NBER WORKING PAPER SERIES

HETEROGENEOUS IMPACT OF THE "SEGURO POPULAR" PROGRAM ON THE UTILIZATION OF OBSTETRICAL SERVICES IN MEXICO, 2001-2006: A MULTINOMIAL PROBIT MODEL WITH A DISCRETE ENDOGENOUS VARIABLE

Sandra G. Sosa-Rubi
Omar Galarraga
Jeffrey E. Harris

Working Paper 13498
http://www.nber.org/papers/w13498

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
October 2007

We acknowledge the research assistance of Edson Serván Mori. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

Heterogeneous Impact of the "Seguro Popular" Program on the Utilization of Obstetrical Services in Mexico, 2001-2006: A Multinomial Probit Model with a Discrete Endogenous Variable
Sandra G. Sosa-Rubi, Omar Galarraga, and Jeffrey E. Harris
NBER Working Paper No. 13498
October 2007
JEL No. I1,I18,I38,O12,O22,O38,O54

ABSTRACT

Objective: We evaluated the impact of Seguro Popular (SP), a program introduced in 2001 in Mexico primarily to finance health care for the poor. We studied the effect of SP on pregnant women's access to obstetrical services.

Data: We analyzed the cross-sectional 2006 National Health and Nutrition Survey (ENSANUT), focusing on the responses of 3,890 women who delivered babies during 2001-2006 and whose households lacked employer-based health care coverage.

Methods: We formulated a multinomial probit model that distinguished between three mutually exclusive sites for delivering a baby: a health unit accredited by SP; a clinic run by the Department of Health (Secretaría de Salud, or SSA); and private obstetrical care. Our model accounted for the endogeneity of the household's binary decision to enroll in the SP program.

Results: Women in households that participated in the SP program had a much stronger preference for having a baby in a SP-sponsored unit rather than paying out of pocket for a private delivery. At the same time, participation in SP was associated with a stronger preference for delivering in the private sector rather than at a state-run SSA clinic. On balance, the Seguro Popular program reduced pregnant women's attendance at an SSA clinic much more than it reduced the probabilityof delivering a baby in the private sector. The impacts of the SP program at the individual and population levels varied with the woman's education and health, as well as the assets and location (rural versus urban) of the household.

Conclusions: The SP program had a robust, significantly positive impact on access to obstetrical services. Our finding that women enrolled in SP switched from non-SP state-run facilities, rather than from out-of-pocket private services, is important for public policy and requires further exploration.

Sandra G. Sosa-Rubi
Centro de Investigación en Sistemas de Salud
Instituto Nacional de Salud Pública
Cuernavaca, Morelos 62508, México
srubi@insp.mx

Omar Galarraga
Centro de Investigación en Evaluación y Encuestas
Instituto Nacional de Salud Pública
Cuernavaca, Morelos 62508, México
ogalarraga@insp.mx

Jeffrey E. Harris
Department of Economics and NBER
MIT, Room E52-252F
50 Memorial Drive
Cambridge, MA 02139
jeffrey@mit.edu

1. Introduction

This paper contributes to three important strands in the health economics literature. First, we add to the emerging body of knowledge on the impacts of novel public policies to finance the health care of the poor in developing economies (Gaviria, Medina et al. (2006); Trujillo, Portillo et al. (2005); Wagstaff (2007); Wagstaff, Lindelow et al. (2007)), including recent innovative interventions in Mexico (Knaul and Frenk (2005); Frenk, Sepulveda et al. (2003); Gakidou, Lozano et al. (2006); Sepúlveda, Bustreo et al. (2006)). We find that the recently established “Seguro Popular” (or “People’s Insurance”) program in Mexico has had a robust, significantly positive effect on the access of poor women to obstetrical care, an important outcome measure of maternal and infant health.

Second, we add to the growing literature on the use of multinomial discrete choice models of the selection of health care providers, including Schwartz, Akin et al. (1988) in the setting of the Philippines, Akin, Guilkey et al. (1995) in Nigeria, Bolduc, Lacroix et al. (1996) in Benin, and Leonard (2007) in Tanzania, as well as recent path-breaking work on multi-equation models involving discrete variables (Balia and Jones (2004); Deb, Munkin et al. (2006)) . We formulate a multinomial probit model that distinguishes between three mutually exclusive sites for delivering a baby: a health unit specifically accredited by Seguro Popular (SP); a non-SP-accredited clinic run by the Department of Health (Secretaría de Salud, or SSA); and private obstetrical services. In what appears to be the first instance of such a technique, we then modify the standard multinomial probit model to explicitly account for the possible endogeneity of the household’s binary decision to participate in Seguro Popular. Women in households that participated in the

SP program, we find, had a much stronger preference for having a baby in a SP-sponsored unit rather than paying out of pocket for a private delivery. At the same time, participation in SP was associated with a stronger preference for delivering in the private sector rather than at an SSA-sponsored clinic. On balance, the Seguro Popular program reduced pregnant women's attendance at an SSA-sponsored clinic much more than it reduced the probability of delivering a baby in the private sector.

Third, we contribute to the nascent but expanding body of work on the heterogeneous impacts of policy interventions in the developing world, including the effect of antiretroviral treatment on labor force participation in Western Kenya (Thirumurthy, Zivin et al. (2006)), the effect of conditional cash transfers on schooling and nutrition in Nicaragua (Dammert (2007)) and Mexico (Djebbari and Smith (2005); Chávez-Martín del Campo (2006)). Here, we find that the quantitative impacts of the SP program at both the individual and population levels varied with the woman's education and health, as well as the assets and location (rural versus urban) of the household.

In Section 2, we review the problem of access to obstetric care for poor women in Mexico, the basic structure of the Mexican health care system, and the introduction of Seguro Popular in 2001. In Section 3, we describe a discrete household decision-making model concerning the use obstetrical services, which shows how a demand-side subsidy such as Seguro Popular can affect the household's relative ranking of service sites. Section 4 explicitly converts our model into econometric form, and takes into account the potential endogeneity of the decision to participate in Seguro Popular, as well as our strategy for evaluating heterogeneous impacts. Section 5 describes our database, the 2006 National Survey of Health and Nutrition (Encuesta Nacional de Salud y Nutrición, or ENSANUT; see Instituto Nacional de Salud Pública (2006)). Section 6 details our empirical results. Section 7 summarizes our findings, discusses the limitations of our research, and considers its implications for public policy and future research on health policy in developing economies.

2. Mexico's Health Care System and the "Seguro Popular" Program

2.1. Health Care Access and Financing in Mexico

Historically, access to health insurance coverage in Mexico was tied to employment in certain sectors of the formal economy. The principal sources of coverage for workers in these sectors were the Mexican Social Insurance Institute (Instituto Mexicano del Seguro Social, or IMSS), the Government Workers' Social Security and Services Institute (Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado, or ISSSTE), as well as insurance programs for employees of such state-run enterprises as PEMEX (petroleum) and SEDENA (national defense). Workers outside these specific sectors and participants in the informal economy had to attend government-sponsored facilities through the Department of Health (Secretaría de Salud, or SSA) or pay out of pocket for medical care at private hospitals or doctors' offices. These private facilities varied considerably in price, quality, and availability. On the one hand, a modern network of private health services for the middle and upper classes, located mainly in urban areas, served those individuals who had insurance coverage or could pay out of pocket for their health care. On the other hand, lower-priced private health services of variable quality, including informal providers such as midwives and traditional healers, were available to poor urban and rural families (Parker and Wong (1997); Nigenda, Troncoso et al. (2003); Pagan, Puig et al. (2007)).

The poorest households in the informal sector were thus left with essentially three options: foregoing health care; seeking whatever care was available from state-sponsored SSA clinics or other low-cost informal providers; or spending a large part of their income on private health care. This has, in fact, been the predicament of the poor in many developing economies (Wagstaff (2007)).

In recent years, Mexico has adopted public policies intended to overcome these historical inequalities in health care coverage (Frenk, Sepulveda et al. (2003)). One especially important initiative has been PROGRESA (Program for Education, Health and Nutrition), later renamed Oportunidades, an incentive-based subsidy program designed to improve the health, nutrition and education of poor families with children (Behrman and Skoufias (2006); Gertler (2000); Gertler (2004); Hoddinott and Skoufias (2004); Skoufias and Parker (2001; Skoufias (2005)). While PROGRESA/Oportunidades has increased poor families' demand for preventive health services and some types of primary care, coverage for more advanced forms of care has remained lacking. For a poor family, essentially any major illness requiring secondary or tertiary medical care was catastrophic.

2.2. Seguro Popular

In 2001, the government of Mexico launched Seguro Popular, a major new effort to improve access of the poor to qualified public health services. The Seguro Popular program specifically targeted poor families in both urban and rural areas of Mexico without access to any other form of private or public coverage (Torres and Knaul (2003)).

Under this voluntary insurance plan, a household makes subsidized contributions, based on ability to pay, to a public fund to prevent catastrophic spending on health care (Frenk, Sepulveda et al. (2003)). Access to primary, secondary and more advanced medical care is guaranteed and provided mainly through a publicly sponsored network of ambulatory health units, general and specialized hospitals. All SP-sponsored health facilities are certified as providing a minimum level of quality of care. Health centers and hospitals are accredited on the basis of their infrastructure, equipment, health personnel, range of medical services and other criteria.

In order to accommodate the lengthy process of health unit accreditation, Seguro Popular was rolled out gradually during 2001–2005. Five states (Aguascalientes, Campeche, Colima, Jalisco and Tabasco) were incorporated into the program in 2001 as part of a pilot study. An additional 15 states were integrated in the program in 2002; four more states were incorporated in 2003; and the remaining states were incorporated in during 2004 and 2005. By the end of 2005, all 32 of Mexico's states had been incorporated, and approximately 4 million families (comprising approximately 12 million individuals) had signed up for the voluntary program (Secretaría de Salud (2006)).

2.3. Maternal Health Services

Access to adequate maternal health care is important for the health of both mother and infant. During the past two decades, policy makers in Mexico have adopted three different approaches in pursuit of this objective. One approach has been to enhance access to services within the existing system of state-run SSA-sponsored clinics. A second strategy, embodied in the PROGRESA/Oportunidades program, provides specific economic incentives to poor families for seeking preventive health services, including prenatal care for pregnant women. The third strategy, reinforced by the Seguro Popular program, entails investment in adequate infrastructure for the provision of the full range of maternal health services, including gynecologic and obstetric care, to women of low socioeconomic status.

The first approach has had limited impact. In some cases, those state-run SSA-sponsored units that did provide some obstetrical services lacked the full range of drugs and equipment, hired deficiently trained personnel, and maintained reduced hours of operation. As a consequence, a significant proportion of pregnant women preferred delivering their babies in the private sector, even though they had direct contact with state-run health facilities for their prenatal care, and even though many private-sector providers were unqualified midwives and traditional birth attendants. This reversal of preferences has been observed in other developing economies (Schwartz, Akin et al. (1988)).

The second approach has met with some success. There is evidence that the PROGRESA/Oportunidades program enhanced the use of formal prenatal health services by the poorest pregnant women (Gertler (2000); Gertler (2004)). However, the approach did not clearly improve access to obstetrical care, especially in rural areas. During 1998–2001, thirty-four percent of births in rural areas were attended by private providers, including traditional midwives (Instituto Nacional de Salud Pública (2000)). The principal explanation for this phenomenon was limited access to modern obstetrical facilities in rural areas.

The first approach, which focused on improving access to basic reproductive health services available through the SSA, was associated with decline in maternal mortality at the national level since 1993 (Mojarro, Tapia-Colocia et al. (2003)). However, such improvements in maternal mortality were not seen in the poorest areas of the country, and substantial regional variations in maternal mortality persisted. During 1997–1999, the national maternal mortality rate was 6.16 per 10,000 live births, with rates of 5.21 and 7.38 in urban and rural areas, respectively, and rates as high as 10.0 in the state of Oaxaca, 9.5 in Tlaxcala, and 9.0 in Chiapas (Mojarro, Tapia-Colocia et al. (2003)). These inequalities in maternal mortality have been attributed to inadequate provision of maternal health services in the poorest regions of the country.

