Heterogeneity in the effect of public health insurance on catastrophic out-of-pocket health expenditures: the case of Mexico

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Low- and middle-income countries increasingly provide broad-based public health coverage to their residents. One of the goals of such programmes is to reduce the extent to which beneficiaries incur catastrophic out-of-pocket expenditures on health care. A recent field experiment showed that on average Mexico's new public insurance programme reduced such expenditures in rural areas. Our reanalysis of that data, augmented with administrative data on health infrastructure, shows that this effect depends strongly on the type of health facility to which the beneficiary has access. A second analysis, based on data from Mexico's National Household Income and Expenditure Surveys (abbreviated ENIGH for its name in Spanish), substantiates those findings. It shows that catastrophic expenditures have fallen sharply for rural households with access to well-staffed facilities, but that they have fallen little if at all for rural households with access to poorly staffed facilities. Our analysis of the ENIGH also shows that Mexico's public health insurance programme has sharply reduced catastrophic spending among urban households. Considering that most Mexicans live either in urban areas or in rural areas with access to well-staffed facilities, our results show that the public health insurance programme has been largely successful in achieving one of its key goals. At the same time, our results show how difficult it can be to provide effective protection against catastrophic health expenditures for residents of remote rural areas.

Keywords   Health insurance, health financing, policy evaluation, spatial analysis, health facilities

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KEY MESSAGES

- Mexico's new public health insurance programme (Seguro Popular) has reduced catastrophic health expenditures in urban areas.

- Seguro Popular has reduced catastrophic out-of-pocket health expenditures in rural areas as well. However, such reductions vary greatly according to the type of health facility to which beneficiaries have access.

- Rural Seguro Popular beneficiaries with access to larger health facilities have enjoyed large reductions in catastrophic health expenditures. Beneficiaries with access to limited facilities have enjoyed little if any reduction.

- Countries with heterogeneous health facilities and hard-to-serve rural populations may have difficulty in providing financial protection to their most vulnerable beneficiaries, even as they achieve universal health coverage.

Introduction

Low- and middle-income countries increasingly provide broad-based public health coverage to their residents (Rodin and Ferranti 2012; Kurowski and Walker 2010). Mexico has become a leading example. In 2000, roughly half of Mexico's population of about 97 million had no health insurance (INEGI 2000; Fundacion Mexicana para la Salud 2013). In 2004, Mexico introduced Seguro Popular, a voluntary, non-contributory health insurance programme for residents not insured through the social security system or private providers. By 2012, 52.6 million people had been incorporated into the programme (Knaul *et al.* 2012).

One of the main goals of Seguro Popular (SP) is to reduce the incidence of catastrophic out-of-pocket health spending among covered households (Frenk 2006; Gakidou *et al.* 2006; Knaul *et al.* 2006). Such financial protection is an important component of the total social benefit that stems from public health insurance (World Health Organization 2000, Knaul *et al.* 2013a). For example, roughly 40% of the total social benefit arising from the American Medicare programme stems from the financial protection it provides (Finkelstein and McKnight 2008). In lower-income countries, such financial benefits may be even greater, since paying for health care out-of-pocket can involve particularly costly measures such as selling household assets or withdrawing children from school (Chetty and Looney 2006, 2007).

A field experiment that encouraged households to enrol showed that SP has reduced catastrophic health spending in rural areas (King *et al.* 2009). Other studies have shown that these effects vary according to demographic characteristics of covered households (Knaul *et al.* 2013b; 2006; Galarraga *et al.* 2010; King *et al.* 2009). Such heterogeneity is important because policy goals often focus on particular subpopulations, such as groups deemed particularly vulnerable. If the programme fails in serving those targeted groups, a reallocation of resources may be called for.

This study is one of the first to focus on how the financial protection afforded by SP varies by geographical proximity to care. We estimate differences in the effect of SP within rural areas according to the type of health-care facility to which beneficiaries have access. Rural areas are generally defined in Mexico as localities consisting of fewer than 2500 people (INEGI 2013a). However, many rural localities are much smaller: 2.3 million Mexicans live in over 123 000 rural localities with fewer than 100 residents (INEGI 2013b).

