with caution. First, the difference is small, and the small sample sizes of ECHO participants do not allow for a deeper analysis to determine whether this difference is statistically significant or not. Second, these combined rates are based on cohorts observed over unequal periods of time, and the cohorts observed for more years dominate the rates corresponding to the further out years. As such, the fourth year retention rates are in fact the fourth year retention rates of the 2011 cohort. As we discuss in the second half of this section, the retention rates of all providers appear to be lower in our data after 2011, so a comparison of retention rates across the 2011 cohort and the post-2011 cohorts may not necessarily reveal ECHO vs. non-ECHO differences, but rather inherent different cohort-specific differences.

As shown in **Table IV.2,** the retention patterns of ECHO participants and non-ECHO participants are similar to those from **Table IV.1**. Non-participants tend to have larger retention rates than ECHO participants in all years and cohorts, and, as shown in **Figure IV.2** in which we combine the cohort-specific retention rates, the retention differential narrows over time. The similar retention patterns in **Tables IV.1** and **IV.2** are the result of a large proportion of ECHO participants being first observed in HPSA locations (about 85% to 90% of all ECHO providers). Also, the across-the-board larger retention rates from **Table IV.2** relative to those from **Table IV.1** are potentially explained by the fact that in **Table IV.2** we include providers located in both HPSA and non-HPSA locations; retention rates in HPSAs tends to be lower than in non-HPSA locations.

Table IV.2. Provider-level 'Same-ECHO' Retention Rates

Years		ECHO providers		Non-ECHO providers	
First Observed in 2011	2011	71		14,003	
	2012	49	69.00%	11,424	81.60%
	2013	44	62.00%	9,782	69.90%
	2014	42	59.20%	8,437	60.30%
	2015	34	47.90%	6,322	45.10%
First Observed in 2012	2012	103		12,406	
	2013	53	51.50%	9,463	76.30%
	2014	48	46.60%	7,852	63.30%
	2015	32	31.10%	6,174	49.80%
First Observed in 2013	2013	86		11,908	
	2014	47	54.70%	8,904	74.80%
	2015	32	37.20%	6,952	58.40%
First Observed in 2014	2014	194		13,971	
	2015	100	51.50%	9,107	65.20%

Figure IV.2. Retention in the Same ECHO Site of All ECHO Participants and Non-Participants



The statistics presented in **Tables IV.1** and **IV.2** (and **Figures IV.1** and **IV.2)** do not provide much evidence on the validity of the first hypothesis. We examine next the HPSA retention of ECHO and non-ECHO participants after they are first observed in an ECHO site. This choice is motivated by the notion that a higher provider retention in shortage areas is a positive outcome of any program or initiative. Using annually updated HPSA information (available at the county level) from the Area Health Resource File (AHRF), in Table **IV.3** we present cohort specific retention rates indicating the retention of providers in the same HPSA where they were first observed ('same HPSA'), or retention in the same or any other HPSA ('any HPSA'). For this analysis, we construct a HPSA indicator, taking the value of 1 if the provider is observed in a given year in a "full-HPSA" county or in a county where one or more parts of that county are designated as a HPSA. We lump together all HPSA types (primary care, mental and dental). Also, in the case of "non-HPSA" and "partial HPSA" counties, we turn the HPSA indicator to 1 if the providers are located in a facility HPSA, such as RHCs, FQHC/CHCs or I/T/Us.

As can be noted, the HPSA retention rates of ECHO participants are substantially larger than retention rates from **Tables IV.1** and **IV.2**. More importantly, they are larger than the HPSA retention rates of non-ECHO providers. The difference increases when comparing the retention of ECHO providers with that of non-ECHO providers in any HPSAs.

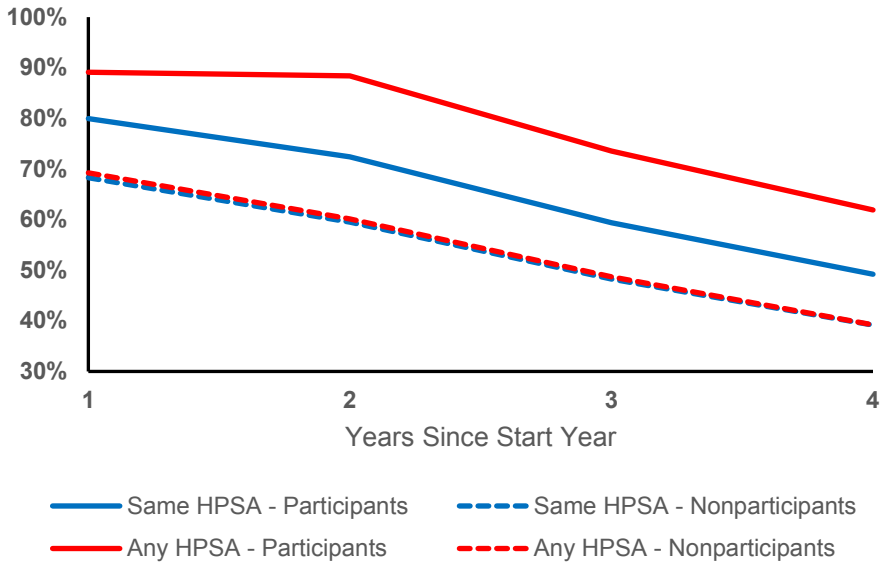
Table IV.3. Provider-level Retention Rates in HPSAs

Years		Same HPSA				Any HPSA			
		ECHO providers		Non-ECHO providers		ECHO providers		Non-ECHO providers	
First Observed in 2011	2011	63		9,210		63		9,210	
	2012	57	90.5%	7,573	82.2%	59	93.7%	7,573	82.2%
	2013	50	79.4%	6,501	70.6%	55	87.3%	6,505	70.6%
	2014	46	73.0%	5,719	62.1%	54	85.7%	5,723	62.1%
	2015	31	49.2%	3,606	39.2%	39	61.9%	3,611	39.2%

Years		Same HPSA				Any HPSA			
		ECHO providers		Non-ECHO providers		ECHO providers		Non-ECHO providers	
First Observed in 2012	2012	92		8,022		92		8,022	
	2013	76	82.6%	6,416	80.0%	86	93.5%	6,509	81.1%
	2014	72	78.3%	5,298	66.0%	86	93.5%	5,387	67.2%
	2015	46	50.0%	2,592	32.3%	60	65.2%	2,672	33.3%
First Observed in 2013	2013	77		9,056		77		9,056	
	2014	67	87.0%	7,045	77.8%	78	100.0%	7,146	78.9%
	2015	46	59.7%	3,845	42.5%	64	83.1%	3,910	43.2%
First Observed in 2014	2014	172		11,842		172		11,842	
	2015	123	71.5%	4,998	42.2%	137	79.7%	5,171	43.7%

In **Figure IV.3** we plot the combined retention rates of ECHO providers and non-ECHO providers in the same HPSA as the initial ECHO site where they are first observed, and in any other HPSA, respectively.

