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ISSN 0921-0210

ABSTRACT

Healthcare in Ecuador has improved substantially over the last 30 years but spending remains low compared to other countries in the region and there are severe inequalities in the system, particularly in access to healthcare for the indigenous population, the poor and those living in rural areas. The 1990s saw a series of health sector reforms, but many of the proposed measures remain to be implemented, hindered by institutional weaknesses and a series of economic crises. The main focus of this paper, however, is on how to reduce infant mortality rates, particularly for marginalized groups. The recommendations aim to help the country achieve the Millennium Development Goal (MDG) of reducing child mortality by two-thirds in the period 1990–2015. For many better-off sectors of the population this target is already in sight. The analysis shows that with the right health spending priorities that are almost budget-neutral, the MDG is within reach for the whole population. The related recommendations for health policies go some way in addressing the broader problems in health service delivery, including low access to services, inequalities across population groups and geographical areas, and low quality of services. The recommendations are to protect the immunization program that has suffered recent budget cuts and expand the Free Maternity Program (guaranteeing free access to free pre-natal and delivery to all women). In the long-term the government could consider a universal health insurance system as a means of improving equity and efficiency in delivering healthcare, especially to the poor. However, current financial constraints make that option impractical at present. The analysis uses an innovative combination of econometric modelling techniques aimed at finding the most cost-effective ways to achieve the desired results.

CONTENTS

1 INTRODUCTION

Public health spending in Ecuador is among the lowest in Latin America. Spending amounts to a meagre 2% of GDP (only Haiti spends less). Yet huge strides forward have been made in improving some health conditions. Since 1970, infant mortality rates have been cut by 70% to 34 per 1,000 live births. Important inequalities remain in the health system, showing much higher mortality rates and limited access to health care for the indigenous population, the poor and those living in rural areas. Health provisioning has shifted towards greater emphasis on primary health care in public provisioning and in-patient hospital care by private health providers. Health policy reforms have also included increases in user fees for public services, decentralization of public services, special programs providing free health care for the poor (including the free maternity program), and introduction of demand subsidies for health through the conditional cash transfer program *Bono de Desarrollo Humano*. Policies have not been consistent though as the health policy framework has changed a number of times during the 1990s and not all reforms have as yet been fully pushed through (such as the decentralization).

Reforms that were implemented, in turn, suffered from mostly tightening budget constraints, as the health budget (in real per capita terms) has declined for most of the 1990s. Recent upward budget adjustments have mainly gone into salary increases of health workers. All of this has had a mixed outcome on health conditions in Ecuador, but principally the policy reforms as implemented so far have failed to address the fundamental problems in health service delivery, including low degrees of access to services, inequalities across social population groups and geographical areas, and low quality of services. Inequalities in access to health facilities have increased, partly because of the introduction of user fees and partly because health inputs (particularly drug supplies) have fallen well behind requirements. On the other hand, continued expansion of the immunization program and the introduction of the free maternity program have compensated for this effect, at least for young children and pregnant women, and which is likely part of the explanation of the continued decline in infant mortality during the 1990s. However, the remaining large differences between rich and poor, non-indigenous and indigenous, and urban and rural populations, suggest such specific interventions have not been sufficient to ensure greater equity in health conditions. It is even less clear to what extent Ecuador's

health system is sufficiently prepared to take on the challenge of increasing health demands due to the epidemiological transition towards injuries and chronic and degenerative diseases, which already by far predominate adult disease prevalence.

The main focus of this paper will be though on the health risks affecting mothers and young children and to find more cost-effective ways to use the health budget to further reduce infant mortality, particularly for those groups with the least favourable health status. The Millennium Development Goal for reducing child mortality is well within reach in the case of Ecuador if trends of the recent past are maintained. However, it is not obvious that without additional effort the goal can actually be met. Public health policies typically are important in influencing outcomes for child survival and, as indicated, some social groups are clearly lagging behind in health status. Public health spending in Ecuador stands at around US$ 18 per person, well below the per capita spending level of US$ 30-40 which international organizations see as a minimum requirement for a scaled-up health system capable of meeting such health targets (WHO, 2001). The Millennium Project of the UN estimates financing gaps in public health spending of between US$ 13 and 30 per capita, per year to reach the health MDGs for countries with low prevalence of HIV/Aids or malaria, like Ecuador (UN Millennium Project, 2005). This would imply roughly a doubling of the country's public health budget. We will argue that with well-targeted and cost-effective interventions the MDG target for child mortality can be reached in Ecuador at a much lower cost.

The remainder of this paper is organized as follows. In section 2, we describe trends in overall health conditions in Ecuador over the past decades through changes in the mortality and epidemiological profiles of the population. We also present descriptives of inequalities in health determinants which most impact on child mortality. Section 3 takes on the issue of efficiency of health spending, particularly that aiming at improving maternal and infant health status. We do this through an innovative two-stage health production function approach, modelling first the determinants of access to health care and choice among public and private providers. Next, we model the determinants of child survival in the first year after birth and assess which policy variables seem most effective to reduce infant mortality. The estimated impacts of the determinants on health demand and child survival – reported in section 4 – are then used in section 5 to assess the budget implications of alternative interventions and spell out a budget tracking methodology which links

health inputs to outputs. We find that the maintenance of the immunization program and the expansion of the Free Maternity Program are the most cost-effective public interventions to achieve the infant mortality MDG in Ecuador. Section 6 provides some final remarks on the policy recommendations emanating from the analysis.

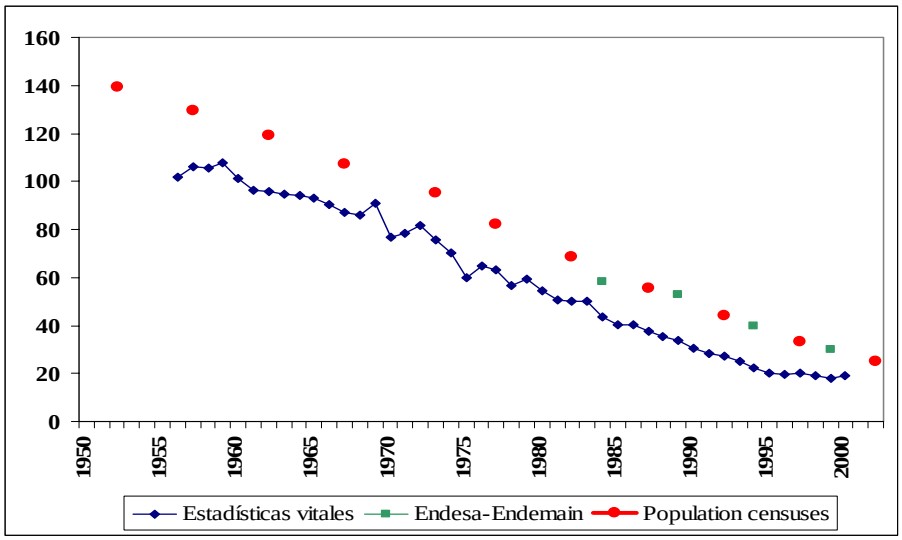
2 HEALTH STATUS AND ACCESS TO HEALTH SERVICES IN ECUADOR

Health conditions of the Ecuadorian population have improved considerably over the past 50 years. Life expectancy increased from 48 to 72 years between 1950 and 2000. This upward trend was sustained during the 1990s gaining another 5 years to the expected years to live of the average Ecuadorian. Parallel patterns are found in declining overall, child and infant mortality rates. The overall mortality rate dropped from 13.8 in 1960 to 4.5 per 100,000 inhabitants in 2001. This rate has not changed much during the 1990s. In contrast, the infant mortality rate has continued to fall in an almost linear trend since 1950 reaching 34 per 1,000 live births for 1995-2000 according to the population census based life expectancy tables, down from 140 in 1950-55 (INEC 2003). This finding of a dramatic improvement in health conditions trend is consistent across various data sources (see figure 1) Child mortality rates follow similar trends as these mainly reflect infant mortality as most child deaths are concentrated among those in their first year of life (table 1). Since 1970, the infant mortality rate has fallen by 70% in Ecuador, which is as impressive as the achievements the rest of the Americas where the rate has fallen on average at a similar rate (WHO 2003). Achievements in Chile, Costa Rica, and Cuba have been even greater with reductions of over 80%.