As such rural areas are quite heterogeneous, so too are their health-care facilities quite diverse. Beneficiaries who are closer to better facilities may enjoy greater financial protection than others. We estimate that in 2010, 9.2 million rural Mexicans who were eligible for SP had geographically limited access to health facilities. This amounted to 14% of the population eligible for Seguro Popular.

We also estimate the effect of SP on catastrophic health spending in urban areas. These are defined as localities with more than 2500 residents. They are home to 77% of the Mexican population (INEGI 2010a), roughly half of whom are eligible for Seguro Popular. They generally have better access to care than rural areas.

Context: health-care reform in Mexico

Before Seguro Popular, health insurance in Mexico was linked to salaried employment. Salaried workers and their family members received health care through one of the social security institutions. Non-salaried workers and their dependents, who constitute roughly 60% of the Mexican population, could obtain health services provided by the Ministry of Health or private providers (INEGI 2010b). However, the Health Ministry did not guarantee coverage and it required payments for medications and services. As a result, Mexican households incurred extreme expenditures on health at a rate substantially higher than that of households in countries with comparable per capita income (Knaul *et al.* 2005; Xu *et al.* 2003).

Largely as a means to reduce extreme out-of-pocket health expenditures, the Ministry of Health introduced SP in 2004 (Knaul *et al.* 2005; Frenk 2006; Knaul *et al.* 2006). Individuals are eligible for SP if they are not covered by social security or private health insurance. Enrolees are guaranteed a package of 275 interventions, classified into six groups: public health; emergencies; general family health services and specialty services; general surgery; hospitalization and dentistry. For the poorest households, SP is free. Other families are supposed to pay an annual fee that rises with income, although the evidence shows that few families pay at all (Lakin 2010; Scott 2006). As of 2013, SP had enrolled 52.7 million beneficiaries (Comision Nacional de Proteccion Social 2013).

Methods

We conduct two separate analyses based on two separate sources of data. The first involves the aforementioned experiment, which was carried out while SP was being implemented nationwide and involved an encouragement design (King *et al.* 2009). The second involves household-level expenditure data from the Mexican National Household Income and Expenditure Surveys (abbreviated as ENIGH for its name in Spanish).

We conducted two separate analyses for two reasons. First, our initial reanalysis of data from the field experiment revealed substantial differences in the effect of SP according to the type of health facility to which the beneficiary had access. To substantiate those findings, and ensure that they were not merely an artefact of post-hoc subgroup analysis, we carried out a separate analysis using the ENIGH data.

Second, since the ENIGH provides nationwide survey data, it enabled us to estimate the effect of SP on catastrophic health spending not only in rural areas, but also in urban areas. Estimates for urban areas are an important contribution in their own right, since they were not covered by the field experiment and since they are home to most of the Mexican population.

Analysis of the field experiment
Design and data
The field experiment was launched in 2005. It involved a paired-cluster randomization design, by which 100 largely rural 'health clusters' were formed into 50 pairs on the basis of similarities in demographic characteristics and health-care infrastructure. Health clusters are defined as a health-care facility and the population living within its catchment area. Within matched pairs

of health clusters, one was randomly assigned to treatment, with the other serving as control. Treatment involved publicity campaigns that encouraged local residents to enrol. Extensive information about the initial design of the experiment has been published elsewhere (King *et al.* 2007; King *et al.* 2009; Sistema de Proteccion Social en Salud 2005).

Pre-intervention baseline data were collected from participant households in 2005. Post-intervention follow-up data were collected in 2006, roughly 10 months after the intervention began. The 2005 survey included 32 515 households. The 2006 survey included 29 897 households, of which 27 755 reported household expenditures.

Published findings from the field experiment showed that 44% of households in the treatment clusters enrolled in SP, compared with 7% in the control clusters. They also showed that SP reduced extreme out-of-pocket spending on health care, particularly among lower-wealth households (King *et al.* 2009).

We estimate the effect of the experimental intervention on catastrophic out-of-pocket health-care spending. A household incurs catastrophic out-of-pocket spending on health if its out-of-pocket health spending exceeds 30% of its total spending, adjusted for a nominal food budget (Xu *et al.* 2003). Our dependent variable is a dummy variable equal to one for households that incur catastrophic out-of-pocket health expenditures and equal to zero otherwise. In results not reported here, we have found that alternative measures of catastrophic spending yield similar results.

