Determinants of education achievement and of the Millennium Development Goals in Honduras

Marcelo T. LaFleur
Department of Economic and Social Affairs
United Nations, New York, USA
E-mail: lafleurm@un.org

María Auxiliadora López M.
Researcher, Institute of Social and Economic Research,IIES
National Autonomous University of Honduras-UNAH
Econometrician—Management of Economic Statistics
National Institute of Statistics, INE-Honduras
Email: mlopez@iies-unah.org

Abstract

Since 1990-2012, basic primary education has been a priority in Honduras' education policy, with similar importance in the Millennium Development Goals. The objective of this study is to identify and quantify the determinants of school enrollment, grade promotion, and graduation rates in primary school, and to reach an understanding of the role of various factors in the timely completion of primary education by Honduras' youth. This work aims primarily to quantify the relationship between education outcomes and socio-economic and policy variables to inform the MAMS general equilibrium model of Honduras, but it also serves to identify the policies that are most likely to improve outcomes and reach development objectives. We find that socio-economic and policy variables vary in their impact in education outcomes. We conclude that there are significant opportunities for policy makers to increase the impact of policies on education outcomes, particularly the effectiveness of spending on timely education achievement, but also though improvements in socio-economic conditions. A key lesson of this study is that it provides a rigorous example of how to analyze the effect of policy on outcomes, requiring detailed data and proper statistical technique in support of better informing policy decisions.

Acknowledgments:
We thank the members of the Inter-institutional Technical Unit (ITU) in Honduras for their contributions, particularly datasets and insight into the workings of the education sector. The ITU was created to use the techniques taught during the project to better advise policy makers. It includes members from the following institutions: UNDP-Honduras, Central Bank of Honduras, Ministry of Social Development, Ministry of Finance, Office of the President, Ministry of Planning and External Cooperation, Ministry of Health, Ministry of Education, the National Statistics Institute, and the National Autonomous University. Significant logistic and financial support was provided by UNDP-Honduras.

1 Introduction

Economic and social difficulties at the global level, such as was seen in the recent financial crisis and is evident in the ongoing global economic conditions, as well as domestic circumstances create uncertainties for the design of human development policies. Prior to the onset of the most recent crisis, studies showed that Latin America and Caribbean countries had a viable path to reach the Millennium Development Goals (MDGs) by the target date of 2015, though only with additional investment and other public interventions (Vos, Sánchez, and Kaldewei 2008). The evidence pointed out that the method of financing this additional spending should be carefully considered due to the effect that raising the funds necessary would have on macroeconomic conditions in countries. Experience shows that a development policy that is able to achieve the MDGs requires a sustained increase in social expenditures, growth in demand for labor, an improvement in income distribution, as well as a strategy for financing new spending that optimizes the mix of tax revenues and foreign borrowing.

Another study estimated the cost necessary to reach the development goals in 18 countries of Latin America and the Caribbean. In the case of the targets for education, child mortality and maternal mortality, and access to water and sanitation services, the additional cost range from one to seven percentage points of GDP each year, relative to a base scenario ("business as usual"). Honduras is the country with the largest additional spending needed (Rob Vos et al. 2010). Altogether, the additional costs required to reach the MDGs in the region were reasonable, as long as the financing of these expenditures were carefully considered.

The effect of the 2008-2009 crisis and the ongoing economic difficulties around the world have worsened this outlook significantly. An analysis of the effects of the global crisis on the likelyhood of attaining the MDGs in six countries of Latin America found that, in lower income countries, the additional cost to reach the goals would range from 1.6 to 3.4 percentage points of GDP each year between 2010 and 2015 above the spending estimated before the crisis. Again, Honduras led the

group with the largest additional spending needed as its spending in education, health, and basic services would need to increase by an additional 3.4 percentage points of GDP per year above the seven percentage points needed before the crisis (Sánchez and Vos 2010).

This reality is daunting for governments who have been committed to reaching development targets. More importantly, the adjustments necessary to accelerate progress will have large repercussions in economic and social conditions in the respective countries. It is of great value for policy makers to understand the total cost of achieving development goals in a given time frame, but it is also important for the policy makers to have sufficiently detailed information on the specific spending policies and financing strategies that can help the country achieve the MDGs and other development goals.

Computable General Equilibrium models (CGE) are often used to provide comparative analysis of policy options and to estimate the relative impact of alternative strategies. The present work is part of ongoing activities to transfer capacities to selected countries on the use of the Maquette for MDG Simulation (MAMS) general equilibrium model and an associated microsimulation framework. The model requires careful estimates of the interaction between certain parameters that form part of the human development module, such as how changes to public spending on education affects grade promotion rates.

