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ANALYSIS OF SELECTED MILLENNIUM DEVELOPMENT GOALS IN NICARAGUA

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ABSTRACT

This study presents an analysis of factors related to selected MDGs in education, health and water and sanitation in Nicaragua. Using available household survey data, complemented with selected supply side data, empirical econometric models of education enrolment, child mortality and the provision of water and sanitation are employed to examine the relationship of individual, household and municipal factors to the achievement of these MDGs. The MDG formulation also provides for a comparison of two different modelling methodologies, the standard logit estimation framework and the application of a proportions estimation methodology at the municipal level. The results are analysed in terms of the model tractability and identification of the major covariates.

INTRODUCTION [1]

Nicaragua, along with the other member states of the United Nations, has committed itself to achieving the Millennium Development Goals (MDGs), a series of eight development targets that must be achieved by 2015, with progress measured according to their levels as at 1990. The MDGs encompass a broad range of development themes; wealth, education, gender equality, health, disease, the environment and social capital. The goals are presented in table 1 below. [2]

Table 1

THE MILLENNIUM DEVELOPMENT GOALS

Goal	Description
MDG 1	Eradicate extreme poverty and hunger
MDG 2	Achieve universal primary education
MDG 3	Promote gender equality and empower women
MDG 4	Reduce child mortality
MDG 5	Improve maternal health
MDG 6	Combat HIV/AIDS, malaria and other diseases
MDG 7	Ensure environmental sustainability
MDG 8	Develop a global partnership for development

Source: United Nations (2000), Resolution adopted by the General Assembly, (A/55/L.2), 55/2. United Nations Millennium Declaration, The General Assembly.

To date Nicaragua's progress towards the achievement of the MDGs has been patchy and whilst measures vary it seems unlikely that the country will achieve more than half the MDGs by 2015 (World Bank, 2008). Since the 1990s Nicaragua has faced numerous structural and macroeconomic shocks that have exacerbated its poor progress towards the goals.

In the early 1990s the country was recovering from a war left over from the 1980s and the suspension of financial and trade ties with international partners, in particular the US, left the macroeconomy broken. During the decade of the 1990s Nicaragua implemented a series of fiscal and financial reforms with the help of large amounts of overseas aid. It opened up trade and privatized a number of state entities but the impact of Hurricane Mitch in 1998, a collapse in core

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[1] This document has its antecedents as a background paper for the UNDP (United Nations Development Programme), UN-DESA (United Nations Department of Economic and Social Affairs) and the World Bank joint project titled "*Public Policies for MDGs in Latin America and the Caribbean*" the results of which were published as an edited volume in 2008 (Vos and others, 2008).

[2] Both the Millennium Development Goals and the associated indicators were agreed to by the UN member states. The details of the specific indicators defined for each MDG are available on the United Nations website: <http://www.un.org/millenniumgoals/>.

agricultural export prices and a banking crisis around the turn of the millennium left the country in huge amounts of external and public debt. Nicaragua entered the IMF's Highly Indebted Poor Country (HIPC) debt relief programme in 2004 and obtained significant amounts of foreign aid in terms of external debt relief and a variety of direct conditional aid assistance targeted towards social development.

Since becoming a signatory to the MDGs Nicaragua has included them in its National Development Plans (NDPs) and its Poverty Reduction Strategy Programmes (PRSPs). The reforms of the 1990s and the focus on social development goals in the new millennium as well as the conditionality of a variety of overseas assistance has helped Nicaragua to increase its public social spending (as a proportion of GDP) since 1990 (ECLAC, 2008).

This study uses Nicaraguan household survey data to uncover significant determinants of the indicators from three selected MDG; MDG 2, MDG 4 and MDG 7. These goals were chosen because the data for the indicators was available in national household surveys. In addition education, health and water and sanitation represent some of the costliest components of public social expenditure (Hammill, 2007).

This research makes two contributions to the literature on empirical estimation of the MDGs. Firstly the identification of significant characteristics that may affect the completion of the MDGs could help in the improved targeting of anti-poverty and social development programmes. Secondly, two different econometric estimation methodologies are employed, a logit type estimation at the individual level and a proportions methodology at the municipal level. The results compare the different estimates and the relative strength of the proportions methodology versus the more common logit counterpart. [3]

The outline of the study is as follows. Section 2 details an analysis of education and the factors that are related to enrolment at different education levels. Section 3 analyzes the estimation of characteristics related to child mortality and Section 4 addresses those that can affect the provision of water and sanitation services. Section 5 concludes with commentary about the major characteristics that are related to each of the MDGs and an assessment of the efficacy of the logit versus the proportions models for estimation of the determinants of the MDGs.

[3] Whilst the analysis is conducted in a partial equilibrium framework, a third contribution is the ability to include these results in CGE models. The results from this study were used to calibrate CGE models that incorporate MDGs and provide a solid basis of parametric econometric analysis upon which to conduct policy simulations (Sánchez and Vos, 2008).

I. EDUCATION

Education is the subject of the second Millennium Development Goal (MDG) and as such is acknowledged as an important investment for social development. Education's links to increased health and welfare of a country's population and the decreases in poverty have also made it one of the most important social policy tools at a government's disposal. This section presents a theoretical model and empirical analysis of the access to education for Nicaragua in an effort to highlight the barriers to education and the social and economic variables that are most related to education in Nicaragua.

A. EDUCATION IN NICARAGUA AND PROGRESS OF MDG 2

MDG 2, which covers education, is the goal of universal primary education for which there are three indicators of achievement; indicator 6 the net enrolment ratio in primary education whose goal is 100 percent by 2015, indicator 7, the proportion of children that start grade 1 and finish grade 5 [4] and indicator 8, the literacy rate amongst youths 15 to 24 years old (United Nations Statistics Division, 2006). The official data on the performance of each of these indicators for Nicaragua is given in table 2 below.

Table 2

INDICATORS OF ACHIEVEMENT OF EDUCATION, MDG 2 FOR NICARAGUA

(Percentages)

Variable	Circa 1990	Circa 2006	2015 target
Net enrolment rate in primary education, both sexes	72	91	100
Primary completion rate, both sexes	60	65	100
Literacy rate of 15-24 year olds, both sexes	68	89	100

Source: ECLAC, 2008.

Nicaragua's performance in education has been noteworthy for the high enrolment rates and the increases in such enrolment since 1990, rising from around 73 percent to almost 92 percent in 2006. At an average of over 1 percentage point increase in enrolment per year, Nicaragua could be close to achieving this first indicator by 2015. However the performance of another indicator has been slower. The primary completion rate increased only 4 percentage points in 2006 from its 1990 level. At the same time there has been a jump in the literacy rate over the same period by over 20 percent from 68 percent to 89 percent of youths being able to read and write.

[4] An alternative indicator is the primary completion rate.

B. LITERATURE ABOUT THE FACTORS RELATED TO ENROLMENT IN EDUCATION

De Jong and others (2006) conducted a cost-effectiveness analysis comparing different policy funding strategies to reach the MDG 2 for primary level education in Nicaragua. The authors develop a theoretical utility maximizing model of attendance based on model frameworks from Gertler and Glewwe (1990) and extended by Bedi, Kimalu, and others (2004). The model allows them to construct a probit model for the probability of attending primary school based on a set of economic and social demographic determinants.

Using LSMS 2001 household survey data they tested a range of demand side individual and household determinants with municipal level supply side data on schools, teachers and facilities. The estimations only analyzed primary enrolment and lacked a number of variables that may influence enrolment including household per capita consumption, the wage premium for the completion of primary education and infrastructure variables. Whilst many variables were not significantly different from zero, education spending, the time to travel to school and the number of students per classroom were significant and negatively related but all quite inelastic in the size of their effects upon the decision to enrol.

In addition to work on Nicaragua, De Jong and others (2006) also conducted estimations of enrolment for Bolivia and Honduras. In the Bolivian case, classroom size and household factors were significant, but education spending and teacher qualifications showed no significant effect on enrolment. For the Honduran case, the teacher qualifications were again insignificant as was the student-teacher ratio although having more than one teacher in the school boosted the enrolment likelihood. However the education spending and time to travel to school both had negative effects on primary enrolment, although the measures are highly inelastic.

Work by Bedi and Marshall (2002) for Honduras estimated determinants of the school attendance decision and specifically compared the opportunity costs versus human capital gains from education. They found that although opportunity costs were a significant factor in school enrolment, human capital gains were a larger positive determinant. Supply factors were once again important determinants of education attendance. Connelly and Zheng, (2003) for China, Deininger (2003) for Uganda, Funkhouser (1999) for Costa Rica, Handa (2002) for Mozambique, and Holmes (2003) for Pakistan all use various versions of the same probability model specification and all find that a variety of personal, household and supply side factors are important in determining enrolment in education. Other specifications beyond the probability model have been formulated and tested in work from Arendt (2005), Ferreira and Leite (2003), and Glewe (1996, 2002, 2001).

In other studies focused on countries outside of Central America, Bedi and others (2004) modelled the determination of primary enrolment in Kenya. The probit results in this case showed that school inputs were again an important determinant with the elasticity for school costs being -0.039 and the elasticity for teacher qualification 0.381, although both are still inelastic. Family and household characteristics and sex of the child were not significant in most

cases, although the number of rooms in the house was significant and is a proxy for the wealth of the household.

Vos and Ponce (2004) used a theoretical framework based on that of Bedi (2004) to estimate the probability of enrolment in primary education for Ecuador. In this case the demand side cost of education was a significant determinant of enrolment but whilst cost of education had a negative effect on enrolment in urban areas, it had a positive effect on enrolment in rural areas. The opposite pattern was observed for the number of students per classroom which had a positive effect on enrolment in urban areas and a negative effect in rural areas. Teacher training had a positive effect on enrolment in both areas whilst the centrally organized appointment of teachers seemed to negatively affect the probability of enrolment.

AL-Qudsi (2003) used a bivariate probit model to analyze school enrolments in five Arab nations. He finds that the cost of schooling, distance to school and lack of teachers have a significant negative effect on enrolments. The opportunity cost of work is also found to be a negative effect on attending school. To counteract these negative affects, the supply side variables of education provision and quality were very important in determining enrolment.

The range of elasticities estimated by different studies for education enrolment is large, sometimes changing signs from positive to negative relationships and sometimes not significantly affecting enrolment at all. Examples of the range of elasticities estimated are given in table 3 below. The ability to compare results is tenuous at best given the different countries, time periods and empirical estimation models and strategies employed. However the subset range gives at best a very approximate indicator of the size and sign of the effect.

Table 3

RANGE OF ESTIMATED ELASTICITIES OF EDUCATION ENROLMENT FOR SELECTED VARIABLES

(Elasticities)

Type of variable	Minimum significant value	Maximum significant value
Education spending or cost of education (fees, uniforms, ancillaries, books)	-0.1975	1.3234
Students per classroom or student teacher ratio	-0.0610	0.1130
Teachers with diploma or teaching qualification (%) a/	-0.4099	1.6331

Source: Author's compilation from various studies (Bedi and others, 2004, De Jong and others, 2006, Vos and Ponce, 2004).

a/ Teaching qualifications should be interpreted with caution given the wide variety of different standards and definitions of such qualifications across countries and time periods.

As shown in table 3 the elasticities for the cost of education vary from nearly -0.2, which is very inelastic, to positive 1.3, highly positive and elastic, depending upon the estimation and country under study. Similarly for supply side variables such as the student teacher ratio and the

teacher qualification measures, the elasticities vary from negative inelastic relationships to positive and elastic relationships. This comparison whilst drawing only very fragile links between the results, indicates that there seems to be little systematic relationship between enrolment in education and similar determinants across different studies. Therefore it becomes far more difficult to predict a priori what relationship the enrolment decision is likely have with the determinants in the case of Nicaragua as estimated in this section.

C. EMPIRICAL ANALYSIS OF EDUCATION IN NICARAGUA

1. Education data

Data for the enrolment in education by education level, the individual, household and community level effects were taken from the LSMS 2001 household survey for Nicaragua. Following Vos and Ponce (2004) and De Jong and others (2006), information about schooling is added to the sample using data taken from the Ministry of Education. [5] This data includes the number of schools and students by different education levels. The schools data is only available at the municipal level and so was matched to each household by municipality of the household. In addition, whilst a panel data set can be created based on the panel subset of households contained in the 2001 survey that were also surveyed in the 1998 round, the schooling data from the Ministry is only available for 2001 and so in this case the education determination model is based only on the 2001 data.

The data was separated and estimated into four education types, the enrolment of the 7 year old cohort into grade 1 of primary school, the enrolment into primary education for the primary aged cohort, enrolment in secondary education and enrolment in tertiary education. The supply side schools data and variables were used for the grade 1, primary and secondary estimations, but was omitted for the tertiary estimations due to a lack of data at this level of education. The enrolment rates at each education level are given in table 4 below.

[5] The author would like to thank Juan Ponce for providing the schools data.

Table 4

SCHOOL ENROLMENT IN NICARAGUA, BY LEVEL OF EDUCATION, 2001

(Proportions)

Variable	Value
Net enrolment rate, grade 1, 7 year old cohort	0.6596
Net enrolment rate, primary level	0.8530
Net enrolment rate, secondary level	0.5151
Net enrolment rate, tertiary level	0.1216

Source: Author's calculations, based on INEC household survey LSMS 2001 Nicaragua.