To analyse heterogeneity with respect to rural health-care facilities, we merged the household survey data with health facility data available from the Mexican Health Ministry's SINAIS database (Sistema Nacional de Información de Salud 2010). This database provides limited staffing information and facility type data for all Health Ministry facilities in the country.

We classify all health-care facilities into one of two categories. The first category consists of primary-care facilities whose staffing consists of a single 'basic nucleus'. A basic nucleus is an administrative staffing unit that in principle consists of one doctor and two nurses. However, in resource-poor environments, interns or medical students may be substituted for certified physicians and technical personnel may be substituted for professional personnel (Secretaría de Salud 1995; Knaul *et al.* 2012). Such facilities served roughly 60% of the households included in the experiment. The second category consists of all other facilities, including both primary-care facilities with multiple basic nuclei and secondary-care facilities.

Statistical analyses

We estimate two types of effects, an intent-to-treat (ITT) effect and a local average treatment effect (LATE).[1] The ITT effect can be interpreted as the effect on catastrophic spending of offering households the opportunity to enrol in SP. It can be calculated by regressing our dependent variable, the 2006 household-level catastrophic out-of-pocket health expenditure dummy, on a treatment-group dummy and cluster-pair dummies.[2] The treatment-group dummy equals one for households in the treatment clusters and zero for households in the control clusters. The cluster-pair dummies are included to ensure that the estimates are based on the within-pair random assignment that was the key element of the experimental design.

The LATE can be interpreted as the average effect of insurance coverage on households that were induced to enrol in SP by the publicity campaigns. It can be estimated by means of an instrumental variables regression of our dependent variable on a household-level SP enrolment dummy and the cluster-pair dummies, where the treatment-group dummy serves as an instrument for the SP enrolment dummy (Angrist *et al.* 1996). The SP enrolment dummy equals one for households enrolled in SP in 2006 and equals zero otherwise.

Because treatment status varies at the level of the health cluster rather than the household, we adjust the standard errors used in constructing confidence intervals for possible dependence at the level of the health cluster (Moulton 1990).

Logistic regression analysis of the ENIGH

Since the subgroup analysis described above was not part of a pre-specified analysis plan, it could potentially be construed as data mining (Assmann *et al.* 2000). To substantiate our results, we carried out a second analysis based on independent data and a different statistical method. This second study also provides estimates of the effect of SP in urban areas.

Data

Our second analysis combines household-level expenditure data from the ENIGH with annual data on the share of eligible persons covered by SP in each state. It uses variation in the expansion of coverage between Mexico's states to estimate the effect of SP on catastrophic out-of-pocket health expenditures among households eligible for SP coverage.

We use data from all ENIGH surveys conducted between 2000 and 2010, namely 2000, 2002, 2004, 2005, 2006, 2008 and 2010.[3] We classify households as being eligible for SP coverage if no one in the household reported having health insurance from the social security system. This yielded a total of 87 736 eligible households. Because eligibility is higher in rural areas than in urban areas (i.e. social security coverage is lower in rural areas) 31 040 of those households (35.4% of the total) were located in rural areas and 56 696 (64.6%) were located in urban areas.

Our dependent variable is again a dummy variable equal to one if a household's out-of-pocket health spending exceeds 30% of its total spending, adjusted for a nominal food budget. Otherwise, the dependent variable equals zero. As was true in the analysis reported above, unreported results based on alternative definitions of catastrophic health spending yielded results similar to those presented here.

Our key explanatory variable is the SP coverage rate. To estimate the coverage rate, we divided the annual number of enrolled persons in each state by the number of eligible persons. Annual state-level data on the number of covered persons were provided to us by the Mexican National Commission for Social Health Protection. We estimated the annual number of eligible persons in each state from the Mexican National Occupation and Employment Surveys (ENOES), which provide samples that are representative of each state (INEGI 2005).