One objective of the Seguro Popular program has been to remedy these persistent deficiencies in maternal health services. Apart from subsidizing health insurance coverage, the program has invested considerable resources in improving the quality and availability of secondary medical provided in public facilities, including obstetric care. Accordingly, in the present research, we sought to evaluate whether enrollment in SP has specifically improved pregnant women's attendance at SP-accredited obstetrical facilities. Given poor women's historical preference for private obstetrical services over state-run facilities, we therefore distinguished between three different sites of care: an SP-accredited obstetric facility; a non-SP state-run health unit; and a private provider, including physicians and midwives delivering in hospitals or at home.

3. Theoretical Model

We begin with a deterministic model of utility maximization by a single, representative household. We then address issues of heterogeneity across multiple households and introduce a stochastic component to our model.

3.1. Deterministic Single-Household Model with Discrete Choice

Although a household may have multiple members, we assume that it makes its consumption decisions as a unified entity. Furthermore, we assume that one member of the household is a pregnant woman who must decide where to have her baby. We posit a strictly quasi-concave household utility function

$$(1) \qquad U\left(z_0, z_1, z_2, x, c\right)$$

where $\left(z_0, z_1, z_2\right)$ denotes the pregnant woman's consumption of obstetric care at each of three different sites, where x measures the consumption of other forms of medical care by any one of the household members, and where c is all other consumption. The three possible sites of care include: z_0, a site run by the Department of Health (Secretaría de Salud, or SSA); z_1, a facility specifically accredited by Seguro Popular (SP); or z_2, delivery by a physician or midwife in a private facility or at home. While we specify only three possible sites, our model can be generalized to any larger number of sites. The household's budget constraint is

$$(2) \qquad q_0 z_0 + q_1 z_1 + q_2 z_2 + px + c = m$$

where $\left(q_0, q_1, q_2\right)$ are the respective prices of obstetric care (net of insurance coverage) at the three sites, where p is the net price of other medical care, where all other consumption has a unit price, and where m is household income. We impose the following non-negativity conditions

$$(3) \qquad z_i \geq 0,\ x \geq 0,\ c \geq 0,\ m > 0,\ p > 0,\ q_i > 0$$

In particular, the medical care net prices p and q_i are assumed to include time and transportation costs, so that they remain strictly positive even with full coverage.

We further assume that the three different sites of obstetric care represent mutually exclusive alternatives. In imposing such a constraint, we focus specifically on the site of obstetric care where the pregnant woman chooses to deliver her baby, as opposed to the sites at which she may seek prenatal care or to which she may be transferred for treatment of postpartum complications. Our constraint on the site of care converts the standard maximization model into a discrete choice problem.

(4) $$z_0 z_1 z_2 = 0$$

The household's problem is to maximize the utility function (1) subject to the constraints (2) through (4). The problem is solved in two steps. First, we define the *conditional* utility functions

(5) $$\begin{aligned} u_0\left(z_0, x, c\right) &= U\left(z_0, 0, 0, x, c\right) \\ u_1\left(z_1, x, c\right) &= U\left(0, z_1, 0, x, c\right) \\ u_2\left(z_2, x, c\right) &= U\left(0, 0, z_2, x, c\right) \end{aligned}$$

For each $i = 0,1,2$, we maximize the conditional utility function

(6) $$\max_{z_i, x, c} u_i\left(z_i, x, c\right)$$

subject to the conditional budget constraint

(7) $$q_i z_i + px + c = m$$

For each $i = 0,1,2$, let $z_i^*(q_i, p, m)$, $x_i^*(q_i, p, m)$, and $c_i^*(q_i, p, m)$ be the corresponding conditional demand functions, and let

(8) $$w_i^*(q_i, p, m) = u(z_i^*, x_i^*, c_i^*)$$

be the corresponding indirect utility function conditional upon choosing site i. The quantities $\{w_0^*, w_1^*, w_2^*\}$ provide a complete ordering among the conditional indirect utilities for the three obstetric sites. The second step is to choose the site i of obstetric care that yields the largest conditional indirect utility, that is,

(9) $$\max_i w_i^*(q_i, p, m)$$

This two-step procedure not only yields an unconditional demand for a specific site z_i, but also a specific quantity x of non-obstetric care. For future reference, we define the discrete variable y_1 as follows:

(10) $$y_1 = i \text{ if } w_i^* = \max\{w_0^*, w_1^*, w_2^*\}$$

where y_1 thus depends implicitly on prices q_0, q_1, q_2, p and income m.

3.2. Effect of Changes in Price

Seguro Popular subsides medical care for the entire household, and not simply for individual members. Specifically, the program subsidizes non-obstetric medical care x for all household members, as well as obstetric care, z_1, at a SP-sponsored site. Equivalently, Seguro Popular reduces in the respective net prices p and q_1. Although the effects of these price reductions on the conditional demand functions are straightforward, the effects on the unconditional demand functions are more complicated.

First consider the effect of changes in prices p and q_1 on the conditional demand functions $z_i^*(q_i, p, m)$ and $x_i^*(q_i, p, m)$. If the pregnant woman has chosen Seguro Popular $(y_1 = 1)$, then we would ordinarily expect the own-price effects on conditional demand to be negative, that is, $\frac{\partial x_1^*}{\partial p} < 0$ and $\frac{\partial z_1^*}{\partial q_1} < 0$. The sign of cross-price effect $\frac{\partial z_1^*}{\partial p}$ will depend on whether SP-sponsored obstetrical care is a complement or substitute for other types of medical care consumed by the household. For example, if these additional types of care include pediatric care for newborns, prenatal or postpartum care for the mother, or medical care for other family members who provide for the newborn child, then we would expect a complementary relationship, that is, $\frac{\partial z_1^*}{\partial p} < 0$. On the other hand, if the additional care represents treatment for an elderly grandparent who does not provide care for the newborn child, then we might expect to observe the opposite sign, that is, $\frac{\partial z_1^*}{\partial p} > 0$.

Continuing to focus on conditional demand, we note that if the pregnant woman has instead chosen another site of obstetric care $(y_1 \neq 1)$, then the cross-price effect of subsidizing care at a SP-sponsored site is necessarily zero, that is, $\frac{\partial z_i^*}{\partial q_1} = 0$. However, the cross-price effect of subsidizing other medical care $\frac{\partial z_i^*}{\partial p}$ can still be positive or negative.

Again, the sign depends on whether the additional care is a complement or substitute for the mother's obstetric care at site $i \neq 1$.

Now consider the effects of changes in price on unconditional demand. Here, a change in the price q_1 of SP-sponsored care or in the price p of non-obstetric care can alter the utility *ordering* of the alternatives. Since the conditional indirect utility function $w_1^*(q_1, p, m)$ is a decreasing function of both q_1 and p, it is obvious that a reduction in the price q_1 of SP-sponsored care or in the price p of non-obstetric care will increase w_i^*. Such price reductions may thus move the SP-sponsored site to a higher relative position in the household's utility ordering. However, our model does not require that these price reductions necessarily place a Seguro Popular-sponsored site at the top of the household's ranking.

What is more, a reduction in the price p of non-obstetric care can also affect the relative ranking of the non-SP-sponsored obstetrical sites. The change in relative ranking can operate through either the income effect or the substitution effect of a reduction in the price p. The income effect, in particular, will tend to increase the consumption of those types of obstetric care that are regarded as normal good and tend to decrease the consumption of those types of obstetric care that are regarded as an inferior good. To the extent that households regard SSA-sponsored obstetrical care z_0 as an inferior good, a subsidy of non-obstetric care could thus lower the relative ranking of a delivery at a SSA-sponsored site. In concrete terms, SP's subsidy of medications, doctor visits and hospitalizations for all household members thus puts money in the family's pocket, which is then spent on those types of obstetric care that are normal goods and diverted away from public SSA-sponsored obstetric care that is regarded as an inferior good.

What is less obvious, however, is that a reduction in the price p can also influence the relative ranking of the obstetrical sites through the substitution effect, without any requirement that one form of obstetrical care be an inferior good. Thus, a decrease in p will not only increase the compensated demand for non-obstetrical care x, but it will also increase the consumption of any type of obstetric care that is a compensated complement and decrease the consumption of any other type of obstetric care that is a compensated substitute. Hence, SP's subsidy of non-obstetric care for all household members can raise the ranking of a private delivery if private obstetrical care is highly complementary with non-obstetrical care. In concrete terms, Seguro Popular thus raises the household's valuation of a private delivery because it subsidizes the evaluation of the newborn baby by a pediatrician in the hospital immediately after delivery.

In Appendix A, we illustrate the foregoing effect of a change in the price p of non-obstetric care by means of a specific utility function.

3.3. Introducing Heterogeneity and Stochastic Components

We let the binary variable y_2 represent the household's decision to enroll in Seguro Popular, where $y_2 = 1$ if the household enrolls in SP, and $y_2 = 0$ otherwise. Since enrollment in Seguro Popular affects the net prices q_1 and p, we can write the household's conditional indirect utility functions w_i^* as functions of y_2 as well. Moreover, there are likely to be other observed and unobserved determinants of the household's indirect utility. We summarize these considerations in the specification:

$$w_i^* = w_i^*\left(q_i, p, m, y_2, X\right) + \varepsilon_i \tag{11}$$

where X is a vector of observed characteristics of the household, and where ε_i is an unobserved stochastic component with zero mean.

4. Econometric Model

We now specify a formal econometric structure on our theoretical model, imposing functional forms on the indirect utility functions and making specific distributional assumptions about the unobserved stochastic components. We address issues of parameter identification, and display our measures of impact on specific populations. Finally, we describe tests for heterogeneity of our model.

4.1. Model Specification and Likelihood Function

For a specific household, we write:

$$(12)\quad \begin{aligned} w_0^* &= X_0'\beta_0 + \gamma_0 y_2 + \varepsilon_0 \\ w_1^* &= X_1'\beta_1 + \gamma_1 y_2 + \varepsilon_1 \\ w_2^* &= 0 \end{aligned} \quad ; \qquad y_1 = i \text{ if } w_i^* = \max\left\{w_0^*, w_1^*, w_2^*\right\}$$

where (X_0, X_1) are vectors of observable explanatory variables, where (β_0, β_1) are conformal vectors of unknown parameters, and where (γ_0, γ_1) are additional unknown coefficients of the variable y_2 that indicates enrollment in Seguro Popular. For clarity, in equation (12), we have omitted subscripts that refer to the specific household. Only the site of obstetric care with the highest indirect utility is observed as the discrete variable y_1. In addition, we have specified a linear model for the determinants of indirect utility, subsuming prices and income within the vectors of observable determinants (X_1, X_2).

Given that we observed only the choice with the highest indirect utility, we recognize that we can identify only the differences in indirect utility, and therefore we set the utility of private obstetric care equal to zero. Finally, we assume that the stochastic terms ε_0 and ε_1 are independent unit normal $N(0,1)$ variables.

We further specify a probit model of enrollment in Seguro Popular:

(13) $$y_2^* = X_2'\beta_2 + \varepsilon_2; \qquad y_2 = \begin{cases} 0, \text{if } y_2^* < 0 \\ 1, \text{if } y_2^* \geq 0 \end{cases}$$

where y_2^* is an unobserved latent variable, where X_2 is a vector of determinants of the decision to enroll, where β_2 is a conformal vector of unknown parameters, and where ε_2 is a stochastic error term.