Table 4 shows that around 66 percent of those in the 7 year old cohort enrolled in grade 1. At the primary level, the net enrolment rate was over 85 percent differing from the 82 percent rate given by the MDG data in table 2, due to the different cohort groups and sources of data used. The cohort measure in table 4 excludes those within the 7 to 12 year age group who may be studying at levels other than primary level which avoids confusion about competing levels of study for the same cohort. This definition was applied to all school levels and the table shows that over half of those children 13 to 17 years were enrolled in secondary education whilst only one person in every eight, between the ages of 18 and 22, was enrolled in tertiary education. The pattern of social variables between the different levels of education is shown in table 5. [6]

It is interesting to note that less than half the population of each education-age cohort is male at every education level. In particular there is a tendency for the proportion of males in education to fall as the education level rises. The average per capita consumption is higher for those individuals enrolled in higher education levels. There are a range of socioeconomic advantages that households have at higher education levels in addition to greater consumption per capita. Higher education levels tend to have higher infrastructure, a larger urban concentration and smaller household sizes. In addition the head of the household has on average more years of study for those individuals enrolled in higher education levels and the child mortality rate is lower for households with individuals in higher levels of education.

[6] Several statistics differ in value from those calculated by De Jong and others, 2006 who used the same survey data for Nicaragua. Firstly in table 8 of De Jong and others, the number of observations given for the rural and urban populations is transposed, although this does not affect the value of the summary statistics that are calculated. Others such as education spending are defined differently. Thirdly some other values differ because the proportions are proportions of the entire age group aged 7 to 12 years and the measures of those who are enrolled in primary education. In the current paper, the individuals in other levels of education are excluded and this is not done in De Jong and others. This author believes that the current restriction of the cohort gives a better indication of the difference between those individuals deciding to enrol and those not enrolled. This avoids the distinction between those enrolled in primary level and those enrolled in other levels of education, which is not the purpose of this study (De Jong and others, 2006).

Education spending rises between primary and secondary levels of education, but falls for tertiary levels, probably because of the small proportion of the population in this cohort that are studying. At the primary level, around 15 percent of children go to schools that provide some books and other materials free of charge and a similar proportion of this cohort attend schools that have a meal programme. The student teacher ratio remains high at both primary and secondary levels at around 38 students per teacher.

One factor that can exert a strong influence on the enrolment decision is the wage premium. For the analysis of determinants of enrolment at each education level, a wage premium variable is included. The wage premium measures the extra returns that an individual can expect in terms of wages, for the extra education level they have achieved. A wage premium was calculated for individuals in each cohort education age group. Using a Mincer-type wage equation based on those individuals in the survey earning wages in 2001, models were generated for wage determination at each level of education. The estimated coefficients were then used to predict the wages for the cohorts.

Table 5

SUMMARY MEASURES OF SOCIAL INDICATORS IN NICARAGUA, BY LEVEL OF EDUCATION, 2001

(Various units)

Variable	Primary cohort	Secondary cohort	Tertiary cohort
Proportion of students male	0.4978	0.4535	0.4281
Mean Consumption per capita	5721	6820	7455
Number of members of the household	7.3350	7.1474	6.9821
Average infrastructure in municipality (measured by rent)	297.7118	393.6966	420.7144
Proportion of population living in urban area	0.4778	0.5547	0.5391
Wage premium primary/secondary	1.4038	1.4024	..
Wage premium secondary/tertiary	..	..	1.7748
Average years of study of head of household	3.5421	3.9535	3.8104
Average municipal child mortality rate	44.6470	41.4273	39.8266
Education spending (fees, uniforms, ancillaries, books)	227.8118	305.7505	171.5366
Average time to travel to school	12.8357	15.8105	19.3269
Proportion of children that receive school bag	0.1580	..	..
Proportion of children attended by school meal programme	0.1524	..	..
Average student teacher ratio	37.9984	37.7226	..
Average teachers per school	4.7776	17.4921	..

Source: Author's calculations based on INEC household survey LSMS 2001 Nicaragua.

Table 5 shows that the wage premium for the primary cohort was 1.4038. This is the wage premium for the difference in education between the current level, primary and the next education level, secondary. The value means that on average across the cohort of primary aged children, if they were to complete secondary education, they would earn 1.4038 times the value

of their wage if they only had primary level education. For secondary students, the completion of their level of study would give an estimated wage on average 1.4024 times as high as the alternative of not enrolling and maintaining their primary education only. The wage premium for tertiary eligible entry is the highest and for those that enrol and complete tertiary education, they can expect to earn on average over 1.77 times the wage that they would earn if they do not enrol and secondary education becomes their highest education level.

2. An econometric model of education enrolment

The decision to enroll a child or not in education is a binary one and thus is suitable to estimation within a probit or logit framework. Whilst numerous theoretical models of education participation exist, a simple tractable framework is sufficient for the derivation of an estimatable model. [7] In a utility maximization framework with rational individuals, the decision to enrol a child in education is based on a decision to maximize utility through the maximization of present and future consumption levels. As such the maximization problem is given as:

$$Max\ U = U(c) \tag{II.1}$$

Where U is the utility level of the individual and c is the present value of all current and future consumption. The function is assumed to be continuous and increasing in c. The enrolment in education gives benefits in future consumption in terms of human capital gains and costs in present consumption. Therefore the decision to enrol in education is made if the present value of all current and future consumption is greater under enrolment in education than for the decision not to enrol. This is shown as:

$$Enrol = yes\ if\ \ U(c_e) > U(c_{ne}) \tag{II.2}$$

$$U(c_e) > U(c_{ne})\ if\ \ c_e > c_{ne} \tag{II.3}$$

Where c_e is the consumption level if the individual enrols in education and c_{ne} is the consumption level if enrolment does not occur. The econometric model can therefore be specified as:

$$S = \alpha + \beta_1 J + \beta_2 K + \beta_3 L + \varepsilon_i \tag{II.4}$$

[7] One theoretical model is the model of utility maximization by enrolment choice as put forward by Bedi and Marshall (2002), Bedi (2004) and followed by Vos and Ponce (2004) and De Jong and others (2006). However there are some issues with the model specification and an exposition is provided in Appendix 2.

Where S is the indicator variable which is equal to 1 if an individual attends education and 0 if they do not. The independent variables are thought to affect the probability of consumption under enrolment being greater than consumption without education enrolment. These factors include individual characteristics, the vector J, household characteristics, the vector K, and school demand and supply characteristics, the vector L. The model in Equation (II.4) can be estimated in a standard logit framework.

3. A proportions model of the enrolment rate

Whilst the logit model provides an easily estimated measure of the determinants of the probability of enrolment, the proportions model is also valid because it estimates the exact MDG measure of education directly, that is the rate of enrolment and not the individual enrolment choice. Although this modelling framework has the advantage of directly estimating the factors that influence the rate of enrolment which is the specific measure of the MDG, the disadvantage is that this method must average factors over the municipalities and therefore loses significant intra-municipal variability which may affect the results. In this case the estimation results can be compared against the logit results to determine the more efficacious technique.

The proportions model is estimated using the logit quasi-maximum likelihood methodology of Papke and Wooldridge (1996). The methodology permits the estimation of dependent variables that represent proportions. In these cases least squares (OLS) cannot be employed because the dependent variable is of limited range, that being between 0 and 1. In addition the standard logit model measures only the indicator variable 0 or 1 and not a range of values between. Before the Papke and Wooldridge method, the conventional estimation technique involved converting each proportion to a log-odds ratio and then estimating the converted values as a linear function. However values of 0 or 1 gave discontinuous results. Because of this, all proportions that were either 0 or 1 had to undergo an ad-hoc addition of a small fraction to lie *within* the 0 to 1 unit interval. The Papke and Wooldridge methodology allows that proportions observations be estimated without having to conduct ad-hoc transformations of the variables and producing estimates that constrain the dependent variable to lie within the unit interval.

The proportions methodology is employed here by using the enrolment rate for each cohort education level as the dependent variable. The sample of each education level cohort is sorted into their respective small local areas, municipalities, and an enrolment rate is calculated for each. Therefore the model to be estimated becomes:

$$E(Enrol \mid \mathbf{x}_m) = G(\mathbf{x}_m\boldsymbol{\beta}) \qquad \text{(II.5)}$$

Where $Enrol$ is the rate of enrolment for each education level in each locality, the vector $\mathbf{x}$ is a vector of municipal level determinants and $G(\,.\,)$ is the proportions functional form.

4. Estimation issues

At each level of education two different estimation models were employed. Firstly a standard logit model was estimated for the probability of an individual in that cohort attending regular education. Secondly, a proportions model was estimated after calculating the enrolment rates for each level of education at each municipality and using these rates as the dependent variable. Both estimation techniques were estimated with heteroskedastic adjusted errors and corrected for clustering. Each set of estimation results are contained in Appendix 4, whilst the elasticities are presented in this section.

Before analyzing the estimates, it is useful to know what the expected relationship is between the dependent variable, enrolment, and the independent variables that reflect the costs and benefits of education.

Table 6 below provides a summary of the a priori expectations of the direction of the relationship.

Table 6

EXPECTED SIGNS OF COEFFICIENTS OF DETERMINANTS FOR ENROLMENT IN EDUCATION

(Signs positive or negative)

Effect on enrolment	Variable
Positive	Consumption per capita
	Average infrastructure in municipality (measured by rent)
	Average years of study of head of household
	Living in urban area
	Wage premium for secondary/tertiary education
	Proportion of children that receive school bag
	Average teachers per school
	Proportion of children attended by school meal programme
Negative	Average municipal mortality rate
	Average time to travel to school
	Average student teacher ratio
	Number of members of the household
Variable	Sex (1 = male)
	Education spending

Source: Author's creation based on a priori expectations.

Factors expected to have positive effects on enrolment include consumption, infrastructure, the years of study of the head of the household, living in an urban area, the wage premium for education and supply factors including the number of teachers per school and school

provisions of meals and equipment. Negative effects are likely to occur for increases in mortality rates, the time to travel to school, the student teacher ratio and the number of members of the household.

Education spending's effect on enrolment is ambiguous because small increases in the costs of education at low income levels are likely to provide a disincentive to enrol from poorer households. However at higher income levels and higher costs of education, further increases in education spending are likely to reflect an increase in quality of education facilities and this may be a positive effect on education enrolment. If the individual is male this can also have an ambiguous relationship on education. Whilst gender inequality in the provision of education can mean that males may be more likely to enrol, the economic needs of the household and the gender assignment of males to the productive sector and females to the reproductive sector of the economy often means that males are less likely to enrol at higher education levels because of the conflicting time constraints and higher opportunity cost with the participation in the labour force.

Before discussing the results of the estimations, it is useful to address the issue of causality within the model. Several of the variables such as consumption per capita and the wage premium appear in the model as explanators of the decision to enrol or the average enrolment rate, depending upon the methodology. However it could also be argued that there is endogeneity within this system as the education levels may be a determinant of one or more explanatory variables especially consumption per capita and the wage premium. This endogeneity problem cannot be addressed explicitly within these models or estimation exercises. Despite this, the econometric estimations carried out are justified according to three rationales. Firstly, any endogeneity problems that are likely to arise would be best addressed through the use of CGE modeling of the general equilibrium effects and explicit flow of causation set out in such models. However CGE models require initial justifiable parameter values derived from partial equilibrium models such as the ones employed here and so from this perspective the estimates may be seen as initial solutions. Secondly, following this line of thought, the estimates from these partial equilibrium analyses can be considered impact elasticities and accurate measures of the first round effects of these determinants upon the enrolment decision. Finally, any feedback effects and endogeneity is more likely to take place over time, for example, the wage premium that currently exists is based upon observed differences in the labour market supply and demand for different skill levels. This has a direct contemporaneous effect on the enrolment decision now, as viewed from the perspective of the utility maximising individual. Any such observed decisions will likely have feedback effects that change the wage premium in the future as the proportion of individuals in the labour force at each education level changes. Similar arguments can be made for the endogeneity of many of the variables including consumption per capita, household size, mortality rate etc. Therefore from this perspective the direct effects of the explanatory variables are contemporaneous whilst the endogenous feedback is dynamic in nature and although this is not tested explicitly, due mainly to data restrictions, these rationales permit the explanatory variables to be considered exogenous in these models.

5. Estimation results

For enrolment into grade 1, the estimated elasticities are given in table 7.

It can be seen in the table that the estimates and significance of the explanatory variables for grade 1 enrolment differ between the two models. The results of the logit estimation for grade 1 enrolment show that several household factors have a significant effect on the probability of enrolment. Increases in consumption per capita, family size, and years of study of the head of the household all have significant positive effects upon the probability of individual enrolment in grade 1. In addition the largest effect, although all effects are inelastic, is the household size which is positively related to enrolment and is contrary to the expected negative sign. Though a negative effect was expected, large family size is correlated with consumption levels per capita and the remaining partial effects after discounting this correlation may be due to the fact that larger households are better able to distribute the opportunity cost of enrolment, which is the loss of income of the child, among their members. Location of the household in urban areas was more likely to result in enrolment and school factors such as the school meal programme had a significant positive effect. The remaining variables were not significantly related to the probability of enrolment in grade 1 for the logit model.

Table 7

ELASTICITIES FOR ENROLMENT IN EDUCATION, GRADE 1, 2001

(Elasticities)

Variable	Logit model		Proportions model	
	Elasticity	P value	Elasticity	P value
Sex (1 = Male)	-0.0858	0.130	-0.0891	0.691
Consumption per capita	0.2042	0.032	0.0000	0.340
Number of members of the household	0.2568	0.012	0.0814	0.456
Average infrastructure in municipality (measured by	0.0109	0.762	-0.2060	0.001
Proportion of population living in urban area	0.0637	0.047	0.0027	0.933
Years of study of head of household	0.0597	0.056	0.1117	0.108
Wage premium for primary/secondary education	1.3650	0.255	0.7956	0.087
Average municipal mortality rate	0.0180	0.371	0.0054	0.189
Education spending	-0.3992	0.672	-0.0720	0.788
Education spending squared	0.0540	0.561	0.0099	0.733
Average time to travel to school	-0.0129	0.917	0.0233	0.671
Proportion of children that receive school bag	0.0386	0.363	0.0392	0.003
Average teachers per school	0.1194	0.141	0.2894	0.000
Average student teacher ratio	-0.3389	0.318	0.0101	0.909
Proportion of children attended by school meal programme	0.1013	0.043	0.0066	0.647

Source: Author's calculations based on INEC household survey LSMS 2001 Nicaragua.