This study aims to provide some of the estimates needed for technical staff in Honduras to be able to run the MAMS model and compare policy options and outcomes. However, while the motivation is to provide the inputs needed by the MAMS model, we go beyond simply estimating the determinants of development outcomes and attempt to shed light on areas where the relationship between its policy and outcomes can be improved. With such careful analysis, policy makers can better understand the efficiency and cost effectiveness of the various policy options to achieve the MDGs.

The specific focus of this study is on estimating the elasticities for the determinants of education achievement (MDG 2A), as well as documenting the methodology and data needed for the exercise. We estimate the effect of socio-economic and political factors on net on-time primary completion rate by estimating three separate education outcomes: school enrollment, grade promotion, and graduation rates. Other studies have estimated elasticities for child and maternal mortality (MDG 4A and 5A) and for access to water and sanitation services (MDG 7C).

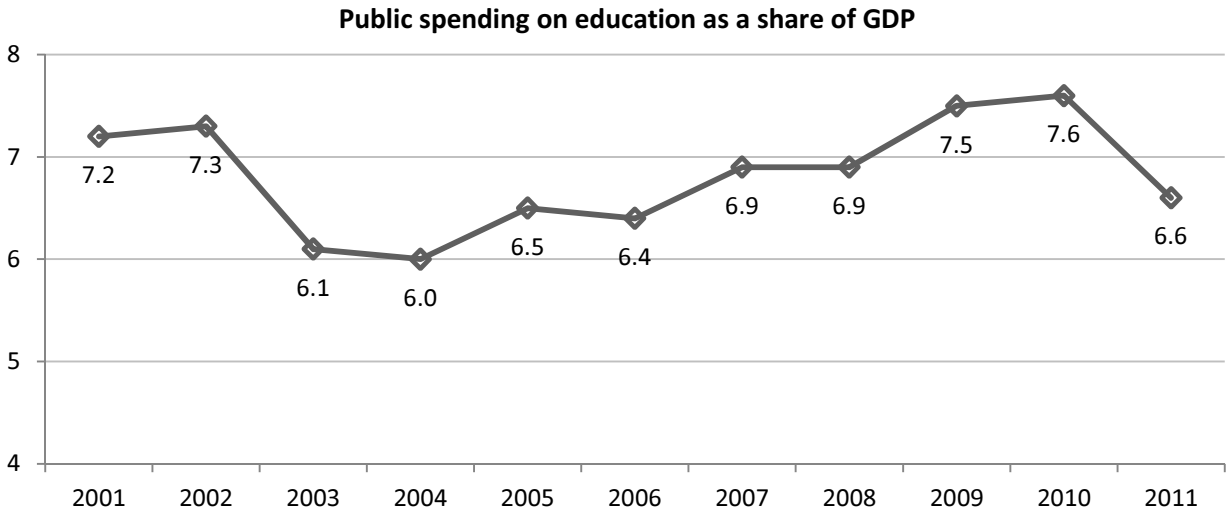
MDG	Description	Instrument in MAMS
MDG 2A	Universal primary education: by 2015, all children have completed primary education.	The net on-time completion rate in each cycle (primary, secondary, tertiary) is a funtin of timely enrollment, grade promotion, and graduation.
MDG 4A	To reduce by 2/3 mortality rates in children under 5 years old.	Infant or child mortality rates.
MDG 5A	To reduce by 3/4 the maternal mortality rates.	Maternal mortality rate.
MDG 7C	To reduce by half the proportion of people without Access to clear water and basic sanitation facilities.	Access to clean water sources and basic sanitation facilities.

This technical note is structured in three sections. First we present the basic characteristics of Honduras' education sector. The next section provides the econometric estimation of the determinants of timely completion of primary education, including a description of the data and of the methodology. The last section identifies lessons learned based on the empirical results and provides some suggestions for improving on future analysis.

2 The Education Sector in Honduras

The rate of enrolment in primary school increased by 5.6 percentage points between 1990 and 2009, reaching 89.5% in that year (United Nations 2010). In the same period, the rate at which students repeated a grade fell significantly. Despite the progress, its speed is insufficient if Honduras is to reach the MDG of 100% enrolment in and completion of primary school by 2015. Further progress is needed in enrolment, grade promotion, and dropout rates.

As a share of GDP, spending on public education is significant, peaking at 7.6 percentage points of GDP in 2010. This reflects the government's commitment to education. In fact, Honduras has an education reform plan with six strategic goals: improve access, efficiency, quality, management, competitiveness, and participation. The government sees education as important to contribute to the national goals of eliminating extreme poverty and an educated and healthy populace supported by a robust social safety net. Additional funding is provided through the conditional transfer program "Bono 10 mil" with the objective of improving human capital formation in the poorest regions.