At the beginning of our sample period in 2000, the SP coverage rate equalled zero in all states by definition, since the

programme was not yet in existence. By 2010 the coverage rate had reached 100% in one state, and exceeded 95% in two others.

To analyse heterogeneity in the effect of SP, we again use the SINAIS data. To do this, we classify all rural households into one of two groups. The first group consists of households with poor access to care, meaning they reside in localities which either (i) have no health facility within a 10-km radius of the locality within which they reside or (ii) have only one of the single-basic-nucleus facilities described above within a 10-km radius of the locality within which they reside. Localities are small administrative units of local government. Radii are defined in terms of distance between locality centroids, since we do not observe the exact geographic location of ENIGH households within localities. The second group consists of rural households with better access to care, meaning that have a larger health-care facility within a 10-km radius of the locality within which they reside. In addition to these two groups of rural households, we separately analyse data for urban households. There are no single-nucleus health-care facilities in urban areas.

Statistical analysis

We estimate the effect of SP coverage by means of a logistic regression model. The sample consists of households that were eligible for SP. The dependent variable is the household-level catastrophic out-of-pocket health expenditure dummy. The key explanatory variable is the SP coverage rate, which varies over time and across states. We include controls for the household head's age, education level, household size, the number of household members aged 12–64, and the number of household members aged >64, on the grounds that these factors may independently influence health spending. We include year dummies to control for general trends in health spending. We also include a separate dummy variable for each state. The state dummies control for otherwise unobservable time-invariant characteristics of states that may influence residents' health spending. If such characteristics were correlated with coverage rates, failing to control for them could lead to biased estimates.

To ease interpretation, we report not the logistic regression coefficients, but rather marginal effects (Wooldridge 2010). The marginal effects can be interpreted as the effect of a one-unit change in the independent variable. In our case, a one-unit change in the coverage rate is equivalent to moving from a coverage rate of zero to a coverage rate of one (both of which are observed in our sample). For this reason, we interpret the marginal effects as the effect of moving from no health insurance coverage to complete health insurance coverage on the probability of catastrophic out-of-pocket health spending.

Because the key explanatory variable varies only across states and over time, we adjust the standard errors used in constructing confidence intervals for possible dependence within states (Moulton 1990).

Results

Table 1 presents our results. The first column reports estimated ITT effects from the SP field experiment; the second presents estimated LATE effects. The third column presents the estimated marginal effects of SP coverage from our logistic regression model based on the ENIGH data. In each cell, the top number in bold is our estimated effect, the numbers in parentheses show the 95% confidence interval for that estimate, the number in square brackets is the share of households incurring catastrophic spending prior to the introduction of SP, and the final number is the sample size. Catastrophic spending shares in brackets are computed from 2005 control-group baseline data in Columns (1) and (2) and from 2000 ENIGH data in Column (3).

The first row presents estimates for all rural areas. All of the estimates are negative and statistically significant, indicating that SP reduced the probability of incurring catastrophic out-of-pocket health expenditures. The estimates in Columns (1) and (2) are similar to those reported previously by King et al. (2009). The estimate in Column (2) indicates that SP reduced the likelihood of incurring catastrophic out-of-pocket health expenditures by 4.5 percentage points among households induced to enrol in the programme by the experimentally assigned publicity campaigns. This amounts to a 43% reduction in relation to the 10.4% of control-group households that incurred catastrophic out-of-pocket health expenditures.

The estimates in Column (3) show results from the ENIGH data. As mentioned above, the reported marginal effects can be interpreted as the effect of going from a coverage rate of 0 to a coverage rate of 1. We see that for rural areas complete coverage by SP reduces the probability of catastrophic out-of-pocket health expenditures by 3.3 percentage points relative to no coverage. This amounts to a 46% reduction in relation to the 7.1% of rural households nationwide that satisfied the SP eligibility criteria and incurred catastrophic out-of-pocket health expenditures in 2000.

The second row reports estimates for residents of rural areas with limited access to care, that is, with access either to a single-nucleus facility or to no facility. These estimates are small and insignificant. The estimate based on the ENIGH is positive, contrary to expectation, but has a wide confidence interval. Estimates from both analyses show that SP has not reduced catastrophic out-of-pocket health spending in areas with limited access to care. In work not reported here, we attempted to distinguish between areas with no access and areas with access to single-nucleus facilities. Unfortunately, the resulting samples were quite small and the estimates correspondingly imprecise.