In terms of the proportions model, the average grade 1 enrolment rate was significantly and positively related to school supply factors such as the average teachers per school in the local area, the average proportion of students that receive a school bag and the average wage premium that individuals in the area expect when they have a secondary education compared to only a primary education level. However infrastructure levels, in terms of the average imputed rent in the locality, were significantly negatively related to enrolment rates.

It is interesting to compare the two estimations. Although the measures in the logit model are individual and household based, whilst the determinants in the proportions model are all municipal averages, it is not unreasonable to expect that significant determinants of individual probability of enrolment would also be determinants of the municipal average enrolment rate. However that is not the case in the results above. None of the measures were significant in both regressions. In addition, of the variables for consumption and education services were the only significant variables in the logit regression whilst the wage premium and other school supply measures were significant in the proportions regression. Infrastructure was also significant here but the sign of the result is contradictory to the direction predicted a priori. Similarly mortality rates did not have a significant effect on enrolment.

The results for the elasticities for primary enrolment are given in table 8. The explanatory variables of primary enrolment that were tested were more likely to have a significant effect on enrolment of individuals as shown by the logit model, compared to the determination of municipal primary enrolment rates. Individual factors were significantly related to primary enrolment probability. Male children were less likely to be enrolled than female children. The level of consumption per capita was positively related to the probability of enrolment in the logit model. A 10 percent increase in consumption per capita would lead to a 0.8 percent increase in the probability of enrolment. The low value is due to the fact that increases in the probability of enrolment are more difficult to achieve when the likelihood is already very high, recalling the fact that in primary education the enrolment rate is already over 85 percent. In addition household factors such as the size of the household, the presence in an urban area and the years of study of the head of the household all had significant positive effects on the likelihood of enrolment. It is interesting to note that none of these factors at the municipal level had significant effects on the average municipal enrolment rate. Once again the household size is contrary to expectations and is probably due to economies of scale as larger families free up more children of primary age to participate in education, as their productivity in labour and other duties is lower when they are of a young age and thus the loss is lower.

Education service factors were significantly related to enrolment. The provision of a school bag and meal programmes significantly increased the likelihood of enrolment whilst the higher student teacher ratios made enrolment less probable. In the proportions model, education supply factors also had significant effects on the local primary enrolment rate. A higher proportion of recipients of school bags and more teachers per school led to increased enrolment rates. However the student teacher ratio and the meal programmes had no effect at the municipal level. The wage premium was significantly positively related to both the individual probability of enrolment and the local primary enrolment rate. The value varied between 0.46 to 0.52 percent increases in enrolment for every one percent increase in the individual or local wage premium. This implies that households may make a conscious decision for enrolment based on changes in future expected earnings.

Consumption per capita and the wage premium were strongly associated with enrolment at the secondary level of education, whilst school supply side factors were less prominent (see table 9). And again the factors were more likely to influence individual enrolment decisions than to affect the overall rate of enrolment at the municipal level.

Table 8

ELASTICITIES FOR ENROLMENT IN EDUCATION, PRIMARY LEVEL, 2001

(Various units)

Variable	Logit model		Proportions model	
	Elasticity	P value	Elasticity	P value
Sex (1 = Male)	-0.0251	0.023	-0.0685	0.422
Consumption per capita	0.0791	0.000	0.0000	0.564
Number of members of the household	0.0326	0.073	0.0091	0.829
Average infrastructure in municipality (measured by rent)	0.0049	0.535	-0.0809	0.000
Proportion of population living in urban area	0.0232	0.001	-0.0063	0.656
Years of study of head of household	0.0455	0.000	0.0413	0.123
Wage premium for primary/secondary education	0.5167	0.087	0.4578	0.033
Average municipal mortality rate	0.0001	0.964	0.0006	0.794
Education spending	-0.1311	0.386	-0.1139	0.290
Education spending squared	0.0195	0.197	0.0141	0.214
Average time to travel to school	0.0055	0.865	-0.0077	0.773
Proportion of children that receive school bag	0.0225	0.004	0.0195	0.000
Average teachers per school	0.0063	0.674	0.1085	0.000
Average student teacher ratio	-0.1402	0.007	-0.0268	0.436
Proportion of children attended by school meal programme	0.0204	0.011	-0.0037	0.477

Source: Author's calculations based on INEC household survey LSMS 2001 Nicaragua.

As was the case for the primary level, the secondary level shows a negative gender effect for boys, who are less likely to attend secondary education than girls. Although at the municipal level the effect is positive showing that areas with higher proportions of male students have higher secondary enrolment rates. This difference could be due to the fact that the individual level is measuring the opportunity cost of lost labour market participation to the individual of enrolment whilst the municipal level may capture a larger gender difference in the enrolment rates between areas with higher male concentrations in the secondary age group compared to lower proportions of males in that age group.

Table 9

ELASTICITIES FOR ENROLMENT IN EDUCATION, SECONDARY LEVEL, 2001

(Various units)

Variable	Logit model		Proportions model	
	Elasticity	P value	Elasticity	P value
Sex (1 = Male)	-0.3707	0.004	0.6887	0.069
Consumption per capita	0.4269	0.000	0.0000	0.773
Number of members of the household	0.0899	0.142	-0.1979	0.459
Average infrastructure in municipality (measured by rent)	0.1059	0.010	-0.0581	0.633
Proportion of population living in urban area	0.0240	0.799	0.1356	0.095
Years of study of head of household	0.1903	0.000	0.1161	0.368
Wage premium for primary/secondary education	1.5874	0.027	-0.9913	0.116
Average municipal mortality rate	-0.0046	0.474	0.0043	0.398
Education spending	0.5191	0.154	-0.2516	0.360
Education spending squared	-0.0245	0.501	0.0406	0.163
Average time to travel to school	0.0216	0.839	0.0051	0.968
Average teachers per school	-0.0326	0.454	0.0841	0.002
Average student teacher ratio	-0.2881	0.001	0.1123	0.272

Source: Author's calculations based on INEC household survey LSMS 2001 Nicaragua.

The two factors that were very large and positively related to enrolment in the logit model were household per capita consumption and the wage premium for secondary education over primary education. For every one percent increase in per capita consumption, the probability an individual would enrol in secondary education increased by over 0.4 percent. The wage premium had an even larger and elastic effect, with a 1.5 percent increase in the probability of enrolment for every 1 percent increase in the premium. This high figure is large because the average attendance rate is just over 51 percent and the logit model predicts the highest marginal effects when the average likelihood is close to 50 percent. For the individual model, the infrastructure level was positively related to enrolment whilst the municipal effect was negative but insignificant. Education supply factors were insignificant except for the student teacher ratio, increases of which were negatively related to secondary enrolment. In the proportions model, the average number of teachers per school was the only education supply factor to significantly affect the average municipal enrolment rate. The differences between the logit and proportions models are prominent with only the sex measure being significant in both regressions and even in that case having opposite signs.

The elasticities for the explanatory variables of tertiary education enrolment are shown in table 10. In the case of tertiary enrolment, only the time taken to travel to the place of education was included as a supply side variable, due to the lack of data about other factors in tertiary institutions such as class sizes and incentive programs.

For the individual logit model, enrolment in tertiary education was likely to increase due to increases in consumption, family size and the years of study of the head of the household. These were all highly significant effects. The per capita consumption effect was elastic and for

every one percent increase in consumption, the probability of enrolment, for the education-age cohort of 18 to 22 years who have completed secondary education, rose by nearly two percent. However given the mean enrolment rate is less than 13 percent, this means that growth in consumption per capita for Nicaragua in the future will see large increases in the likelihood of enrolment at the tertiary level.

Table 10

ELASTICITIES FOR ENROLMENT IN EDUCATION, TERTIARY LEVEL, 2001

(Various units)

Variable	Logit model		Proportions model	
	Elasticity	P value	Elasticity	P value
Sex (1 = Male)	-0.5999	0.191	1.837	0.037
Consumption per capita	1.9724	0.000	0.000	0.445
Number of members of the household	0.7029	0.000	-0.566	0.340
Average infrastructure in municipality (measured by rent)	-0.1001	0.000	-0.021	0.914
Proportion of population living in urban area	0.2646	0.369	0.063	0.774
Years of study of head of household	0.2862	0.000	0.178	0.553
Wage premium for secondary/tertiary education	2.3849	0.308	0.385	0.755
Average municipal mortality rate	0.0329	0.057	0.003	0.740
Education spending	1.0167	0.511	-0.037	0.911
Education spending squared	-0.0665	0.631	0.028	0.486
Average time to travel to school	0.0580	0.872	0.043	0.815

Source: Author's calculations based on INEC household survey LSMS 2001 Nicaragua.

In addition findings that would seem contradictory to expectations were the municipal mortality rate having a small positive relationship with the enrolment likelihood, but not at the 5 percent level of significance, and the small negative effect of infrastructure, as measured by rental costs. At the municipal level, only one variable was significant and this was the elastic gender effect on enrolment, where males were more likely to be enrolled at the tertiary level than females.

D. COMMENTS

There are several broad trends that arise from the results in terms of the explanatory variables and the models of education enrolment across the different levels of education. The first is that the logit model tended to provide more significant estimates than the proportions model. Although the proportions model uses a direct enrolment rate as its dependent variable, rather than a probability of individual enrolment, the model was weaker than the logit. Parsimony in the estimation technique has had the advantage over complexity and the loss of individual variation

in terms of this test of the factors that are related to education enrolment. The proportions model suffers greatly from a loss of information since all determinants and the dependent variable had to be averaged at the municipal level. Although there are over 120 municipalities, the loss of variance in the variables and their observations has significantly hampered their ability to provide a thorough explanation of the variation in enrolment rates. The logit model, whilst not a direct definition of the MDG for education enrolment, is a simple and flexible model that used the entire depth of information available in the surveys and thus has much stronger results.

The significant factors that are related to enrolment in education vary dependent upon the education level under consideration. However there are some common conclusions that can be drawn from the exercise. Firstly the determinants of education such as infrastructure and child mortality rates tended to have little effect on enrolment when tested empirically across the different education levels. However education supply effects, when they could be measured, did tend to be significant factors related to the enrolment decision, although the specific supply variables that were significant varied between the education levels. In addition individual and household factors such as sex, family size and the location of the household were often significant influences on enrolment.

A key result of this study is that in terms of education across the different levels, in general, there tended to be strong effects of consumption per capita and the wage premium on the probability of enrolment in education. Many other studies have omitted these factors for various reasons including the choice of theoretical model. From the results described here, it can be concluded that their omission will likely lead to biased estimates and the size of the impact elasticities in other studies may be adversely affected by the omission of these variables from the estimations. In particular it has been noted that previous work has concentrated on the strong effect of the education spending or cost of education variable upon the probability of enrolment. The results of the estimation conducted for Nicaragua show that at no education level was the expenditure on education significantly related to either the probability enrolment or the municipal enrolment rate. One possible reason may be that the significant and strong results for education spending are due to the fact that this is correlated with the consumption per capita and that the omission of consumption from the estimations has led to this effect being captured in the spending variable although it is not possible to conclude this without further testing.

The large positive effects from consumption per capita show that households will invest in education as their capacity to do so increases. The positive effect of the wage premium shows that households make decisions for enrolment based upon future expected returns and as those returns become more unequal between low and high education levels, the desire to have members in higher education levels also increases. This has very important policy considerations as the increasing returns to education drive enrolment, they also promote inequality for those who still have low education levels and for various reasons, face significant barriers to increasing their education levels.

One final caveat is that in each estimation, the sample was restricted to those individuals in the ideal age-education cohort. Whilst Nicaragua faces strong adjustment difficulties in increasing the education levels of its population, there will be significant fluidity in the age of individuals at the various education levels as older individuals begin or return to education. In particular the age-education cohort for tertiary education was very restrictive considering that

many countries view tertiary education as a life-long process and average ages of participation are often far higher than the upper limit of 22 considered in this sample. However the restricted sample was chosen to minimize the effects of other life cycle factors, such as family decisions and careers, upon the decision to enrol in tertiary education.

II. HEALTH

A core component of the wellbeing of a population is its health and the MDGs address this issue in several goals, one of which is the reduction of infant and child mortality rates. [8] The growing interest in social development issues and their links to economic characteristics of the population acknowledge the important effects economic factors can have on health outcomes. This section presents the results of the application of an econometric model to factors related to child mortality for Nicaragua.

A. MDG 4 IN NICARAGUA

MDG 4 states a goal for every country by 2015 for the reduction by two-thirds of the child mortality rate compared to the 1990 level. There are three indicators for this MDG, the under-five mortality rate, the infant mortality rate which is the mortality rate of children in their first 12 months and the proportion of 1 year old children immunized against measles. The official country data for each indicator is given in table 11 below.

Table 11

INDICATORS OF CHILD MORTALITY, MDG 4 FOR NICARAGUA a/

(Various units)

Year	Child mortality rate (under 5 years of age, per 1000 live births) b/	Infant mortality rate, (less than 1 year, per 1000 live births) b/	Measles immunization rate (proportion of children less that 1 year immunized) b/
1990	68	52	82
1995	50	41	85
2000	43	34	86
2004	38	31	84
2015 target	23	18	100

Source: Data from United Nations Statistics Division (http://mdgs.un.org/unsd/mdg/default.aspx).

a/ Estimated data only.

b/ Appendix I contains definitions of the MDG indicators for child mortality. Appendix II contains details of the construction of the MDG indicator variables.