Source: Honduras Secretariat of Finance and Secretariat of Education

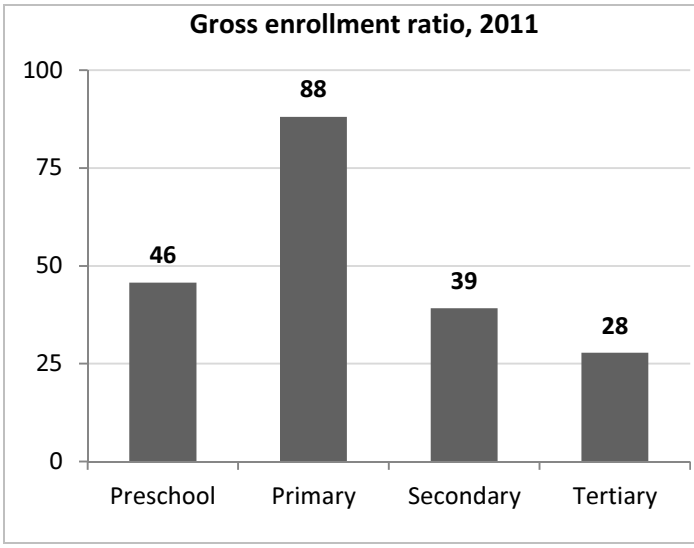
The public education system in Honduras for 2010 has a significant reach with approximately 80% of students in the primary level attending a public institution (BCIE, 2010). This reach drops to only 20% of students in the secondary level, reflecting a large shit towards private schools. It also indicates that many students who attended primary public schools are not continuing their education, and those that are prefer the private system even at a higher cost.

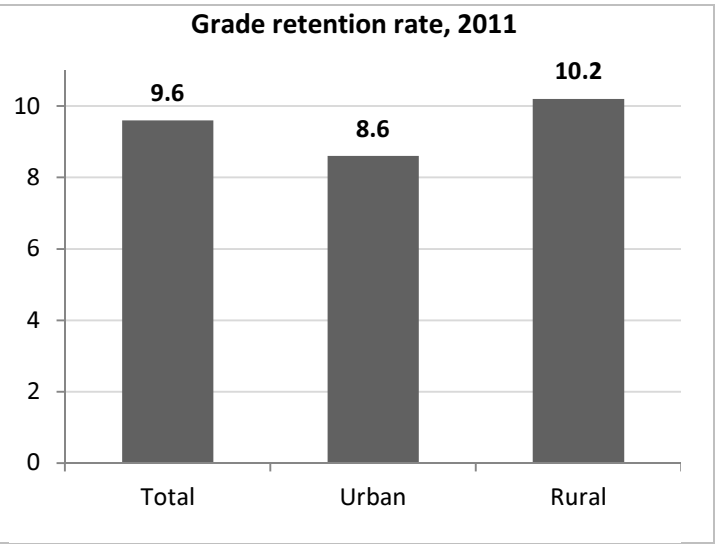
The results also show that spending is insufficient and ineffective to make significant progress, as statistics only show a small marginal return on the investment in public education. The rates of enrollment have shown some small improvements, with 2011 showing a reversal of any improving trend, perhaps in line with the fall in education spending in that year. A cursory glance at the data on