The estimates in the third row, which pertain to rural areas served by larger facilities, are negative, sizeable and statistically significant. The estimates from the two different analyses are quantitatively similar. Both suggest that, among families in rural areas with access to care, SP coverage has greatly reduced catastrophic out-of-pocket health expenditures.

The differences in the estimates by facility type are statistically significant. The t-statistic to test for similarity between the LATE effects in rows 2 and 3 of Column (2) is 2.7 ($P = 0.003$). The t-statistic to test for similarity between the marginal effects in rows 2 and 3 of Column (3) is 3.1 ($P < 0.001$).

The estimate in the fourth row shows that SP has reduced catastrophic out-of-pocket health expenditures in urban areas. Again the magnitude of the effect is large. It indicates that complete coverage of eligible urban dwellers reduces their

Table 1 Estimates of the effect of SP on catastrophic out-of-pocket health expenditures for rural areas by type of health-care facility and for urban areas

Data source	SP field experiment	SP field experiment	National Household Income and Expenditure Survey
Estimated effect	ITT	LATE	Marginal effect from logistic regression
Area/facility type	(1)	(2)	(3)
1. All rural areas	**–0.017**	**–0.045**	**–0.033**
	(–0.029 to –0.007)	(–0.069 to –0.021)	(–0.058 to –0.008)
	[0.104]	[0.104]	[0.071]
	27 755	27 755	31 040
2. Rural areas with	**–0.007**	**–0.017**	**0.021**
single-nucleus or	(–0.023 to 0.009)	(–0.050 to 0.016)	(–0.027 to 0.069)
no healthcare	[0.104]	[0.103]	[0.066]
facility	12 958	12 958	13 848
3. Rural areas with	**–0.031**	**–0.101**	**–0.069**
larger healthcare	(–0.049 to –0.013)	(–0.152 to –0.050)	(–0.1 to –0.039)
facility	[0.107]	[0.107]	[0.074]
	7667	7667	16 856
4. Urban areas			**–0.029**
			(–0.051 to –0.008)
			[0.041]
			56 696

Numbers in bold are estimated effects. Numbers in parentheses show 95% confidence intervals. Numbers is brackets give the share of households incurring catastrophic out-of-pocket expenditures: in columns (1) and (2), in control-group households in 2005; in column (3), in 2000. Last number in each cell is the sample size. In Columns (1) and (2), sample sizes in rows 2 and 3 do not add to the sample size in row 1 because rows 2 and 3 utilize only cluster-pairs where both the treatment and control facilities are of the same type, that is, both are single-nucleus facilities or both are larger facilities. In Column (3), sample sizes in rows 2 and 3 do not add to sample size in row one because: (1) distance to nearest healthcare facility could not be computed (294 observations); (2) observations from row-2 sample in Tlaxcala were dropped, because there were no households with catastrophic spending there (14 observations) and (3) observations from row-3 sample in Baja California Sur were dropped, because there were no households with catastrophic spending there (28 observations).

likelihood of catastrophic out-of-pocket health expenditure by 2.9 percentage points relative to no coverage, which amounts to 72% of the 4.1% rate at which catastrophic expenditures were incurred among eligible urban households in 2000.

Discussion

We have taken two approaches to analyse the link between SP coverage, health-care facility resources, and catastrophic out-of-pocket health expenditures. The findings from both approaches accord closely. They show that there is heterogeneity in the extent to which SP provides financial protection for its beneficiaries. In rural areas remote from health-care facilities, or proximate only to facilities with limited staffing, the programme has not reduced catastrophic out-of-pocket health expenditures. In rural areas proximate to larger facilities, in contrast, the programme has provided considerable financial protection. Also in urban areas, SP has substantially reduced catastrophic out-of-pocket health spending among beneficiaries.