[8] Child mortality is defined as the mortality rate of those children less than 5 years of age. Infant mortality is defined as the mortality of those aged less than 1 year. Whilst another health related MDG, MDG 5, sets goals for improvement in rates of maternal mortality, it was omitted from this MDG analysis due to the lack of suitable data in Nicaragua for this goal and its indicators.

The child mortality rate for Nicaragua in 2004 has nearly halved compared to its level in 1990, to 38 children per 1000. A similar trend occurred for the infant mortality rate, dropping from 52 to 31 infants per 1000 live births in 2004. With these estimates it would seem that a linear projection would see Nicaragua being able to meet its commitments to MDG 4 by 2015. The rate of measles immunization for infants had also been steadily increasing, peaking at 98 percent of the population in 2002, but in the last two years observed, has again dropped to the same levels as a decade ago. However since all of these values are estimates only, it would be unwise to draw any concrete conclusions about any sudden changes between estimates. At this point it seems that Nicaragua is making steady progress in reducing child mortality and improving child and infant health across the country.

B. PREVIOUS HEALTH LITERATURE

Empirical work related to infant and child mortality (MDG 4) is a popular subject of analysis for developing countries but is often hampered by the lack of comprehensive data needed for robust evaluations. This section provides a brief overview of the for Nicaragua and in other countries.

There exist numerous studies that analyse various indicators of wellbeing, from infant mortality to life expectancy. The methods of estimation often vary from study to study depending upon the available data and the indicator of interest. Hazard models lend themselves to applications in the estimation of child mortality and have been used in the study of child survival by Vos and others (2005) for Ecuador. Using data from a demographic health survey in 1999, they capture all births and deaths since 1994 for children rather than simply the status of the last child as is common in the LSMS studies. They find that for infant mortality, sex and birth order and premature status are all important individual indicators of mortality with males suffering a higher mortality rate than females. Health care and pre-natal controls, maternal education, household size and region dummies are significant determinants of infant mortality. Van der Klaaw and Wang (2004) also use a hazard model to assess determinants of child mortality in India. They find that in India factors that significantly affect the probability of mortality are sex (a large negative effect for females), parental education, measures of household wealth, and the presence of running water and sanitation. In addition access to health services is a significant determinant.

Fay and others (2005) conduct a cross country study on the determinants of the three health related MDG indicators, infant, child and maternal mortality. With DHS data from 39 developing countries the authors use a maximum likelihood estimation procedure to calculate the effects of macroeconomic and social development determinants on the three rates. They find that increase in GDP, equality and female literacy have negative effects on mortality whilst urbanization, lack of access to services, malnutrition, and lack of infrastructure tend to be positively related to the mortality rates.

Other related forms of study include an example of a study for Mexico that analyzed the economic crisis and its affects on the mortality rate (Cutler and others, 2002). By using a double-difference methodology and data from before and after the crisis in Mexico, the authors find that crises do indeed have a negative effect on the mortality rate and associated covariates such as female labour participation.

With respect to Nicaragua, the World Bank poverty assessment (2001) conducted an empirical study on the determinants of infant and child mortality using Nicaraguan DHS data from 1993-1998. The estimation was a probability model of survival at age 5. The report shows that maternal and child health care practices are the most significant positive factor, maternal education is also a significant positive factor, pregnancy at a young age is a significant negative factor and another factor is access to safe drinking water.

C. DATA AND RESULTS

Data limitations restrict the choice of model that can be applied to estimate the determinants of child mortality in Nicaragua. Whilst a common empirical estimation technique is the hazard model which lends itself to determining child mortality, there is insufficient information within the LSMS 2001 data set to employ such a model. [9] The 2001 data set for Nicaragua allows the identification of those individuals under 5 years of age who have died and combining this with the individuals who are alive under 5 years for the same households, a sample was constructed for the child mortality measure. The 2001 household survey contains responses to basic questions for mothers about the state of health of their last child and their activities regarding health care during and after the pregnancy. However the sample of mortality is much smaller than the total rate as these factors are only reported for the last child born and also due to probable under-reporting of deaths. This makes the sample too small for the estimation of robust models of mortality. Instead the data on mortality was collected from a separate set of questions about all family mortalities, which does not restrict the sample of under 5 year olds to the last born per mother. Censoring this sample for the under 5 population gives a mortality rate closer to the MDG rate, but still exhibits some evidence of under-reporting compared to the official 2000 estimate for Nicaragua. Another disadvantage is that the general mortality questions cannot identify the mother for every child and so the maternal health care behaviours cannot be added to the model. In addition the survey contains no information about health care for children who have died. Therefore, instead the models applied in this chapter employ household level factors of family characteristics and distance from health care centres in addition to individual and municipal characteristics.

With the 2001 survey linked to the 1998 survey it is possible to form a panel in some cases for the changes in households over time. Unfortunately the lack of questions in the 1998 survey about mortality has ruled out the option of a panel being constructed for estimation of child mortality and so only the 2001 data was used. Given that it is not possible to estimate a hazard model for child mortality, a simple logit model of the probability of mortality before age 5 is estimated. The model has the form:

$$\Pr(Mort = 1 \mid \mathbf{x}_i) = F(\mathbf{x}_i\boldsymbol{\beta}) \qquad \text{(III.1)}$$

[9] In particular it is not possible to identify the births and deaths of all children who have died and so are not present in the survey. In addition there is no information about health seeking behaviours of families or characteristics of the individual children who have died. This is only collected for those children who are alive in the sample.

where *i* is the individual household. *Mort* is MDG indicator of child mortality, taking a value of 1 if the child of less than 5 years died and zero otherwise. *F( )* is the standard logistic function and the matrix **x** contains vectors of relevant socio-economic factors thought to affect child mortality. In terms of the factors related to child mortality, the model includes household per capita consumption, access to water, access to sanitation, health services provision, and infrastructure. In addition a number of other variables are included in the estimation. A proportions model based on the cross-section of municipal level mortality rates was also estimated in order to compare the results of the two methodologies.

As in the previous chapter's discussion of education enrolment, the issue of causality and the possible endogeneity between child mortality and the explanatory variables is recognised as a weakness of this modelling methodology. The model estimated here is not intended to be a complete deterministic model of child mortality. Given that child mortality rates are an example of a health outcome, rather than a health process it would be difficult to justify that the simple model employed here can explain the complex interrelationships between the mix of socio-cultural and economic factors that determine child mortality. However this estimation still provides a good first indicator of some of the individual, household and municipal covariates that are related to child mortality.

Some descriptive statistics of child mortality and potential explicators for households that have had children in the target group are given in table 12 below. The child mortality rate is only just over half the official rate for 2000 for Nicaragua, which (as noted above) is possibly due to some under-reporting of deaths by the head of the household. The indicator of health services supply is given as the average time, in minutes, to travel to the nearest health care facility. Other details of health care delivery are given in the survey, but only for those children alive and not for those who had died.

Table 12

SUMMARY MEASURES OF CHILD MORTALITY AND OTHER SOCIOECONOMIC FACTORS, NICARAGUA, 2001

(Various units)

Variable	Total	Child alive	Child not alive
Child mortality per 1 000 live births	23.3	..	..
Average time to travel to nearest health care facility (minutes)	52.1	52.0	60.1
Access to water (percent)	73.3	73.6	62.7
Access to sanitation (percent)	37.3	37.6	25.4
Household per capita consumption (Cordobas per month)	5 620	5 646	4 542
Infrastructure proxy (Rental cost per month in household)	291.3	292.5	239.5
Region (percent urban)	46.1	46.1	49.2
Number of members of household	7.3	7.3	6.6
Sex (percent male)	50.9	50.5	67.8
Average years of study of head of household	3.5	3.5	2.6

Source: Author's calculations based on information in 2001 LSMS household survey.

The distance to health centres was greater for those households with recorded mortalities compared to those households without recorded mortalities. Access to water and sanitation, household per capita consumption and the average years of study for the head of the household were lower for households with mortalities. However it is interesting to note households with mortalities were more likely to live in urban areas, although this could be a sampling anomaly.

Estimation results

The simple logit model was estimated for the probability of child mortality. In addition a proportions model was estimated similar to that described in the previous chapter. In this case the dependent variable was the municipal level mortality rate and the equation was estimated, once again, following the technique of Papke and Wooldridge (1996). The results of the elasticities of each equation are given in table 13, whilst the coefficient estimates are detailed in Appendix 3.

The results of the estimations show that higher per capita consumption is associated with falls in child mortality and the mortality rate increases for those in urban areas. These two factors are the only effects that are unambiguously significant in both models where they were related to elastic responses in the rate of child mortality at the municipal level, and inelastic responses at the individual level. Whilst the individual logit model used individual level data, the municipal level proportions model used municipal averages for all of the independent variables.

Table 13

ELASTICITIES FOR CHILD MORTALITY IN NICARAGUA, 2001 a/

(Various units)

Child mortality under 5 years	Elasticity	P value	Elasticity	P value
Average time to travel to nearest health care facility (minutes)	0.0118	0.856	0.0208	0.941
Access to water (percent)	-0.3268	0.138	-1.1422	0.109
Access to sanitation (percent)	-0.1315	0.309	-0.6241	0.109
Household per capita consumption (Cordobas per month)	-0.6133	0.034	-1.4966	0.059
Infrastructure proxy (Rental cost per month in household)	0.1296	0.104	0.6195	0.073
Region (percent urban)	0.3326	0.019	1.3789	0.000
Number of members of household	-0.9532	0.003	-0.0308	0.980
Sex (percent male)	0.3593	0.011	1.4361	0.266
Average years of study of head of household b/	-0.2266	0.135	0.0679	0.906

Source: Author's calculations.

a/ Estimations corrected for heteroskedasticity and clustering at the municipal level.

b/ Although it would have been of great interest to analyse the education levels of the mother and father, the survey data lacked the ability to identify the specific persons in the household who were parents of the living and deceased children.

The health supply variable was not significant in either case, although it had the expected sign. In addition access to water, access to sanitation and the dummy variable for sex all had expected signs but were not related to child mortality rates in the sample. The number of members of the household was significantly negatively related to child mortality at the individual level, however the proportions model, using municipal averages for each independent variable, found no significant relationship at the local level. This could be due to the aggregation problem the proportions model faces as individual or household level variation is lost when aggregating variables to the municipal level. The education level of the head of the household also had no effect on child mortality.

D. COMMENTS

Child mortality rates in Nicaragua are high, but have experienced a steady decline since 1990. At this stage the data show that it is probable that Nicaragua will meet the 2015 MDG 4 obligation with continued efforts in this sector.

In terms of the ability to determine the influential factors of child mortality, the lack of detailed data and the necessarily simple analytical model to the simple framework of analysis, the results are far more uncertain. The LSMS 2001 data restrictions have also forced the model to omit factors such as maternal care and health care behaviour during pregnancy and in the first five years of the child's life. The results show that the limited data within the LSMS surveys and the variables collected have little capacity to explain, even within the partial equilibrium framework, the variation in child mortality incidence in Nicaraguan households. There is a strong relationship between child mortality and household per capita consumption levels but the possible effects of other household and local factors are more ambiguous, including the health supply variable. Neither was there a clear advantage in using the logit or proportions models with both methodologies giving mostly statistically insignificant results.

The conclusions that can be drawn from this analysis are limited. In terms of the capacity for these results to feed into more complex general equilibrium type models that include a child mortality component, this analysis provides a starting point for such work. Given the data limitations and the lack of robust significant estimates little else can be said about the pattern and covariates of child mortality in Nicaragua. Overcoming data restrictions to allow a better analysis of the relationships between child mortality incidence and household and other social development characteristics is a clear priority. In this case it is useful to consider further research into this area such as following the methodology of Vos and others, 2005 for Ecuador and their use of the detailed demographic health survey (DHS) data which has more extensive information on health care.

III. WATER AND SANITATION

Access to adequate water and sanitation are normally considered core infrastructure components provided by a country to its citizens. Infrastructure provision remains an underdeveloped component of microeconomic theory and as such there are no conventional theoretical models of water and sanitation provision from which to derive a set of determinants. The consumption of the water and sanitation services is similar to the behaviour of a normal good, for example the price effect of the water consumption function would be expected to be negative.

The infrastructure provision necessary to ensure access to adequate water and sanitation services involves large fixed costs, changing variable and maintenance costs and a perceived long-run return for the state or private enterprise. In addition competition for the supply of the infrastructure only takes place prior to its provision. As households do not need multiple providers of water or sanitation, and any subsequent shift to other providers of access would involve prohibitively large fixed costs for the change in the infrastructure, competition would usually be encountered in terms of choice of supplier of the service, but not choice in the supplier of the infrastructure. In this sense the market is similar to that of other utilities such as gas, electricity and landline telephony. This means that regular microeconomic demand models of competitive markets cannot be easily applied in the provision of access to water and sanitation services, where access is the key term that defines the difference between the regular consumption and the infrastructure establishment.

This section studies the situation of access to adequate water and sanitation in Nicaragua given information provided in the LSMS 2001 survey data. From the available data, alternatives for the specification of models of the probability of access to water and sanitation are derived and empirically estimated. The results are discussed in terms of the importance of the determinants for the fulfilment of MDG 7.