Figure IV.3. Retention of ECHO Participants and Non-Participants in HPSAs



We find that the retention in the same HPSA where the initial ECHO site is located is larger for ECHO providers than the retention of non-ECHO participants by 10 to 12 percentage points in each year. Comparing the 'same HPSA' retention rates of ECHO participants from **Figure IV.3** with their 'same ECHO' retention rates from **Figures IV.1** and **IV.2**, it is clear that even though the ECHO providers tend to leave their initial ECHO site at high rates, they tend to move at sites in the close proximity, i.e., within the same HPSA. Moreover, comparing the two red profiles from **Figure IV.3**, we find that the ECHO participants are much more likely to remain in HPSAs than the non-ECHO participants. These differences are even larger than in the case of the 'same HPSA' retention; the 'any HPSA' differences range between 20 and 28 percentage points in each year since the start year. It therefore appears that ECHO participation is associated with important gains in the retention of providers serving in HPSAs.

Additional analyses would be needed to determine whether this link is directly the result of Project ECHO participation. However, this finding is consistent with the possibility that Project ECHO participation offers providers an important opportunity to provide higher-quality care to underserved population, which in turn increases their own professional satisfaction. If that is the case, even if they leave the site where they start their ECHO participation, they are more likely to continue serving in similar areas and likely serve similar populations. It is possible that the increase in professional satisfaction they receive as a result of ECHO participation comes as a "positive shock" in their period-by-period decision-making regarding the location where they practice. In other words, ECHO participation provides them with a better ex-post experience than initially anticipated when they moved to an ECHO site. As such, their probability of staying in HPSAs increases relative to a case when Project ECHO does not exist. Future work will also have to provide better insights into why an ECHO participant would leave their ECHO site, but still remain in the same (or other) HPSA in higher proportions than non-ECHO participants. It is possible that age or years in practice (which we cannot observe) could be part of this discrepancy, as well as other characteristics that are not available in our data.

An important caveat is that the current data do not allow us to resolve potential issues of 'reverse causality' when analyzing this hypothesis. Specifically, if providers who join ECHO also have a 'higher predisposition', on average, to working at sites located in areas with provider shortages compared to other providers working in these areas, the results we obtain by comparing the retention of ECHO participants with that of non-ECHO participants may not reflect true retention effects that are directly attributable to ECHO. Rather they may reflect the additional efforts of individuals who want to continue practicing at their current location, regardless of the potential downsides of practicing in these areas, to find ways to improve their skills and access to opportunities to interact with other medical professionals. Although for testing the first hypothesis the non-ECHO participants that we use for retention comparisons are from the same sites where the ECHO participants work (hence reducing the risk of reverse causality), it may still be the case that ECHO participants are more driven than non-ECHO participants to remain in those locations due to other reasons than ECHO participation. Another source of unobserved characteristics that may be correlated with the providers' location decisions is participation in federal- or state-funded incentive programs, such as medical school loan repayment or loan forgiveness programs, scholarships, tax credit benefits or malpractice insurance subsidies. Providers benefiting from these programs may have different retention patterns than those who do not (Lewin, 2014). However, with the current data we are unable to isolate the impact of these programs on provider retention behavior.[9]

Also, defining ECHO participants only as providers who attend a minimum of 15 ECHO sessions may potentially have the consequence of including in the group of non-ECHO participants providers with a non-trivial number of ECHO sessions, for instance right below the threshold of 15. In this sense, the comparison of ECHO and non-ECHO participants' retention rates is not necessarily reflecting a comparison between ECHO participants and providers without any ECHO experience, but rather a comparison between 'more intense' and 'less intense' ECHO participating

[9] Merging administrative data on NHSC participation over the 2000-2013 period with the analytic dataset used for the provider-level analysis (by first and last name of the provider), we find that the fraction of NHSC participants among ECHO and non-ECHO participants is about 10% and 3%, respectively. However, when excluding NHSC participants from both groups, the 'same site' retention patterns of ECHO and non-ECHO participants remain practically the same as those in Table IV.2 and Figure IV.2.

groups. Of course, the latter group also includes providers without any ECHO sessions. Unfortunately, our data do not allow us to identify which providers had a number of ECHO sessions between 0 and 14, so a sensitivity analysis by degree of ECHO exposure below the threshold is not possible in this study.

Another relevant question is whether once providers who move to another HPSA they are more or less likely to move to ECHO sites in those new HPSAs. However, given the small number of providers who move from one HPSA to another, we do not have enough data to explore this question.

In **Table IV.4** we present all the combined retention rates for both groups, along with a calculation of the expected time in an ECHO site (or in a HPSA) based on the retention rates. The calculations performed in **Table IV.4** use the retention rates from **Figures IV.1**-**IV.3** which are turned into "survival" rates. These are probabilities of not leaving ECHO sites, conditional on not having done so in the previous year. These survival rates are then used as weights in the calculation of the average years in ECHO sites.[10]

We find that the expected time in the same ECHO site in HPSA locations is 2.18 years (out of a total of 4 years that are afforded by our observation period between 2011 and 2015). The expected time in the same ECHO site in HPSAs of non-participants is larger, 2.58 years. For the 'same ECHO' retention metric, the expected years are 2.29 and 2.85 for ECHO participants and non-ECHO participants, respectively. Not surprisingly, the ECHO participants' expected time is 3.07 years and 3.54 years, in the same HPSA and in any HPSA, respectively. These are much larger times than the ECHO participants' expected times in ECHO sites.

[10] Using the combined retention rates, we calculate the expected years in ECHO sites for each provider group in two steps. First, we calculate the survival probability in each year using the formula: $S_t = \prod_{t=1}^{4}(1 - h_t)$, where h_t is the hazard of leaving an ECHO site in year *t*. Second, we use the following formula to obtain the expected years in ECHO sites: $\hat{\tau} = (1 - S_1) + \sum_{t=2}^{v-1}[S_{t-1} \cdot (1 - C_t) \cdot t] + S_{v-1} \cdot v$,where v is the maximum number of periods afforded by the data (in our case four years, or three years when excluding the 2011 cohort), and C_t is the conditional retention rate, expressed as $C_t = {S_t}/{C_{t-1}}$.

Note that since $C_1 = S_1$, the above equation can be expressed only as a function of the survival probability. If retention is 100% in every year, then $\hat{\tau} = v$. A retention that is lower than 100% in every year ensures that $\hat{\tau} < v$, and lower levels of retention yield lower values of $\hat{\tau}$.