Our findings parallel well-known results that show that health outcomes are related to health-care resources (Shi and Starfield 2001; Perrin and Valvona 1986; Needleman *et al.* 2002). They also reflect recent findings that SP has had stronger effects on health in areas with a greater supply of health-care professionals (Bleich *et al.* 2007). However, our study is the first to differentiate the effect of coverage on catastrophic spending by access to care.

Our findings are important for several reasons. First, much of the social benefit of public health insurance derives directly from the financial protection that it provides (Finkelstein and McKnight 2008). Second, much of Mexico's motivation in launching SP stemmed from a desire to reduce catastrophic out-of-pocket payments for health care (Frenk 2006; Gakidou *et al.* 2006; Knaul *et al.* 2006, 2013c). Third, poor areas were targeted to have priority for coverage (Gakidou *et al.* 2006). Our findings suggest that the programme provides financial protection for the majority of its beneficiaries. At the same time, they also highlight the difficulties of providing financial protection to residents of rural areas with limited infrastructure, who, according to our estimates, account for 38% of eligible rural residents.

As in other low- and middle-income countries, Mexico's rural population is quite disadvantaged. Twenty-seven per cent of the rural population lives in extreme poverty, 16% are illiterate, and 40% are distributed among 157 215 localities with fewer than 500 residents (Consejo Nacional de Evaluacion de la Politica de Desarrollo Social 2013; Narro and Moctezuma 2013; INEGI

2013b). Our findings may be relevant not only for Mexico, but also for other middle-income countries with heterogeneous health-care facilities and hard-to-serve rural populations. However, a limitation of our study is that our samples are not large enough for us to disaggregate our findings along these important dimensions. Similarly, we were unable to further disaggregate our findings between rural areas that were close to small health facilities and rural areas that were distant from health facilities of any kind.

Another important limitation is that we do not know the mechanism by which SP fails to provide financial protection for beneficiaries served by the smallest rural facilities. Since facilities are categorized by staffing levels, staffing differences provide a natural hypothesis, but such facilities may also be lacking in equipment. In analyses not reported here, we found that neither the number of doctors, nor the combined number of doctors and nurses, fully explained differences in the effect of SP by type of facility. Recent ethnographic work indicates that rural Mexicans point to limited hours of operation, lack of medicines, inadequate equipment, and perceptions of poor treatment by medical staff as reasons for avoiding Health Ministry facilities (Sanchez Lopez 2008). Further research to test whether such factors explain differences in financial protection by facility type would be invaluable.

Another important extension of this research is the study of the long-term effects of insurance against catastrophic health expenditures. A single catastrophic expenditure event, such as that which may be captured in a cross-sectional study, may be enough to affect asset accumulation and other consumption patterns. However, households may incur recurrent catastrophic health expenditures, whose consequences could be even more damaging. Longitudinal data at the household level would allow the analysis of this issue, which would improve our understanding of the long-term impacts of SP.

Conclusions

Our study shows that the effects of public health insurance on catastrophic out-of-pocket health spending may vary depending on where the beneficiary lives and on the type of health-care facility to which she has access. In the case of SP, urban beneficiaries enjoy substantial reductions in catastrophic expenditures, as do rural beneficiaries served by larger, relatively well-staffed facilities. However, rural beneficiaries served by poorly staffed facilities, or remote from any facility at all, enjoy no significant reductions. Considering the distribution of Mexico's population, our results show that SP has been largely successful in achieving one of its key goals. At the same time, our results point out how difficult it may be to provide effective protection against catastrophic health expenditures for disadvantaged rural populations, even for programmes that enrol all eligible households and provide coverage for the majority of the population.

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Conflict of interest statement. None declared.

Endnotes

[1] We also estimated the marginal effect of treatment on the probability of incurring into catastrophic expenditures via a logistic regression. Those estimates were omitted because, to the fourth decimal place, they are the same as the ITT estimates reported in Table 1.

[2] Because our data has an experimental design, no further control variables from the baseline survey were included. As a robustness exercise, we initially included some 2005 controls. As expected, they had little effect on the estimated ITT.

[3] The ENIGH has also been used to study catastrophic health expenditures by Knaul *et al.* (2005), Scott (2006), Knaul *et al.* (2006), Barros (2008), Sosa-Rubi *et al.* (2011), and Knaul *et al.* (2013b).

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