These aggregate trends hide important inequalities across different groups. Table 1 shows that boys have a higher probability of dying at early age than girls, probably due to worldwide biological reasons as found worldwide (WHO, 2003).[1]

[1] Higher child mortality for boys is found with few exceptions around the world. In China, India, Nepal and Pakistan, mortality in girls exceeds that of boys. This disparity is particularly noticeable in China, where girls have a 33% higher risk of dying than their male counterparts. These inequities are thought to arise from the preferential treatment of boys in family health care-seeking behaviour and in nutrition. Throughout Latin America child mortality is higher for boys.

FIGURE 1
Infant mortality, estimates from various sources, 1950-2002



Sources: INEC (2003); Demographic and Health Surveys (Endesa-Endemain) of 1987, 1989, 1994 and 1999; INEC, Estadísticas Vitales.

Note: See also INEC (2003) and WHO Life Tables in López et al. (2002), for a similar compilation including some additional estimates based on older population census projections and indirect estimates from the DHS surveys. All sources confirm the trends shown above. The data from the administrative records of health centres (*Estadísticas Vitales*) are for the indicated years. DHS data are based on the indirect method of calculating the infant mortality rate and are for 1982-87, 1989, 1994 and 1999. The series from the population censuses (1950, 1974, 1992, 1990 and 2001) are adjusted IMR estimates applying the Brass/Trussel method to the observed number of live births and survivors and the Coale-Demeny Model Tables for the Western Family. These estimates are taken from INEC (2003) and refer to five-year averages which are graphed at mid-period points.

Interestingly, indigenous children have about double the child mortality rate than non-indigenous children (i.e. 90.5 against 38.5 per 1,000 live births). They form the most disadvantaged group in this sense. As we shall try to analyse later on, this is likely caused by the fact that indigenous mothers tend to have less education, less knowledge of (modern) reproductive health care and limited access to professional pre-natal care and birth delivery assistance. As can also be derived from table 1, the gap in the risk of dying at early age between indigenous and non-indigenous born has not narrowed during the 1990s. Child and infant mortality are also significantly higher for Afro-Ecuadorians. The probability of early child death for this population group is 10-15% higher than the average, though much less than that for the indigenous population. The risk of child mortality is significantly higher in rural than in urban areas, even though this difference has narrowed slightly from 1.9 to 1.7 during the

1990s.[2] As expected, children of poor families are at greater risk than those of non-poor families, but also here we observe a reduction in the gap in the 1990s (from 2.1 to 1.6 for child mortality and from 1.9 to 1.5 for infant mortality).[3]

TABLE 1
Socio-demographic profile of infant (0-1 years) and child mortality (0-5 years) (per 1,000 live births), 1995-2000

	1985-90			1995-2000		
	Age groups			Age groups		
	0 - 1	**1 - 5**	**0 - 5**	**0 - 1**	**1 - 5**	**0 - 5**
Ethnicity (language)						
Non-indigenous	53.3	17.8	70.0	35.0	7.5	38.5
Indigenous	98.8	48.0	141.5	66.0	26.0	90.5
Ethnicity (self-definition)						
Indigenous	n.a.	n.a.	n.a.	66.0	26.0	89.8
Black (Afro)	n.a.	n.a.	n.a.	38.0	10.0	48.3
Mestizo	n.a.	n.a.	n.a.	31.0	7.0	37.8
Caucasian	n.a.	n.a.	n.a.	26.0	5.3	30.8
Other	n.a.	n.a.	n.a.	29.0	6.5	35.3
Area of residence						
Urban	40.5	11.0	51.0	27.0	5.5	32.3
Rural	71.3	29.3	98.5	44.0	12.8	56.0
Poverty by UBN						
Extremely poor	66.3	26.3	90.5	42.0	12.0	53.5
Poor	60.5	22.5	81.8	38.0	10.0	47.5
Non-poor	31.5	7.0	38.5	25.0	4.8	29.3
Total	**55.3**	**19.0**	**73.3**	**34.0**	**8.3**	**42.3**

Source: Estimates based on INEC, Population Censuses of 1990 and 2001, using same estimation method as indicated in note to figure 1.

As analyzed in Vos et al. (2004), the main causes of mortality in early childhood are related to preventable, communicable diseases. Malnutrition is reported as a direct cause of infant death in less than 5 percent of the cases and this share has been declining. The figure likely underestimates the impact of malnutrition, as it is a compounding factor in infectious diseases. Malnutrition (stunting) fell from 34 to 26 percent between 1985 and 2000, but in line with inequalities in infant mortality rates, mainly affects children in rural areas, poor households, and – most in particular – those that are indigenous born (Vos et al. 2004: table A4.6).

Despite these large differences in the risk of child death persists across socioeconomic groups, Ecuador seems well on track to reach the Millennium

[2] For infant mortality this gap reduced from 1.75 to 1.63.
[3] Poverty is measured here according to the unsatisfied basic needs measure (UBN) as defined by SIISE (2003).

Development Goal (MDG) for child mortality well before 2015. The internationally agreed target is to reduce child mortality by two-thirds between 1990 and 2015. Ecuador already achieved such a reduction by 2001 for girls aged 1-5 and with unchanged (linear) trends this should also have been reached for boys aged 1-5. With unchanged trends the goal for infant mortality (0-1 year olds) could be reached by 2010 for boys and by 2008 for girls. The question remains whether public health budget priorities are compatible with the need to sustain these trends. In effect, Ecuador's government budget system – including the health budget – long has been highly centralized, rule oriented and input based. The input-based characteristic has led to incremental allocations (in nominal terms) according to cost changes of main health supply components. Budget rules in Ecuador ever since the 1970s have included a host of fixed allocations from specified revenues (including the repartition of oil revenues) and fixed-share or growth rules, such as the rule that health spending should increase at least as fast as aggregate public spending. This practice has imposed rigidities in the spending pattern and has made the health budget to adjust pro-cyclically at least until 1995, as analyzed in a study by Vos et al. (2003). Attempts towards systems of more decentralized budget allocation and performance-based budget have been part of the health policy reforms of the 1990s. Implementation of these reforms has been difficult, leaving much of the traditional health budgeting system still in place (see Vos et al. 2004). Potentially, keeping such health budgetary practices may put at risk the achievement of the MDG for child mortality.

3 MODELLING ACCESS TO HEALTH CARE AND COST-EFFECTIVENESS IN HEALTH SPENDING

This section explores first what motivates Ecuadorian individuals when selecting among different health services (either public or private or no service at all). Once these determinants are known, the effects of access to health services on infant mortality are analysed. As a result, public health policy strategies are linked with the key development goal of infant mortality reduction. This link is two-fold: one shows the effects of private and public interventions on infant mortality directly; the other shows the impact on infant mortality through its induced change on health demand.

An innovative element of our analysis is to connect methodologically access to health services during delivery with the phenomenon of infant mortality.