Table IV.4. Combined Provider-level Retention Rates and Expected Times in ECHO Sites and HPSAs

Years	'Same ECHO in HPSA'		'Same ECHO'		'Same HPSA'		'Any HPSA'	
	ECHO	Non-ECHO	ECHO	Non-ECHO	ECHO	Non-ECHO	ECHO	Non-ECHO
1	51.7%	66.8%	54.8%	74.4%	80.0%	68.3%	89.1%	69.2%
2	44.6%	57.4%	47.7%	64.2%	72.4%	59.5%	88.4%	60.1%
3	39.1%	46.0%	42.5%	55.3%	59.4%	48.2%	73.5%	48.7%
4	38.1%	36.1%	47.9%	45.1%	49.2%	39.2%	61.9%	39.2%
Expected Years	2.18	2.58	2.29	2.85	3.07	2.65	3.54	2.67

In our regression analysis, guided by the specification in equation (1) from Chapter III, we attempt to isolate the impact of other observable characteristics that may be related to the individual providers' decision to continue to serve or leave ECHO sites in each year. For this purpose, we estimate regression models of the provider's decision to remain in the same ECHO site, as a function of ECHO participation and a number of county level characteristics, such as the unemployment rate, median income, level of education, rates of insurance by insurance type, and number of other medical providers in the area. For the same ECHO retention we estimate four separate models – one for each year elapsed since the provider became an ECHO participant, or the years since the non-participant was first observed in an ECHO site. While these regression models (shown in **Tables A.2** in the Appendix) provide useful insights into some of the factors determining the retention decisions of providers, the estimates of interest (on the ECHO participation variable) yield marginal effects that virtually are equal to the retention differences shown in **Figure IV.2 and Table IV.2**. In other words, the provider type variables and the local areas characteristics do not explain the unadjusted retention differentials from **Table IV.2**. Also, the estimates on the ECHO participation indicator variable are negative and statistically significant for years 1, 2 and 3, but statistically insignificant for year 4. Regression models in which the dependent variable is replaced with the HPSA retention metrics (not shown) yield similar results, i.e., the unadjusted difference between participants and non-participants is not explained by observable provider- and local-area characteristics.

In what follows, we provide breakdowns of the retention rates by provider type and site type. For ease of exposition and tractability, we focus only the 'same ECHO' retention rates. In **Table IV.5** we present the retention rates by physicians and non-physicians. The category of non-physicians includes nurse practitioners (NP), physician assistants (PA), and all the other provider disciplines. The small number of ECHO providers prevents us from considering more granular categories of non-physicians. The fraction of physicians and non-physicians varies in the groups of ECHO and non-ECHO participants. For instance, the fraction of physicians among ECHO participants by the 2011-2015 cohorts is: 60.6%, 44.7%, 46.5% and 47.9%, respectively. Among non-ECHO participants, the fractions are: 46.8%, 36.8%, 34.3% and 34.6%.

We note that the retention rates of ECHO participating physicians tend to be lower than the overall retention rates of all participants. The resulting expected times in the same ECHO site is 2.16 years– lower than the 2.29 years in ECHO sites from **Table IV.4** for the overall population of participants. Conversely, we find that the retention rates of participating non-physicians are larger than the overall retention rates of participants. Also, the expected time in the same ECHO site is 2.44 for non-physician participants, larger than the corresponding value in the overall population of

participants. As to non-ECHO providers, the differences in the expected time in ECHO sites appear to be more muted across provider types than in the case of ECHO participants. **Table A.3** in the Appendix provides a more detailed breakdown of the provider-level retention rates by provider type and by entry cohort.

Table IV.5. Provider-level Retention Rates by Provider Type

	Years Since Start Year	Same ECHO	
		ECHO Providers	Non-ECHO Providers
Physicians	1	55.0%	72.4%
	2	43.4%	64.5%
	3	36.0%	57.2%
	4	27.9%	47.0%
	Years in ECHO	**2.16**	**2.87**
Non-Physicians	1	54.7%	75.6%
	2	51.9%	63.9%
	3	49.4%	53.9%
	4	78.6%	43.5%
	Years in ECHO	**2.44**	**2.84**

Further, we examine the provider-level retention rates considered above by whether providers work in CHC/FQHCs, private practices and other sites. Unfortunately, more granular breakdowns by site type do not yield meaningful results, as sample sizes for RHCs, I/T/U sites or community outpatient hospitals are very low. In **Table IV.6** we present the retention rates of providers who are first observed in any of the three site types considered.[11] As shown in **Table IV.6**, the retention rates of participants in CHC/FQHCs is lower in all years, while in the case of private practices and other sites it is lower in the first three years since the start year. In the fourth year, the retention rate is larger for participants working in private practice and other sites. The time spent in ECHO sites by participants is lower than that of the non-participants for each site type. A detailed breakdown by entry cohort of the retention rates from **Table IV.6** is available in **Table A.4** in the Appendix.

[11] Calculation of rates that strictly distinguish across all possible migration paths (e.g., from a CHC/FQHC to: another CHC/FQHC, a private practice, or other site) becomes problematic due to small sample sizes.

Table IV.6. Provider-level Retention Rates by Site Type

Site Type	Years Since Start Year	Same ECHO	
		ECHO Providers	Non-ECHO Providers
CHC/FQHC	1	54.3%	71.4%
	2	49.0%	60.9%
	3	42.7%	53.5%
	4	45.0%	46.7%
	Years in ECHO	**2.30**	**2.75**
Private Practice	1	58.6%	75.7%
	2	53.2%	65.6%
	3	50.0%	55.1%
	4	52.2%	43.3%
	Years in ECHO	**2.49**	**2.88**
Other Site	1	51.7%	77.1%
	2	37.7%	67.5%
	3	32.4%	62.0%
	4	50.0%	45.2%
	Years in ECHO	**2.01**	**3.00**

There is a large qualitative literature emphasizing the importance of factors affecting providers' decisions to locate in non-urban areas. Most of these factors are unfortunately hard to quantify and account for in quantitative studies. Without fully reviewing this large literature, for instance, Hancock et al. (2009) find that exposure to rural life through education, recreation, or upbringing increases the chances of future rural practice as it addresses the provider's desire for familiarity, sense of place, community involvement and self-actualization. In addition, local mentorship and ''place-specific education'' can further support the integration, and thus longer-term retention, of new rural physicians. Walker et al (2010) also find that personal motivators, career motivators and clinic support are paramount to the decision primary care providers make to locate in underserved areas. Similarly, Boscardin et al (2014) find that community health field experience, learning another language, becoming more aware of perspectives of individuals from other backgrounds and attending schools with a higher social mission score represent educational and individual factors that were strongly associated with the medical students' intention to practice in underserved areas.

With the data available for this study, it is impossible to account for these important characteristics. Therefore, we cannot claim that the unadjusted or regression-adjusted retention effects estimated in this chapter represent causal effects of ECHO on provider retention. The implicit assumption behind our approach is that these characteristics are equally distributed across the ECHO participants and non-participants. However, without a randomized control trial in which ECHO participation is assigned randomly, we have no guarantee that this is the case. We therefore caution against interpreting our estimates through the causal lens, and rather consider them as indicative of relevant associations that warrant future study.