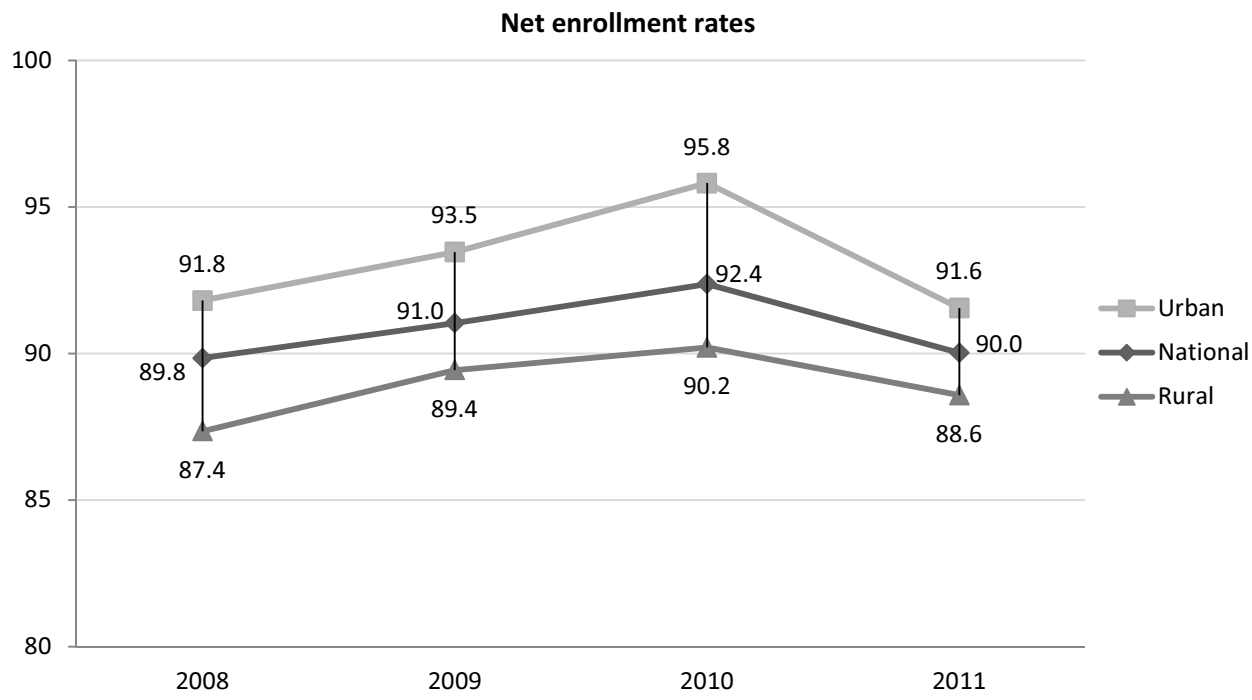
spending and on enrolment supports the view that the increase has done very little to improve enrolment. Reaching 100% enrolment will likely require more than just more money.

Other supply factors that impact the results are the existing infrastructure capacity at schools and in general, as well as the number of teachers, their quality, and their remuneration. Targeting the efficiency of spending by finding bottlenecks and other barriers to the entry of students in primary school is more likely to bridge the gap to universal enrolment. Here policymakers must compete with the value of children in helping around the household, in urban and rural areas, but more must be done to understand the decision by families to delay enrolment. Demand factors also lay an important part as the cost of education (including the opportunity cost of a child going to school) is likely too high for many families.

Enrolment statistics show another very clear problem for Honduras to overcome: while enrollment in primary school is very good, at or near 90%, less than half continue to the next educational level. Enrollment drops to fewer than 40% in the next cycle and to under 30% in the tertiary level.







Source: EPHPM survey, May of 2008-2011, INE Honduras.

3 Determinants of timely completion of education goals

Given the dynamic shown above and the clear opportunities for improvement, an analysis of the effects of policy options and socio-economic variables on education outcomes is of great value to policy makers. This analysis begins from the need to quantify the relationship between education outcomes and socio-economic and policy variables and to provide coefficients needed in the MAMS CGE model for Honduras. With a careful estimate of the interaction between certain parameters that form part of the human development module, the model is able to identify the policies that are most likely to improve outcomes and reach development objectives.

As mentioned above, the methodology and structural form of the estimations are constrained by the needs of MAMS. However, this study goes beyond a simple estimate of the determinants of development outcomes and attempts to shed light on areas where the relationship between its policy and outcomes can be improved.

The MAMS framework, and this study, uses a different definition for MDG 2A. Rather than using the enrolment in primary education as the indicator, we take a more detailed and nuanced approach that measures whether the child is able to complete the entire primary education cycle on time. The indicator is the combination of: a) enrolment in primary school at the correct age; b) promotion rate; and c) graduation from primary school. Using this method has the advantage of providing meaningful insight into education outcomes, particularly since most developing countries have achieved high levels of enrolment in primary schools. This approach is also in line with Rosales (2006), who describes education as sequential decisions of enrollment, completing the cycle, and continuing to the next level.

Using this structure it is easy to see the barriers that exist in education. In Honduras, repetition rates for first, second, and third grades are worrisome at 9.5%, 6.3%, and 5.1% respectively in 2012. Dropout rates hover around 1%. There are also large gender disparities in enrollment and other education indicators (SEDUC, 2013).

The academic literature on what affects these results is expansive, but largely similar in its findings. Student behavior and outcomes depend on the quality of education, the household ability to purchase or access available services, income incentives, health status, and the availability of public infrastructure. Some studies find that the tension between school and work for children is a significant barrier to educational achievement, as is the case in Honduras (Sabonge 2004). He argues that rural households tend to view children as available to help with household responsibilities, while those in urban areas view the children as workers in the informal sector. This study also shows that parents' education levels are associated with school attendance and performance. Better education parents, it is argued, place a higher value on educational achievement and are financially better able to ensure their children complete their education. Having both parents living in the households adds to this effect.