Traditionally, the health demand literature has focused on separating the effects of price-related and socioeconomic-related variables determining access to services. Gertler, Locay and Sanderson, 1987 or Gertler and van der Gaag, 1990 are classic and pioneering references for analyses of socioeconomic, demographic and geographical influences on child health status using production functions. Estimation problem issues such as simultaneity of consumption, leisure, time allocation and child health have been a constant concern in this literature and dealt extensively in Thomas and Strauss (1992), Pitt, Rosenzweig and Gibbons (1995), Glewwe (1998) or Behrman et al. (2004). Differences in child nutritional status have been also used in the intrahousehold allocation literature to test for underlying bargaining allocation rules as in Rosenzweig and Schultz (1982), Haddad and Hoddinott (1990), Thomas (1994), and Quisumbing and Maluccio (2003). Specifically, the relation of parental education on child health and nutritional status has been long established, but more recently there has been an increasing literature concentrating on the role that child nutrition and health status has on the child's educational achievement (see for example World Bank, 1993, Behrman, 1996, Alderman et al., 1999, and Glewwe et al., 2001). Also, there is a large literature focusing on the child nutritional and health impacts, from early studies such as Alderman (1986), Behrman and Deolalikar (1987), to more recent studies such as Behrman, Foster and Rosenzweig (1997), Behrman et al (2004) and Gertler (2004), which specifically evaluates the health impacts on children accruing from the cash conditional PROGRESA (now called *Oportunidades*) program in Mexico. In addition, most of the existing infant mortality studies have emphasised the likely mutual causation between infant mortality and fertility decisions (Rosenzweig and Schultz, 1982; Hanmer and White, 1998; Dreze and Murthi, 2001). Charmarbagwala et al. (2004) provide a recent and extensive survey of child and infant mortality studies. However, in this array of literature the combined modelling of infant mortality and the choice of health services has not been attempted before.

The traditional emphasis in the previous literature is taken into account though in our modelling approach. While we do not directly include price considerations, by controlling for affiliation (if any) to alternative health insurance systems and presence of private and public health providers we obtain a proxy for price differences faced by health users. The relation between fertility and infant mortality is taken into account implicitly since many of the determinants of fertility are also factors affecting mortality. In addition, possible forms of household behaviour in relation to infant

mortality such as “replacement” (higher fertility due to higher mortality) and/or resource-competition among household members are controlled for in the proposed child survival specification. This is believed to capture the consequences of an intertwined relation between fertility and mortality.

Theoretical underpinnings

Access to health services during child delivery

Given data limitations, the use of health care is not measured in terms of the quantity of health care consumed, but in terms of choices among alternative health care providers. We use the standard framework employed in several studies of the determinants of access to health care services as a starting point (see Gertler, Locay and Sanderson, 1987, Mwabu, Ainsworth and Nyamete, 1993, and Behrman et al. 2004 for a recent survey). The framework is a short-run static model with a utility function defined over health status and the consumption of all other goods.

This description of the manner in which an individual makes a choice concerning health care provision may be formalized by considering utility conditional on receiving care from health care provider (HCP) *j*. Utility conditional on choosing provider *j* is given by,

$$U_{ij} = U(H_{ij}, C_{ij}, T_{ij}) \quad (1)$$

where H_{ij} is the expected health status of the individual conditional on receiving treatment from provider *j*, C_{ij} is the consumption of all other goods except those associated with health care, T_{ij} represents the non-monetary costs of access to provider *j*. The expected improvement in health care status is unobservable but is assumed to depend on the characteristics of an individual (health status, habits, etc.) and the quality of health care received by the individual. This allows us to write a health production function defined over X_i, the attributes of an individual and Z_j, the attributes of the provider *j*. Hence,

$$H_{ij} = H(X_i, Z_j) \quad (2)$$

Turning to the level of consumption, it depends on the income of the individual and the costs associated with buying health care. If the user fee associated with provider *j* is P_j and Y is an individual's income then, this yields a function where utility is given as,

$$U_{ij} = U(X_i, Z_j, Y_i, P_j, T_{ij}) \quad (3)$$

Thus, the benefits from visiting a particular health care provider depend on individual characteristics, the attributes of the provider, individual income, user fees faced at provider *j* and non-monetary costs associated with visiting provider *j*.

An individual's health care provider (HCP_i) choice may now be expressed as

$$HCP_i = j \quad \text{if } U_{ij} > \max\{U_{ik}\}, \qquad j = 1 \ldots J, \; k \neq j, \quad (4)$$

The parameters of (3) and the probability that individual *i* chooses health care provider *j* may be obtained by estimating a multinomial discrete choice model. The selection rule (4), combined with the assumption that the stochastic error term follows a Weibull distribution, defines a multinomial logit model where

$$P_{ij} = \Pr(HCP_i = j) = \exp(\alpha_j' W_i + \beta' K_j) / \sum_{k=1}^{J} \exp(\alpha_k' W_i + \beta' K_k) \quad (5)$$

Determining child survival

On the other hand, duration models have been extensively used in socioeconomic analysis in issues such as unemployment spells, education enrolment or social benefit schemes. (Nickell et al, 1991, Meyer, 2000) There is also a rather extensive epidemiological literature on the duration of health conditions, among others, infant, child or adult mortality (Keller, 1988; Martorell, Khan and Schroeder, 1994; Masset and White, 2003; and Charmarbagwala et al., 2004 to cite some relevant studies). Following Greene (2001) notation, let '*T*' be a random continuous variable with a probability function *f( )*. This probability function indicates the number of periods elapsed until the incumbent event takes place in a period 't'. This probability function is dependant on a set of variables, x_i, capturing from socioeconomic conditions to individual characteristics or any other factor that affects the duration of the studied event. Let *F( )* be the cumulative probability of the duration variable, *T*. The probability that an event takes place in a period '*t*' is given by:

$$F(t) = \int_0^t f(x)dx = \Pr ob(T \leq t) \quad (6)$$

Conversely, an underlying survival function indicates the probability that the duration of the process unfolding in the observed event takes '*t*' periods to materialised is given by:

$$S_u(t) = 1 - F(t) = \Pr ob(T \geq t) \tag{7}$$

The survival function in (7) indicates that each period is independent of the previous as far as the probability of observing the event is concerned. This is typically not true in the kind of socioeconomic events such as infant mortality or unemployment spells. More appropriately, a survival function can be expressed as a process of intertwined relations of x_i upon *F(t) conditional* to survival in previous periods:

$$S_c(t) = (T = t \left| T \geq t \right.) \tag{8}$$

In the case of infant mortality, '*t*', typically represents the number of successive months in the first year after birth during which the infant stays alive. Thus, the survival probability of remaining alive in the, say, fourth month of life for an infant is the conditional probability that that infant survived the first, second and third month after birth. This (*conditional*) survival function in (8) can be expressed conveniently in the form of a hazard rate, that is, the ratio between the probability of failure (death) and success (survival) of an event taking place. As Jenkins (1995) shows, (8) can be re-arranged in the following way:

$$S_u(t) = \Pr ob(T = t \left| T > t \right.) = h(t) \cdot \prod_{k=1}^{t-1} (1 - h(k)) = \frac{h(t)}{1 - h(t)} \prod_{k=1}^{t} (1 - h(k)) \tag{9}$$

Cox and Oakes (1984) parameterised this conditional probability in the form of proportional hazards with respect to a baseline individual leading to the Cox Proportional Hazard model (CPH) explained below. Using maximum likelihood estimation, the CPH can estimate the unknown coefficients, β_i, of a set of determinants, x_i, on infant mortality.

Data

The database for both models comes from the demographic and health survey (ENDEMAIN) of 1999 which investigates in an exhaustive manner the birth history of every single child born alive in a period of six year before this survey, as well as the use of reproductive health services by mothers and sanitary conditions of the household. In this sense, ENDEMAIN stands out from other surveys such as the LSMS and the population census of 2001 that ask information of mortality just for the last child born and also do not allow to find out the age at which the children died. The sample size of the 1999 ENDEMAIN is representative at the national, regional

and provincial levels. The data set for the modeling of infant mortality is composed by 9,391 children born alive since January 1994, of which 301 died before the first year and 9,090 survived the first year of their lives. For the health demand model, the number of observations for pregnant women that gave birth is 8,789. Table A.1 provides the basic descriptives of the key variables derived from the ENDEMAIN survey.