B. Site-level Retention

In **Table IV.7** we present the site-level retention rates calculated for ECHO sites and the non-ECHO look-alike sites. These retention rates are calculated as the fraction of providers who remain at these sites in each year after at a start point. While the provider-level retention rates from the previous section are constructed by tracking cohorts of providers over time, the retention rates in this section are calculated by tracking sites over time. Specifically, we use as a denominator for the site level retention rate calculation the number of providers practicing in a given site in the first year we can observe that site. These providers represent the stock of providers that are observed in the start year. To make sure the site-level retention rates are not muddled by new entries in those sites over time, yearly inflows of new providers after the start year are ignored. In this way, the site level retention rates can be viewed as year-by-year depletion rates of the initial stock of providers. Given the small average of per-site ECHO participation, we exclude from the calculations those sites that have more than 200 providers (participants and non-participants). Arguably, the potential site-level effect of ECHO participation in large sites with small numbers of ECHO participants should tend to zero. An important addition in this section is the inclusion of 2018 as a new year over which we track the site-level retention of sites first observed in the years of the 2011-2014 period. This is facilitated by the purchase of new Provider 360 data including the providers who as of 2015 were still in the sites where they were initially observed in any of the years of the 2011-2014 period. This sub-sample is limited to include around 10,000 providers.

To the extent that the non-ECHO sites included in this analysis represent a valid comparison group, the retention rates in those sites should reflect the counterfactual retention rates from a scenario when ECHO does not exist. In the case of ECHO sites the overall retention rate is a blend between the retention of ECHO and non-ECHO participants. Therefore, the measure of interest for the site-level analysis is the retention rate of non-ECHO participants. This measure helps us determine whether there is empirical evidence for the second hypothesis, according to which the site-wide retention increases when ECHO providers are present at the site. In other words, an ECHO presence "spills over" to non-ECHO participants once ECHO providers are present.

As shown in this section, we do not find clear evidence for the second hypothesis in our site-level analysis. In **Table IV.7,** the retention of non-ECHO providers in ECHO sites is sometimes larger than that of providers from comparable non-ECHO sites and sometimes it is smaller. In the case of sites observed for the first time in 2011, the 1- to 4-year retention of non-ECHO providers in ECHO sites is, respectively, 81.66%, 62.23%, 54.01% and 40.01%. The corresponding site-level retention rates of providers in the comparison non-ECHO sites is about 2 to 3 percentage points lower in the first three years after the start year. However, the 4-year retention differential (defined as the difference between the retention rate of non-ECHO providers in ECHO sites and the retention of providers in comparable, non-ECHO sites) inverses, showing a larger site-level retention of non-ECHO providers (by about 4 percentage points) relative to the retention of non-ECHO providers in ECHO sites. This may indicate that if an ECHO retention effect at the site level exists, it may vanish after a few years. The retention differential does not appear to change by 2018.

Table IV.7. Site-level Retention Rates of ECHO and Comparable non-ECHO Sites

	Years	ECHO Sites						Non-ECHO Sites		Difference (percentage points)
		Non-ECHO Providers		ECHO Providers		All				
First Observed in 2011	2011	1,472		254		1,726		9,158		
	2012	1,202	81.66%	214	84.25%	1,416	82.04%	7,254	79.21%	2.45%
	2013	916	62.23%	174	68.50%	1,090	63.15%	5,442	59.42%	2.80%
	2014	795	54.01%	136	53.34%	931	53.94%	4,871	53.19%	0.82%
	2015	589	40.01%	94	37.01%	683	39.57%	4,018	43.87%	-3.86%
	2018	315	21.40%	22	8.66%	337	19.52%	2,320	25.33%	-3.93%
First Observed in 2012	2012	397		67		464		981		
	2013	255	64.23%	55	82.09%	310	66.81%	608	61.98%	2.25%
	2014	212	53.40%	43	64.18%	255	54.96%	540	55.05%	-1.65%
	2015	189	47.61%	34	50.75%	223	48.06%	440	44.85%	2.75%
	2018	83	20.91%	4	5.97%	87	18.75%	216	22.02%	-1.11%
First Observed in 2013	2013	368		52		420		1,111		
	2014	254	69.02%	43	82.69%	297	70.71%	679	61.12%	7.91%
	2015	194	52.72%	27	51.92%	221	52.62%	549	49.41%	3.30%
	2018	100	27.17%	7	13.46%	107	25.48%	260	23.40%	3.77%
First Observed in 2014	2014	961		127		1,088		740		
	2015	632	65.76%	83	65.35%	715	65.72%	327	44.19%	21.58%
	2018	240	24.97%	31	24.41%	271	24.91%	171	23.11%	1.87%

It is important to remember that sites that are first observed in 2011 in our data may include sites that open in that year, as well as in years before 2011. This is because, as mentioned above, 2011 is the first year in our Provider 360 data. Although the distribution of sites established in 2011 or the years before 2011 should a priori be the same for ECHO and comparison non-ECHO sites, our data offers not guarantee that this is the case. One way of circumventing this issue is to focus on sites that are established in 2012 or later. The sites from each of these cohorts can be unambiguously pinned to the year when they were first established. In the 2013 and 2014 site cohorts, we find that the site-level retention rate of non-participants in ECHO sites is larger than the retention rate of the non-ECHO comparison sites in all years after we first observe these sites. For instance, the 1-year retention rate of non-ECHO providers in ECHO sites that are established in 2013 is 69.02%, while the 1-year retention in non-ECHO sites is 61.12%, a difference of 7.91 percentage points. The difference in 1-year retention is larger for sites established in 2014 (21.58 percentage points), but then it drops to 1.87% by the fourth year (which in the case of that cohort is 2018). Regardless of the actual value of the retention differentials, it is apparent that over time, the retention differentials tend to decrease, a finding that potentially indicates that if a site-level ECHO retention exists, it diminishes, and maybe eventually disappears. However, even the positive retention differentials, which could be indicative of an ECHO-retention effect at the site level, are small and potentially within a conventional margin of error.

In general, the retention rates in **Table IV.7** have a relatively steep decline from one year to the next. At least in part this is due to the fact that some sites vanish from our data during our observation period. This is in many cases the result of sites being closed. Once that happens, providers in those sites are not included in the retention rate calculations in subsequent years. In **Table IV.8** we present site-level retention rates for the subset of sites (ECHO and non-ECHO) that can be tracked in each year once they are first observed in the data. As expected, all retention rates are larger and experience a slower decline over time. The main findings remain unchanged: the retention rate of non-participants in ECHO sites may be positive (and small, for the most part) in the first years, and this difference reverses (and becomes large and negative in the more recent cohorts) as time goes by. Nonetheless, with the current data we cannot detect clear patterns in the retention differentials patterns of the two groups of interest.