While the Mexican government has phased in Seguro Popular over time, thus determining when specific communities will be eligible for the program, the household's enrollment nonetheless remains a voluntary decision. Accordingly, we cannot exclude the possibility that the binary variable y_2 is endogenous. This potential endogeneity is captured by correlations between the error term ε_2 in equation (13) and the error terms ε_0 and ε_1 in equation (12). We parameterize these correlations as follows:

(14) $$\varepsilon_2 = \sigma_0\varepsilon_0 + \sigma_1\varepsilon_1 + v$$

where σ_0 and σ_1 are unknown parameters, and where v is a unit normal $N(0,1)$ random variable that is distributed independently of ε_0 and ε_1. This error structure admits two types of unobserved heterogeneity. When the parameter σ_0 is non-zero, households have unobserved characteristics that influence their decision to enroll in SP and, at the same time, influence the pregnant woman's preferences for SSA-sponsored public clinic over private health care. When the parameter σ_1 is non-zero, households have unobserved characteristics that influence their decision to enroll in SP and, at the same time, influence the pregnant woman's preferences for an SP-sponsored unit over a private site.

Given (14), the error terms $(\varepsilon_0, \varepsilon_1, \varepsilon_2)$ are joint normally distributed:

$$(15) \quad \begin{pmatrix} \varepsilon_0 \\ \varepsilon_1 \\ \varepsilon_2 \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 & \sigma_0 \\ 0 & 1 & \sigma_1 \\ \sigma_0 & \sigma_1 & 1+\sigma_0^2+\sigma_1^2 \end{pmatrix}\right]$$

with correlation coefficients $\mathrm{Corr}(\varepsilon_0, \varepsilon_2) = \rho_0 = \sigma_0 / \sqrt{\tau}$ and $\mathrm{Corr}(\varepsilon_1, \varepsilon_2) = \rho_1 = \sigma_1 / \sqrt{\tau}$, where $\tau = 1 + \sigma_0^2 + \sigma_1^2$. The variance-covariance matrix of the error terms is positive definite for all values of the parameters σ_0 and σ_1.

We estimate the parameters $\boldsymbol{\beta} = (\beta_0, \beta_1, \beta_2)$, $\boldsymbol{\gamma} = (\gamma_0, \gamma_1)$, $\boldsymbol{\sigma} = (\sigma_0, \sigma_1)$ in the model of equations (11) through (13) by maximum likelihood. The details of construction of the likelihood function and parameter estimation are given in Appendix B.

4.2. Parameter Identification

To identify the parameters of our structural model, we impose exclusion restrictions on the explanatory variables in $\boldsymbol{X} = (X_0, X_1, X_2)$. Specifically, we took advantage of the fact that Seguro Popular has been gradually phased in over time in different states within Mexico. We therefore constructed three dummy variables, indicating whether the woman's locality of residence had been formally incorporated into Seguro Popular by the years 2002, 2003, and 2004, respectively. In particular, a woman living in a locality that was not incorporated until 2005 would have zero-values for all three dummy variables, and thus serves as a reference case. Because SP was only in the pilot phase during 2001, we did not specify a dummy variable for that year. We included the three dummy variables in the participation equation (13) but excluded them from the health care utilization equations (12).

4.3. Measures of Impact: Individual versus Population

Given estimates of the parameters $\left(\hat{\boldsymbol{\beta}},\hat{\boldsymbol{\gamma}},\hat{\boldsymbol{\sigma}}\right)$, we can compute the respective probabilities $P_{i\cap j}\left(\boldsymbol{X}\right)=\Pr\left\{y_1=i,y_2=j\,\middle|\,\boldsymbol{X},\hat{\boldsymbol{\beta}},\hat{\boldsymbol{\gamma}},\hat{\boldsymbol{\sigma}}\right\}$, where $i=0,1,2$ and $j=0,1$, for any given vector of household characteristics $\boldsymbol{X}$. Given these joint probabilities, we can compute the conditional probabilities $P_{i\,|\,j}\left(\boldsymbol{X}\right)=\dfrac{P_{i\cap j}\left(\boldsymbol{X}\right)}{P_{i\cap 0}\left(\boldsymbol{X}\right)+P_{i\cap 1}\left(\boldsymbol{X}\right)}$, where, for example, $P_{2\,|\,1}\left(\boldsymbol{X}\right)$ denotes the predicted probability that a woman in a household with exogenous characteristics $\boldsymbol{X}$ will choose a private obstetrical site given that the household is enrolled in Seguro Popular. We can also compute the probability of enrollment in SP, that is, $P_1\left(\boldsymbol{X}\right)=\Pr\left\{y_2=1\,\middle|\,\boldsymbol{X},\hat{\boldsymbol{\beta}},\hat{\boldsymbol{\gamma}},\hat{\boldsymbol{\sigma}}\right\}=P_{0\cap 1}\left(\boldsymbol{X}\right)+P_{1\cap 1}\left(\boldsymbol{X}\right)+P_{2\cap 1}\left(\boldsymbol{X}\right)$.

At the level of the *individual*, our measure of the impact of SP on the probability of choosing site $i=0,1,2$ is difference in conditional probabilities, that is,

(16) $$I_i\left(\boldsymbol{X}\right)=P_{i\,|\,1}\left(\boldsymbol{X}\right)-P_{i\,|\,0}\left(\boldsymbol{X}\right)$$

We note that, for a fixed vector of maternal and household characteristics $\boldsymbol{X}$, the three measures of impact of Seguro Popular necessarily sum to zero, that is, $I_0(\boldsymbol{X}) + I_1(\boldsymbol{X}) + I_2(\boldsymbol{X}) = 0$. At the *population* level, our measure of the impact of SP on the probability of choosing site $i = 0,1,2$ is the difference in joint probabilities

$$(17) \qquad R_i(\boldsymbol{X}) = P_{i\cap 1}(\boldsymbol{X}) - P_{i\cap 0}(\boldsymbol{X})$$

The quantities $R_i(\boldsymbol{X})$ measure the impact of the Seguro Popular program as a policy intervention, because they account explicitly for the probability of enrolling in SP, and not simply the individual treatment effect conditional on SP enrollment. Although a pregnant woman without SP was not legally entitled to have a baby at an SP-sponsored unit, we did not impose the constraints that $P_{1|0}(\boldsymbol{X}) = 0$ and $P_{1\cap 0}(\boldsymbol{X}) = 0$.

We took advantage of the asymptotic normality of the maximum likelihood estimates $(\hat{\boldsymbol{\beta}}, \hat{\boldsymbol{\gamma}}, \hat{\boldsymbol{\sigma}})$ to compute approximate 95% confidence intervals for the impact measures $I_i(\boldsymbol{X})$ and $R_i(\boldsymbol{X})$. Specifically, we made repeated random draws from a multivariate joint normal distribution with mean $(\hat{\boldsymbol{\beta}}, \hat{\boldsymbol{\gamma}}, \hat{\boldsymbol{\sigma}})$ and estimated asymptotic variance-covariance matrix $\hat{\boldsymbol{V}}$, and with each draw recomputed the impact measures $I_i(\boldsymbol{X})$ and $R_i(\boldsymbol{X})$ for a fixed value of $\boldsymbol{X}$. The confidence intervals for each impact measure were then computed from the range of recomputed values of $I_i(\boldsymbol{X})$ and $R_i(\boldsymbol{X})$.

4.4. Analysis of Heterogeneity of Impact

Because our model is nonlinear, the marginal effects of changes in the principal treatment variable (that is, affiliation with Seguro Popular, or y_2) depend on the values of the explanatory variables (that is, maternal and household characteristics, or $\boldsymbol{X}$). Although it is commonplace to report these marginal effects at the sample means, we focused on the extent of heterogeneity in the impact of Seguro Popular at the individual and population levels. We therefore computed the impact measures $I_i(\boldsymbol{X})$ and $R_i(\boldsymbol{X})$ for four prototypical households or "cases," that is, four different sets of explanatory variables $\boldsymbol{X}$.

4.5. Comparison with Simplified Bivariate Probit Model

We compared our multinomial choice model (12) with a simplified bivariate probit model, in which a pregnant woman has only two choices: a birth attended at a SP-sponsored facility $(y_1 = 1)$, or a birth elsewhere $(y_1 = 0)$. In place of equation (12), we write:

$$(18) \qquad \begin{array}{l} w_1^* = X_1'\beta_1 + \gamma_1 y_2 + \varepsilon_1 \\ w_0^* = 0 \end{array}; \qquad y_1 = i \text{ if } w_i^* = \max\left\{w_0^*, w_1^*\right\}$$

which is equivalent to a probit specification in which a non-SP obstetric facility is the reference category. Retaining equation (13) for y_2 and setting $\varepsilon_0 = 0$ in equation (14), we obtain a two-equation probit model with a discrete endogenous variable (that is, y_2) and an unconstrained correlation coefficient between the error terms. Such a model can be estimated by maximum likelihood as if it were a simple bivariate probit model without endogenous variables. (See, for example, p. 183 in Maddala (1983) and p. 853 in Greene (2000).) For this purpose, we used the "biprobit" routine in Stata (StataCorp (2005)).

5. Data

5.1. ENSANUT Survey Data and Analytical Sample

Our principal source of data is the 2006 Mexican National Health and Nutrition Survey (Encuesta Nacional de Salud y Nutrición, or ENSANUT), conducted during November 2005 – May 2006 (Instituto Nacional de Salud Pública (2006)), a nationally representative cross-section of 48,304 households containing 206,700 individuals. ENSANUT contained information on respondents' education, employment, socioeconomic and demographic characteristics, prevalence of self-reported acute and chronic illnesses, as well as health care utilization and source of payment.

We focused on the 5,988 female respondents of reproductive age (15–49 years) who reported having delivered their last baby during 2001–2006. We then excluded 1,900 respondents who reported delivering at a facility sponsored by employer-based health insurance (IMSS, ISSSTE, and PEMEX), as well as an additional 198 observations that had missing values of the explanatory variables to be described below. These exclusions resulted in a sample of 3,890, which served as the principal basis for our statistical analyses. We refer to this sample as the *analytic sample*.

Households covered by Mexico's employer-based plans are not legally entitled to participate in Seguro Popular. Accordingly, the exclusion of households covered by employer-based plans permitted us to focus sharply on the target population eligible for the Seguro Popular program. Given the lack of flexibility in Mexico's labor market, we considered it unlikely that our exclusion of women covered by employer-based plans produced a significant bias of self-selection. Nonetheless, in order to check the sensitivity of our results to our exclusion criterion, we repeated our analyses with two alternative samples that were not drawn on the basis of household insurance coverage: (1) an *enlarged sample* of 5,762 adult women who had a baby since 2001 and who had no missing values for any explanatory variables; and (2) a *restricted sample* of 1,934 adult women whose household resided in a locality with a moderately high or very high index of socioeconomic marginality ("índice de marginación") (CONAPO (2005)).

5.2. Dependent Variables

As noted in Section 4, our two discrete dependent variables were: y_1, the site of obstetric care; and y_2, the binary decision to enroll in Seguro Popular. With respect to the former, each respondent to ENSANUT who had her last baby during 2001–2006 was asked where she delivered her baby. (Specifically, question 9.15 of the Adult Questionnaire inquired: "¿En dónde le atendieron su último parto?" See Instituto Nacional de Salud Pública (2006).) With respect to the latter, the person in charge of the household ("la persona responsable del hogar") was asked about each household member's medical coverage. (Specifically, question 2.08 of the Household Questionnaire inquired: "¿Está [NOMBRE] afiliado o inscrito a algún seguro médico?")

Table 1 shows the joint distribution of the two dependent variables in our analytic sample of 3,890 women. Among the households who did not participate in SP, nearly half paid out of pocket for obstetrical services in the private sector, while the other half had their babies in clinics sponsored by the Secretaría de Salud. Among the households that did participate in SP, the great majority of women (72 percent) had their babies in an SP-sponsored unit, but nearly 21 percent still paid out of pocket for private obstetrical services.

Given that the measurement of these dependent variables was based on self-reported survey responses, we performed a number of checks for reliability. To check whether the decision to participate in Seguro Popular is made at the household level, we verified that 90 percent of the respondents who reported themselves as enrolled in SP belonged to households in which the remaining members were likewise enrolled in the SP program. Moreover, we verified that 95 percent of the women reporting participation in SP lived in a household where the person in charge reported a date of affiliation in SP for at least one household member. (Questions 8.03 and 8.04 of the Household Questionnaire inquired, respectively, "¿Alguna de las personas que componen su hogar ha estado inscrita en el Seguro Popular de Salud?" and "¿En qué fecha se inscribieron al Seguro Popular?")