Specification and estimation issues

The existing literature suggests a large number of possible determinants of access to health services and infant mortality. Tables 2 and 3 summarize expected effects of a wide range of possible determinants. More importantly, it is widely recognised that the estimation of health production functions is subject to problems of interdependence and endogeneity. Many of the likely determinants, such as family income and education of parents are interrelated, such that having both as determinants could give biased estimators. In addition, there tend to exist mutual relations between health inputs (supply variables) and health outputs (illness incidence) causing endogeneity in the estimation of health production functions (see e.g. Thomas and Strauss 1992, Pitt et al 1995, Deolalikar 1996, Glewwe 1998, Behrman et al. 2004). In particular, it is possible that health supply variables at a regional or municipal level are endogenously determined by the magnitude of infant mortality. If so, higher infant mortality rates would be driving a higher provision of health services.

The traditional econometric solution to the endogeneity problem is the use of instruments for endogenous variables (Greene, 2001). Obvious candidates for current health supply variables are lagged health supply, based on the assumptions that health policies changes require time both to articulate and to generate expected outcomes. In Ecuador, a practical constraint prevents a satisfactory use of instruments for contemporary supply variables. Statistical sources on supply variables at district (*parroquía*) level only permit the construction of lagged variables for 1998 and these variables limit to per capita in-patient hospital services. While this rules out a strategy based on instrumental estimation, the virtual identical significance, size and sign of the infant mortality coefficients with contemporaneous and lagged supply variables

TABLE 2

The expected effects of possible determinants on the demand of maternal health services

Variable	*Expected sign on demand of medical services*	*Hypotheses*
Personal characteristics:		
Mother's age	Ambiguous	Sign will depend on the magnitudes of two conflicting effects: increased demand with age as risk increases vs. decreased demand of professional attention as mother's experience rises.
Mother's education	Increase in demand for professional services	Partly this effect captures an economic relation (higher education is associated with higher economic status), while it may also capture different preferences between educated and non-educated women. If there are important differences of quality in favour of private health services, one could expect more educated women (with better access to information) to prefer such services.
Mother's ethnic background	Decrease in demand for professional services	Individuals of ethnic background may prefer traditional delivery practices attended by individuals other than professional medical staff
Household characteristics:		
Urban location	Increase in demand for professional services	Residence in urban areas typically implies a better access to medical facilities for delivery and other health-related practices.
Sierra / Costa location	Increase in demand for professional services	Residence in highlands or coastal locations increases access to medical facilities with respect to forest and jungle areas (Amazonía) of the country. This variable may well capture therefore differences in public infrastructure that make health services more accessible in certain areas than others.
Socioeconomic status: (i) per capita consumption level; (ii) per capita consumption separated by poverty status	Increase in demand for professional services	The higher the economic status of the household (proxied by either consumption levels or poverty status), the more likely that a mother is both willing to use and able to afford available medical services offered to her at the time of delivery. Similarly, if there are important perceived differences in quality of public and private services favouring the latter, higher income groups likely will prefer using private health services.
Health inputs and medical conditions:		
Personal:		
Affiliation to public social security scheme or private health insurance	Increase in demand for professional services	Affiliation to health systems makes more likely that mothers use the services covered by their affiliation and those affiliated with the social security system will be expected to use public health services.
Premature delivery	Increase in demand for professional services	Complications in the delivery typically increase the demand of professional staff attention.
Prenatal visits	Increase in demand of professional services	Prenatal visits may indicate a mother's higher preference for a complete professional attention throughout pregnancy. These visits indicate also the existence of institutional facilities providing such attentions.
Community health services:		
District (parroquía) average availability of hospital beds	Increase in demand of professional services.	Larger public health supply indicators at district level reflect a wider access to public services, which may lead to higher associated with the fact that the level of public provision can be targeted to communities with lower health supply indicators. Alternatively, wealthiest communities might also capture more per capita public political leverage.
District (parroquía) average availability of medical personnel		

Note: These variables refer to z_i in the estimation model (5).

TABLE 3
The expected effects of possible determinants on infant mortality

Variable	*Expected sign on infant mortality*	*Comments*
Personal and biological characteristics:		
Infant's sex	Larger probability of male infant mortality (IM)	Male infants are reported to survive less frequently than females in the first year of life (WHO 2003)
Infant's ethnic background	Ambiguous	Once controlled for educational, consumption, behavioural, household composition and community-wide health supply differences among different ethnic groups, it is not clear whether ethnicity-driven aspects have additional impacts on the probability of IM.
Multiple delivery (twins, etc.)	Increase in probability of IM	Multiple delivery increases the probability of less healthy borne infants.
Premature delivery	Increase in probability of IM	Premature delivery increases the probability of less healthy borne infants.
Birth order	Decreases in probability of IM	Under the hypothesis of intra-household competition, higher-ordered infants (first born) are more likely to capture available resources (food, care) in the household to ensure their survival.
Behavioural characteristics of mother:		
Type of attention received during delivery	Professional attention decreases probability of IM	Professional attention should reduce the probability of delivery problems later on causing infant mortality. It is, however, an open question whether the impact on infant mortality is significantly different between private and public health care and most likely will be associated with differences in quality of service.
Prenatal visits	Ambiguous	More prenatal control visits may indicate a higher preference and larger opportunities for professional attention, thus reducing health risks for the foetus and the born infant. It may also indicate, however, that foetus complications exist and that the infant when born is more prone to illness or physical deformation.
Breastfeeding	Decrease probability of IM	Biologically, it has been shown that breast feeding improves nutritional and immunological conditions of the infant. Also, it may indicate that mother is around to personally take care of infant. Further, breastfeeding provides a natural form of contraceptive, which may help spread the interval between births and reduce risk of early child death.
Contraceptive use	Ambiguous	Use of contraceptives may indicate that mothers are more aware of – and more willing to use – available medical services regarding infant care as well as other health issues. It will also reduce the number of children born to the mother (fertility) and may help spread the interval between births, reducing the risk of early child death However, less likely, it may also increase health risks for mothers if their use is uncontrolled or protracted. It is, however, unlikely that this variable properly captures mother's health status.
Household characteristics:		
Socioeconomic:		
Mother's age	Ambiguous	Sign will depend on the interaction of two conflicting effects: older age at birth increases health risks for born infants but also increases the experience of maternal and infant health care. There might also be a non-linear relation between mother's age and IM. This kind of argument (hypothesis) is tested by introducing the square of the variable of mother's age.
Mother's education	Decrease probability of IM	Again, this variable captures an economic relation that implies that better educated parents devote more resources to the benefit of infant's health. It also accounts for a presumably better use of available child caring technology, which should also positively affect infant health status. Finally, higher education of the mother implies a higher opportunity cost of personally taking care of her infant. This should lead to a lower optimal time devoted to her infant health care. There is, therefore, a possible trade-off between quality and quantity of time mothers devote to infant care.

Variable	*Expected sign on infant mortality*	*Comments*
Household size	Ambiguous	Two potential conflicting effects: more individuals in the household may mean higher fertility rates (thus higher health risk) and tougher competition for resources available to infants. Also, it may indicate that other household members may take care of an infant welfare in case of need.
Socioeconomic status: (i) Poverty status (ii) Per capita consumption	Decrease probability of IM	A higher economic status (captured either through levels of consumption or poverty conditions) is related to a lower probability of IM. However, the socioeconomic effect may be already captured by other variables such parental education, basic infrastructure in the household or geographical location.
Basic social infrastructure: Water Sanitation	Decrease probability of IM	Better sanitation and drinking water access of the household should positively improve hygienic and health conditions for all members. However, this effect may be already captured by socioeconomic status or education variables, as the distribution of social infrastructure within households is correlated with socioeconomic status (and geographical location).
Geographical:		
Urban residence	Decrease probability of IM	The effect of urban location in IM that are not already captured by economic or educational variables may account for a wider access to health facilities in urban areas with respect to rural areas.
Sierra / Costa residence	Decrease probability of IM	Residence in highlands or coastal areas imply more favourable living conditions for infants (and other individuals) with respect to forest and jungle areas (Amazonía), so it should be associated with decreases in IM.
Community characteristics:		
District *(parroquía)* immunisation rate	Likely decrease probability of IM (might be ambiguous)	On the one hand, higher immunisation rates at the community level indicate a wider access and use of public health facilities which should expectedly lead to improved health status of infants. Also, they may also indicate that unfavourable community conditions attract targeted policy intervention in such communities. The underlying health performance at community level should then be responsible for higher individual IM rates.