Table IV.8. Site-level Retention Rates of ECHO and Comparable non-ECHO Sites (Subset of Sites Observed in Every Year)

	Years	ECHO Sites						Non-ECHO Sites		Difference (percentage points)
		Non-ECHO Providers		ECHO Providers		All				
First Observed in 2011	2011	1,194		166		1,360		7,195		
	2012	1,008	84.42%	147	88.55%	1,155	84.93%	5,904	82.06%	2.37%
	2013	802	67.17%	127	76.51%	929	68.31%	4,718	65.57%	1.60%
	2014	731	61.22%	110	66.27%	841	61.84%	4,292	59.65%	1.57%
	2015	567	47.49%	88	53.01%	655	48.16%	3,690	51.29%	-3.80%
	2018	311	26.05%	21	12.65%	332	24.41%	2,317	32.20%	-6.16%
First Observed in 2012	2012	375		56		431		610		
	2013	246	65.60%	48	85.71%	294	68.21%	458	75.08%	-9.48%
	2014	208	55.47%	39	69.64%	247	57.31%	434	71.15%	-15.68%
	2015	186	49.60%	34	60.71%	220	51.04%	366	60.00%	-10.40%
	2018	83	22.13%	4	7.14%	87	20.19%	216	35.41%	-13.28%
First Observed in 2013	2013	295		42		337		708		
	2014	230	77.97%	37	88.10%	267	79.23%	556	78.53%	-0.56%
	2015	192	65.08%	26	61.90%	218	64.69%	468	66.10%	-1.02%
	2018	100	33.90%	7	16.67%	107	31.75%	260	36.72%	-2.82%
First Observed in 2014	2014	826		96		922		523		
	2015	604	73.12%	75	78.13%	679	73.64%	327	62.52%	10.60%
	2018	240	29.06%	31	32.29%	271	29.39%	171	32.70%	-3.64%

In **Table IV.9** we present a breakdown of the site-level retention rates by whether sites are in HPSA locations (or are HPSA facilities) when the site is first observed. While some variability in the site-level retention rates exist, the main conclusions drawn from the above analysis hold.

Table IV.9. Site-level Retention Rates of ECHO and Comparable non-ECHO Sites in HPSAs (Subset of Sites Observed in Every Year)

			ECHO Sites								Difference (percentage points)
		Years	Non-ECHO Providers		ECHO Providers		All		Non-ECHO Sites		
HPSAs	First Observed in 2011	2011	788		120		908		4,970		
		2012	680	86.29%	105	87.50%	785	86.45%	4,121	82.92%	3.38%
		2013	516	65.48%	90	75.00%	606	66.74%	3,285	66.10%	-0.61%
		2014	473	60.03%	78	65.00%	551	60.68%	3,012	60.60%	-0.58%
		2015	391	49.62%	61	50.83%	452	49.78%	2,558	51.47%	-1.85%
		2018	223	28.30%	21	17.50%	244	26.87%	1,628	32.76%	-4.46%
	First Observed in 2012	2012	282		45		327		387		
		2013	181	64.18%	38	84..44%	219	66.97%	287	74.16%	-9.98%
		2014	152	53.90%	32	71.11%	184	56.27%	274	70.80%	-16.90%
		2015	128	45.39%	30	66.67%	158	48.32%	239	61.76%	-16.37%
		2018	54	19.15%	3	6.67%	57	17.43%	156	40.31%	-21.16%
	First Observed in 2013	2013	194		32		226		540		
		2014	148	76.29%	27	84.38%	175	77.43%	423	78.33%	-2.04%
		2015	120	61.86%	20	62.50%	140	61.95%	355	65.74%	-3.89%
		2018	59	30.41%	6	18.75%	65	28.76%	197	36.48%	-6.07%
	First Observed in 2014	2014	486		59		545		392		
		2015	318	65.43%	45	76.27%	363	66.61%	240	61.22%	4.21%
		2018	118	24.28%	14	23.73%	132	24.22%	127	32.40%	-8.12%

		Years	ECHO Sites						Non-ECHO Sites		Difference (percentage points)
			Non-ECHO Providers		ECHO Providers		All				
Non-HPSAs	First Observed in 2011	2011	406		46		452		2,225		
		2012	328	80.79%	42	91.30%	370	81.86%	1,783	80.13%	0.65%
		2013	286	70.44%	37	80.43%	323	71.46%	1,433	64.40%	6.04%
		2014	258	63.55%	32	69.57%	290	64.16%	1,280	57.53%	6.02%
		2015	176	43.35%	27	58.70%	203	44.91%	1,132	50.88%	-7.53%
		2018	88	21.67%	0	0.00%	88	19.47%	689	30.97%	-9.29%
	First Observed in 2012	2012	93		11		104		223		
		2013	65	69.89%	10	90.91%	75	72.12%	171	76.68%	-6.79%
		2014	56	60.22%	7	63.64%	63	60.58%	160	71.75%	-11.53%
		2015	58	62.37%	4	36.36%	62	59.62%	127	56.95%	5.41%
		2018	29	31.18%	1	9.09%	30	28.85%	60	26.91%	4.28%
	First Observed in 2013	2013	101		10		111		168		
		2014	82	81.19%	10	100.00%	92	82.88%	133	79.17%	2.02%
		2015	72	71.29%	6	60.00%	78	70.27%	113	67.26%	4.03%
		2018	41	40.59%	1	10.00%	42	37.84%	63	37.50%	3.09%
	First Observed in 2014	2014	340		37		377		131		
		2015	286	84.12%	30	81.08%	316	83.82%	87	66.41%	17.71%
		2018	122	35.88%	17	45.95%	139	36.87%	44	33.59%	2.29%

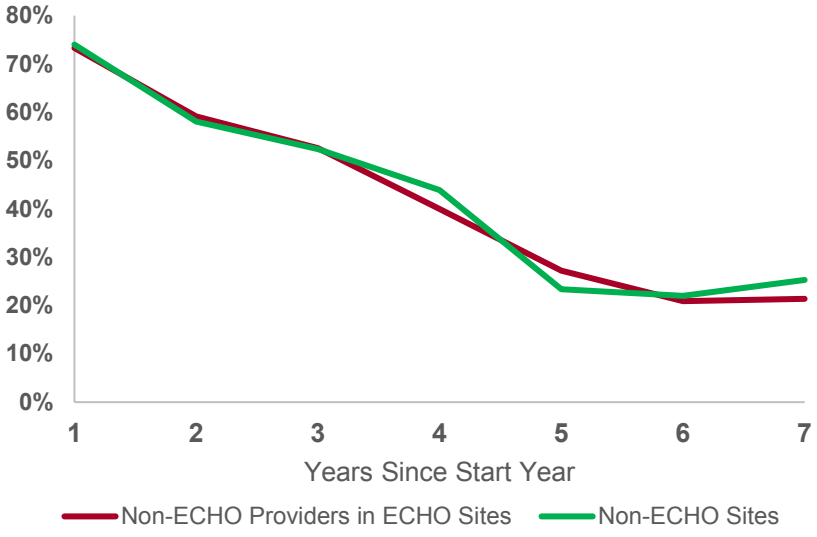
In **Table IV.10** we combine the site-level retention rates from **Tables IV.7 and IV.8** for the non-ECHO providers working in ECHO sites and for the non-ECHO participants working in comparable, non-ECHO sites. We also construct these retention rates by excluding the 2011 sites cohort, and by including only the subset of sites that are observed all years of our timeframe. The conclusions from above remain the same: the retention differentials jump around from one year to another, and they are largely small. It is important to remember that when combining cohorts of unequal length, the retention calculations for the further out years from **Table IV.9** tend to be driven by the earlier cohorts (since they get observed for longer periods of time).