We also addressed the possibility that some women who reported current SP participation were not in fact eligible for SP at the time of their delivery. Seguro Popular was rolled out gradually over time in different states throughout Mexico, with most states enrolling in 2002–2004 and all states enrolled by 2005. The official dates of incorporation of each state in SP need to be regarded as approximate, as many localities may not have complied with legally established deadlines. In a separate sensitivity analysis, we reclassified a total of 195 women as not enrolled in SP and not delivering a baby in an SP-accredited facility if the woman reported a date of delivery at an SP-sponsored facility before the official year of incorporation of SP in the state or before the reported date of enrollment reported on the household questionnaire. We then repeated our analyses on this *reclassified sample*.

5.3. Independent Variables and Instrumental Variables

Our independent variables consisted of individual- and household-level data from ENSANUT, supplemented by data from external sources on the characteristics of the locality or state of the woman's residence (Secretaría de Salud (2005)). Individual-level variables included the woman's age and age squared, educational attainment, marital status, parity, primary language (indigenous versus Spanish), and the presence or absence of three self-reported conditions: depression, diabetes, and high blood pressure. (With respect to self-reported conditions, adult respondents were asked: "¿Alguna vez le ha dicho un médico u otro personal de salud que sufre o ha sufrido depresión?" [Question 3.2] "¿Algún médico le ha dicho que tiene diabetes o alta el azúcar en la sangre?" [Question 4.1] "¿Algún médico le ha dicho que tiene la presión alta?" [Question 5.1] See Instituto Nacional de Salud Pública (2006).) Household-level variables included: the presence of young children; rural versus urban location; the proportion of women in the locality who had employment-based health insurance (IMSS, ISSSTE, etc.); the density of public health units in the locality; and an asset index, based upon household infrastructure, building materials, and ownership of certain durable assets, as a proxy for household's wealth (McKenzie (2004)).

Table 2 shows the descriptive statistics for the independent variables, as well as the marginal proportions of the dependent variables, in our analytic sample. Approximately half of the women had no more than a primary school education, more than a third lived in a rural area, and nearly a quarter spoke an indigenous language. The average family in our sample had low assets and lived in a locality where only 1 in 10 families had employment-based health insurance, and where there were fewer than 1 health center per 100 women. The ratio of the maximum to the minimum density of health centers was nearly two orders of magnitude, and indicated enormous variability in access to formal health services.

For instrumental variables, as described in Section 4.2 above, we constructed dummy variables for each of three years (2002, 2003, and 2004), where the dummy variable for a particular year indicated whether the Seguro Popular had been officially incorporated in the woman's state of residence by that year. The process of incorporation entailed decisions at the state and federal level, rather than at the level of the individual client or health center. We know of no evidence that such decisions suffered from "policy endogeneity," that is, states with the highest probability of attracting a pregnant mother to a health center were incorporated earlier. We recognize that the official dates of incorporation are not exact indicators of program availability, since some health centers were still undergoing accreditation by the end of the year. We therefore view these instruments as indicators of likelihood that SP was available to each household in the survey. Our use of year-of-incorporation dummies as instruments is thus analogous to Duflo's use of distance from schools as instruments in her study of impact of school construction on educational attainment and wages in Indonesia (Duflo (2001)). The year-of-incorporation dummies were thus excluded from the equations (12) determining the effect of SP enrollment on the site of delivery.

6. Results

Table 3 presents the results of the simplified bivariate probit model of obstetric care utilization and enrollment in SP for the analytic sample. We show the estimated marginal effects only for the utilization equation on the left (corresponding to equation (18) above), but not for the enrollment equation on the right (corresponding to equation (13) above). The estimates in the enrollment equation in Table 3 supported the validity of our year-of-incorporation dummy variables as instruments. The dummy variables for all three years were significant. The significant negative coefficient for the year 2003, during which only four of Mexico's 32 states were incorporated into SP, implies a lower rate of enrollment than in the reference year 2005. Moreover, in the utilization equation, the significantly positive coefficient for enrollment in SP supported the hypothesis that Seguro Popular has had an effect on obstetric utilization. The estimated marginal effect, which is equivalent to our measure of the impact of the individual-level impact of SP, is 0.430. That is, controlling for other factors affecting the choice of delivery site, a woman in a family enrolled in SP had a probability of giving birth at an SP-accredited facility that was 43 percentage points higher than a woman in a family not enrolled in SP.

In Table 3, the estimated coefficient of correlation of the error terms is negative and significantly different from zero. While the finding of a non-zero correlation coefficient might support the conclusion that enrollment in SP is an endogenous variable, the negative sign is difficult to explain on the basis of the estimates alone. The other covariates in the enrollment equation do not reveal any related anomalies. In particular, women in rural localities with a higher availability of health centers are more likely to enroll in SP. One might conclude that unobserved factors enhanced the probability of enrollment in SP and, at the same time, diminished the probability of having a baby at an SP-accredited facility. An alternative interpretation, however, is that the simplified bivariate model is not correctly specified.

We therefore turn to Table 4, which shows the results of our full multinomial probit model (equations 12-14) for the analytic sample. The column denoted “SSA vs. Private” refers to a woman’s preference for giving birth at an SSA-sponsored facility in comparison to a private facility, which serves as the reference category. It corresponds to the equation for the latent variable w_0^* in equation (12) above. The column denoted “SP vs. Private” refers to a woman’s preference for having a baby at a SP-sponsored facility in comparison to a private facility. It corresponds to the equation for the latent variable w_1^* in equation (12) above. Finally, the column denoted “SP Enrollment” refers to the household’s preference for enrollment in Seguro Popular, and corresponds to the equation for the latent variable y_2^*, that is, equation (13).

In the column “SSA vs. Private,” the estimate of the parameter γ_0 is negative and highly significant, while in the column “SP vs. Private,” the estimate of the parameter γ_1 is positive and highly significant. Accordingly, women in households that participated in the SP program had a much stronger preference for having a baby in a SP-sponsored unit rather than paying out of pocket for a private delivery. At the same time, however, participation in SP was associated with a stronger preference for delivering in the private sector rather than at an SSA-sponsored clinic. These results confirm the hypothesis, posed in Section 3.2, that the household-level subsidy embodied in SP can affect the relative ranking of all three sites of obstetric care. In the language of our model of Section 3, reductions in the medical care prices q_1 and p increased the household’s indirect utility $w_1^*(q_1, p, m)$ and decreased the indirect utility $w_0^*(q_1, p, m)$ in relation to the indirect utility $w_2^*(q_1, p, m)$.

The estimated correlation coefficients ρ_0 and ρ_1 in the multinomial probit model of Table 4 present a different pattern than that observed in the simplified bivariate probit model of Table 3. The estimate of ρ_0 is significantly positive, while the estimate of ρ_1 is indistinguishable from zero. Accordingly, there were unobserved factors that enhanced the probability of enrollment in SP and, at the same time, enhanced the probability of preferring an SSA-sponsored facility to a private delivery. In less formal terms, mothers in households attracted to Seguro Popular were more likely to have preferred to deliver in state-run SSA-sponsored facilities than to pay out of pocket for a private delivery. The ability of our multinomial model to differentiate between two different types of endogeneity (as specified in equations (14) and (15)) thus permits us to resolve the apparent paradox of a negative correlation coefficient in the simplified bivariate probit model of Table 3.

In Table 4, the estimates of the coefficients of the year-of-incorporation dummy variables in the SP enrollment equation further support the validity of these variables as instruments. Moreover, in the enrollment equation, residence in a rural locality, a lower proportion of families enrolled in employment-based insurance, and a higher density of health centers all had a significant positive effect, while the women's speaking an indigenous language had a significant negative coefficient. Self-reported diabetes, education, and indigenous language had significant effects in the site of delivery equations as well.

Given the parameter estimates based upon the multinomial probit model in Table 4, we computed the measures of individual-level and population-level impact described in Section 4.3. At the mean values of the independent variables, the predicted probability of enrollment in SP (that is, $P_1(\boldsymbol{X})$ in Section 4.3) was 20.9 percent, and the corresponding individual-level impact on having a baby at an SP-accredited facility (that is, $I_1(\boldsymbol{X})$ in equation (16)) was 70.6 percent (95% CI, 65.7–75.0). The latter measure of impact was significantly larger than the marginal effect of 40.3 percent estimated from the simplified bivariate probit model in Table 3. In less formal terms, our multinomial probit model detected an impact of Seguro Popular on the decision to have a baby at an SP-accredited site that was nearly double the impact estimated from a simplified bivariate probit model.

Table 5 and Figure 1 show our computations of the individual-level impact of SP enrollment for four representative cases, that is, four profiles of women based on different values of the explanatory variables. The details of each profile are shown in the notes to Table 5. Cases 1 and 2 refer to women residing in rural areas. For Case 1 (a rural woman without any formal education, who speaks an indigenous language, has low socioeconomic status and reports all three medical conditions), the probability of enrollment in SP was $P_1(\boldsymbol{X}) = 43.65$ percent, while the individual-level impact was $I_1(\boldsymbol{X}) = 82.09$ percent (95% CI, 59.13–84.29). By contrast, for Case 2 (a rural woman with at least primary school, who speaks Spanish, has comparatively higher socioeconomic status and does not report medical conditions), the estimated probability of enrollment in the SP was higher (51.51%), but the individual-level impact was notably lower (61.24%; 95% CI, 43.00–72.05). The difference between the individual-level impacts in Case 1 and Case 2 was 20.85 percent (95% CI, -6.96–35.88).

Cases 3 and 4 refer to women residing in urban areas. For Case 3 (an urban woman with primary education, who speaks Spanish, has low socioeconomic status and reports depression, diabetes, and high blood pressure), the probability of enrollment in SP was 54.43 percent, while the individual-level impact was 78.91 percent. By contrast, for Case 4 (an urban woman with a university education, who speaks Spanish, has elevated socioeconomic status and does not report medical conditions), the estimated probability of enrollment in the SP was 0.16 percent. Among the very few women with this profile who enroll in SP, the individual-level impact on delivering in an SP-accredited facility was 65.15 percent.

Table 5 and Figure 1 show not only the individual-level impacts on delivering at a SP-accredited facility, but also the corresponding individual-level impacts on having a baby at a SSA-sponsored health unit (that is, $I_0(\boldsymbol{X})$) and a private facility (that is, $I_2(\boldsymbol{X})$). In each of the four cases, but especially in Cases 1 through 3, the Seguro Popular program reduced pregnant women's attendance at an SSA-sponsored clinic much more than it reduced the probability of delivering a baby in the private sector.

Table 6 and Figure 2 show our computations of the population-level impacts of SP enrollment for four representative cases. The pattern of heterogeneity in population-level impacts differed from the pattern observed for individual-level impacts. While the individual-level impact $I_1(\boldsymbol{X})$ was largest for Case 1, the population-level impact $R_1(\boldsymbol{X})$ was largest for Case 3, a Spanish-speaking urban woman with primary education, low socioeconomic status and multiple medical problems. For Case 4, the probability of enrolling in SP was so low that the population-level impact was negligible.

Appendix C shows estimates of the most important parameters for our three sensitivity analyses: the extended sample, the restricted sample, and the reclassified sample. In all cases, our multinomial probit estimates were robust with respect to different assumptions about the study population and the definitions of the dependent variables.

7. Discussion and Conclusions

In this paper, we found that the recently established Seguro Popular program in Mexico has had a significantly positive effect on the access of poor women to obstetrical care, an important outcome measure of maternal and infant health. Women in households that participated in the SP program, we found, had a much stronger preference for having a baby in a SP-sponsored unit rather than paying out of pocket for a private delivery. At the same time, participation in SP was associated with a stronger preference for delivering in the private sector rather than at an SSA-sponsored clinic. On balance, the Seguro Popular program reduced pregnant women's attendance at an SSA-sponsored clinic much more than it reduced the probability of delivering a baby in the private sector. These findings were robust with respect to variations in the population under study and the classification of subjects' survey responses.