Note: These variables refer to x_i in the estimation model (9).

confirm that endogeneity may not be a serious problem after all. The hypothesis of no serious endogeneity is further confirmed by a very low explanatory power of infant mortality averages on averages of public health expenditures per municipality. In other words, differences in the incidence of infant mortality do not appear to explain much of the distribution of public health provision.

With respect to the interdependence issue, non-economic variables such as education or geographical location are not entirely independent from economic variables such as consumption levels or poverty status. For instance, education may not only affect infant mortality because is closely and positively linked to consumption levels (its *economic* effect) but also because affects preferences and skills referring to infant care (*non- economic* effects). All these effects from education are expected to affect infant mortality, and the inclusion of consumption in the infant mortality function acts as a control variable for the *economic* effects of education. A similar issue may arise with access to drinking water and other sanitation conditions

which are likely linked to consumption levels and poverty status, not in the least also because sanitary conditions were used as explanatory variables in the construction of the consumption variable for the ENDEMAIN survey (see Vos et al. 2004). Apart from checking the relevance of such different dimensions, we also test for multicollinearity and drop variables causing such problems.

A final specification problem refers to omitted variables. While trying to test for as many likely determinants as possible, data limitations did not allow for the inclusion of some. For instance, it was not possible to include indicators of mother's health status during delivery, as these are not reported in the demographic and health survey (ENDEMAIN). Instruments for mothers' health status (and life style) such as alcoholic or smoking habits are not reported either. The use (abuse) of contraceptives or pre-natal visits can be considered to be imperfect instruments only. The expected relation between mothers' health and socioeconomic conditions may partially offset this omission. Further, the model does not consider the price of health services, as these are not reported in the ENDEMAIN survey. The consumption variable is also not part of the survey, but could be imputed using an indirect method (see Vos et al. 2004 for the estimation method). Per capita consumption is to pick up both the income and cost differential effect on demand for health services, which is of course an imperfect approximation.

4 RESULTS

Demand for health services

Tables 4a and 4b present the results of the demand for health services model in the form of elasticities. ***Personal*** characteristics of the mother do not seem to have a consistently significant effect on the choice of medical attention. However, *indigenous* mothers have a lower probability of making use of professionally assisted medical care during birth delivery. Being an indigenous mother increases the probability of unattended delivery by 27%. Being non-indigenous increases both the probability of demanding public and private delivery services, roughly by the same amount each (around 13-14%).

As expected, *mother's education* turns highly significant and the simultaneous significance of per capita consumption indicates that there are non-economic effects underlying this relation. In fact, the magnitude of the impact of each additional year of

education is relatively modest. Each 1% increase in the education level decreases the probability of child delivery without professional care by 0.7%, while it is expected to increase private service demand by 0.4% and public service demand by 0.15%.

TABLE 4a
Effects of determinants on access to Health Provision Services (elasticities)

		Effect on the probability of no professional maternity care during delivery (%)	Effect on the probability of public maternity care during delivery (%)	Effect on the probability of private maternity care during delivery (%)
Personal characteristics				
Mother's age	motherage	1.162	-0.111	-0.877*
Mother's age squared	motheragesq	-0.636	0.049	0.504**
Mother's ethnic background	ethnic	0.043***	-0.010***	-0.020***
Mother's education (years of school)	motherschool	-0.745***	0.147***	0.404***
Medical variables				
(reference: no affiliation to health system)				
Affiliation to IESS	Segiess	-0.013***	0.025***	-0.040**
Affiliation to other health insurance system	Segother	0.025***	-0.015***	0.007
Premature delivery	Premature	-0.020***	0.005***	0.010***
Pre-natal visits	Prenatal	-0.675***	0.242***	0.139***
District (*parroquía*) average supply of in-patient hospital services	tasin99	-0.065	0.092***	-0.130***
District (*parroquía*) average supply of medical personnel	tasper99	-0.010	0.008***	-0.006***
Household characteristics				
Urban residence	Urban	-0.264***	0.005***	0.241***
(reference: Amazonía)				
Costa	Coast	-0.356***	-0.131***	0.613***
Sierra	Sierra	-0.291***	0.053***	0.167***
Per capita consumption (log)	Logcons	-0.832***	0.010***	0.773***

* significant at 10%; ** significant at 5%; *** significant at 1%.
Source: Multinomial logit model estimates based on 1999 Demographic and Health Survey for Ecuador (ENDEMAIN).

Estimates for ***health inputs and medical condition*** variables confirm the hypotheses of table 2 with some qualifications. First, given the difficulty of using instruments, the magnitude of estimated coefficients for average availability *in-patient hospital services* at the *parroquía* level confirms the existence of some degree of endogeneity bias. In contrast, *average availability of medical personnel* at public health services may capture well quality considerations of health provisioning. The quantitative effect is rather small though. Each 1% increase in the supply of health

workers (per 100,000) increases the demand of public provisioning by a meagre 0.01%, while it decreases the demand for private services by 0.01% and that of no use of services equally by 0.01%. Even though these particular estimates need to be taken with some caution, it seems safe to conclude that improvements in the supply of health workers will have a very limited impact on the demand for maternal health care.

Affiliation to the social security system (IESS, SCS) increases, as expected, the probability of choosing public provision. The effect is rather small and in addition it appears to be (partly) offset by a lower demand for private services. Hence expanding public health insurance per se will not have a big impact on the demand for professional maternity care.

Premature delivery decreases the probability of unattended delivery, resulting in a very similar increase of private and public intervention. As a premature case appears, mothers may want to take no chances and require professional assistance. Also, *prenatal controls* decrease the probability of unattended delivery by almost 20% (marginal effect). As a result, there is an increase in the demand of public provision of 15% and 4% of private provision, reflecting that most of prenatal control schemes are public and targeted to the poor.

TABLE 4b
Combined effect of poverty and consumption

		Effect on the probability of no professional care during child delivery (%)	Effect on the probability of public care during child delivery (%)	Effect on the probability of private care during child delivery (%)
Per capita consumption of the poor	Povertycons	-0.143 ***	-0.059	0.258***
Per capita consumption of the non poor	Nopovertycons	-0.192 ***	-0.050	0.284***

* significant at 10%; ** significant at 5%; *** significant at 1%
Source: Multinomial logit model estimates based on 1999 Demographic and Health Survey for Ecuador (ENDEMAIN).

Effects on the choice of delivery services from ***household*** characteristics are as expected. Residence in *urban areas* and *regions* other than the Amazonía decreases the probability of unattended delivery (by 11% in the case of urban residence; 18% for Costa; and 14% for Sierra), and typically results in increases in the demand for

both public and private services. Interestingly, increased demand for professional care is stronger for private than public areas. Each increase of 1% in *per capita consumption* increases in the demand for private services nearly proportionally (0.7%) to the detriment of unattended deliveries, and no substantial change of demand for publicly provided care. This key result may indicate that Ecuadorians are willing to immediately shift to private rather than to public services. This might be attributed to a generalised lack of confidence in the perceived quality of public health care. Also, it is worth noting that the impact of a higher consumption level only slight differs between poor and non-poor, as table 4b indicates. An important policy implication would be further that an unconditional cash transfer program (such as the *Bono Solidario* which operated in the country between 1998 and 2003) would be expected to enhance demand for private health care. In contrast, a conditional cash transfer would increase access to public health care services because of its conditionality and not because the additional income would induce such demand.