A. ACCESS TO WATER AND SANITATION IN NICARAGUA

The MDG 7 to ensure environmental sustainability, contains two indicators of achievement related to water and sanitation access; the proportion of the population with sustainable access to an improved water source, urban and rural and the proportion of the population with sustainable access to improved sanitation (United Nations Statistics Division, 2006). The specific goal for these indicators is to halve, between 1990 and 2015, the proportion of people without access to safe drinking water and basic sanitation. Table 14 below reproduces the official values for Nicaragua of the indicators for the MDGs and compares these to the indicators for the 1998 and 2001 household survey data.

Table 14

INDICATORS OF ACHIEVEMENT OF ACCESS TO WATER AND SANITATION FOR MDG 7 a/

(Percentage of population)

Variable	1990	1998	2001	2004	2015 target
Proportion of population with sustainable access to an improved water source, total	70	83	86	79	85
Proportion of population with sustainable access to an improved water source, urban	91			90	
Proportion of population with sustainable access to an improved water source, rural	46			63	
Proportion of population with access to improved sanitation, total	45	44	52	47	68
Proportion of population with access to improved sanitation, urban	64			56	
Proportion of population with access to improved sanitation, rural	24			34	

Source: Author's calculations for 1998 and 2001 data from LSMS surveys. 1990 and 2015 data from United Nations Statistics Division (http://mdgs.un.org/unsd/mdg/default.aspx).

a/ Appendix I contains definitions of the MDG indicators for water and sanitation. Appendix II contains details of the construction of the MDG indicator variables from the LSMS 1998 and LSMS 2001 survey data.

The values for the water and sanitation coverage do differ according to data source. The proportion of the population that has access to improved water sources is 86 percent according to the 2001 household survey data but is 79 percent according to the UN statistics provided to the statistics division by Nicaragua in 2004. Therefore according to the household surveys, the MDG 7 has already been met for the indicator of adequate water access. One caveat, however, is that the target for the indicator is based on the level in 1990 which is taken from the UNSD data and not from household surveys. In terms of access to improved sanitation, the household survey data once again gives higher proportions in 2001 than the official data in 2004. However despite this improvement, the slow progress of this indicator and the target of 68 percent coverage imply that it may be unlikely that Nicaragua will achieve MDG 7 with respect to access to improved sanitation by 2015.

B. EMPIRICAL MODELS OF WATER AND SANITATION

There is little economic theory from which to derive tractable empirical models of water and sanitation access. Instead estimatable models must be derived from a priori assumptions about the relationship of access to water and access to sanitation and any explanatory variables. It is natural to assume that the access to each indicator is dependent on the provision of such water and sanitation infrastructure to each household. In addition, the quality of the infrastructure can be assumed to be positively related to the quantity of water and sanitation services delivered or paid for by the household. Indeed, those households without access to adequate water and sanitation must still pay for some equivalent service such as purchasing bottled water and using other community or private sanitation resources at a cost. Also following this logic, it can also be

assumed that the provision is more likely if other basic infrastructure services exist in the community, for example roads and electricity infrastructure. A proxy for water and sanitation infrastructure provision can be constructed based on the household expenditure on such services. For other infrastructure a proxy indicator can also be constructed based on the paid or predicted household rent. Table 15 shows the average proxy amounts for infrastructure and water and sanitation provision split across the households that do or do not have access to adequate water and sanitation.

Table 15

AVERAGE INFRASTRUCTURE AND WATER AND SANITATON SERVICE PROVISION BY ADEQUATE ACCESS TO WATER AND SANITATION, 1998 and 2001a/

(Córdobas per month)

Variable	Provision of water and sanitation infrastructure expenditure		Other infrastructure expenditure	
	1998	2001	1998	2001
Population without sustainable access to an improved water source	23.49	53.26	224.46	281.10
Population with sustainable access to an improved water source	45.48	74.49	301.89	393.25
Population without sustainable access to improved sanitation	30.85	58.82	248.86	314.53
Population with access to improved sanitation	55.95	83.55	341.16	436.68

Source: Author's calculations for 1998 and 2001 data from LSMS surveys.

a/ Appendix I contains definitions of the MDG indicators for water and sanitation. Appendix II contains details of the construction of the MDG indicator variables from the LSMS 1998 and LSMS 2001 survey data.

Between 1998 and 2001 the values for infrastructure and water and sanitation service infrastructure have increased. In addition, expenditure is greater for those with access to improved water and sanitation than for those without access to these services. Household consumption per capita is assumed to be positively related to the provision of water and sanitation access. Households with higher consumption levels are expected to be more likely to have adequate access to improved water sources as shown in table 16.

Table 16

AVERAGE INFRASTRUCTURE AND WATER AND SANITATON SERVICE PROVISION
BY ADEQUATE ACCESS TO WATER AND SANITATION, 1998 and 2001 a/

(Córdobas per month)

Variable	Average household per capita consumption	
	1998	2001
Population without sustainable access to an improved water source	3 456.65	4 046.49
Population with sustainable access to an improved water source	6 178.72	7 631.24
Population without sustainable access to improved sanitation	4 940.26	6 079.89
Population with access to improved sanitation	5 912.35	7 315.81

Source: Author's calculations for 1998 and 2001 data from LSMS surveys.
a/ Appendix I contains definitions of the MDG indicators for water and sanitation. Appendix II contains details of the construction of the MDG indicator variables from the LSMS 1998 and LSMS 2001 survey data.

It is difficult to construct many additional explanatory variables for adequate access to water and sanitation. Whilst the provision of water and sanitation infrastructure is associated with other measures of social development such as health, education and occupational group, it is more likely that these other factors are instead dependent upon access to adequate water and sanitation. In a partial equilibrium framework they cannot be considered causes of access to water and sanitation services. Such causation would instead function as a result of feedback effects through the economy. These effects are best modelled within a general equilibrium framework and are beyond the scope of this paper.

The selection of an appropriate partial equilibrium reduced form model should be based upon the fit of the model to the available data and the robustness with which the model is resistant to change. The most appropriate model will also contain values that are reasonable and consistent with a priori assumptions. Given the ability of the 2001 household data to be matched to the 1998 household data, a panel data set can be constructed, albeit with only two time periods.

1. A pooled logit model

At the individual level, the dependent variables for any regression are the dummy variables for access to adequate water supply and access to adequate sanitation. Therefore the models will require a logit or probit formulation. The selection of the appropriate probabilistic model for use with the panel data is limited. The consideration of how to account for the unobservable effects is an important one. At first glance the fixed effects estimation of the probit or logit model would be conducted. But the fixed effects probit model leads to inconsistent estimation of the parameters due to the incidental parameters problem and whilst the fixed effects logit estimator avoids this problem it cannot estimate the partial effects on the probabilities without explicitly estimating

and specifying a distribution for the unobserved effects (Wooldridge, 2002). Other alternative random effects probit and logit specifications also present difficulties. The access to water and the access to sanitation were instead modelled using a pooled logit model. The model is given as:

$$\Pr(MDG_j = 1 \mid \mathbf{x}_{it}) = G(\mathbf{x}_{it}\boldsymbol{\beta}) \qquad \text{(IV.1)}$$

where i is the individual household and t is the time period which is either 1998 or 2001. MDG is the MDG indicator of $j = 1$, the access to water or $j = 2$, the access to sanitation. The matrix of explanatory variables $\mathbf{x}_{it}$ includes vector measures of household water and sanitation infrastructure provision, other infrastructure measured at the household level, and the per capita consumption of the household. The function $G(\cdot)$ is the standard logistic function. In addition the matrix $\mathbf{x}_{it}$ contains a dummy variable if the household lives in a rural or urban area. A time period dummy variable was also added to capture dynamic level shifts in the panel. [10]

The estimation results, corrected for heteroskedasticity, are shown below in table 17 including the elasticities estimated at their mean values.

Per capita consumption and the provision of water and sanitation infrastructure are significantly and positively related to the likelihood of having adequate access to water. However the measure of other infrastructure for the household, although positive, was not significant[11]. Urban areas are also more likely to have access to water than their rural counterparts. In addition access to water has increased for households compared in 2001 compared to the same situation in 1998. The explanatory power of the regression is low and, therefore, it is prudent to assume that some unobserved effect exists.

Given the high proportion of the population that already has access to adequate water supplies, it is reasonable to assume that the cost of supplying the remaining proportion of the population would increase as coverage increases. Indeed this is the inherent property of the logit model. In terms of the elasticities estimated, it is within reason to predict that the results will be positive but inelastic with respect to the explanatory variables and this is indeed what the results show in table 17. For a one percent increase in per capita consumption, access to adequate water supply is likely to increase by just 0.11 percent. Similarly a one percent increase in the provision of water and sanitation service infrastructure will only increase the likelihood of access to water by 0.03 percent. This elasticity signifies the insensitivity of changes in water and service infrastructure to changes in access to adequate water for several reasons. It is not reasonable to assume that a country like Nicaragua, in which over half the population already has access to adequate water supplies, will devote every increase in water and sanitation spending to improving access to new communities and households. Fluctuations in the budgeting arrangements for this infrastructure could be due to changes in government and political priorities towards certain areas, changes in the need to invest in infrastructure maintenance and changes in the behaviour of private water and sanitation or foreign aid infrastructure providers.

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[10] Whilst it would have been desirable to add lagged dependent and independent variables in order to capture total dynamic independence, the restriction of the panel with only two time periods did not permit it. In addition the panel was unable to be differenced due to the dummy variable nature of the dependent variable and the scarcity of surveyed changes in status between the two periods.

[11] See appendix 3 for details of the definition of this variable.

Table 17

ESTIMATES OF POOLED LOGIT MODEL ELASTICITIES FOR ACCESS TO ADEQUATE WATER AND SANITATION IN NICARAGUA, 1998 AND 2001 a/

(Various units)

	Coefficient	Significance	Elasticity
Access to adequate water			
Per capita consumption	0.0001282	0.000	0.112
Water and sanitation infrastructure	0.0047267	0.000	0.036
Other infrastructure	0.0000558	0.538	0.002
Region (urban = 1/rural = 0)	1.479817	0.000	0.109
Dummy variable (year 1998 = 1)	-0.0544625	0.064	-0.003
Constant	-0.0078274	0.000	
Predicted Value	0.860		
Psuedo R2	0.15		
Number of observations	39 942		
Access to adequate sanitation			
Per capita consumption	0.0000756	0.000	0.265
Water and Sanitation infrastructure	0.0052415	0.000	0.160
Other infrastructure	0.0004561	0.0000	0.084
Region (urban/rural)	0.7055045	0.000	0.210
Dummy variable (year 1998 = 1)	0.0868544	0.000	0.022
Constant	-1.573124	0.000	
Predicted value	0.434		
Psuedo R2	0.11		
Number of observations	39 942		

Source: Author's calculations from pooled logit estimations using data for 1998 and 2001 from LSMS surveys.
a/ Appendix I contains definitions of the MDG indicators for water and sanitation. Appendix II contains details of the construction of the MDG indicator variables from the LSMS 1998 and LSMS 2001 survey data.

In terms of the access of households to adequate sanitation, the explanatory power was also low. Again the unobserved effects that could not be measured with the available data may be a cause of this. The determinants were all statistically significant and all had a positive effect on the likelihood to access to sanitation. Elasticities were generally higher than those for the access to water. This may be due to the fact that with less than half the population of Nicaragua in 1998 and 2001 having access to adequate sanitation, the effects of each increase in the explanatory variables would have larger beneficial effects on sanitation than upon water where only a minority fails to have access to adequate supplies. Access to sanitation is 0.27 percent more likely for each percent increase in consumption compared with only 0.16 percent for water and sanitation infrastructure and 0.08 percent for other infrastructure. In terms of the cost-effective means of providing increased sanitation, whilst a one percent increase in consumption is the best alternative among the three, the level of the consumption compared to level of infrastructure for

the other two determinants could mean this may be the more expensive outcome if the levels in córdobas are very different.

2. A proportions model

As in the previous sections on education and health, it is possible to directly estimate proportions models of water and sanitation with observations of the dependent and independent variables at the municipal level. Once again the additional data from 1998 is included to provide additional observations for the model. The equation of the model is given as:

$$E(MDG_j \mid \mathbf{x}_{mt}) = G(\mathbf{x}_{mt}\boldsymbol{\beta}) \qquad \text{(IV.2)}$$

where m is the population weighted average for the municipality and t is the time period which is either 1998 or 2001. MDG is the MDG indicator of $j = 1$, the access to water or $j = 2$, the access to sanitation. The matrix of determinants $\mathbf{x}_{mt}$ includes municipal averages of household water and sanitation infrastructure provision, other infrastructure measured at the household level, and the per capita consumption of the household. The function $G(\cdot)$ is not the standard logistic function in this case but a linear model. In addition the matrix $\mathbf{x}_{mt}$ contains the proportion of households in the municipality living in a rural or urban area. A time period dummy variable was also added to capture dynamic level shifts in the panel. The choice of panel data method is a modification of the standard pooled OLS with adjustments made to the model given the dependent variable is a proportion.

Once again the estimation method is a logit quasi-maximum likelihood methodology taken from the theoretical framework of Papke and Wooldridge (1996). This framework avoids the estimation of a standard linear model for data that is obviously censored. In addition, it estimates a model more appropriate to the properties of the proportions data rather than the conventional ad hoc method of converting the dependent variable to a log-odds ratio to estimate in terms of a probability model. The estimation is adjusted for heteroskedasticity and clustering and the results are presented in table 18.

The level of per capita consumption is positively and significantly related to the proportion of the municipality that has access to adequate water supply. The elasticity though is quite low at 0.163. The provision of water and sanitation infrastructure is significant only at the ten percent level but the effect is very low with each extra percent increase in infrastructure of water and sanitation associated with only a 0.06 percent increase in access. The provision of other infrastructure is significant but again only at the ten percent level. However other infrastructure is negatively related to the proportion with access to water. Whilst a positive relationship would be expected a priori, the negative relationship is probably a factor of the fact that the positive effects may have been extracted from other correlated factors such as the per capita consumption and the water and sanitation infrastructure. It is possible that the other infrastructure variable is simply measuring residual municipal specific effects in this case. As expected, municipalities with a greater proportion of urban populations have greater access to water and the negative sign on the year dummy variable indicates that the access has improved between 1998 and 2001.

