Exploring the Association Between Family Planning and Developing Telecommunications Infrastructure in Rural Peru

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Abstract

This paper explores the association between the mobile telecommunications movement and family planning in rural Peru using geocoded DHS data available from 2000 through 2004-2008 and a unique dataset of cell phone coverage maps. Peru has historically high levels of social stratification but has increasingly developed an integrated mobile telecommunications network. Two linkages between cell phone coverage and family planning are posited. First, there is a direct association between knowledge transferred via cell phone and family planning behaviors. Second, there is an indirect link between modernization accompanying cell phone coverage and fertility transitions. I test these associations in a difference regression model which accounts for spatial dependence in family planning and fertility activities. Preliminary results suggest that cell phone coverage accompanies modernization which changes fertility preferences, but the technology is not being used directly to transfer information and attitudes about family planning activities.

Introduction:

This paper will explore how cell phone coverage is associated with changes in community family planning in rural Peru between 2000 and 2008, using a spatial data analysis. Peru presents an interesting case study for understanding how the mobile telecommunications movement could affect family planning. The expansion of cell phone service has been rapid and inexpensive to consumers as a consequence of heavy competition among cell phone provider companies and government subsidized programs. These initiatives have expanded the scope of cell phone coverage areas and provided access to rural and disadvantaged areas. It is also interesting to study changes in family planning in Peru, given that the country is in the midst of its demographic transition. Fertility has been steadily declining since the mid 1990s as a consequence of intense government efforts to educate the population and supply contraceptives. However, these efforts have been more successful in urban areas, resulting in a large urban-rural fertility disparity: in 2004 the total fertility rate averaged 4.3 children per woman in rural areas and 2.2 children per woman in urban ones[2].

Because urban areas have largely completed their fertility transition, I look at how cell phone coverage may affect family planning in rural locations. I focus on two theoretical pathways linking cell phone coverage and family planning. First, there is a possible indirect effect. For communities, receiving cell phone coverage may be endogenous with other types of development ongoing in an area, so individuals may have greater access to family planning services, ability to afford it, and attitudinal support to do so. Second, there is a potential direct effect. If individuals in communities receiving cell phone coverage own and use cell phones to either talk to acquaintances in more urban areas about family planning or use the technology to reach out to health care providers, cell phones could be directly associated with increased family planning. These potential effects may not be mutually exclusive and I intend to test both using the unique data available.

Data and Methods:

To explore the association between cell phone coverage and family planning activities, this paper utilizes geocoded data from the 2000 standard and 2004-2008 experimental Demographic Health Surveys. Across the two DHS surveys, interviewers returned to the same sampling clusters and conducted a probability sample of households and women in their reproductive ages (15-49). This data collection technique allows for a longitudinal analysis of these communities across the two surveys. Because the 2004-2008 DHS collected data on a continuous basis, I have standardized changes in family planning measures and associated covariates as an annual average of change between the two surveys. This DHS data is then matched with a map of projected cell phone coverage for Peru during the period. The cell phone coverage map was constructed using a census of cell phone towers in Peru and a topographically sensitive signal estimation program. Then, the estimated signal received by each DHS cluster was calculated as was the date when the cluster received sufficient cell phone coverage to make a phone call. [1]

[1] The exact procedure for this estimation procedure is detailed in [1]

Dependent Variables:

In this analysis, I use three measures to capture changes in the prevalence of family planning activities in rural Peru. The first measure is the average rate of change in the proportion of women in each community who report currently using any family planning method. The second measure is the average rate of change in the proportion of women in each community who report ever using any family planning method, a measure which may be less volatile to specific period effects. The final measure is average rate of change in the community total fertility rate. Community averages of these measures are in Table 1.

Explanatory Variables:

Summary statistics for explanatory variables can be seen in Table 2. The key explanatory variables are cell phone coverage and the duration for which a community had that coverage. Controlled for in these models is the change in prevalence of electricity in communities is included to capture structural capacity for media usage in these Peruvian communities. I also control for a community's proximity from an urban center, here defined as a city with over 100,000 occupants, as rural areas which are closer to urban areas may have greater access to family planning and media more generally. The prevalence of television, telephone, and radio ownership is also captured as a proxy for individual capacity to use media within communities. Given that birth preferences and fertility vary by age, the mean age of female respondents is also controlled for in these models. I also control for the prevalence of female literacy within communities to serve as a proxy for female education. Finally, in each model, I include a temporally lagged variable for the measure of family planning in 2000. This variable both determines the extent of positive change in family planning that is possible within communities and controls for all earlier determinants of family planning.

Methods:

I begin by calculating descriptive statistics for family planning in rural Peru and associated covariates as well as exploratory statistics related to the spatial distribution of community family planning. Specifically, I calculate the Moran's I which is a spatial statistic that indicates whether the distribution of a variable deviates from an assumption of spatial randomness and indicates the direction of that deviation (either an attractive or repulsive process). Such a statistic is key for diagnosing spatial patterns and directing future analysis. The regression analysis will examine the average rate of change in family planning between the 2000 and 2004-2008 Demographic Health Surveys. I run three models for each measure of family planning all with the same set of covariates: whether an area received cell phone coverage, the duration of coverage, change in prevalence of female literacy, television ownership, electricity, telephone ownership, mean age of women in 2000, change in the mean age between surveys, radio ownership, and a lagged indicator of the family planning measure in 2000. I will then run Lagrange Multiplier Diagnostics on these models to determine if spatial dependence is affecting model efficiency and if needed, run models incorporating space to better assess the relationship between cell phone coverage and contraceptive use during the period. The Lagrange Multiplier Diagnostic indicates two types of spatial models, error and lag. In error processes, an observation's error structure is associated with that of its neighbors. This association means that space is introducing unaccounted for heteroskedasticity into regression estimates. In lag processes, an observation's predicted value is associated with that of its neighbors. When lag models are run, an area's predicted value is considered relative to the value of its neighbors.