Infant mortality

Estimates from the survival model are reported in tables 5 and mostly confirm the expected signs of the determinants of infant mortality. Regarding **personal and biological** factors, being born as a *male* or *prematurely* both increase the probability of infant mortality. Although the impacts are statistically quite significant, their magnitudes are rather low (elasticities are 0.17 and 0.13, respectively). Being a *first born* (with or without other siblings) implies having a lower probability of dying in the first year of age. This is taken as evidence that if there is competition of resources within the household, older siblings have a better chance to capture more resources for survival. Higher risk associated with *multiple delivery* does not seem to have significant effects.

More interestingly, *indigenous* infants are not more prone to infant mortality than non-indigenous for reasons unrelated to socio-economic, household or behavioural factors (and controlled for by a different set of variables). What matters more, so it seems, are the factors associated with a lack of access to medical assistance for birth delivery.

Behavioural and health policy variables seem in general to have significant bearings on infant mortality and have the expected signs. *Professional medical care* reduces the probability of infant mortality, but the significance and magnitude of this

effect varies somewhat by category of service. That is, the effect on infant mortality of private care is larger than the effect of public health care. The elasticities do not differ widely, but it is perhaps of importance that the statistical significance of public attention only passes confidence intervals of 10% while the significance of private attention is accepted at 1%. Prenatal visits – when conducted – reduce infant mortality, indicating the effectiveness of this intervention in preventing future infant deaths. *Breastfeeding* also significantly reduces infant mortality, its effect being the largest among both behavioural and non-behavioural factors. If all women giving birth would breastfeed their children, this is expected to reduce infant mortality by 18%.

Coverage of *immunization* is also very significantly related to lower prevalence of infant mortality. For each 1% increase in the coverage of immunization, infant mortality goes down by about 1.1%. The effectiveness of this preventive action stands out. In contrast, *access to safe drinking water and sewerage* is not found to have a significant impact on infant mortality. As indicated, this result may well be due to problems of multicollinearity with other determinants, such as education and area of residence. However, we also do not find a very high simple correlation between infant mortality and sanitary conditions, such that the latter might be a conditioning or compounding factor rather than a direct determinant.

Socio-economic characteristics present a mixed combination of effects, substantiating the relations that some of these variables have among them. *Mother's age* does not affect infant's survival possibilities, probably indicating at offsetting effects of more experience and more biological risk as age rises. However, higher levels of *maternal education* reduce infant mortality: each percentage increase in the average level of maternal education reduces the probability of infant mortality by 0.5%. Several specifications including paternal education and difference of parental education did not prove significant, though In contrast, the *poverty status* of the household does not seem to reduce infant mortality. This is not very surprising as maternal education is related to consumption levels and socioeconomic status of the household. The same explanation may underlie the statistical insignificance of water and sanitation services, indicated earlier. Although it is difficult to disentangle the possible different effects of education on infant mortality, the fact that this variable strips the significance of other socioeconomic variables may point at the importance of economic determinants of infant mortality.

TABLE 5
Impact elasticities of infant mortality determinants

Variable		*Effect (%)*
Personal and biological characteristics		
Sex (male=1)	*sexh*	0.168 **
Ethnic background	*etnia*	0.003
Multiple delivery	*multi*	0.006
Premature birth	*prematu*	0.133 ***
First born	*primo*	-0.149 ***
Behavioural factors		
(reference: no medical assistance)		
Private health care	*private*	-0.175 ***
Public health care	*public*	-0.116 *
Pre-natal controls	*prenatal*	-0.461 ***
Breastfeeding	*breast*	-18.496 ***
Use of contraceptives	*anticon*	-0.002
Household characteristics		
Mother's age	*motherage*	-0.714
Mother's age squared	*motheragesq*	0.352
Mother's education (years of schooling)	*motherschool*	-0.460 **
Household size	*hhsize*	-0.993 ***
Poor household (dummy *times* per capita consumption)	*poverty*	0.130
Access to safe drinking water	*water*	0.134
Access to sewerage	*sanitation*	0.225
Urban residence	*urban*	0.042
Costa location	*coast*	-0.140
Sierra location	*sierra*	-0.188 *
(reference: Amazonía)		
District (*parroquía*) has a satisfactory immunisation record	*immune*	-1.102 ***
Birth in 1994	*b1994*	-0.050
Birth in 1995	*b1995*	-0.060
Birth in 1996	*b1996*	0.016
Birth in 1997	*b1997*	-0.044
Birth in 1998	*b1998*	-0.002
(*reference: 1999*)		

* significant at 10%; ** significant at 5%; *** significant at 1%
Source: Cox Proportional Hazard model of infant survival. Estimates based on 1999 Demographic and Health Survey for Ecuador (ENDEMAIN).

Of the remaining significant determinants on infant mortality, *household size* decreases the probability of infant mortality. As discussed in table 3, we may expect an ambiguous sign, as a larger household size could reflect higher fertility and thus greater health risk, as well as that it could reflect greater competition for household resources. The alternative hypothesis is that it increases the opportunity that other household members can take care of infants. Apparently, this latter effect outweighs the former. *Geographical location* does not seem to have a substantial impact on infant mortality on its own. Urban residence *per se* does not reduce infant mortality having already controlled for factors related to geography, such as access to services,

or socioeconomic patterns. Residence in the Costa or Sierra does not affect significantly the probability of infant mortality, although there is some weak effect attributed to living in the highlands (Sierra). This may be related to better transport and health infrastructure as compared to Amazonian areas, but this kind of effect is neither substantial nor systematic across non-Amazonian areas.

Finally, the regression equation includes an additional variable for the year in which the child was born. The latter allows us to check for an unexplained progress over time in reducing infant mortality which remains after controlling for all other microeconomic and non-economic factors. However, the time dummies are not significantly different from zero (not even at a 10% confidence interval). Therefore, we cannot conclude there is any apparent unexplained trend explaining changes in infant mortality.

5 HEALTH BUDGET TRACKING AND COST PROJECTIONS FOR REACHING THE MDG

A methodology for budget tracking

A first step towards a more comprehensive result-oriented budgeting system bundles all (central and decentralized) programs and interventions aiming at improving health outcomes and monitor each for their cost-effectiveness. In line with the MDGs, further reduction of infant mortality is a priority target for the Ecuadorian government. In that vein, the results of the health demand and child survival models of section 4 may serve as a starting point for the development of a result-oriented expenditure tracking methodology. In effect, the two models serve to establish input-output relationships in health, i.e. between policy interventions, access to health services and expected health outcomes measured by infant mortality. The relative importance of each determinant discussed in section 4 is quantified as elasticities expressing the impact of a 1% change of a given determinant on, respectively, the probability of professionally assisted child delivery and child survival (see tables 4a/b and 5 in section 5). After linking these to unit costs we obtain a basis for making budget projections for alternative resource allocations. We perform this analysis in three related steps:

1. The impact on access to health services. In our case the specification is for the probability of professionally assisted child birth and pre-natal controls. For this we

use the relevant elasticities with inverse sign from Tables 4a and 4b for the likelihood of receiving no medical assistance during child delivery. The key policy variables are access to health insurance and availability of health services and medical personnel. In addition, we assume that expansion of the free maternity program will increase professionally assisted child birth commensurately. Household determinants include the educational level of the mother and per capita household consumption. The averages of the latter two variables are assumed to change at fixed rates of 1.5% per annum, thus imposing a trend in rising access to health services due to improving socio-economic conditions.[4] We assume further that use of pre-natal controls has similar determinants and impact as the probability of medically assisted child delivery.