The work of Morales (2004) also examines the link between parents' education and whether young people attend school. He finds that this link provides a good place for policy makers to target campaigns for less educated households, but he also finds that the income level of households is a strong indicator of educational attainment. The author suggests that subsidies and other monetary incentives would be effective in improving the results.

Vos and Ponce (2004) points to three factors with the largest effects on enrollment in Ecuador: a) improving the quality of teachers so as to lower the number of teachers hired; b) using the savings to invest in education infrastructure, subsidies, and other incentives for lower income households; and c) design monetary incentives to further encourage enrollment and performance. The study also points to the need to decentralize the decision making, empowering local communities to select teachers and directors of their schools.

These three examples show that studies of the determinants of educational outcomes can help identify policy options that increase the effectiveness of government intervention. Having a careful understanding of the determinants is particularly important in the context of a macro-level model such as MAMS, since the estimated elasticities are important coefficients that often drive the long term results of the model. Not only is it essential to estimate these elasticities as well as possible given the data, it is also informative to understand what factors are able to vary these elasticities. Armed with the impetus to inform the MAMS model and the incentive to understand policy and socio-economic impacts on outcomes, we move ahead with estimating the determinants of educational achievement in Honduras.

3.1 Data sources

We use household level data to estimate the effect of policy variables as well as socio-economic conditions on educational outcomes. The source of the household data is the "Encuesta Permanente de Hogares de Propósito Múltiples" (EPHPM). This survey is conducted twice a year (in May and in September) and each of these semi-annual surveys does not typically provide a representative sample at the sub-national level. The 2011 survey is an exception, however. In addition, the Honduran statistics bureau (Instituto Nacional de Estadística – INE, in Spanish) was able to provide a combined survey as a single representative data set, greatly increasing the coverage of the dataset.

The EPHPM includes information on demographic characteristics, migration, education, household composition, dwelling, income, labor market (including details by gender and by labor condition), work by children and the young, and poverty. The detailed information on education status by individual, and the associated household information, is the key data from this survey. The EPHPM covers 16 of the 18 administrative regions in Honduras (it excludes Gracias a Dios e Islas de la Bahía). It also represents four domains: Central District, San Pedro Sula, other Rural, and other Urban.[1]

For public spending data we use information provided by the Honduran Education Ministry (Secretaría de Educación de Honduras – SEDUC, in Spanish). The information provided includes:

- Budget implementation, grades 1-6, by region and municipality (2010, 2011)
- Budget implementation, grades 7-12, by region and municipality (2010, 2011)
- Enrollment, grades 1-9 and 10-12, by age and sex (2010-2011)

Variables that require a regional aggregation, such as available public infrastructure, are computed using four possible levels of aggregation. The specific level used in the estimation varies depending on pragmatic considerations, as there isn't a rule that determines the optimal size of the aggregates (Soobader et al. 2001). The four levels of regional aggregate considered are:

1. Department ("depto") – 18 administrative regions.
2. Department and domain ("depdom") – 36 groups (18 departments by urban/rural domains).
3. Sanitary Regions ("regsan") – 18 administrative regions as well as the Municipality of the Central District (Tegucigalpa) and San Pedro Sula. These two large cities are treated separately.
4. The municipalities available in the survey data.

Infant and child mortality rates are estimated for the 10-year period preceding the 2005-2006 Demographic and Health Survey and published in the survey report (INE Honduras and Macro International 2006, 126). Mortality rates are available for each of the Sanitary Regions.

The education cycles in the EPHPM dataset follow the new Honduran classification created in 2012. This classification includes a "basic" education cycle with nine grade levels. Only the first six are associated with the traditional "primary" cycle. The last three years of the newly created "basic" cycle, as well as the "common cycle" and the "diversified" cycle are associated with the traditional "secondary" cycle. The table below provides the concordance between the 2012 (new) classification system and what we term a "standard" classification, for lack of a better term. It is this "standard" classification and grade levels that are used in our analysis

[1] See http://www.ine.gob.hn/index.php/censos-y-encuestas/encuestas-todos-las-encuestas-de-honduras/encuesta-permananente-de-hogares.