Table 18

ESTIMATES OF POOLED PROPORTIONS MODEL AND ELASTICITIES FOR ACCESS TO ADEQUATE WATER AND SANITATION IN NICARAGUA, 1998 AND 2001 a/

(Various units)

	Coefficient	Significance	Elasticity
Access to adequate water			
Per capita consumption	0.0001823	0.016	0.163
Water and sanitation infrastructure	0.0079909	0.064	0.061
Other infrastructure	-0.0010691	0.059	-0.053
Proportion in urban areas	1.053874	0.002	0.079
Dummy variable (year 1998 = 1)	-0.0896106	0.510	-0.005
Constant	-0.0286095	0.892	
Predicted value	0.877		
Number of observations	198		
Access to adequate sanitation			
Per capita consumption	0.0000364	0.501	0.132
Water and sanitation infrastructure	0.0054541	0.099	0.171
Other infrastructure	0.0007785	0.140	0.158
Proportion in urban areas	0.911696	0.001	0.278
Dummy variable (Year 1998=1)	0.0819758	0.296	0.018
Constant	-1.513421	0.000	
Predicted value	0.49975643		
Number of observations	198		

Source: Author's calculations using pooled data for 1998 and 2001 from LSMS surveys.

a/ Appendix I contains definitions of the MDG indicators for water and sanitation. Appendix II contains details of the construction of the MDG indicator variables from the LSMS 1998 and LSMS 2001 survey data.

In general the proportions model for access to adequate water is a far better fit than the same independent variables in the attempt to model access to adequate sanitation. For the sanitation estimation, the per capita consumption and other infrastructure measures had no effect on the proportion of the municipality with adequate sanitation. The water and sanitation infrastructure had a significant effect at the ten percent level and it is interesting that the measured elasticity, although still highly inelastic, is three times the value of the same elasticity for access to water. This could be a property of the fact that infrastructure provision for water and sanitation is likely to have a larger impact on the proportion of households with access to sanitation which is still less than half the population, whilst the majority of the population have access to adequate water supply. Once again municipalities with higher proportions of urban populations have more access to sanitation.

C. COMMENTS

The two different methodologies employed give similar results for the water and sanitation MDGs according to the estimated equations. For the access to water, the effects of per capita consumption are very similar between the individual panel logit and the proportions model. Both methods give inelastic measures of between 0.112 and 0.163 percent increases in the population with access to adequate water supply for each percent increase in household per capita consumption. The water and sanitation infrastructure effect is also similar between 0.036 and 0.061. The other infrastructure variable is unusual because of the difference in the sign between the two methods in the measure of its relationship with the access to water. Whilst the logit method gave a positive sign, the proportional method estimates a negative relationship to other infrastructure. Regional effects are positive and the dummy effects are negative in both estimation methods. In terms of the sanitation estimations, again the results are very similar between the two methods, despite the fact that the elasticities for the proportions model are generally insignificant except for water and sanitation infrastructure and the regional effects. The results have the same sign and roughly the same magnitude of effects.

Overall, despite the differences in the methodologies, the estimates for access to adequate water and access to adequate sanitation were quite similar. Generally they are positively related, but quite small in magnitude. Between the water and sanitation estimations, the effects on sanitation access tend to be greater but, as explained earlier, this is most likely due to the fact that in Nicaragua over half the population will be affected by increased access whilst the majority of the population already have access to adequate water so increases in determinants here will affect a smaller proportion of the population. The similar magnitude of the coefficients in many cases indicates that the estimated relationships for access to water and sanitation tend to be robust to the methodology employed. However the significance of the variables is sensitive to the methodology employed. Given the lack of similar studies for the factors related to adequate access to water and sanitation, it is impossible to compare these results to other studies done for Nicaragua or for other countries.

IV. CONCLUSION

This paper presents an analysis of factors related to selected MDG indicators in education, health, water and sanitation for Nicaragua concentrating on individual and household characteristics as well as local municipal factors.

This study makes a contribution to the study of the MDGs in Nicaragua by using an empirical methodology that permits a comparison of two econometric techniques, the individual logit model and the proportions model. Each method was applied to Nicaraguan survey data and the efficacy of the each model was assessed across the three different MDGs related to education, child mortality and water and sanitation. In addition the models compare a range of individual, household and municipal factors not found in other similar empirical studies for Nicaragua. In fact this study is one of the first empirical estimations of factors that are related to water and sanitation provision in Nicaragua.

The first analysis for the estimation of factors related to the decision to enrol in education at different education levels showed that the factors that influence education enrolment across most education levels include household factors such as the size of the household and the years of study of the head of the household. Regional and sex differences were also related to the probability of enrolment at various levels of education. However the largest relationships to enrolment were the positive estimates of increased consumption per capita and increases in the wage premium.

In addition the size of the estimates tended to increase at higher education levels. Whilst various studies from different countries have emphasized the importance of the costs of education, the results of this study show that in none of the education estimations was the cost of education significantly related to the probability of enrolment. Given that other studies omitted consideration of the wage premium and the per capita consumption measures in their estimations, it is possible that the importance of education costs has been overestimated. One caveat in this case is that the limitation of the analysis to enrolment in education, although incorporating supply side factors for education, may still fail to adequately capture indicators of the quality of education, particularly in poorer and more rural areas.

For Nicaragua the results show that policies of conditional cash transfer programmes such as the Social Protection Network (*Red de Protección Social*) can have a positive impact on enrolment and education levels by targeting the household consumption that is positively associated with enrolment, particularly at the primary and secondary levels. At the same time, research has stressed the effectiveness of education cost reduction policies such as the school lunch program (*Bolsa Escolar*) that are linked to nutrition and overcoming barriers to school attendance (World Bank, 2001) and the results of this study are in line with this conclusion for education enrolment at the primary level. Whilst the lack of available data meant that it was not possible to examine the quality of education supply factors, other studies emphasize their strong influence on education and the possibility of making strong progress in advancing MDG 2 by

combination of policies and funding targeted towards these supply factors and complementing the demand side policies (World Bank, 2008).

In terms of MDG 4, there was some evidence of underreporting in the child mortality rates used for the empirical exercise. Child mortality is lower when per capita consumption increases. Increases in consumption are important because they allow for purchases of medical attention and adequate health care. Male children are more likely to die than female children and rural areas have higher mortality rates than urban areas. However the empirical application was hampered by poor data and missing variable factors from the household survey. In addition the model is a simplified statistical model that gives an indication of the association between child mortality and the household and municipal factors but cannot fully identify the complex interrelationships between the economic and social conditions and child deaths. With respect to Water and Sanitation, this MDG is also significantly positively influenced by increases in consumption per capita. And there are significant inequalities in access to both water and sanitation in terms of the population in rural areas. In addition infrastructure levels have a close relationship with water and sanitation levels.

The estimations are by nature set within a partial equilibrium framework that does not include feedback effects from the economy and the changes in the MDGs that would cause changes in the independent variables used in the equations. In this sense the elasticities that were estimated can be considered impact elasticities and measures of the first round effects of the variables upon each of the probabilities of enrolment, mortality and access to water and sanitation. Overall, in terms of the model specifications, the proportions model, though perhaps closer to the MDG definition, was the poorer method, producing fewer significant factors. The loss of information when dealing with simple municipal local area aggregates far outweighed the benefits of a methodology that more precisely reflects the MDG definitions. In this case the logit model was the more adaptable and robust, able to employ individual, household and local level data together. In terms of applying the alternatives in empirical exercises in other countries, if data is derived from household level surveys, the lesson of this experience would be to retain the logit method.

Across all of the MDGs the ability of households to achieve gains in per capita consumption levels is perhaps one of the strongest relationships with improved outcomes in each of these development goals. The effect of the individual supply factors for education, health and water and sanitation were limited. Although this may be due to some difficulties of measurement in terms of the supply variables, it also acknowledges that the major barriers and opportunities to achieving the MDGs are based upon the ability of the government to adapt public policy that accounts for existing household characteristics and provides the right incentives for the right target groups. Supply side policies for public social spending and service provision that focus on socially vulnerable populations, such as the emergency social investment fund (*FISE*), are factors that were not able to be analyzed in this study but are essential complements to the household and municipal characteristics that are related to the demand for education, health, water and sanitation. Improving the mix of demand side and supply side policies and programmes for social development will give Nicaragua its best chance of achieving or getting as close as possible to achieving the MDGs in education, health, water and sanitation by 2015.

BIBLIOGRAPHY

AL-Qudsi, S. S. (2003), "Family background, school enrollments and wastage: evidence from Arab countries", *Economics of Education Review*, vol. 22, N° 2 (EDCE), North Holland, Elsevier Science B.V.

Arendt, J. N. (2005), "Does education cause better health? A panel data analysis using school reforms for identification", *Economics of Education Review*, vol. 24, N° 2 (EDCE), North Holland, April 2005. Elsevier Science B.V.

Bedi, A. S. and others (2004), "The Decline in Primary School Enrolment in Kenya", *Journal of African Economies*, vol. 13, N° 1 (EDCE), Kenya, March 2004. Centre for Study of African Economies.

Bedi, A. S. and J. H. Marshall (2002), "Primary School Attendance in Honduras", *Journal of Development Economics*, vol. 69, N° 1 (EDCE), North Holland, October 2002. Elsevier Science B.V.

Connelly, R. and Z. Zheng (2003), "Determinants of school enrollment and completion of 10 to 18 year olds in China", *Economics of Education Review*, vol. 22, N° 2 (EDCE), North Holland, Elsevier Science B.V.

Cutler, D. M. and others (2002), "Financial crisis, health outcomes and ageing: Mexico in the 1980s and 1990s", *Journal of Public Economics*, vol. 84, N° 3 (HCE CGE), Great Britain, Elsevier Science B.V.

De Jong, N. and others (2006), "Result-oriented Budgeting for Education: The Cases of Bolivia, Honduras and Nicaragua", Thematic Report 2005, April 2006, Stockholm.

Deininger, K. (2003), "Does cost of schooling affect enrollment by the poor? Universal primary education in Uganda", *Economics of Education Review*, vol. 22, N° 2 (EDCE), North Holland, Elsevier Science B.V.

ECLAC (2008), *Social Panorama of Latin America, 2008*, Santiago, Chile, ECLAC.

Fay, M. and others (2005), "Achieving Child-Health-Related Millennium Development Goals: The Role of Infrastructure", *World Development*, vol. 33, N° 8 (HCE), New York, Pergamon Press Inc.

Ferreira, F. H. G. and P. G. Leite (2003), "Policy Options for Meeting the Millennium Development Goals in Brazil: Can Micro-Simulations Help?", *The World Bank, Policy Research Working Paper Series*, N° 2975 (Microsimulations MDGS), Washington, World Bank.

Funkhouser, E. (1999), "Cyclical economic conditions and school attendance in Costa Rica", *Economics of Education Review*, vol. 14, N° 1 (EDCE), North Holland, February 1999. Elsevier Science B.V.

Gertler, P. and P. Glewwe (1990), "The Willingness to Pay for Education in Developing Countries: Evidence from Rural Peru", *Journal of Public Economics*, N° 42 Washington D.C.

Glewwe, P. (1996), "The relevance of standard estimates of rates of return to schooling for education policy: A critical assessment", *Journal of Development Economics*, vol. 51, N° 2 (EDCE), North Holland, Elsevier Science B.V.

___ (2002), "Schools and Skills in Developing Countries: Education Policies and Socioeconomic Outcomes", *Journal of Economic Literature*, vol. 40, N° 2 (EDCE), Nashville, American Economic Association.

Glewwe, P., H. Jacoby and E. M. King (2001), "Early childhood nutrition and academic achievement: a longitudinal analysis", *Journal of Public Economics*, vol. 81, N° 3 (EDCE), Great Britain, Elsevier Science B.V.

Hammill, M. (2007), "Growth, poverty and inequality in Central America", *Serie Estudios y Perspectivas*, N° 88 Mexico, September 2007. CEPAL.

Handa, S. (2002), "Raising primary school enrolment in developing countries. The relative importance of supply and demand", *Journal of Development Economics*, vol. 69, N° 1 (EDCE), North Holland, October 2002. Elsevier Science B.V.

Holmes, J. (2003), "Measuring the determinants of school completion in Pakistan: analysis of censoring and selection bias", *Economics of Education Review*, vol. 22, N° 2 (EDCE), North Holland, Elsevier Science B.V.

Papke, L. E. and J. M. Wooldridge (1996), "Econometric methods for fractional response variables with an application to 401(k) plan participation rates", *Journal of Applied Econometrics*, vol. 11, N° 6 New York, November/December 1996. John Wiley & Sons, Ltd.

Sánchez, M. V. and R. Vos, R. Vosand others, (eds.) (2008), Nicaragua, *Políticas Públicas para el Desarrollo Humano: ¿Cómo lograr los Objetivos de Desarrollo del Milenio en América Latina y el Caribe?*, Santiago de Chile, October. Uqbar Editores.

United Nations Statistics Division (2006), "Millennium Development Goals Indicators: The official United Nations site for the MDG indicators" United Nations Statistics Division, 11 September 2006, <http://mdgs.un.org/unsd/mdg/Data.aspx?cr=558>.

Van der Klaauw, B. and L. Wang (2004), "Child Mortality in Rural India", Working Paper, World Bank, HCE.