We formulated a multinomial probit model that permitted us to go beyond the standard two-way dichotomy between utilization and non-utilization as outcome measures in the evaluation of policies designed to subsidize and increase access to health care. We found that the conventional bivariate probit approach suffered from apparent problems of model misspecification, with a peculiarly negative correlation coefficient between error terms in the obstetrical utilization and Seguro Popular enrollment equations. What is more, estimates based the standard two-equation approach understated the impact of Seguro Popular on obstetrical utilization by 40 percent.

Our modification of the multivariate probit model to account of a discrete endogenous variable appears to be the first instance of such a model specification. Early applications of multinomial discrete choice models in the selection of health care providers include the works of Schwartz, Akin et al. (1988) in the setting of the Philippines, Akin, Guilkey et al. (1995) in Nigeria, and Bolduc, Lacroix et al. (1996) in Benin, and most recently Borah (2006) in India and Leonard (2007) in Tanzania. However, these papers did not explicitly incorporate endogeneity of the treatment or policy variable into the multinomial choice framework.

Other investigators have employed variations of the now-standard bivariate probit model, in which an endogenous binary participation variable enters on the right-hand side of a probit utilization equation. (See Bertranou (1998) in the setting of Argentina; Cameron, Trivedi et al. (1988) in Australia; Gitto, Santoro et al. (2006) in Sicily; Sapelli and Vial (2003) in Chile; Suraratdecha, Saithanu et al. (2005) in Thailand; and Waters (1999) in Ecuador.) Trujillo (2003) specified a binary utilization variable as well as two endogenous binary variables to represent participation in both public and private insurance programs in Colombia.

Still other researchers have considered multi-equation models in which one or more equations entailed a discrete endogenous variable. Munkin and Trivedi (2003) specified a three-equation model in which one demand equation entailed Poisson-distributed count data, the second demand equation contained a continuous exponential dependent variable, and the third participation equation involved a binary dependent variable representing self-selection of insurance coverage. Deb, Munkin et al. (2006) specified a multi-equation model for health care utilization, in which the first equation was a probit model of non-zero health-care utilization, the second was conditional log-linear expenditure model, and the third was a multinomial probit model for choice of insurance coverage. The latter model, like that of Munkin and Trivedi (2003), was estimated by Markov chain Monte Carlo simulation techniques. Balia and Jones (2004), in an interesting study of health habits and mortality, specified a recursive multi-equation model, in which each binary lifestyle variable (such as smoking) served as a dependent variable in a behavioral equation and as a regressor in a mortality equation. Our model in this paper can be readily estimated by full maximum likelihood, taking advantage of now-standard techniques to evaluate three-dimensional probit integrals, such as the GHK simulator written by Cappellari and Jenkins (2006). (See Appendix B.)

We based our analysis of heterogeneous impacts on four cases, which represented different profiles of women based on the values of the observed independent variables. While the simulated confidence intervals around the impact measures were relatively wide, nonetheless we observed significant variability in individual-level impacts. A comparison of Cases 1 and 2, both women residing in urban areas, is illustrative. A woman in Case 1 spoke an indigenous language, had low socioeconomic status and reported multiple medical conditions, while a woman in Case 2 had a primary school education, spoke Spanish, had comparatively higher socioeconomic status, and did not report any medical conditions. In Case 1, the individual-level impact of Seguro Popular on the probability of having a baby at a SP-accredited facility was 21 percentage points higher than in Case 2, and the 95% confidence interval of this difference in individual-level impacts ranged from -7% to +36%.

The pattern of variation in population-level impacts was even greater. An urban woman in Case 4, with a university education, who spoke Spanish, had average assets and no health problems had a very small probability of enrolling in SP. As a result, the population-level impact was negligible. By contrast, an urban woman in Case 3, with a primary-school education, who spoke Spanish, had minimal assets and reported multiple medical conditions had a probability of enrollment greater than 50 percent and, as a result, displayed a very substantial population-level impact.

In our analysis of heterogeneous impacts, we did not specify interaction terms between treatment variables and other explanatory variables, as would be required in a purely linear model. Having specified a parametric joint distribution for the error terms $(\varepsilon_0, \varepsilon_1, \varepsilon_2)$, we did not explore more generalized non-parametric procedures, such as quantile treatment effects regression (Djebbari and Smith (2005); Dammert (2007)), and thus our analysis does not capture the full extent of heterogeneity of program impact due to variations in unobservables.

We posited a simple theoretical model of household choice, in which the household was regarded as a unified decision-making unit. This theoretical structure was sufficient to predict the reversals in relative ranking of obstetrical sites that might result from SP's subsidizing medical care at the household level. We did not find it necessary to posit potentially conflicting interests among household members. Recent work on game theoretic models of decision making (Harris and González López-Valcárcel (2007)) and resource allocation within the household (Djebbari (2005); Chávez-Martín del Campo (2006)) would be interesting to pursue in this context.

Our empirical findings on the substantial impact of Seguro Popular confirm the preliminary results reported by Gakidou, Lozano et al. (2006), who found a positive relation between hospital discharge rates per capita and the rate of SP enrollment in a regression analysis of a cross-section of Mexican municipalities. These authors also reported a positive relation between the probability of using health services and SP enrollment, conditional on perceived need, based upon a cross-sectional regression study of the 2006 ENSANUT survey, but details of the methodology were not reported.

This observational study has a number of limitations. We relied upon self-reported data, which inevitably contains response errors. For example, in Table 1, out of a total of 2,978 households did not report enrollment in Seguro Popular, 49 women (1.65 percent) reported delivering a baby in a SP-accredited facility. Although we performed a number of reliability checks of our data, uncertainty due to errors in reporting cannot be eliminated. Nonetheless, our results remained robust with respect to changes in the sample analyzed and the definitions of the dependent variables. We have no direct measures of the characteristics of the obstetric facilities selected by the pregnant women and their families. It is well recognized that such characteristics are a critical determinant of the choice of site of care (Leonard (2007)). In the case of obstetric services in Mexico, direct measurement of the level of training of personnel, accessibility of rural sites, and the state of medical equipment would be very valuable, especially if we are to assess the adequacy of the accreditation process employed by Seguro Popular. Measurement of the quality of state-run SSA-sponsored sites would be valuable in determining why SP-enrolled women expressed a much stronger preference for SP-accredited sites over SSA-sponsored sites.

We distinguished between SP-accredited health units, SSA-sponsored facilities, and private care. While we excluded women who had employment-based health insurance from our analytic sample, the category of "private care" nonetheless remains heterogeneous, ranging from the services of private obstetricians within hospitals to traditional midwives who work outside the hospital setting. In our ENSANUT analytic sample, the latter category comprised only 10.36 percent of all reported deliveries (results not shown.) Increasing the number of sites of obstetric care would have required additional computational resources to evaluate a four-dimensional probit model in samples with up to 6,000 observations.

Finally, our analysis covers the time period 2001–2006, during which the Seguro Popular program was being gradually phased in throughout Mexico. Within the limits of currently available data, we cannot test the hypothesis that the impact of Seguro Popular has changed as the Mexican people have come to learn of its advantages, or as the quality of SP-accredited facilities has further improved.

A number of findings in Table 4 give us cause for concern. The coefficients for women who speak indigenous language are negative, that is, non-Spanish speaking women appeared less likely to enroll in and take advantage of Seguro Popular. The family asset index has a negative coefficient in the equation for SSA versus Private, suggesting that some poor families were still paying out of pocket for private care. The coefficient for a rural household is significant in the SP enrollment equation, but is not significant in the equation for SP versus Private, suggesting that rural households enrolled in SP but pregnant women within those households did not take advantage of the program. These findings suggest a continued focus on the availability of Seguro Popular for the very poorest indigenous households in rural areas.

Perhaps the most troubling findings, however, are the relative impacts on SSA-sponsored and private obstetrical care that we observed in Table 5. On balance, enrollment in Seguro Popular reduced deliveries at state-run SSA-sponsored facilities much more than it reduced the use of private obstetrical services. One explanation is that SSA-sponsored facilities, in which trained staff and adequate equipment are not guaranteed, are perceived as low quality. There may also be problems of "crowding out," whereby SSA-sponsored facilities are simply too limited in availability. There is also the potential concern that private facilities may be serving as alternatives to SP-sponsored facilities with inadequate capacity. More research is required to determine why poor uninsured Mexican women still pay out of pocket for obstetrical care despite the substantial impacts of Seguro Popular documented in this paper.

Text Tables

Table 1. Obstetric Care in Mexico, by Type of Facility Sponsorship, for Women in Families with and without Seguro Popular (SP), 2001–2006*

	With SP		**Without SP**	
Childbirth in a Facility Sponsored by:	*N*	(%)	*N*	(%)
Secretaría de Salud (SSA)	65	7.13	1,514	50.84
Seguro Popular (SP)	657	72.04	49	1.65
Private Facility	190	20.83	1,415	47.52
Total	912	100.00	2,978	100.00

*Based upon all women who reported their most recent birth during 2001–2006, exclusive of all women whose households reported insurance through IMSS, ISSSTE, PEMEX, SEDENA or other form of Seguridad Social (Social Security).

Source: Calculations based on ENSANUT (Instituto Nacional de Salud Pública (2006)).

Table 2. Descriptive Statistics

	Analytic Sample (N = 3,890)*			
	Mean	**SD**	**Min**	**Max**
Individual characteristics of woman				
Age	29.80	6.49	18	49
Educational attainment: No education ¶	0.06	0.23	0	1
Educational attainment: Primary school ¶	0.43	0.50	0	1
Educational attainment: High school ¶	0.31	0.46	0	1
Educational attainment: Professional/University ¶	0.20	0.40	0	1
Married ¶	0.82	0.38	0	1
Speaks indigenous language ¶	0.23	0.42	0	1
Parity	3.43	2.19	1	18
Childbirth in a facility sponsored by:				
Secretaría de Salud (SSA) ¶	0.41			
Seguro Popular ¶	0.18			
Private ¶	0.41			
Reported depression ¶	0.11	0.31	0	1
Reported diabetes ¶	0.01	0.10	0	1
Reported high blood pressure ¶	0.11	0.31	0	1
Household characteristics				
Family with Children ≤ 7 years old ¶	0.92	0.27	0	1
Asset Index	-0.25	0.91	-1.99	1.58
Access to Seguro Popular program by the family ¶	0.23	0.42	0	1
Household in rural locality ¶	0.36	0.48	0	1
Municipality and state characteristics				
Proportion of households with Seguridad Social §	0.10	0.08	0	0.67
Health centers per 100 women †	0.84	0.62	0.08	5.17
State incorporated into SP program by 2002 ¶	0.64			
State incorporated into SP program by 2003 ¶	0.79			
State incorporated into SP program by 2004 ¶	0.92			

* Based upon all women who reported their most recent birth during 2001–2006, exclusive of all women whose households reported insurance through Seguridad Social.
¶ Binary variable.
§ Seguridad Social includes: IMSS, ISSSTE, PEMEX, SEDENA or other form of Social Security.
† 1,010 observations were imputed at the sample mean value.

Source: Calculations based on ENSANUT (Instituto Nacional de Salud Pública (2006); Secretaría de Salud (2005); Secretaría de Salud (2006)).