Table IV.10 Combined Site-level Non-ECHO Retention Rates

	Years Since Start Year	Non-ECHO Providers in ECHO Sites		Non-ECHO Sites	
		All Cohorts	2012 and beyond	All Cohorts	2012 and beyond
All Sites	1	73.3%	66.1%	74.0%	57.0%
	2	59.1%	53.1%	58.1%	52.1%
	3	52.6%	47.6%	52.4%	44.9%
	4	40.0%	25.0%	43.9%	23.1%
	5	27.2%	27.2%	23.4%	23.4%
	6	20.9%	20.9%	22.0%	22.0%
	7	21.4%	-	25.3%	-
Subset of Sites Observed All Years	1	77.6%	72.2%	80.2%	72.8%
	2	64.5%	59.7%	66.0%	68.4%
	3	58.4%	49.6%	59.7%	60.0%
	4	47.5%	29.1%	51.3%	32.7%
	5	33.9%	33.9%	36.7%	36.7%
	6	22.1%	22.1%	35.4%	35.4%
	7	26.0%	-	32.2%	-

To ensure a better visualization of the main results from the site-level analysis, we plot the combined retention rates from covering years 1 to 7, from the upper part of **Table IV.9** in **Figure IV.4**.

Figure IV.4 Site-Level Retention of ECHO and Comparable non-ECHO Sites



Next, we explore how the site-level retention rates in ECHO and comparable non-ECHO sites compare with each other once we stratify the analysis by provider type. Comparing the retention rates of non-ECHO providers working in ECHO sites with that of providers in comparable non-ECHO sites, we find that the retention rates tend to be larger for physicians, especially in the more recent cohorts. But these differences are not large, and the small sample sizes that allowed these calculations limit the firmness of any conclusion with respect to their retention patterns.

Table IV.11. Site-level Retention Rates of ECHO and Comparable non-ECHO Sites by Provider Type (Subset of Sites Observed All Years)

Years		ECHO Sites						Non-ECHO Sites		
		ECHO Providers			Non-ECHO providers					
		Physician	NP/PA	Other	Physician	NP/PA	Other	Physician	NP/PA	Other
First Observed in 2011	2012	84.8%	83.9%	92.1%	80.7%	87.6%	85.6%	81.4%	84.6%	82.0%
	2013	71.7%	67.7%	82.0%	61.3%	60.0%	70.6%	61.9%	67.0%	67.1%
	2014	58.7%	71.0%	68.5%	55.2%	51.4%	65.1%	51.2%	61.2%	63.3%
	2015	43.5%	58.1%	56.2%	37.4%	41.9%	52.6%	40.9%	49.3%	56.4%
	2018	8.7%	3.2%	18.0%	15.6%	21.0%	31.2%	18.7%	22.9%	39.8%
First Observed in 2012	2013	81.3%	66.7%	93.5%	57.5%	61.5%	70.0%	63.3%	61.0%	78.2%
	2014	81.3%	55.6%	67.7%	52.8%	38.5%	59.6%	51.9%	65.9%	74.7%
	2015	75.0%	55.6%	54.8%	49.1%	35.9%	52.2%	36.7%	56.1%	64.1%
	2018	6.3%	11.1%	6.5%	17.0%	20.5%	24.8%	13.9%	14.6%	40.6%
First Observed in 2013	2014	77.8%	83.3%	100.0%	76.0%	67.9%	82.0%	59.4%	67.8%	84.9%
	2015	50.0%	50.0%	77.8%	68.0%	39.6%	71.9%	50.0%	54.2%	71.8%
	2018	0.0%	33.3%	27.8%	21.3%	15.1%	45.5%	13.0%	10.2%	46.2%
First Observed in 2014	2015	75.0%	64.3%	83.3%	63.2%	78.9%	76.6%	42.9%	56.1%	71.9%
	2018	17.9%	14.3%	44.4%	11.7%	18.9%	39.0%	7.5%	18.2%	46.0%

To gain additional insights into whether a larger presence of ECHO providers is associated with an increased retention of non-participants working in ECHO sites, we construct site-level retention statistics by site size. We define the site size as the total number of providers at the site when the site first appears in our data, and we consider the following site sizes: 1-5, 6-10, 11-20 and more than 20 providers.

Table IV.12 indicates that for the most part the site-level retention rates of non-participants who practice in ECHO sites (labeled as "ECHO" for convenience) are larger than the retention rates of providers from comparable non-ECHO sites. The retention differential between non-ECHO participants working in ECHO sites and providers from comparable non-ECHO sites tends to be larger in the case of larger sites. Finally, as in the main analysis, the retention differential increases in the more recent cohorts, and it increases more for the larger sites. This may be driven by the possibility that ECHO participants entering the program in the more recent years join larger sites. Other site-specific factors that we cannot account for in our data may be responsible for this as well.

Table IV.12. Site-level Retention Rates of ECHO and Comparable non-ECHO Sites, by Site Size (Subset of Sites Observed All Years)

Years		Size 1-5		Size 6-10		Size 11-20		Size ≥20	
		ECHO	Non-ECHO	ECHO	Non-ECHO	ECHO	Non-ECHO	ECHO	Non-ECHO
Sites First Observed in 2011	2012	79.69%	92.13%	86.21%	86.07%	87.77%	84.73%	80.54%	67.61%
	2013	75.00%	82.01%	66.95%	71.43%	71.28%	64.00%	62.32%	49.39%
	2014	70.31%	77.34%	59.48%	66.92%	67.55%	56.22%	55.42%	42.94%
	2015	57.81%	70.50%	47.13%	57.32%	54.26%	47.57%	39.90%	35.44%
	2018	26.56%	45.33%	20.98%	35.52%	28.99%	31.34%	27.59%	20.56%
Sites First Observed in 2012	2013	68.18%	78.07%	50.85%	74.29%	76.11%	60.34%	62.04%	
	2014	62.12%	75.44%	50.85%	70.00%	69.03%	50.00%	43.07%	
	2015	48.48%	64.62%	37.29%	61.43%	61.06%	27.59%	45.99%	
	2018	28.79%	42.11%	8.47%	28.57%	35.40%	20.69%	13.87%	
Sites First Observed in 2013	2014	75.29%	84.33%	84.62%	72.92%	70.67%	74.47%	80.65%	36.84%
	2015	67.06%	74.38%	66.35%	57.92%	56.00%	53.19%	77.42%	26.32%
	2018	35.29%	41.29%	37.50%	31.25%	20.00%	40.43%	51.61%	0.00%
Sites First Observed in 2014	2015	73.89%	72.89%	66.24%	59.83%	69.14%	24.49%	89.54%	12.00%
	2018	47.78%	40.36%	30.80%	29.06%	21.88%	6.12%	16.34%	0.00%