Results and Directions for Future Research:

I have so far calculated descriptive statistics and the Moran's I for my three measures of family planning and the associated covariates (Tables 1-3). These descriptive statistics show that the proportion of current family planning users remained fairly constant between the 2000 and 2004-2008 DHS surveys but reports of ever family planning use increased. Additionally, the total fertility rate in these rural Peruvian communities declined for the period. As expected, Moran's I statistics were positive for all three dependent variables, demonstrating that family planning behaviors in rural Peru are spatially dependent, with a community's family planning activities positively associated with those of its neighbors. The preliminary linear regression estimates of the effects of cell phone coverage on family planning indicate that receiving cell phone coverage is only associated with a decreased total fertility rate but that the duration of cell phone coverage was not significant, consistent with a modernization hypothesis. However, the Moran's I calculated earlier and Lagrange Multiplier Diagnostics on these models suggested that community observations were not independent and a spatial model is needed to achieve efficient regression estimates. The linear regression estimates for my models are included below in table 3, and I am in the process of revising spatial models to efficiently estimate the association between family planning and cell phone coverage.

Following these models, I will conduct a sensitivity analysis of my findings. I will do this first by varying my choice of weights matrices. Currently, I control for spatial associations by using a binary distance matrix where communities are defined as geographic neighbors if they are within 21 kilometers of each other. I chose this specification because cell phone coverage is not affected by geopolitical boundaries and because the maximum distance a signal can travel is 21 kilometers. However, in future models, I will vary my spatial weights matrix to determine if my findings are sensitive to how space is operationalized. Given that cell phone coverage appears to be endogenous with development, I will also utilize a matching technique to determine if when communities are matched in their level of development, receiving cell phone coverage increases changes in family planning. This will provide another test of whether there is a direct of cell phone coverage on family planning behaviors.

Measure	Mean 2000	Mean 2004
Currently using family planning (%)	28.06	28.03
Ever used family planning (%)	64.65	72.20
Total Fertility Rate	3.18	3.02

Table 1: **Descriptive Statistics for Family Planning Measures**

Table 2: **Descriptive Statistics for Independent Covariates**

Variable	**mean**
Communities with Coverage in 2004(%)	12.87%
Mean Time with Coverage in Years	2.53
Change in Electricity (%)	2.77%
Change in Female Illiteracy (%)	-.65%
Change in Landline Phone Ownership (%)	.11%
Change in Radio Ownershp (%)	1.03%
Change in Television Ownership (%)	1.23%
Change in Age Standard in Years	.14
Average Age of Women in 2000 Survey	29.90
Average Distance from an Urban Center (km)	68.06

Measure:	Value in 2000	Value in 2004
Currently Using Family Planning	.253*	.184*
Ever Used Family Planning	.200*	.197*
Total Children Born Per Woman	.069	.200*

* $p \leq 0.05$

Table 3: **Moran's I for Family Planning Measures**

	Currently Using Family Planning		Ever Used Family Planning		TFR	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
(Intercept)	0.036	(0.02)	0.056*	(0.014)	-0.202*	(0.082)
changeinagestand	-0.001	(0.003)	0.012*	(0.002)	0.169*	(0.011)
agecluster2000	0	(0.001)	0.002*	(0)	0.016*	(0.003)
change in electricity	0.004	(0.029)	0.007	(0.021)	0.123	(0.12)
change in illiterate pop	0.052	(0.044)	0.012	(0.031)	0.388*	(0.182)
change in landline ownership	0.048	(0.123)	0.048	(0.088)	-0.805	(0.509)
change in radio ownership	0.053	(0.04)	0.023	(0.029)	-0.042	(0.167)
change in television ownership	0.046	(0.04)	-0.004	(0.028)	-0.147	(0.164)
gained cell phone coverage	0.009	(0.007)	0.001	(0.005)	-0.069*	(0.029)
time with cell phone coverage	-0.002	(0.002)	-0.002	(0.001)	-0.002	(0.008)
distance from urban center	0	(0)	0	(0)	0*	(0)
currently using family planning 2000	-0.129*	(0.007)	.		.	
ever used family planning 2000	.		-0.145*	(0.006)	.	
tfr 2000	.		.		-0.11*	(0.007)
N	567		567		567	
R^2	0.368		0.569		0.643	
Non-Constant Variance Test	4.888*		5.089*		11.22*	
Lagrange Multiplier Robust Error	8.229*		21.516*		15.83*	
Lagrange Multiplier Robust Lag	11.11*		17.05*		5.389*	

* $p \leq 0.05$

Table 4: **OLS Regression Estimates of The Relationship of Family Planning and Telecommunications**

Bibliography

[1] D. Beuermann, C. McKelvey, and C. Sotelo-Lopez. The Effects of Cellular Phone Infrastructure: Evidence from Rural Peru. 2010.

[2] J Jaime Miranda and Alicia Ely Yamin. Reproductive Health Without Rights in Peru. *The Lancet*, 363:68–69, 2004.