Table 3. Bivariate Probit Model of Obstetric Care Utilization and Enrollment in Seguro Popular

	Childbirth in SP-sponsored facility		Enrollment in Seguro Popular (SP)
	Coefficient	**Marginal Effect †**	**Coefficient**
Individual characteristics			
Age/10	-0.038	-0.003	0.159
	[0.462]	[0.037]	[0.296]
$(Age/10)^2$	-0.006	-0.0004	-0.023
	[0.074]	[0.006]	[0.047]
Primary education ¶	-0.186	-0.014	**0.267**
	[0.157]	[0.012]	**[0.105]***
Secondary education ¶	**-0.286**	**-0.021**	**0.298**
	[0.168]+	**[0.011]+**	**[0.112]****
University education ¶	-0.195	-0.014	-0.115
	[0.188]	[0.012]	[0.127]
Married ¶	0.170	**0.012**	0.085
	[0.105]	**[0.007]+**	[0.064]
Speaks indigenous language ¶	-0.103	-0.008	**-0.287**
	[0.106]	[0.007]	**[0.059]****
Parity	-0.009	-0.001	0.009
	[0.021]	[0.002]	[0.010]
Reported depression ¶	0.086	0.007	0.099
	[0.112]	[0.010]	[0.078]
Reported diabetes ¶	0.163	0.015	**0.453**
	[0.261]	[0.027]	**[0.201]***
Reported high blood pressure ¶	-0.055	-0.004	0.107
	[0.112]	[0.008]	[0.074]
Household characteristics			
Enrollment in Seguro Popular ¶	**2.153**	**0.430**	
	[0.319]**	**[0.117]****	
Household in rural locality ¶	0.005	0.0004	**0.323**
	[0.103]	[0.008]	**[0.057]****
Family with children ≤ 7 years old ¶	-0.096	-0.008	-0.082
	[0.121]	[0.011]	[0.084]
Asset Index	-0.042	-0.003	-0.012
	[0.051]	[0.004]	[0.034]
Locality and state characteristics			
Proportion of households with	**2.950**	**0.234**	**-2.386**
Seguridad Social §	**[0.537]****	**[0.0523]****	**[0.378]****
Health centers per 100 women	-0.020	-0.002	**0.204**
	[0.064]	[0.005]	**[0.038]****
State incorporated into SP by 2002 ‡			**0.296**
			[0.065]**
State incorporated into SP by 2003 ‡			**-0.158**
			[0.084]+
State incorporated into SP by 2004 ‡			**0.414**
			[0.120]**

Table 3. Continued

	Childbirth in SP-sponsored facility		**Enrollment in Seguro Popular (SP)**
Constant	**-2.218** **[0.730]****		**-1.745** **[0.484]****
Coefficient of correlation of error terms			**-0.537** **[0.232]***
Observations	3,890	3,890	3,890

¶ Binary variable.
† Marginal effects evaluated at the mean values of the independent variables (as given in Table 2). Marginal effects correspond to discrete changes of dummy variables from 0 to 1.
§ Seguridad Social includes: IMSS, ISSSTE, PEMEX, SEDENA or other form of Social Security
‡ Instrumental variable.
Standard errors in brackets; + significant at 10%; * significant at 5%; ** significant at 1%

Table 4. Multinomial Probit Model

	SSA vs. Private	SP vs. Private	SP Enrollment
Individual characteristics			
Age/10	0.316 [0.270]	**0.783** **[0.466]+**	0.149 [0.401]
$(Age/10)^2$	**-0.072** **[0.043]+**	-0.120 [0.074]	-0.020 [0.064]
Primary education ¶	**0.226** **[0.097]***	**-0.328** **[0.164]***	**0.338** **[0.154]***
Secondary education ¶	0.168 [0.103]	**-0.314** **[0.176]+**	**0.372** **[0.163]***
University education ¶	**-0.387** **[0.111]****	**-0.613** **[0.197]****	-0.184 [0.173]
Married ¶	**-0.206** **[0.059]****	-0.021 [0.104]	0.105 [0.088]
Speaks indigenous language ¶	**-0.321** **[0.055]****	**-0.260** **[0.099]****	**-0.372** **[0.103]****
Parity	-0.001 [0.009]	-0.034 [0.022]	0.011 [0.013]
Reported depression ¶	0.067 [0.071]	-0.141 [0.120]	0.140 [0.109]
Reported diabetes ¶	**0.549** **[0.233]***	**0.593** **[0.301]***	**0.613** **[0.290]***
Reported high blood pressure ¶	**0.202** **[0.071]****	0.094 [0.117]	0.176 [0.109]
Household characteristics			
Family with children ≤ 7 years old ¶	-0.072 [0.080]	-0.126 [0.130]	-0.146 [0.119]
Asset Index	**-0.143** **[0.031]****	-0.070 [0.052]	-0.041 [0.048]
Household in rural locality ¶	**0.169** **[0.061]****	0.030 [0.102]	**0.417** **[0.108]****
Proportion of households with Seguridad Social §	0.297 [0.391]	**1.828** **[0.595]****	**-3.420** **[0.858]****
Locality and state characteristics			
Health centers per 100 women	**0.204** **[0.039]****	0.104 [0.064]	**0.270** **[0.071]****
State incorporated into SP by 2002 ‡			**0.384** **[0.106]****
State incorporated into SP by 2003 ‡			**-0.324** **[0.135]***
State incorporated into SP by 2004 ‡			**0.588** **[0.194]****
Constant	-0.060 [0.426]	**-2.828** **[0.748]****	**-2.110** **[0.733]****

Table 4. Continued

	SSA vs. Private	SP vs. Private	SP Enrollment
γ_0	**-1.988** **[0.165]****		
γ_1		**2.792** **[0.286]****	
σ_0	**0.901** **[0.390]***		
σ_1		-0.143 [0.259]	
Coefficient of correlation ρ_0	**0.666** **[0.159]****		
Coefficient of correlation ρ_1		-0.106 [0.187]	
Observations	3,890	3,890	3,890

¶ Binary variable.
§ Seguridad Social includes: IMSS, ISSSTE, PEMEX, SEDENA or other form of Social Security
‡ Instrumental variable.
Standard errors in brackets; + significant at 10%; * significant at 5%; ** significant at 1%

Table 5. Individual-Level Impacts of Seguro Popular on Obstetric Care Utilization in Mexico, by Rural versus Urban Area, Health and Socioeconomic Status*

	Probability (%)		
	Mean	[95% C.I.]	
Case 1: Rural Area, Low Health & SES			
Probability of enrollment in Seguro Popular	43.65		
Impact of SP on Probability of Delivering a Baby at:			
Secretaría de Salud (SSA)	-62.56	-72.31	-41.20
Seguro Popular	82.09	59.13	84.29
Private	-19.52	-41.98	-0.69
Case 2: Rural Area, Medium Health & SES			
Probability of enrollment in Seguro Popular	51.51		
Impact of SP on Probability of Delivering a Baby at:			
Secretaría de Salud (SSA)	-49.32	-59.03	-39.61
Seguro Popular	61.24	43.00	77.05
Private	-11.91	-26.19	4.46
Case 3: Urban Area, Medium Health & SES			
Probability of enrollment in Seguro Popular	53.43		
Impact of SP on Probability of Delivering a Baby at:			
Secretaría de Salud (SSA)	-68.80	-75.33	-54.04
Seguro Popular	78.91	53.29	84.33
Private	-10.11	-25.22	4.25
Case 4: Urban Area, High Health & SES			
Probability of enrollment in Seguro Popular	0.16		
Impact of SP on Probability of Delivering a Baby at:			
Secretaría de Salud (SSA)	-39.77	-62.25	5.51
Seguro Popular	65.15	21.41	78.54
Private	-25.38	-50.74	-5.26

* Derived from multivariate probit estimates at different values of explanatory variables, described below:

Case 1: A 30-year-old woman, without primary education, speaks an indigenous language, parity 5, married in a household with a minimum asset index and with young children at home, lives in a rural locality with an average density of health centers but no households enrolled in Social Security, and reports depression, diabetes, and high blood pressure.

Case 2: A 30-year-old woman, with secondary education, speaks Spanish, parity 3, married in a household with an average asset index and young children at home, lives in a rural locality with an average density of health centers but no households enrolled in Social Security, and does not report depression, diabetes or high blood pressure.

Case 3: A 30-year-old woman, with primary education, speaks Spanish, parity 5, married in a household with a minimum asset index and young children at home, lives in an urban locality with an average density of health centers but no households enrolled in Social Security, and reports depression, diabetes or high blood pressure.

Case 4: A 30-year-old woman, with university education, speaks Spanish, parity 1, married in a household with a mean asset index and young children at home, lives in an urban locality with an average density of health centers and the highest density of households enrolled in Social Security, and does not report depression, diabetes or high blood pressure.

Table 6. Individual-Level versus Population-Level Impacts of Seguro Popular on Obstetric Care Utilization in Mexico*

	Probability of Enrollment in SP (%)			Individual Impact on SP Utilization (%)			Population Impact on SP Utilization (%)		
Case	Median	95% CI		Median	95% CI		Median	95% CI	
1	44	29	63	81	64	84	34	21	53
2	51	44	61	62	43	77	32	22	43
3	53	32	72	79	53	84	40	23	59
4	0	0	5	60	21	79	0	0	4

*Based upon multinomial probit estimates in Table 4 and formulae for $P_1(\boldsymbol{X})$, $P_1(\boldsymbol{X})$ and $P_1(\boldsymbol{X})$ in Section 4.3.

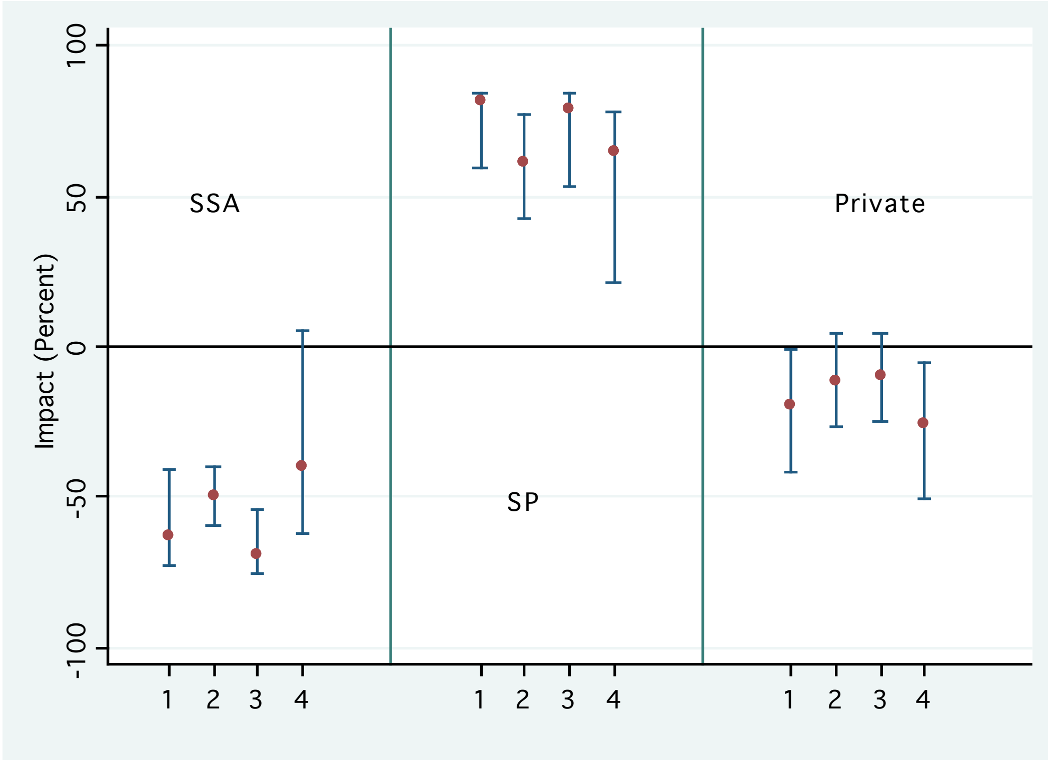

Figure 1. Individual-Level Impact of Seguro Popular on the Probability of Delivering a Baby at a Site Run by the Department of Health (SSA), a Unit Sponsored by Seguro Popular (SP), and a Private Facility.

Source: Table 5.