2012 classification used in EPHPM dataset		"Standard" classification used in analysis	
Cycle (in Spanish)	**Grade**	**Cycle**	**Grade**
Programa de alfabetización	-	None	-
Pre-básica	1-3	Preschool	-
Básica	1-6	Primary	1-6
Básica	7-9	Secondary	7-9
Ciclo Común	1-3	Secondary	7-9
Diversificado	1-4	Secondary	8-12
Técnico Superior	1-4	Tertiary	-
Superior no universitaria	1-4	Tertiary	-
Superior universitaria	1-8	Tertiary	-
Post grado	1-5	Tertiary	-

Finally, we must build the proper cohort to track the timeliness of enrollment and completion of education. The EPHPM dataset, however, has significant data limitations in this regard and introduces large imprecisions in the age cohorts. In Honduras, the proper age of enrolment in primary school is six years old at the beginning of the school year (February). The survey, however, includes the number of completed years of the individual but not the month of birth. This creates significant uncertainty in the creation of the cohorts, made worse by the fact that the survey is conducted in May and in September. In the May survey, a child who has completed six years at the time of the survey may have up to a three month error in the cohort (February, March, and April). For the September survey, this error may be as large as seven months. To try to minimize this problem, the estimations were conducted using a wide cohort of children of six or seven completed years at the time of the survey. This is a limitation in the data that we hope will be corrected in future versions of the survey.

3.2 Estimating the determinants of timely completion of primary education

As mentioned above, the educational objective in the MAMS framework differs from that of the MDG target in that we aim that the child is able to complete the entire primary education cycle on time. As a result, we require estimates of the determinants of three educational achievement goals: enrollment at the proper age, promotion rates, and graduation and continuation to the next cycle. Each of these dependent variables is estimated separately and the resulting elasticities are used as inputs into the MAMS model to estimate on-time completion of educational goals.

In selecting the determinants for each of the three models we are limited by the availability of data as well as some specific constraints imposed by the need to provide inputs to the MAMS framework. Independent variables include estimates of public spending on education, household consumption and income, levels of public infrastructure, rates of infant and child mortality, the wage premium for completing educational cycles, and other socio-economic control variables following similar studies and the available empirical literature, particularly the work of Sánchez and Sbrana (2009; 2010), Ponce, Bedi, and Vos (2003), and Vos and Ponce (2004). The MAMS model framework specifically requires estimates of the impact of public spending, levels of infrastructure, household income, returns to educational achievement, and child mortality on educational outcomes. This requirement forces equations to include at least these variables.

The following variables are used as determinants for each of the three educational goals (enrollment, promotion, and completion):

1. Public spending on education per capita, 2010

   This the policy variable directly linked to educational outcomes. We use data on spending by educational cycle in 2010 and 2011 provided by the Ministry of Finance and the Ministry of Education. This information is available for each of the departments. We expect a positive correlation with educational enrolment, promotion, and graduation and continuation.

2. Household per capita income

   Household income determines the ability of the child to purchase or otherwise access educational services and is expected to have a positive correlation with outcomes.

3. Access to electricity in household

   The availability of public infrastructure impacts the ability of student to access educational services (road network) as well as the provision and the quality of these services (electricity, telephone access, etc.) As there is no available data on the road network, we opted to use the availability of electricity in the selected regional aggregate or directly by the household as a proxy for public infrastructure. We also tested access to the telephone network.

4. Infant Mortality

   Infant mortality has a direct impact on the child's ability to complete the educational cycle, but may also have an impact on other children in the household. This variable is only available for the "sanitary regions" aggregation level. We expect that it will have a negative impact on educational achievement.

5. Returns to educational achievement

   The additional income that is expected from having completed an educational cycle is a measure for the economic value of an education. To compute this, studies often compare the average wage income of workers with and without the relevant education, by industry or another appropriate group. However, this introduces a selection bias, since we are only observing those that are employed and reporting wage incomes. The additional salary that is observed is a function of not only educational levels of workers, but also of the employment status, which is likely to have a different impact at different levels of education. This difference, and the implicit reservation wage, requires a correction. We use Heckman's two-step correction methodology to adjust for this selection bias. This estimation is presented below.

6. Other variables

   We control for changes in sex, urban or rural household, dwelling characteristics, the size of the household, educational level of the head of household, income quintiles, and whether the child is an orphan.

3.2.1 Estimating the wage premium of educational achievement

To estimate the marginal returns to education, we use a Heckman two-step correction to adjust for the sample selection bias that is present since we only observe the incomes of those that are employed. In the first step we must estimate the selection bias λ using an equation for the probability that an individual receives a wage income, or that the individual is employed. The results of this estimation are presented in the appendix.