2. Impact on infant mortality. Results of policy simulations on the demand for maternal care (at child delivery and pre-natal controls) are subsequently used into the health "production function" for child survival. The survival model further suggested that breastfeeding has a strong positive effect on avoiding early child death. We did not model the determinants of breastfeeding practices. We checked whether having access to pre-natal maternal care increases the likelihood of breastfeeding, but this does not appear to be the case as there is no significant difference in such practice between those that do and those that do not have access. Moreover, since breastfeeding practices are already widespread (over 90%) we do not consider increases in the budget simulations. According to the model findings, this then leaves the coverage of the immunization program as the policy variable with the most important expected effect on reduction of infant mortality. Ethnicity and female education variables are considered as the relevant household variables in determining infant mortality.

3. Budget implications. We add unit cost estimates for the relevant public health input variables, such as salaries of health workers, construction and maintenance of hospitals and health centers, as well as of the special programs, specifically the immunization and free maternity programs. See Table 6. In addition, we considered the possibility of increasing access to health services through a subsidy

[4] The growth in years of schooling of females is assumed to follow the trend of the 1990s up to 2015. The assumption about per capita consumption (income) – albeit modest – is above growth rates achieved in the 1990s.

TABLE 6
Unit cost estimates for public health services (in US$)

In US dollars	Unit	Comment	Beneficiaries in 2003	Estimated unit costs	
				2002	2003
General medical services					
- Personnel cost IESS					
Nurses	per worker/month			414.93	665.25
Auxiliary personnel	per worker/month			338.26	542.33
Medical doctors (4 hour shift)	per worker/month			457.29	733.17
Medical doctors (6 hour shift)	per worker/month			582.36	933.69
Dentists	per worker/month			393.47	630.84
- Personnel cost MoH					
Resident doctor assistant	per worker/month			324.00	519.46
Doctor (tratante 15) (8 hr)	per worker/month			702.00	1,125.51
Doctor (tratante 15) (6 hr)	per worker/month			527.00	844.93
Doctor (tratante 1) (8hr)	per worker/month			379.00	607.64
Nurse (2) (6 hr)	per worker/month			251.00	402.42
Mean auxiliary health worker (8 hr)	per worker/month			204.00	327.07
Construction cost of health centres					
Municipal hospital	unit	250 m2 construction, equipment and furniture			325,000
Health centre	unit	150 m2 construction, equipment and furniture			169,500
Clinic	unit	200 m2 construction, equipment and furniture			236,000
Maintenance and operation cost health centres					
Hospitals and clinics	per health unit	Own estimate			135,079
Health centres	per health unit	Own estimate			20,404
Special programs					
- Bono Desarrollo Humano (Bono Solidario)	person/year	Includes administrative overhead and targeting costs	1,273,346		186.92
- Maternidad gratuita	beneficiary/year	Includes administrative overhead and cost medical personnel	1,999,867		14.94
- Immunization program (PAI)	beneficiary/year	Budget divided by vaccinated children	948,049		10.97
- Mobile health units	per health unit/year	Operating cost			29,300.00
	per beneficiary/consult	Per medical consult	182,562		5.09
- Subsidies on health insurance premium targeted at poor	per beneficiary/month	Assumption by authors			1.00
- Subsidies on health insurance premium for non-poor	per beneficiary/month	Assumption by authors			1.00
- Subsidies on health insurance premium for indigenous population	per beneficiary/month	Assumption by authors			1.00

Source: Authors and SIISE, based on budget data.

of the health insurance premium and thereby broadening coverage of health insurance, but these have been dropped from the results reported below as increasing health insurance coverage has very little direct impact on infant mortality. We did not consider expansion of the BDH to enlarge the impact on the use of health services. On the main, this program currently has a (direct) impact on access to education. By changing the relevant health input variables, the required health budget will adjust according to the change in coverage of services times the corresponding unit cost parameter. In the simulation results presented below, we use two alternative scenarios. One assumes that if demand for maternal health care increases there will have to be a related increase in the supply of doctors, nurses, and health infrastructure to meet that demand.[5] The second assumes, as the free maternity program does, that the additional demand for health care can be met using existing resources, assuming slack capacity.[6] We assume further that the nominal health budget (for all items) is adjusted for a given inflation rate (3% per year) to account for changes in input costs. Also nominal salaries of health workers are adjusted over time this way. In the budget simulations presented below, we assume constant real wages for doctors and nurses.

The models presented in section 3 did not detect structural differences across population groups in the impact of the mentioned determinants, except for the income (consumption) variable. The gaps in health status (as measured by infant mortality and access to health services) between poor and non-poor and indigenous and non-indigenous thus seem explained essentially by differences in initial conditions. The objective of the budget simulations is to see what would be cost-effective ways to achieve both the MDG in child mortality and reduce inequality in health status across population groups. The latter can thus be achieved by targeting interventions at the (extreme) poor and indigenous population.[7]

[5] As we make a projection of the total public health budget and focus only on demand for maternal and child care, we assume in the reported simulations that the growth in demand for such services should lead for 20% of that growth in overall public health inputs.

[6] This has not been investigated systematically, but there is some evidence suggesting substantial underutilization of public health resources. Using health input indicators provided by INEC's Vital Statistics and Data on Human Resources in Hospitals and Health Centers, the average number of medical consults (of any kind) per hour in public health services is less than one.

[7] In the reported budget simulations, the "poor" refer to the "extreme poor" as identified by the UBN index.

Cost of reaching the MDG for child mortality

Table 7 shows the results for three budget scenarios under the assumption that there is a 0.2% endogenous increase in medical personnel and infrastructure for each 1% increase in demand for public maternity care:

(i) Reaching full coverage of the *vaccination program* for all. This would require an annual growth of the number of beneficiaries of the program of about 3% per annum until 2015 (particularly to cope with the current under-coverage of DPT vaccinations).

(ii) Expansion of the *Free Maternity* program targeted at the poor and indigenous population, such that these target groups have unrestrained access to maternal and child care by 2015. For this, the program's expansion would amount to about 2% per annum for the (non-indigenous) poor and 3% for the indigenous population.

(iii) Combination of the first two scenarios.

Our target is to reduce overall infant mortality from 34 to 18 per 1,000 live births between 2004 and 2015. For the poor the reduction should be from 42 to 22 and for the indigenous population from 66 to 33. Our baseline simulation projects improvements in education and per capita consumption forward to 2015 under the assumptions indicated above. However, it also assumes that health programs show no further expansion from their coverage reached in 2003. The baseline then projects that without health input improvements infant mortality would reach 30.5 per 1,000 live births by 2015.

The simulations presented in table 7 show that reaching full coverage of the immunization program or the expansion of the free maternity program targeted at the poor by themselves are not sufficient to reach the MDG targets for infant mortality. The expansion of the immunization program would reduce infant mortality to 20.1 per 1,000 live births by 2015. As the immunization program is universal and initial coverage does not differ much across population groups, this policy would reduce infant mortality for all, but would not narrow differences between poor and non-poor or indigenous and non-indigenous.