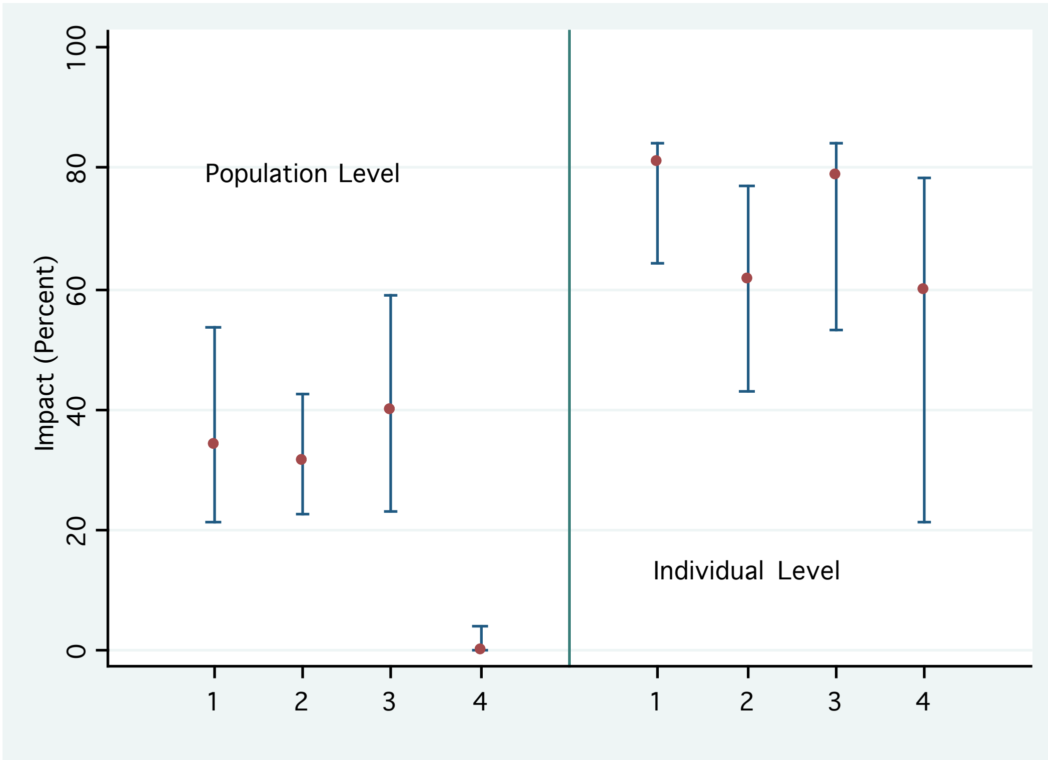

Figure 2. Population-Level versus Individual-Level Impacts of Seguro Popular on the Utilization of a SP-Accredited Obstetrical Unit.

Source: Table 6.

Appendices

Appendix A. Illustrative Example of Preference Reversals as a Function of Price

To illustrate the effect of a change in the price p of non-obstetric care on household rankings of obstetric care, we specify the household utility function

$$\text{(A.1)} \quad U\left(z_0, z_1, z_2, x, c\right) = \sum_{i=0}^{2} \frac{z_i x}{\zeta_i z_i + \alpha_i x} + \ln c$$

where $\alpha_i, \zeta_i > 0$, and where $U\left(0,0,0,0,c\right) = \ln c$. Each of the terms in the summation is a CES utility function of the form $f_i\left(z_i, x\right) = \left(\alpha_i z_i^{-\rho_i} + \zeta_i x^{-\rho_i}\right)^{-1/\rho_i}$, where $\rho_i = 1$. The last term is an additively separable component that implies diminishing marginal utility of income.

The corresponding conditional demand functions are:

$$\text{(A.2)} \quad c_i^*\left(q_i, p, m\right) = \varphi_i, \qquad x_i^* = \sqrt{\frac{\zeta_i}{p}}\left(\frac{m}{\varphi_i} - 1\right), \qquad z_i^* = \sqrt{\frac{\alpha_i}{q_i}}\left(\frac{m}{\varphi_i} - 1\right)$$

where $\varphi_i = \left(\sqrt{\alpha_i q_i} + \sqrt{\zeta_i p}\right)^2$ for $i = 0,1,2$. These conditional demand functions hold so long as $m > \varphi_i$. Otherwise, when $m \le \varphi_i$, the solution is $c_i^* = m$ and $x_i^* = z_i^* = 0$, so that the household spends all its income on the numeraire good. For each $i = 0,1,2$, the conditional indirect utility is:

$$\text{(A.3)} \quad w_i^* = \frac{m}{\varphi_i} - 1 + \ln \varphi_i$$

which is a decreasing function of φ_i so long as $m > \varphi_i$.

For the utility function in equation (A.1), a reduction in the price p of non-obstetrical care can alter the relative ranking of private care $(i = 2)$ and SSA-sponsored care $(i = 0)$. Specifically, there exist values of the parameters $\{\alpha_i, \zeta_i\}$ such that the differential utility $w_0^*(q_0, p, m) - w_2^*(q_2, p, m)$ is a strictly increasing function of p with a root $p' = \left(\dfrac{\sqrt{\alpha_0 q_0} - \sqrt{\alpha_2 q_2}}{\sqrt{\zeta_2} - \sqrt{\zeta_0}} \right)^2 > 0$, that is, $w_0^*(q_0, p', m) - w_2^*(q_2, p', m) = 0$. If we assume that the net price of private obstetrical care exceeds that of SSA-funded obstetrical care, that is, $q_2 > q_0$, these conditions imply that $\alpha_2 q_2 < \alpha_0 q_0$ and $\zeta_2 > \zeta_0$.

Our example is illustrated in Figure A.1, which plots w_0^*, w_1^*, and w_2^* as a function of the price p of non-obstetrical care. A woman will choose a private obstetric facility (where $w_2^* > w_0^* > w_1^*$ and $y_1 = 2$) when p is sufficiently low, while a woman will choose an SSA public facility (where $w_0^* > w_2^* > w_1^*$ and $y_1 = 0$) when p is high. Our example shows that coverage by Seguro Popular can result in preference reversals even though each of the three obstetric sites is conditionally a normal good, that is, $\dfrac{\partial z_i^*}{\partial m} > 0$. What matters is that private obstetrical care has a strong complementary relation with non-obstetrical care.

[Figure A.1 is on the following page.]

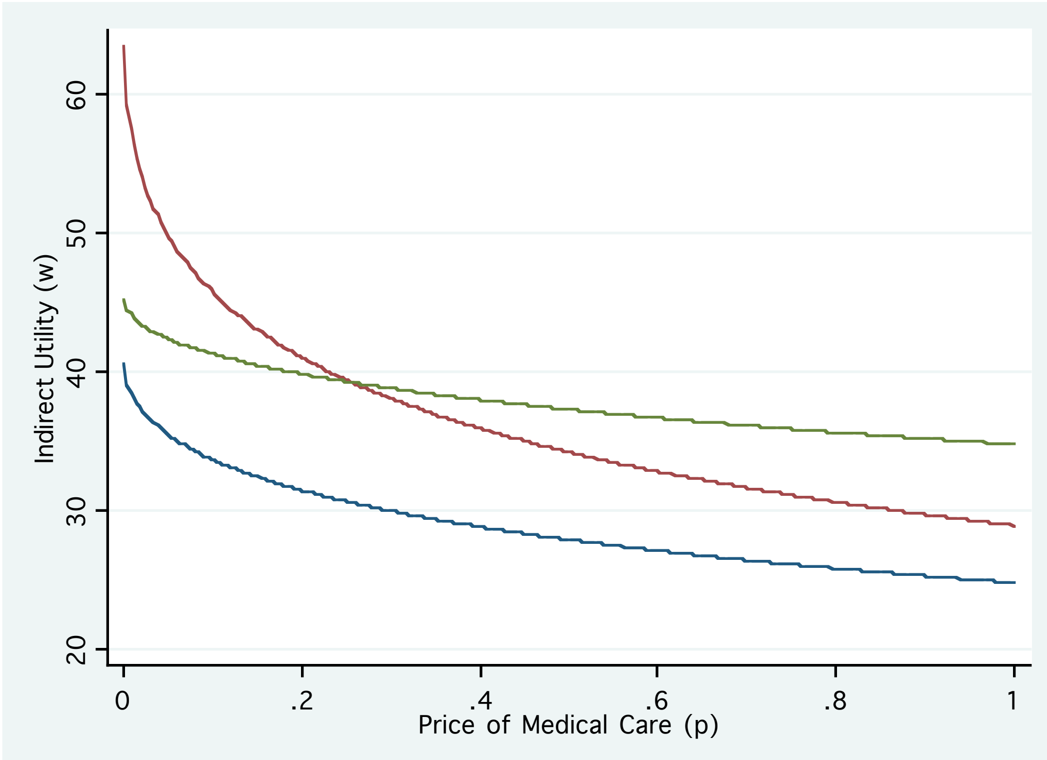

Figure A.1. A change in the price p of non-obstetric care can reverse the ordering of the indirect utility functions for the three delivery sites: Secretaría de Salud $(i=0)$; Seguro Popular $(i=1)$; and private obstetrical care $(i=2)$. The specific parameters in this example are: $m=200$, $(q_0,q_1,q_2)=(1,1,5)$, $(\alpha_0,\alpha_1,\alpha_2)=(20,25,2,)$, and $(\zeta_0,\zeta_1,\zeta_2)=(2,12,16)$. There is a reversal of preferences at price $p'=0.257$.

Appendix B. Construction and Estimation of Log Likelihood Function

Here, we derive the contribution to the log likelihood for two of the six possible cases $\{(y_1,y_2)|\ y_1=0,1,2;\ y_2=0,1\}$, leaving remaining cases to the reader.

First, consider an observation where $y_1=2, y_2=0$, that is, where the pregnant woman chooses a private site to deliver her baby, and where the household decides not to enroll in Seguro Popular. From equations (12) and (13), we conclude that

$w_0^* < 0, w_1^* < 0, y_2^* < 0$. Given the error structure in equation (14), we conclude that the contribution of this observation to the log likelihood is

$$\text{(B.1)} \quad L_{20} = \ln \Pr\left\{y_1 = 2, y_2 = 0 \mid \boldsymbol{X}, \boldsymbol{\beta}, \boldsymbol{\gamma}, \boldsymbol{\sigma}\right\} = \ln \Phi_3\left(\begin{pmatrix} -X_0'\beta_0 \\ -X_1'\beta_1 \\ -X_2'\beta_2 \end{pmatrix}, \begin{pmatrix} 1 & 0 & \sigma_0 \\ 0 & 1 & \sigma_1 \\ \sigma_0 & \sigma_1 & \tau \end{pmatrix}\right)$$

In (B.1), the term $\Phi_3(v, \Sigma)$ denotes $\Pr\{V < v\}$, where V is a 3-dimensional vector of random variables with a trivariate normal distribution with zero means and 3×3 variance-covariance matrix Σ.

Next, consider an observation where $y_1 = 0, y_2 = 1$, that is, where the pregnant woman chooses an obstetric site sponsored by the Secretaría de Salud, and where the household decides to enroll in Seguro Popular. From equations (12) and (13), we conclude that $-w_0^* < 0,\ w_1^* - w_0^* < 0,\ -y_2^* < 0$. The contribution of this observation to the log likelihood is therefore

$$\text{(B.2)} \quad L_{01} = \ln \Pr\left\{y_1 = 0, y_2 = 1 \mid \boldsymbol{X}, \boldsymbol{\beta}, \boldsymbol{\gamma}, \boldsymbol{\sigma}\right\} =$$
$$\ln \Phi_3\left(\begin{pmatrix} X_0'\beta_0 + \gamma_0 \\ X_0'\beta_0 + \gamma_0 - X_1'\beta_1 - \gamma_1 \\ X_2'\beta_2 \end{pmatrix}, \begin{pmatrix} 1 & 0 & \sigma_0 \\ 0 & 2 & \sigma_0 - \sigma_1 \\ \sigma_0 & \sigma_0 - \sigma_1 & \tau \end{pmatrix}\right)$$

The individual terms of the log likelihood function entail three-dimensional probit integrals, which we evaluated by means of the GHK simulator written by Cappellari and Jenkins (2006).