We also analyze whether the site-level retention of non-ECHO providers in ECHO sites may be a function of the size of an ECHO presence. Specifically, we look into the retention of non-ECHO participants in ECHO sites by four site groups: sites with 1 ECHO participant; sites with 2 ECHO participants, sites with 3 ECHO participants and sites with 4 or more ECHO participants. We do not find clear patterns indicating that a larger ECHO presence is associated with a larger site-level retention of non-ECHO participants (results not shown here). This may be because of the small sample sizes beyond the group of sites with more than 2 ECHO participants. We conduct another excursion into the HPSA site-level retention, by looking at the site retention at sites that were first observed in HPSAs, or were facility HPSAs when they were first observed. This analysis (not reported here) does not reveal any retention differences either.

Given the usually small number of ECHO participants in a site relative to non-ECHO participants, it is likely that the decision to join ECHO tends to be an individual decision, rather than a site-wide decision. However, in recent years ECHO participation increased substantially, which may be indicative that the decision to join Project ECHO could have potentially shifted toward a blend of provider individual-level and site-level decisions.

Sampling variability, relatively small sample sizes and the likely presence of many unobservable characteristics invite caution when interpreting these results. Stronger tests of our hypotheses and the formulation of firmer conclusions would require more precise data and larger sample sizes than currently afforded by our datasets.

V. Discussion and Conclusions

In this study we evaluate whether participation in technology-enabled collaborative learning and capacity building models increases provider retention at the sites where these models are present. More specifically, we test whether providers practicing in Project ECHO sites have a higher retention than providers who practice at sites that are not part of Project ECHO. The main reason why Project ECHO providers are hypothesized to have a higher retention than non-Project ECHO providers is that through Project ECHO they have stronger professional development, lower professional isolation, and no-fee continuing medical education (CME). Moreover, the presence of providers who participate in Project ECHO in a given site may generate synergies that translate into higher levels of professional satisfaction and achievement even for providers who do not participate in ECHO. If that is the case, then the retention of non-participating providers that work at sites with an ECHO presence may be improved as well. To test the first hypothesis, we consider provider-level retention metrics for the provider-level retention analysis. The first one is the 'same ECHO' retention rate, which is calculated as the fraction of providers that remain in the same ECHO site every year elapsed after a first year of observation.

Our analysis reveals evidence of a potential ECHO effect on provider-level retention (i.e., for the first hypothesis) over the timeframe we considered. We find that the retention in the same HPSA where the initial ECHO site is located is larger for ECHO providers than the retention of non-ECHO participants by 10 to 12 percentage points in each year. Moreover, we find that the ECHO participants are much more likely to remain in HPSAs than the non-ECHO participants (between 20 and 28 percentage points in each year since the start year). The ECHO participants' expected time is 3.07 years and 3.54 years (out of a total of 4 years that are afforded by our observation period between 2011 and 2015), in the same HPSA and in any HPSA, respectively. It therefore appears that ECHO participation is associated with important gains in the retention of providers serving in HPSAs. Additional analyses are needed to determine whether this link can be attributed to Project ECHO participation.

An important caveat is that the current data do not allow us to resolve potential issues of 'reverse causality' when analyzing the first hypothesis. Specifically, if providers who join ECHO also have a 'higher predisposition', on average, to working at sites located in areas with provider shortages compared to other providers working in these areas, the results we obtain by comparing the retention of ECHO participants with that of non-ECHO participants may not reflect true retention effects that are directly attributable to ECHO. Rather they may reflect the additional efforts of individuals who want to continue practicing at their current location, regardless of the potential downsides of practicing in these areas, to find ways to improve their skills and access to opportunities to interact with other medical professionals. Although for testing the first hypothesis the non-ECHO participants that we use for retention comparisons are from the same sites where the ECHO participants work (hence reducing the risk of reverse causality), it may still be the case that ECHO participants are more driven than non-ECHO participants to remain in those locations due to other reasons than ECHO participation.

For the other retention metrics considered (e.g., 'same ECHO in HPSA' and 'same ECHO'), our findings are less conclusive with respect to the first hypothesis. The retention of ECHO participants is lower than that of non-ECHO participants by these two metrics. We estimate an expected time in the same ECHO site for participants and non-participants that are first observed in

HPSA locations of 2.18 years and 2.58 years, respectively. The expected time in the same ECHO site (for HPSA and non-HPSA locations) is 2.29 years for participants and 2.85 years for non-participants. Breaking down the 'same ECHO site' estimates, we find that the retention rates of ECHO participating physicians translate into lower expected years than the overall expected years of all participants (2.16 years vs. 2.29 years), while for ECHO participating non-physicians the expected time in the same ECHO site is 2.44 years.

To test the second hypothesis, we construct site-level retention rates that are calculated as the fraction of providers who remain at sites in each year after a start year. For the most part we do not find clear evidence for the second hypothesis in our site-level analysis. The site-level retention of non-ECHO providers in ECHO sites is sometimes larger than that of providers from comparable non-ECHO sites and sometimes it is smaller. The retention differential is smaller in the first years since the start year, but in the further out years it tends to decrease. This may indicate that if an ECHO retention effect at the site level exists, it may vanish after a few years. Nonetheless, with the current data we cannot detect clear patterns in the retention differentials patterns of the two groups of interest.

In addition to not being able to address reverse causality issues, the results of our study may be affected by a number of additional limitations that could not be addressed with the data that were available to us. Sampling variability, relatively small sample sizes and the likely presence of many unobservable characteristics invite caution when interpreting these results. Another important limitation is that we do not have information on the retention of providers and sites that entered Project ECHO in the last few years. Given that Project ECHO participation has increased tremendously in recent years, a subsequent retention analysis should be performed at a later date to assess whether the retention rates of this intervention change as the platform matures. Stronger tests of our hypotheses, and an updated perspective of provider-level and site-level retention patterns, as well as the formulation of firmer conclusions would require more precise and more up-to-date data, as well as larger sample sizes than currently afforded by our datasets. Also, further explorations may be able to take into account variations in retention patterns associated with different ECHO topics.