Vos, R. and others (2005), "Reaching the Millennium Development Goal for Child Mortality: Improving Equity and Efficiency in Ecuador's Health Budget", Working Paper.

___ (2008), *Políticas Públicas para el Desarrollo Humano: ¿Cómo lograr los Objetivos de Desarrollo del Milenio en América Latina y el Caribe?*, Santiago de Chile, October. Uqbar Editores.

Vos, R. and J. Ponce (2004), "Meeting the Millennium Development Goal for Education: A Cost-Effectiveness Analysis for Ecuador", Working Paper.

Wooldridge, J. M. (2002), *Econometric Analysis of Cross Section and Panel Data*, Cambridge, Massachusetts, MIT Press.

World Bank (2001), "Nicaragua Poverty Assessment".

___ (2008), "Nicaragua Poverty Assessment", Report, 30 May 3008.

ANNEXES

Annex I

DETAILS OF MILLENNIUM DEVELOPMENT GOALS, TARGETS AND INDICATORS

GOAL 2: Achieve universal primary education

Target 2A: Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling

Indicators: Net enrolment ratio in primary education.

Proportion of pupils who start grade 1 and reach last grade of primary.

Literacy rate of 15-24 year-olds.

Definitions

Education level: For international comparison, data from the population census are needed for three levels of education: primary, secondary, and post-secondary. (33, para. 2.156) Programmes at level 1 are designed on a unit or project basis to give students a sound basic education in reading, writing and mathematics along with an elementary understanding of other subjects such as history, geography, natural science, social science, art and music. In some cases religion if featured. The core at this level consists of education provided for children, the customary or legal age of entrance being not younger than five years or older than seven years. This level covers in principle six years of full-time schooling. The contents of education at level 2 are typically designed to complete the provision of basic education which began at ISCED level 1. In many, if not most countries, the educational aim is to lay the foundation for lifelong learning and human development on which countries may expand, systematically, further educational opportunities. the programmes at this level are usually on a more subject-oriented pattern using more specialized teachers and more often several teachers conducting classes in their field of specialization. The full implementation of basic skills occurs at this level. The end of this level often coincides with the end of compulsory education where it exists. Level 3 of education typically begins at the end of full-time compulsory education for those countries that have a system of compulsory education. More specialization may be observed at this level that at ISCED level 2 and often teachers need to be more qualified or specialized than for ISCED level 2. The entrance age to this level is typically 15 or 16 years. The educational programmes included at this level typically require the completion of some 9 years of full-time education (since the beginning of level 1) for admission or a combination of education and vocational or technical experience and with as minimum entrance requirements the completion of level 2 or demonstrable ability to handle programmes at this level. (60.)

Education enrolment: Persons enrolled and/or registered in a programme of education.

Education, percentage starting grade 1 and finishing grade 5: Survival rates may at times exceed 100 due to fluctuations in enrolment. Where such results are published they should be interpreted as the country having a survival rate approaching 100%. Children starting primary school who eventually attain grade 5 and final grade. The estimate is based on the Reconstructed Cohort Method, which uses data on enrolment and repeaters for two consecutive years. Repeaters are pupils who are enrolled in the same grade as the previous year.

Primary completion rate: The proxy indicator for the primary completion rate is the gross intake rate at the last grade of primary. It is calculated as the total number of new entrants in the last grade of primary education, regardless of age, expressed as a percentage of the population of the theoretical entrance age to the last grade.
Literacy/illiteracy: A person is literate who can with understanding both read and write a short simple statement on his everyday life. A person is illiterate who cannot with understanding both read and write a short simple statement on his everyday life.

GOAL 4: Reduce infant mortality
Target 4A: Reduce by two-thirds, between 1990 and 2015, the mortality of children under 5 years of age.
Indicators: Under 5 mortality rate
Infant mortality rate
Proportion of 1 year old children immunized against measles
Definitions:
Mortality Rate: excludes foetal death. Only after live birth.
Immunization:is the injection of serum etc to render person immune from infections.
Measles: is a highly contagious acute disease of childhood, characterized by a spreading skin rash, fever, cough, coryza, conjunctivitis, eruption of the buccal mucosa (Koplik's spots) and prostration. Overcrowding and disaster conditions are conducive to outbreaks, with high mortality, especially among the malnourished.

GOAL 7: Ensure environmental sustainability
Target 7C: Halve by 2015 the proportion of people without access to safe drinking water and sanitation.
Target 7D: By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers.
Indicators: Proportion of people with sustainable access to an improved water source, urban and rural (UNICEF, WHO)
Proportion of population with access to improved sanitation, urban and rural (UNICEF, WHO)
Proportion of households with access to secure tenure (UN-HABITAT)
Definitions:
Water, access to improved drinking supply: "Improved" water supply technologies are: household connection, public standpipe, borehole, protected dug well, protected spring, rainwater collection. "Not improved" are: unprotected well, unprotected spring, vendor-provided water, bottled water (based on concerns about the quantity of supplied water, not concerns over the water quality), tanker truck-provided water. It is assumed that if the user has access to an "improved source" then such source would be likely to provide 20 litres per capita per day at a distance no longer than 1000 metres. This hypothesis is being tested through National Health Surveys which are being conducted by WHO in 70 countries. (Communication of 25 March 2003 from the WHO Water, Sanitation and Health Programme).
Sanitation: "Improved" sanitation technologies are: connection to a public sewer, connection to septic system, pour-flush latrine, simple pit latrine, ventilated improved pit latrine. The excreta disposal system is considered adequate if it is private or shared (but not public) and if hygienically separates human excreta from human contact. "Not improved" are: service or bucket latrines (where excreta are manually removed), public latrines, latrines with an open pit.

Slum population: Research on estimating the number of slum dwellers started with an attempt to measure the phenomenon "secure tenure". Secure tenure is the concept of "protection from involuntary removal from land or residence except through due legal process". The lack of data based on a specific and operational definition made direct estimation impossible. Initial efforts attempted unsuccessfully to use tenure status data (owner, renter and squatter) as a proxy measure. UN-HABITAT then proposed that the attribute of secure tenure would be demonstrated in household behaviour. Households with secure tenure would tend to have more improvements than households without secure tenure and that this could be measured by a proxy index that included dwelling structure and amenities data. This was seen as a subset of the UN-HABITAT slum index initiative that was already underway. The resulting secure tenure index provides a fair assessment of the magnitude of slum dwellings. The characteristic variables include: the proportion of households with access to water (within 200 meters), the proportion of permanent structures in the housing stock, the proportion of housing that is in compliance with local regulations, the proportion of households connected to a sewer, the proportion of households connected to electricity.

Secure Tenure: UN-HABITAT has developed a secure tenure index that focuses on the comparability well-measured physical representation of secure tenure and better estimates the magnitude of slum dwellers. The index is a statistical composite permanency and legality of structure, and access to water, sewerage and electricity as reported in city summary data collected by UN-HABITAT. It represents the percentage of households with inadequate housing attributes. The percentage of households is converted directly into a population estimate using the World Urbanization Prospects population figures and projections.

Annex II

A THEORETICAL MODEL OF EDUCATION PARTICIPATION

The theoretical model of education enrolment given here is a brief summary of the extended human capital model used in Bedi (2004), and followed by Vos and Ponce (2004) and De Jong and others (2006). This exposition's objective is to highlight a key theoretical irregularity of the model and implications for any empirical estimation based on the model.

This model maximizes the utility of the household between two different choices, enrolment in education and non-enrolment. The utility for enrolment in education is based upon the consumption of the household and the benefits to be expected from the participation in education. As such the utility function is given as:

$$U_1 = U(b, c_1) \tag{A2.1}$$

Where b is the expected benefits from education and c_1 is the consumption level of the household under the decision to enrol in education. The subscript *1* is used to signify utility levels if the decision to enrol is taken. The economic benefits associated with education are based upon a set of individual, household and community characteristics. Therefore:

$$b = B(h, w, z) \tag{A2.2}$$

Where h is the set of individual characteristics, w is the set of household characteristics and z is the set of school characteristics. Household income is expended upon consumption for the household and the costs of the provision of education, both economic and opportunity costs. The budget constraint is:

$$y = c_1 + p \tag{A2.3}$$

Where y is household income and p includes the economic and opportunity costs of schooling. If the individual does not enrol in education, the utility function is represented by consumption only:

$$U_0 = U(c_0) \tag{A2.4}$$

Where the subscript *0* is the alternative without enrolment. C_0 is therefore consumption without enrolment. Similarly the budget constraint is given as:

$$y = c_0 \tag{A2.5}$$

Therefore the choice to enrol in education depends on the values of the alternative utility scenarios. The maximization problem is then simply:

$$U^* = U_{\max}(U_0, U_1) \tag{A2.6}$$

where U^* is the maximized utility value.

In the specification of the utility functions to derive a decision rule and estimatable equation, the linear utility function is commonly used. Therefore the utility function when enrolment occurs is:

$$U_1 = \beta_1 b + \beta_2 c_1 + \varepsilon_1 \tag{A2.7}$$

Rearranging the budget constraint in equation (A2.3) and substituting for consumption gives:

$$U_1 = \beta_1 b + \beta_2 (y - p) + \varepsilon_1 \tag{A2.8}$$

Under the decision not to enrol, the utility function is:

$$U_0 = \beta_2 y + \varepsilon_0 \tag{A2.9}$$

Thus the marginal utility of income is assumed to be equal for both alternatives of the education participation decision. The maximization decision is therefore that the enrolment occurs when U_1 is greater than U_0. :

$$\beta_1 b + \beta_2 (y - p) + \varepsilon_1 > \beta_2 y + \varepsilon_0 \tag{A2.10}$$

and rearranging, this becomes:

$$\beta_1 b - \beta_2 p + (\varepsilon_1 - \varepsilon_0) > 0 \tag{A2.11}$$

Equation (A2.11) can be reinterpreted as a probit or logit model based on a sample of those who have enrolled or not in education. The equation becomes:

$$\Pr(s = 1) = \Pr(\beta_1 b + \beta_2 p + \varepsilon_s) > 0 \tag{A2.12}$$

where s is the school enrolment decision and ε_s is the difference of the error terms of utility when enrolled and utility when not enrolled. Inserting the determination of benefits of education into equation (A2.12) gives:

$$\Pr(s = 1) = \Pr(\beta_1 B(h, w, z) + \beta_2 p + \varepsilon_s) > 0 \tag{A2.13}$$

Equation (A2.13) is the estimatable equation used in Bedi (2004), Vos and Ponce (2004) and De Jong and others (2006). The derivation of the equation has caused the household income or household consumption variable to be cancelled out. Each of the authors estimates this form of the equation without any income or consumption measure.

The model postulates from equation (A2.13) that the probability of enrolment is independent of household income or household consumption levels. The key aspect of the model that drives the transition from a theoretical model to an estimatable one is the linearity of the utility function. It is the linearity of the utility function that allows the income measure to drop from the equation. For example, using log utility functions in place of the linear functions would give:

$$U_1 = \ln(b, y - p) \tag{A2.14}$$

$$U_0 = \ln(y) \tag{A2.15}$$

After substituting consumption for the budget constraint. Maximizing the functions would give the following inequality:

$$U^* = U_{\max}(U_0, U_1) = U_1 \quad if \quad \ln(b, y - p) > \ln(y) \tag{A2.16}$$

$$\therefore U^* = U_1 \quad when \quad \ln(b, y - p) - \ln(y) > 0 \tag{A2.17}$$

In this case, regardless of the nature of the relationship between y and b, the income cannot be substituted from the inequality because of the additive nature of the variable p. Whilst this does not prove that the linear utility is the only function that permits the substitution of household income from the equation, it does show that there are a range of non-linear functions for which this cannot hold. Therefore the linear utility function is a very strong assumption in this model and crucial to the derived equations.

A second difficulty with the linear utility function in this model is that the use of the function implies that the marginal utility for individual and household characteristics is dependent upon enrolment. The linear utility functions for the enrolment and non-enrolment decisions under the model are reproduced below:

$$U_1 = \beta_1 b + \beta_2 (y - p) + \varepsilon_1 \tag{A2.8}$$

$$U_0 = \beta_2 y + \varepsilon_0 \tag{A2.9}$$

The equation for the determination of benefits from education b is also reproduced

$$b = B(h, w, z) \tag{A2.2}$$

and substituted into Equation (A2.8) to give:

$$U_1 = \beta_1 B(h, w, z) + \beta_2 (y - p) + \varepsilon_1 \qquad \text{(A2.18)}$$

where h is the set of individual characteristics, w is the set of household characteristics and z is the set of school characteristics. Under this model, the marginal utility of income is the same in both decisions (whether the individual enrols or does not the marginal utility is still β_2).

In addition the utility function for those enrolling in education, U_1 now contains a direct marginal utility with respect to h, w, and z. The utility function U_0 has no such marginal utility because the benefits do not enter directly into the utility function as there is no education under this decision.

This difference leads directly to the conclusion that if an individual enrols in education, they will obtain a marginal utility from their individual or household characteristics equal to $\beta_1 B'(h, w, z)$ whilst if the individual does not enrol in education, there is no marginal utility gain from having a certain individual or household characteristic.

To use an example, suppose that the benefits to education, explained as determinants of human capital gains, are dependent upon an individual characteristic such as sex (the sex indicator variable is included in every education estimation based upon this theoretical framework). Theoretically the argument is postulated that there is a gender difference from the derivation of benefits to education. However there would seem to be no reason for an individual to obtain greater satisfaction from being female if they enrol in education than the satisfaction or utility they feel by being female if they choose not to enrol in education.