Appendix C. Results for the Enlarged, Restricted and Reclassified Samples

Table C.1 shows the estimated values of the parameter $(\gamma_0, \gamma_1, \rho_0, \rho_1)$ for each of the alternative samples in our sensitivity analyses. Also shown for each case are the sample size (N) and the estimated individual-level impact $I_1(\boldsymbol{X})$ in Case 1.

Table C.1 Estimates of Multinomial Probit Model Parameters and Individual-Level Impact (Case 1) for Enlarged, Restricted and Reclassified Samples

Parameter	Enlarged Sample §	Restricted Sample ¶	Reclassified Sample ‡
γ_0	-1.819 [0.182]	-2.202 [0.126]	-2.374 [0.114]
γ_1	2.815 [0.281]	2.843 [0.265]	2.716 [0.237]
ρ_0	0.646 [0.163]	0.931 [0.093]	0.750 [0.076]
ρ_1	-0.177 [0.174]	-0.200 [0.201]	-0.001 [0.142]
N	5,762	1,934	3,891
$I_1(\boldsymbol{X})$ Case 1	72.0% [42.4-81.4]	67.4% [34.5-81.2]	72.6% [38.4-86.0]

§ *Enlarged Sample*: Adult women who had given birth since 2001, including those who had Social Security (IMSS/ISSSTE/PEMEX/SEDENA), exclusive of responses with missing values for any explanatory variables.
¶ *Restricted Sample*: Observations in the enlarged sample, restricted to those women whose households resided in a locality with a moderately high or very high index of socioeconomic marginality ("índice de marginación") (CONAPO (2005)).
‡ *Reclassified Sample*: Observations in the analytic sample, after reclassification of 195 women as not enrolled in SP and not delivering a baby in an SP-accredited facility if the woman reported a date of delivery at an SP-sponsored facility before the official year of incorporation of SP in the state or before the reported date of enrollment reported on the household questionnaire.

Acknowledgements

We acknowledge the research assistance of Edson Serván Mori.

References

Akin, J. S., D. K. Guilkey, et al. (1995). "Quality of services and demand for health care in Nigeria: a multinomial probit estimation." Soc Sci Med **40**(11): 1527-37.

Balia, S. and A. M. Jones (2004). Mortality, Lifestyle and Socio-Economic Status. York, United Kingdom, University of York, Department of Economics, Working Paper.

Behrman, J. R. and E. Skoufias (2006). "Mitigating Myths about Policy Effectiveness: Evaluation of Mexico's Antipoverty and Human Resource Investment Program." Annals Am Acad Political Social Sci **606**(1): 244-275.

Bertranou, F. (1998). "Health care services utilization and health insurance coverage: evidence from Argentina." Revista de Análisis Económico (Universidad Alberto Hurtado Chile) **13**: 25-52.

Bolduc, D., G. Lacroix, et al. (1996). "The choice of medical providers in rural Benin: a comparison of discrete choice models." J Health Econ **15**(4): 477-98.

Borah, B. J. (2006). "A mixed logit model of health care provider choice: analysis of NSS data for rural India." Health Econ **15**(9): 915-32.

Cameron, A. C., P. K. Trivedi, et al. (1988). "A microeconometric model of the demand for health care and health insurance in Australia." Review of Economic Studies **55**(1): 85-106.

Cappellari, L. and S. P. Jenkins (2006). Calculation of multivariate normal probabilities by simulation, with applications to maximum simulated likelihood estimation. Colchester UK, University of Essex, Institute for Social and Economic Research, Working Paper 2006-16.

Chávez-Martín del Campo, J. C. (2006). Does Conditionality Generate Heterogeneity and Regressivity in Program Impacts? The Progresa Experience. Ithaca NY, Cornell University, Department of Applied Economics and Management, Working Paper 2006-09.

CONAPO (2005). Índice de marginación a nivel localidad, 2005 Distrito Federal, Mexico, Consejo Nacional de Población (CONAPO), http://www.conapo.gob.mx/publicaciones/indice2005xloc.htm.

Dammert, A. C. (2007). Heterogeneous impacts of conditional cash transfers: Evidence from Nicaragua. Hamilton, Ontario, Canada, McMaster University, Department of Economics Working Paper, http://socserv.mcmaster.ca/dammert/nicaragua_APRIL07.pdf.

Deb, P., M. K. Munkin, et al. (2006). "Bayesian analysis of the two-part model with endogeneity: application to health care expenditure." Journal of Econometrics **21**(7): 1081-99.

Djebbari, H. (2005). The Impact on Nutrition of the Intrahousehold Distribution of Power. Bonn, Germany, IZA Discussion Paper No. 1701, http://ftp.iza.org/dp1701.pdf.

Djebbari, H. and J. Smith (2005). Heterogeneous program impacts: Experimental evidence from the PROGRESA program. Ann Arbor, Michigan, University of Michigan, Department of Economics, Working Paper.

Duflo, E. (2001). "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment." American Economic Review **91**(4): 795-813.

Frenk, J., J. Sepulveda, et al. (2003). "Evidence-based health policy: three generations of reform in Mexico." Lancet **362**(9396): 1667-71.

Gakidou, E., R. Lozano, et al. (2006). "Assessing the effect of the 2001-06 Mexican health reform: an interim report card." Lancet **368**(9550): 1920-35.

Gaviria, A., C. Medina, et al. (2006). Evaluating The Impact Of Health Care Reform In Colombia: From Theory To Practice. Bogotá, Colombia, Universidad de Los Andes-CEDE, Documento CEDE 2006-06.

Gertler, P. J. (2000). Final Report: The Impact of PROGRESA on Health. Washington DC, International Food Policy Research Institute, http://www.ifpri.org/themes/progresa/pdf/Gertler_health.pdf.

Gertler, P. J. (2004). "Do conditional cash transfers improve child health? Evidence from PROGRESA's control randomized experiment." American Economic Review **94**(2): 336-341.

Gitto, L., D. Santoro, et al. (2006). "Choice of dialysis treatment and type of medical unit (private vs public): application of a recursive bivariate probit." Health Econ **15**(11): 1251-6.

Greene, W. H. (2000). Econometric Analysis, Fourth Edition. Upper Saddle River, NJ, Prentice Hall.

Harris, J. E. and B. González López-Valcárcel (2007). "Asymmetric Peer Effects in the Analysis of Cigarette Smoking among Young People in the United States, 1992 – 1999." J Health Econ **In Press**.

Hoddinott, J. and E. Skoufias (2004). "The Impact of PROGRESA on Food Consumption." Economic Development and Cultural Change **53**: 37–61.

Instituto Nacional de Salud Pública (2000). Encuesta Nacional de Salud. Cuernavaca, México, Instituto Nacional de Salud Pública, http://www.insp.mx/ensa/.

Instituto Nacional de Salud Pública (2006). Encuesta Nacional de Salud y Nutrición (ENSANUT). Cuernavaca, México, Instituto Nacional de Salud Pública, http://www.insp.mx/ensanut/.

Knaul, F. M. and J. Frenk (2005). "Health insurance in Mexico: achieving universal coverage through structural reform." Health Aff (Millwood) **24**(6): 1467-76.

Leonard, K. L. (2007). "Learning in Health Care: Evidence of Learning about Clinician Quality in Tanzania." Economic Development and Cultural Change **55**: 531-555.

Maddala, G. (1983). Limited Dependent and Qualitative Variables in Econometrics. New York, Cambridge University Press.

McKenzie, D. J. (2004). "Measuring inequality with asset indicators." Journal of Population Economics **18**(2): 229-260.

Mojarro, O., G. Tapia-Colocia, et al. (2003). Mortalidad materna y marginación municipal. Distrito Federal, Mexico, Conjeso Nacional de Población (CONAPO), http://www.conapo.gob.mx/publicaciones/2003/09.pdf.

Munkin, M. K. and P. K. Trivedi (2003). "Bayesian analysis of a self-selection model with multiple outcomes using simulation-based estimation: an application to the demand for healthcare." Journal of Econometrics **114**: 197 – 220.

Nigenda, G., E. Troncoso, et al. (2003). Mezcla público-privada en el sector salud. Reflexiones sobre la situación en México. Caleidoscopio de la salud: De la investigación a las políticas y de las políticas a la acción. F. M. Knaul and G. Nigenda. Distrito Federal, México, Fundación Mexicana para la Salud: 229–242.

Pagan, J. A., A. Puig, et al. (2007). "Health insurance coverage and the use of preventive services by Mexican adults." Health Econ.

Parker, S. W. and R. Wong (1997). "Household income and health care expenditures in Mexico." Health Policy **40**(3): 237-55.

Sapelli, C. and B. Vial (2003). "Self-selection and moral hazard in Chilean health insurance." J Health Econ **22**(3): 459-76.

Schwartz, J. B., J. S. Akin, et al. (1988). "Price and income elasticities of demand for modern health care: The case of infant delivery in the Philippines." World Bank Economic Review **2**(1): 49-76.

Secretaría de Salud (2005). Sistema Nacional de Información en Salud (On-line Database). Distrito Federal, México, Secretaría de Salud (SSA), http://sinais.salud.gob.mx/.

Secretaría de Salud (2006). Sistema de Protección Social en Salud. Vols. 1-3. Distrito Federal, México, Secretaría de Salud (SSA), Gobierno de México.

Sepúlveda, J., F. Bustreo, et al. (2006). "Improvement of child survival in Mexico: the diagonal approach." Lancet **368**(9551): 2017-27.

Skoufias, E. (2005). PROGRESA and Its Impacts on the Welfare of Rural Households in Mexico (Summary). Washington DC, International Food Policy Research Institute, Research Report 139, http://www.ifpri.org/pubs/abstract/139/rr139toc.pdf.

Skoufias, E. and S. W. Parker (2001). "Conditional Cash Transfers and Their Impact on Child Work and Schooling: Evidence from the PROGRESA Program in Mexico." Economia **2**(1): 45-96.

StataCorp (2005). Stata Statistical Software: Release 9. College Station TX, StataCorp LP.

Suraratdecha, C., S. Saithanu, et al. (2005). "Is universal coverage a solution for disparities in health care? Findings from three low-income provinces of Thailand." Health Policy **73**(3): 272-84.

Thirumurthy, H., J. G. Zivin, et al. (2006). The economic impact of AIDS Treatment: Labor supply in Western Kenya. Hatfield, South Africa, Southern Africa Regional Poverty Network, http://www.sarpn.org.za/documents/d0001904/Impact-Aids_Jan2006.pdf.

Torres, A. C. and F. M. Knaul (2003). Determinantes del gasto de bolsillo en salud e implicaciones para el aseguramiento universal en México: 1992–2000. Caleidoscopio de la salud: De la investigación a las políticas y de las políticas a la acción. F. M. Knaul and G. Nigenda. Distrito Federal, México, Fundación Mexicana para la Salud**:** 209–225.

Trujillo, A. J. (2003). "Medical care use and selection in a social health insurance with an equalization fund: evidence from Colombia." Health Econ **12**(3): 231-46.

Trujillo, A. J., J. E. Portillo, et al. (2005). "The impact of subsidized health insurance for the poor: evaluating the Colombian experience using propensity score matching." International Journal of Health Care Finance and Economics **5**(3): 211-39.

Wagstaff, A. (2007). Health insurance for the poor : initial impacts of Vietnam's health care fund for the poor. Washington DC, World Bank Impact Evaluation Series No. 11, Policy Research Working Paper No. WPS4134, http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2007/02/05/000016406_20070205110453/Rendered/PDF/wps4134.pdf

Wagstaff, A., M. Lindelow, et al. (2007). Extending Health Insurance to the Rural Population: An Impact Evaluation of China’s New Cooperative Medical Scheme. Washington DC, World Bank Impact Evaluation Series No. 12, Policy Research Working Paper No. WPS4150, http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2007/02/22/000016406_20070222160135/Rendered/PDF/wps4150.pdf.

Waters, H. R. (1999). "Measuring the impact of health insurance with a correction for selection bias--a case study of Ecuador." Health Econ **8**(5): 473-83.