TABLE 7
Achieving MDG for child mortality and budget implications

	Baseline projection for IMR		MDG for IMR	Baseline projection for assisted child delivery		Simulated impact		Additional budget cost (over baseline) (annual average 2004-2015)	
						IMR	Access to maternal care	US$ million	% of GDP
	2000	2015	2015	2003	2015	2015	2015		
Full coverage immunization program by 2015								3.5	0.01%
Total population	*34.1*	*30.5*	*18.2*	*84%*	*82%*	*20.1*	*81%*		
Poor	42.0	37.4	21.9	*78%*	*76%*	*24.9*	*74%*		
Non-Poor	28.9	25.8	10.4	*87%*	*86%*	*16.8*	*85%*		
Indigenous	66.0	58.7	32.6	*65%*	*63%*	*39.6*	*62%*		
Non-indigenous	30.2	27.0	15.2	86%	83%	17.6	83%		
Full coverage Free Maternity program for poor and indigenous by 2015								3.8	0.01%
Total population	*34.1*	*30.5*	*18.2*	*84%*	*81%*	*28.0*	*91%*		
Poor	42.0	37.4	21.9	78%	*74%*	31.1	100%		
Non-Poor	28.9	25.8	10.4	87%	*85%*	25.8	86%		
Indigenous	66.0	58.7	32.6	65%	*62%*	43.3	100%		
Non-indigenous	30.2	27.0	15.2	86%	91%	26.1	91%		
Combination of expansion immunization, and free maternity								7.2	0.02%
Total population	*34.1*	*30.5*	*18.2*	*84%*	*81%*	*18.2*	*91%*		
Poor	42.0	37.4	21.9	*78%*	*74%*	*20.6*	*100%*		
Non-Poor	28.9	25.8	10.4	*87%*	*85%*	*16.8*	*86%*		
Indigenous	66.0	58.7	32.6	*65%*	*62%*	*28.9*	*100%*		
Non-indigenous	30.2	27.0	15.2	86%	91%	17.0	91%		

Source: Author's estimates based on health budget tracking model. (Scenario assumes that each 1% increase in the demand for maternal care leads to an endogenous 0.2% increase in supply of public health inputs. See text for implications of dropping this assumption).

A targeted expansion of the free maternity care program would narrow such gaps. Generating unrestricted access to medically assisted child delivery and maternal care for the poor and indigenous population would reduce the overall infant mortality rate to 28 per 1,000 live births, but by its objective to the exclusive benefit of the target population thus narrowing the health status gaps. The higher probability of early child deaths among the poor as compared to the non-poor would fall from 45% around 2000 to 21% in 2015, and the gap between the indigenous and non-indigenous population would be almost halved from 118 to 67%.

The additional budgetary cost of the expansion of these programs as simulated would be about the same for each: between US$ 3 and 4 million per year (or 0.01% of

GDP), which would seem quite affordable. Combining the two previous scenarios would sum to an annual cost of US$ 7.2 million over the baseline budget (or 0.02% of GDP). The combination of these two policies would be sufficient to reach the MDG targets for the poor and indigenous population groups, but would still fall slightly short for the non-poor. It is quite possible that the actual cost could be less if there is synergy between the two programs. However, for lack of further information we assume they are fully complementary.

As discussed in Vos et al. (2004) and under the budget scenario assumptions, there is some reason to believe that there is slack capacity in the public health system (at least in relation to executing its present tasks). In fact, the design of the Free Maternity program assumes the existence of such slack capacity. By dropping the assumption that supply of medical personnel and infrastructure adjusts automatically in response to increased demand for maternity care, the budgetary requirements of the expansion of both programs are reduced to US$ 5.7 million per year.

If the health ministry would decide to redress the somewhat distorted proportion of doctors to nurses, it could "finance" the indicated extra budget requirements through cost-savings, if gradually (over the 11 year time span of the simulations) it would reduce the number of doctors (40 per annum) under contract with the Ministry of Health and increase the number of nurses (by about 50 per annum). This would increase the share of nurses to doctors in public health centers slightly from 0.5 to 0.56. Bringing this proportion to 1:1 could imply an annual cost-saving of US$ 29 million or about 8% of the total public health budget.[8]

6 FINAL REMARKS ON HEALTH POLICIES

We found the somewhat paradoxical outcome that infant mortality rates have come down steadily, despite low public health expenditures, an apparently poorly functioning health system and a persisting high incidence of malnutrition in Ecuador. Much of the answer is to be found in the continued improvement of education levels and urbanization of the population with associated improvements in sanitary conditions and knowledge of adequate reproductive health conditions. The same factors likely also have contributed to the strong reduction in fertility rates which has

[8] Such a scenario, leaving all other things equal, would require firing some 2,500 medical doctors and hiring some 2,600 nurses during the period 2004-2015.

further pushed down infant mortality in a mutually reinforcing trend. Health interventions have mattered tough, most in particular the expanded coverage of the immunization program and the program's related contribution to improving environmental conditions for disease control. During the 1990s this role of the program has been strengthened along with specific interventions trying to ensure sufficient access for the poor to maternity care (among others through the Free Maternity program). Such policies seem effective at low cost. In fact, a targeted expansion of the Free Maternity program would be an effective option for the short to medium run. As analyzed in Vos et al. (2004), at present, this program does not overlap much with the benefits of the *Bono de Desarrollo Humano* program which conditions receipt of a cash transfer to attending either school or health services for child and maternal care. Potentially though, such overlap may become important with possible expansion of the cash transfer program.

Of course, further fine-tuning of budget scenarios will be needed to guide actual policy decision making. The relatively low cost estimates are influenced by the assumption of a stable macroeconomic environment in the coming decade with low inflation and a steady rise in real per capita incomes. Actual conditions may be more volatile, for which the budget tracking methodology may help keep a focus on the health outcomes and make the health budget much more anti-cyclical than in current-day practice. More specific implementation issues will also require additional attention, such as reaching the indigenous population with (culturally) adequate health services, quality control of health delivery and avoiding absenteeism of health workers, as much as overall rising health cost as the country's epidemiological profile is shifting towards a predominance of cancer and cardio-vascular diseases. Finally, the budget strategy should not only comprise the protection of full immunization coverage but also a much stronger move towards enhanced coverage of health insurance. All of this would require appropriate coordination for which the health budget tracking model might provide meaningful inputs. These policy directions can be fully consistent with the envisaged decentralized budget allocation mechanisms. The main requirement is though that decentralized budgeting equally incorporates a focus on health outcomes, rather than on health inputs. Ultimately, Ecuador's challenges in improving its health delivery systems are large, but resource constraints cannot be an excuse though for not achieving the MDG targets for infant mortality.

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APPENDICES

TABLE A.1
Descriptives of key variables used in access to health care and survival models

Variable	Category	Value
	Characteristics of the delivery (% shares)	
Survival ctatus children	Alive	96.7
	Not alive	3.3
Sex children	Male	48.6
	Female	51.4
Ethnicity children	Non indigenous	93.2
	indigenous	6.8
Multiple delivery	Yes	1.2
	No	98.8
Premature delivery	Yes	5.7
	No	94.3
	Health behaviour of the mother (% shares)	
Type of care during	Assisted by a medical professional in public health facilities	42.4
child delivery	Assisted by a medical professional in private health facilities	21.9
	Not assisted by a medical professional	35.8
Prenatal visits	Yes	78.1
	No	21.9
Breastfeeding children	Yes	96.0
	No	4.0
Use of contraceptive methods	Yes	76.3
	No	23.7
	Socioeconomic status of the household	
Mother's age	Mean of age	27.9
Mother's education	Mean of completed schooling years	8.0
Household size	Mean of members	5.6
Social status children	Non Poor (%)	46.7
	Poor	53.3
Household per capita consumption	Mean of the first quintil (sucres 1999)	95,685
	Mean of the second quintil (sucres 1999)	163,561
	Mean of the third quintil (sucres 1999)	239,930
	Mean of the fourth quintil (sucres 1999)	344,195
	Mean of the fifth quintil (sucres 1999)	664,165
Access to safe water	Yes	71.6
	No	28.4
Access to sanitation	Yes	66.2
	No	33.8
Mother's affiliation to	Yes	7.2
Social security	No	92.8
	Geographical location of the household (% shares)	
Area	Urban	48.0
	Rural	52.0
Region	Costa	33.3
	Sierra	56.0
	Oriente	8.7
	Insular (Galápagos)	2.0
	District (parroquia) health input indicators	
District immunization rate	Percentage of population (%)	52.7
District average supply of medical personnel	Rate per 100,000 inhabitants	8.6
District average supply of inpatient hospital services	Rate per 100,000 inhabitants	107.0

Source: 1999 Demographic and Health Survey for Ecuador (ENDEMAIN)