In this theory the insertion of the benefits of education directly into the utility function is problematic and creates a range of difficulties about marginal utility across different choices. A far more efficient theoretical strategy would be to leave utility solely as conditional upon consumption and to rearrange the benefits and costs of education as factors that affect present and future consumption. This would be more in line with the Human Capital Theory of education as presented by Becker (1964). It also provides a natural explanation that the benefits of education do not affect utility directly, but affect the ability of an individual to raise their potential income levels, and therefore future consumption levels. Whilst the theoretical framework already illustrates the links that tie the benefits to future human capital gains (Bedi and Marshall, 2002), the current theoretical specification is an imperfect tool for this purpose.

Annex III

DETAILS OF CONSTRUCTION OF VARIABLES FROM THE HOUSEHOLD SURVEYS

Education variables

Proportion of children aged 7 years who enter grade 1 (GR17ENR, NETGRD1): This was calculated by constructing an indicator variable taking the value of 1 if the child is aged 7 and attending grade 1, and the value of 0 if the child aged 7 years is not attending grade 1. Children aged 7 but attending other grades were excluded from the count in order to measure the rate of the regular cohort entry. In addition an associated variable was created that specified the net enrolment rate to grade 1 in each municipality.

Education enrolment ratio, net, primary level, both sexes (UNESCO) (PAGEENR, NETPRIM): This was calculated by taking the primary enrolment rate of all children of regular year cohorts from 7 years to 12 years. Children outside this age group and attending primary education were excluded from the count. In addition, children within this age group but attending studies at other levels were excluded from this count, for example a large proportion of 12 year olds that were studying secondary level education. A dummy variable taking a value of 1 if the eligible child was enrolled and 0 otherwise was constructed. Another variable was created from the dummy variable to give the net primary level enrolment rate in each municipality.

Education enrolment ratio, net, secondary level, both sexes (SAGEENR, NETSEC): A dummy variable was constructed from the 2001 survey for all those individuals of regular cohort age for secondary education, that is between 13 and 17 years inclusive. The variable took a value of 1 if the individual was enrolled in secondary education and a value of zero if they were not. Individuals in the age group but attending other levels of education were excluded from the sample. In addition the net secondary enrolment rate was derived from the enrolment dummy variable for each municipality.

Education enrolment ratio, net, tertiary level, both sexes (TAGEENR, NETTERT): A core cohort age of tertiary attendance was set to between 18 and 22 years inclusive. This age group were considered the indicator target group of tertiary attendance in terms of the calculation of the dummy variable for tertiary enrolment and thus the tertiary enrolment ratio. Other age groups were omitted from the sample as well as individuals in the target age group who were attending other levels of education. The variable took a value of 1 if the individual was enrolled in some form of tertiary education and zero otherwise. The net tertiary enrolment rate is the rate of enrolment for tertiary level studies within the selected group of individuals by municipality.

Wage premium: A mincer-type wage model was estimated based on various individual and household characteristics, for those members of the survey earning wages. Fitted values were then applied to individuals in education, given different education levels, primary, secondary and tertiary. The primary/secondary wage premium was then calculated as the fitted wage value for secondary education divided by the wage value applying primary level education. The secondary/tertiary wage premium was calculated as the division of the tertiary fitted model by the secondary fitted model for each individual in the target cohort.

Education of Head of Household (ANOESTJ, AVSTUDJ): This variable is a measure of the total years of approved study that have been completed by the head of each household. Municipal averages were also created.
Costs of Schooling: Costs of schooling were measured for each level of education as the sum of the enrolment fees, uniform expenses, book expenses and other utilities required for school.
Supply of school bag: This is a measure of the proportion of schools in the municipality that supply some form of school bag, which includes school books and teaching materials.
Provision of Food at place of education: This is a measure of the proportion of schools in the municipality that provide food to their students at some point in the school week.
Student Teacher ratio: The student teacher ratio was created as an average for each municipality given the student teacher ratios in each school. This was done for each different level of education. 7 year old enrolment used the primary school student teacher ratio.
Teacher school ratio: The teacher school ratio measures the number of teachers for each school. This is therefore a proxy measure for school size. Municipal averages were also derived.

Health variables

Child mortality rate, the number of children under 5 years of age who died per 1000 live births (MORTRATE): Using the LSMS 2001 survey and calculating from mortality questions, the number of children under 5 at age of death and having died in the last 5 years of the survey were counted and then compared with the total number of children having been born in the last 5 years of the survey. Rates were then calculated for each municipality as an alternative to the dummy indicator variable.
Access to health services: Access to health services was calculated from the survey as the average time in minutes that it takes for a household member to reach the nearest health service centre, whether hospital, clinic or other service.

Water and Sanitation Variables

MDGWATER, Water, percentage of population with access to improved drinking water sources (WHO, UNICEF): A dummy variable was created taking a value of 1 if a household had access to improved drinking water sources and 0 otherwise. Access to safe water was defined as including piped water to the property, a public access point, or a public or private well (values 1 to 4 in the question ABASAGUA). In addition only those who lived less than 1000 metres away (less than or equal to 1000 in question DISTMT02) were included. There is also a question in the survey about the treatment of the water (TRATAGUA). This could be used to define treated water that is drinkable but the technical definition of access to safe drinking water for the MDG only specifies safe in terms of how the household obtains the water, not whether the water is treated or not. In addition the question about treatment does not specify whether the treatment was needed in terms of minimum standards. For example, some 76 percent of people do not treat their water, but the survey cannot differentiate between those that do not treat the water because it is already treated and those that do not treat the water out of choice and accept possibly higher risk of disease and illness. Recoding was done for the 1998 to ensure data values corresponded with those from the 2001 survey.
MDGSANITATION, Sanitation, percentage of population with access to improved sanitation (WHO, UNICEF): A dummy variable was created taking a value of 1 if a household had access to improved sanitation and 0 otherwise. Access to improved sanitation was defined as a treated toilet or latrine, a toilet or latrine with access to piping for black water or one with a septic system (values 2 to 4 in the question SERHIG). Untreated latrines and latrines that discharged waste into rivers or open pits were considered inadequate (values 1 and 5 in the question SERHIG). Whilst the question SERHIGEX asks if the sanitation facilities are shared, only those that are public are

considered inadequate whilst shared are considered adequate according to the indicator definition. Therefore the question could not be used because it could not identify between shared and public facilities. The questionnaire for 1998 does not differentiate between toilets or latrines that are untreated and those that are treated. Using the matched households between 2001 and 1998, the households that had treated toilets and latrines in 2001 were assumed to have had them in 1998 and the 1998 data was subdivided accordingly.

WSSERV, Services of water and sanitation: The survey data contained no information about the direct provision of water and sanitation services. This variable was constructed from the question CTOPAGA which asked about the cost of the last months water that was consumed by the household. Given that many households (around 48 percent in 2001) do not pay for water due to a variety of reasons (such as water charges being included in the rent), the cost of water was determined for these households by estimating a basic linear regression for each survey year of the cost of water on the number of people in the household and dummy variables for each municipality. The predicted values were applied to households without data for the amount paid.

OTHINF, Other Infrastructure: A proxy variable was created for other infrastructure based upon the rent paid for the property in which the household lives. Those observations missing values for rent were replaced with the imputed rent data asked in the survey. Given that there is a proportion of the sample from each survey that do not pay rent or have not declared the imputed rent, these observations were replaced with predicted values of rent based upon a linear regression model using the existing sample of those who paid rent against the per capita consumption level, number of people in the household, municipality and the number of rooms in the place in which the individual lives. The regression was corrected for heteroskedasticity.

Annex IV

ESTIMATION RESULTS

Table IV.1

ESTIMATION RESULTS FOR ENROLMENT IN EDUCATION, GRADE 1, 2001

(Various units)

Variable	Logit model		Proportions model	
	Coefficient	P value	Coefficient	P value
Sex (1 = Male)	-0.5407	0.138	-0.6884	0.692
Log Consumption per capita	0.6642	0.037	0.0001	0.343
Number of members of the household	0.1086	0.009	0.0457	0.455
Average infrastructure in municipality	0.0002	0.761	-0.0021	0.001
Proportion of population living in urban area	0.5919	0.050	0.0193	0.933
Average years of study of head of household	0.0888	0.049	0.1119	0.103
Wage premium for secondary/tertiary	3.1871	0.258	2.1731	0.081
Average municipal mortality rate	0.0009	0.362	0.0005	0.187
Log education spending	-1.2988	0.672	-0.2745	0.788
Log education spending squared	0.1756	0.561	0.0376	0.733
Average time to travel to school	-0.0029	0.917	0.0060	0.670
Proportion of children that receive school bag	0.8391	0.362	1.0405	0.002
Average teachers per school	0.0926	0.141	0.2098	0.000
Average student teacher ratio	-0.0291	0.310	0.0010	0.909
Proportion of children attended by school	1.9791	0.047	0.1708	0.649
Constant	-7.8170	0.334	-3.0810	0.371

Source: Author's calculations based on INEC household survey LSMS 2001 Nicaragua.

Table IV.2

ESTIMATION RESULTS FOR ENROLMENT IN EDUCATION, PRIMARY LEVEL, 2001

(Various units)

Variable	Logit model		Proportions model	
	Coefficient	P value	Coefficient	P value
Sex (1 = Male)	-0.535	0.021	-1.122	0.423
Log Consumption per capita	0.846	0.000	0.000	0.565
Number of members of the household	0.047	0.080	0.011	0.829
Average infrastructure in municipality (measured	0.000	0.536	-0.002	0.001
Proportion of population living in urban area	0.523	0.001	-0.096	0.654
Average years of study of head of household	0.137	0.000	0.088	0.126
Wage premium for secondary/tertiary education	3.951	0.079	2.651	0.027
Average municipal mortality rate	0.000	0.964	0.000	0.794
Log education spending	-1.401	0.383	-0.920	0.288
Log education spending squared	0.209	0.192	0.114	0.212
Average time to travel to school	0.004	0.866	-0.004	0.773
Proportion of children that receive school bag	1.607	0.003	1.099	0.000
Average teachers per school	0.014	0.674	0.167	0.000
Average student teacher ratio	-0.039	0.006	-0.006	0.436
Proportion of children attended by school meal	1.416	0.009	-0.201	0.476
Constant	-8.788	0.058	-0.212	0.939

Source: Author's calculations based on INEC household survey LSMS 2001 Nicaragua.

Table IV.3

ESTIMATION RESULTS FOR ENROLMENT IN EDUCATION, SECONDARY LEVEL, 2001

(Various units)

Variable	Logit model		Proportions model	
	Coefficient	P value	Coefficient	P value
Sex (1 = Male)	-1.6534	0.004	2.8686	0.066
Log Consumption per capita	0.9736	0.000	0.0000	0.773
Number of members of the household	0.0289	0.138	-0.0602	0.458
Average infrastructure in municipality (measured by	0.0006	0.013	-0.0003	0.632
Proportion of population living in urban area	0.0945	0.798	0.4995	0.093
Average years of study of head of household	0.1055	0.000	0.0600	0.368
Wage premium for secondary/tertiary education	2.0971	0.026	-1.1891	0.113
Average municipal mortality rate	-0.0003	0.475	0.0002	0.395
Log education spending	1.1839	0.153	-0.5148	0.359
Log education spending squared	-0.0559	0.500	0.0831	0.161
Average time to travel to school	0.0034	0.839	0.0007	0.968
Average teachers per school	-0.0042	0.454	0.0099	0.002
Average student teacher ratio	-0.0172	0.001	0.0060	0.275
Constant	-15.9373	0.000	0.3697	0.819

Source: Author's calculations based on INEC household survey LSMS 2001 Nicaragua.

Table IV.4

ESTIMATION RESULTS FOR ENROLMENT IN EDUCATION, TERTIARY LEVEL, 2001

(Various units)

Variable	Logit model		Proportions model	
	Coefficient	P value	Coefficient	P value
Sex (1 = Male)	-1.1977	-1.310	4.2056	0.036
Log Consumption per capita	2.0695	11.360	0.0001	0.445
Number of members of the household	0.1064	3.790	-0.0938	0.340
Average infrastructure in municipality (measured by	-0.0002	-4.680	-0.0001	0.914
Proportion of population living in urban area	0.4936	0.900	0.1276	0.774
Average years of study of head of household	0.0759	3.780	0.0509	0.552
Wage premium for secondary/tertiary education	1.4447	1.020	0.2545	0.755
Average municipal mortality rate	0.0009	1.910	0.0001	0.740
Log education spending	1.0668	0.660	-0.0422	0.911
Log education spending squared	-0.0698	-0.480	0.0315	0.486
Average time to travel to school	0.0042	0.160	0.0033	0.815
Constant	-27.8036	-6.100	-5.2205	0.001

Source: Author's calculations based on INEC household survey LSMS 2001 Nicaragua.

Table IV.5

ESTIMATION RESULTS FOR CHILD MORTALITY, 2001

(Various units)

Variable	Logit model		Proportions model	
	Coefficient	P value	Coefficient	P value
Average time to travel to nearest health care facility (minutes)	0.0002	0.856	0.0008	0.941
Access to water (percent)	-0.4539	0.137	-1.4762	0.109
Access to sanitation (percent)	-0.3594	0.309	-1.3885	0.108
Household per capita consumption (Cordobas per month)	-0.0001	0.034	-0.0002	0.059
Infrastructure proxy (Rental cost per month in household)	0.0005	0.105	0.0017	0.072
Region (percent urban)	0.7345	0.019	2.6574	0.000
Number of members of household	-0.1337	0.003	-0.0046	0.980
Sex (percent male)	0.7184	0.011	2.9626	0.266
Average years of study of head of household	-0.0655	0.135	0.0182	0.906

Source: Author's calculations based on INEC household survey LSMS 2001 Nicaragua.