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Appendix

Table A.1. Distribution of Providers by ECHO Hubs

Hub Name	Observations
Baylor St. Luke's Medical Center	168
Billings Clinic	50
Cherokee Nation Hastings Hospital	20
Cincinnati Children's Hospital Medical	15
Community Health Center, Inc.	1,380
Johns Hopkins University	33
Missouri Telehealth Network	227
Oklahoma State University - Center for Health Sciences	28
St. Joseph's Hospital and Medical Center	193
University of Massachusetts Memorial Medical Group	23
University of California San Francisco	59
University of Chicago	625
University of Nevada	522
University of New Mexico	5,168
University of Rochester Medical Center	179
University of Texas MD Anderson	178
University of Utah Health	248
University of Washington	353
University of Wyoming	556
Washington State Department of Health	80
West Virginia Clinical and Translational Science Institute	39
Total	**10,144**

Table A.2. 'Same ECHO' Logit Models

	1 Year	2 Years	3 Years	4 Years
ECHO Participant	-1.397***	-1.289***	-0.836***	-0.401
	(0.135)	(0.198)	(0.296)	(0.414)
Nurse Practitioner	-0.197**	-0.202**	-0.182	-0.038
	(0.087)	(0.088)	(0.118)	(0.196)
Physician Assistant	-0.107	-0.159	-0.159	-0.015
	(0.119)	(0.144)	(0.140)	(0.139)
Other Provider	-0.995***	-1.246***	-1.182***	-1.794***
	(0.115)	(0.144)	(0.257)	(0.520)
Unemployment Rate	-0.049	-0.317***	-0.864***	-1.812***
	(0.053)	(0.092)	(0.177)	(0.442)
Median Household Income (in $1000s)	-0.018	-0.040*	-0.072*	-0.031
	(0.014)	(0.021)	(0.042)	(0.059)
Fraction with HS Diploma	-0.102**	-0.103**	-0.272***	-0.656***
	(0.041)	(0.049)	(0.093)	(0.162)
Fraction Over Age 65	-0.018	-0.079	-0.344	-0.644
	(0.082)	(0.114)	(0.216)	(0.456)
County Population (in 1000s)	0.001*	-0.000	-0.001	-0.001
	(0.000)	(0.001)	(0.001)	(0.002)
Percent Minorities	0.014**	0.020***	0.039**	0.030
	(0.006)	(0.007)	(0.019)	(0.042)
Percent Medicaid	-0.101**	-0.075	-0.134*	-0.138
	(0.043)	(0.047)	(0.078)	(0.130)
Percent Medicare	0.022	0.105	0.674*	1.854**
	(0.148)	(0.210)	(0.392)	(0.787)
Percent of Uninsured	-0.067**	-0.075*	-0.233***	-0.581***
	(0.031)	(0.041)	(0.078)	(0.159)
Number of Hospital Beds	-0.000	-0.000*	-0.000*	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Number of Skilled Nurse Facilities	0.001	0.019	0.047*	0.028
	(0.009)	(0.014)	(0.027)	(0.041)
Number of SNF Beds	0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Number of Primary Care Practitioners	-0.000*	0.000	0.001	0.001
	(0.000)	(0.000)	(0.001)	(0.001)
Number of NP/PAs	0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.001)
Constant	14.714***	16.880***	37.832***	72.377***
	(4.729)	(6.157)	(11.293)	(17.253)
Observations	45,168	30,331	20,204	11,434

Table A.3. Provider-Level Retention by Provider Type and Cohort

Provider Type	Years		Same ECHO			
			ECHO providers		Non-ECHO providers	
Physicians	First Observed in 2011	2011	43		6,554	
		2012	28	65.10%	5,518	84.20%
		2013	24	55.80%	4,839	73.80%
		2014	19	44.20%	4,116	62.80%
		2015	12	27.90%	3,078	47.00%
	First Observed in 2012	2012	46		4,565	
		2013	25	54.30%	3,477	76.20%
		2014	23	50.00%	2,841	62.20%
		2015	13	28.30%	2,248	49.20%
	First Observed in 2013	2013	40		4,081	
		2014	19	47.50%	2,787	68.30%
		2015	9	22.50%	2,131	52.20%
	First Observed in 2014	2014	93		4,838	
		2015	50	53.80%	2,723	56.30%
Non-physicians	First Observed in 2011	2011	28		7,449	
		2012	21	75.00%	5,906	79.30%
		2013	20	71.40%	4,943	66.40%
		2014	23	82.10%	4,321	58.00%
		2015	22	78.60%	3,244	43.50%
	First Observed in 2012	2012	57		7,841	
		2013	28	49.10%	5,986	76.30%
		2014	25	43.90%	5,011	63.90%
		2015	19	33.30%	3,926	50.10%
	First Observed in 2013	2013	46		7,827	
		2014	28	60.90%	6,117	78.20%
		2015	23	50.00%	4,821	61.60%
	First Observed in 2014	2014	101		9,133	
		2015	50	49.50%	6,384	69.90%

Table A.4. Provider-Level Retention by Site Type and Cohort

Site Type	Years		Same ECHO			
			ECHO providers		Non-ECHO providers	
CHC/FQHC	First Observed in 2011	2011	40		6,563	
		2012	28	70.00%	5,223	79.60%
		2013	27	67.50%	4,473	68.20%
		2014	25	62.50%	3,865	58.90%
		2015	18	45.00%	3,067	46.70%
	First Observed in 2012	2012	56		3,227	
		2013	29	51.80%	2,183	67.60%
		2014	29	51.80%	1,725	53.50%
		2015	16	28.60%	1,371	42.50%
	First Observed in 2013	2013	49		4,339	
		2014	25	51.00%	3,077	70.90%
		2015	15	30.60%	2,401	55.30%
	First Observed in 2014	2014	111		4,857	
		2015	57	51.40%	3,070	63.20%
Private Practice	First Observed in 2011	2011	23		5,798	
		2012	16	69.60%	4,762	82.10%
		2013	14	60.90%	4,097	70.70%
		2014	13	56.50%	3,510	60.50%
		2015	12	52.20%	2,512	43.30%
	First Observed in 2012	2012	21		7,725	
		2013	13	61.90%	6,121	79.20%
		2014	11	52.40%	5,138	66.50%
		2015	9	42.90%	3,947	51.10%
	First Observed in 2013	2013	18		4,835	
		2014	10	55.60%	3,618	74.80%
		2015	8	44.40%	2,817	58.30%
	First Observed in 2014	2014	49		5,519	
		2015	26	53.10%	3,577	64.80%

Site Type	Years		Same ECHO			
			ECHO providers		Non-ECHO providers	
Other Site	First Observed in 2011	2011	8		1,642	
		2012	5	62.50%	1,439	87.60%
		2013	3	37.50%	1,212	73.80%
		2014	4	50.00%	1,062	64.70%
		2015	4	50.00%	743	45.20%
	First Observed in 2012	2012	26		1,454	
		2013	11	42.30%	1,159	79.70%
		2014	8	30.80%	989	68.00%
		2015	7	26.90%	856	58.90%
	First Observed in 2013	2013	19		2,734	
		2014	12	63.20%	2,209	80.80%
		2015	9	47.40%	1,734	63.40%
	First Observed in 2014	2014	34		3,595	
		2015	17	50.00%	2,460	68.40%