Once we estimate the value of the selection bias λ for each individual, it is possible to estimate the additional wage income that an individual expects from completing each educational cycle (López-Méndez María, 2013). The following log-linear model finds the relationship between the wage income and the individual's characteristics (e.g., age, sex, industry), as well as the type of job that he or she occupies (e.g., public sector). We estimate this model for each of the regional aggregates used in the estimation of the determinants to educational achievement.

$$Ln(w)_{ikt} = \beta_0 + \sum_{i=1}^{3} \beta_i(education\ level) + \beta_4 experience + \sum_{i=5}^{7} \beta_i(age\ group) + \beta_8 sex + \beta_9 publicempl + \beta_{10} privateempl + \beta_{11} selfempl + \beta_{12}\lambda_i + e_i$$

Where $Ln(w)_{ikt}$ is the logarithm of the individual *i's* wage income in the *k* regional department in year *t*. The *educational level* is a dummy for having completed primary, secondary, or tertiary and is cumulative, meaning that those who completed secondary also have completed primary. The number of years of experience in the labor market is captured in *experience*. The *age group* captures the marginal effect of belonging to one of the following three age cohorts: 18-24, 25-34, and 35-44. The gender of the individual is captured in *sex*. There are three possible sectors where the individual works: public, private, or self-employed (*publicempl*, *primateempl*, or *selfempl*, respectively). The variable λ_i captures the selection bias estimated in the first-step, while the error term (e_i) includes any not-observed variables. The coefficients $\beta_1, \beta_2,$ and β_3, reported below as averages, are the expected changes to wages from having completed primary, secondary, and tertiary education. On average across all regions in Honduras, a worker with a completed Tertiary education will gain an additional 17%+59%+75% of income compared to a non-educated worker. A full table with the results for all regions in Honduras is available in the appendix.

Average additional returns to completing educational cycles

Primary	Secondary	Tertiary
0.17	0.59	0.75

3.2.2 Determinants of educational achievement

Armed with the independent variables listed above, including the estimated returns to education for each of the regional aggregates, we can now proceed with estimating the effect of policy and socio-economic variables on education. We use a standard binomial logit model, defined as:

$$\text{Prob}(Y = 1|X) = \frac{e^{\beta_0+\beta_1 X_1+\cdots+\beta_n X_n}}{1 + e^{\beta_0+\beta_1 X_1+\cdots+\beta_n X_n}}$$

Where Prob(Y=1|X) is the probability that the dependent variable is found to be true conditioned on a vector of independent variables X that are the determinants defined above. The coefficients to be estimated are the β_i. We estimate three separate equations, one each for enrolment in primary education, grade promotion, and graduation and continuation.

The table below presents the results for each of the three logistic models estimated: primary enrollment, promotion rates, and graduation rates. As expected, we have difficulty in identifying statistically robust correlations between the independent and the dependent variable. In many cases the signs are opposite what is expected or the correlations are not significant. It is important to keep

in mind that the coefficients reported by logistic models do not have a clear economic interpretation. This is compounded by the addition of interaction variables in the model.[2] We can reach some conclusions on the validity of some of the variables based on their range (whether they include negative values) and if there is any interaction (see below for the estimated marginal effects of the determinants of the dependent variables.)

The estimated models allow us to observe a degree of sensitivity of the results to changes in the model specification. This was expected due to the small variation in some of the indicators and other data limitations.[3] Specification tests confirm that the final models for primary school enrolment and graduation are sufficiently well specified. The tests show some weakness in the model to predict promotion rates in primary schools.

[2] For example, we add an interaction variable between income and income quintile to examine the possibility that poorer households have a different income elasticity of demand for education. Because of this, neither coefficient reported for income nor its statistical significance can be used to interpret the impact of income given that the model ascribes part of this effect to the interaction variable. See the Annex for a discussion on interpreting coefficients of logistical models.

[3] To have a well specified model, we do not want to exclude any independent variables that are statistically significant. In Stata, we use the -*linktest*- command. In addition, we try to measure the model's "goodness-of-fit" by comparing the models predicted positive outcomes with the actual positive outcomes in the dataset, and the predicted false positives in relation with the actual negative outcomes in the dataset (using -*lroc*- in Stata). Finally, we use the Hosmer-Lameshow test to see if the frequency distribution predicted by the model approaches the actual distribution of the dataset.

Logit models of determinants of educational achievement in primary school

Variables	Enrollment rate	Promotion rate	Graduation rate
Public spending per capita – log	-0.580	1.148**	0.259
Infant mortality	0.001	-0.145**	-0.024*
Infant mortality squared		0.003**	
Wage premium – primary school	0.666***	0.092	0.624**
Wage premium – primary school squared		0.580**	
Household income per capita – log	0.195	0.148**	
Household income per capita			0.001
Income quintile (base=1st quintile)			
2nd quintile	-8.735*		0.200
3rd quintile	-7.649		-0.647
4th quintile	-15.516**		1.540
5th quintile	1.298		1.726**
Income per capita (log) x Quintile			
Income in 2nd quintile	1.281*		
Income in 3rd quintile	0.931		
Income in 4th quintile	1.896**		
Income in 5th quintile	-0.261		
Income per capita x Quintile			
Income in 2nd quintile			-0.000
Income in 3rd quintile			0.000
Income in 4th quintile			-0.001
Income in 5th quintile			-0.001
Has access to electricity	-0.433**	0.443**	1.025**
Child attended preschool	2.068***		
Child is male	-0.175	-0.370**	-0.202
Child is orphan (mother)	-1.001	-0.086	
Child is orphan (father)	0.438	-0.270*	
Household members per room		-0.161**	
Constant	4.374	-3.770*	-1.873
N	1,696	10,149	1,413

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Elasticities

Using the model estimated above and the reported coefficients, we can evaluate the average marginal effects of the variables of interest. The marginal effect measures the change in the probability that the dependent variable is true. We interpret this as the elasticity between the independent variable and the outcome (see Annex I), and the results are reported in the table below.

We find that public spending on education has an effect on promotion rates, increasing the probability of promotion into the next grade level by 12% for every 1% increase in spending. The relationship between school enrolment and public spending per capita is found to be not significant, though the estimated sign is negative. Some studies have found elasticities with the opposite sign and not statistically significant. This can be due to large differences between rural and urban households in how education is valued, particularly as children are a source of additional labour for the households and the opportunity costs of attending school are higher. Ponce, Bedi, and Vos (2003) as well as Vos and Ponce (2004), for example, find large differences in the marginal effects of each of the determinants of school enrolment in primary and secondary schools. The authors identified the differences in decision making between urban and rural households, as well as between poor and non-poor households.

The wage premium for having completed primary school has the expected effect on educational outcomes. A one percent increase in the expected wage premium increases the probability of enrolment, promotion, and graduation by between one and two percent. The largest effect is that of household economic conditions, as this is seen as the most significant constraint on the ability and desire of families to send their children to school. The probability of enrolment increases by almost 25% for every one percent increase in household per capita income. This matches well with the hypothesis that education and work are competing for children's time.

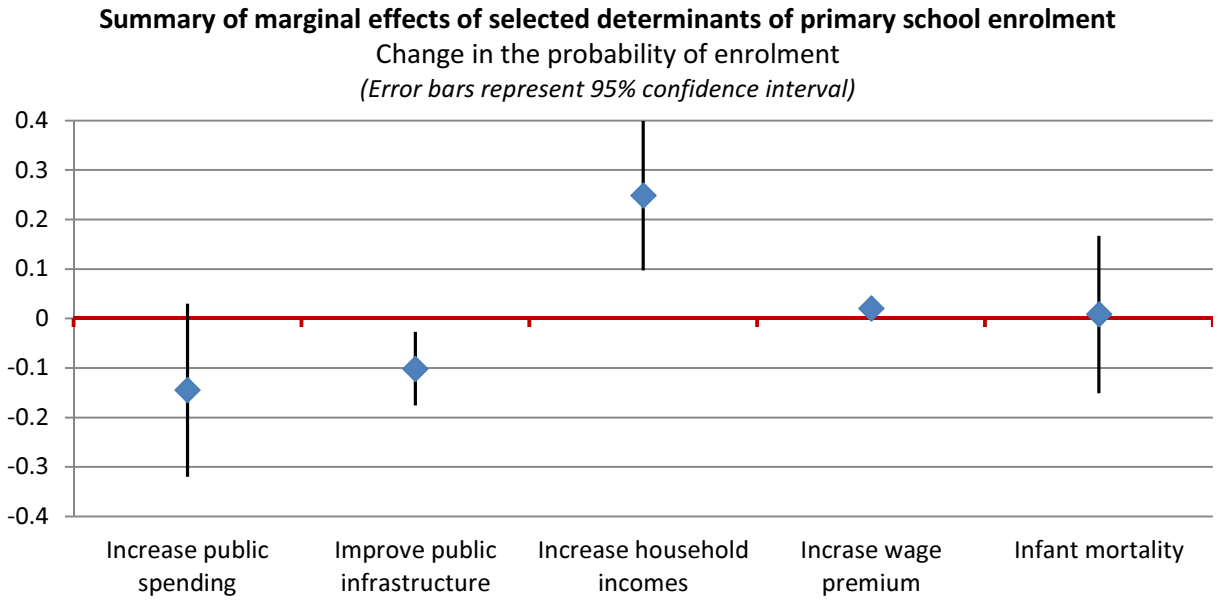
Our proxy for public infrastructure availability is whether the household has access to the electricity grid. This likely has some interaction with income variables, but it is also largely dependent on location and whether the grid has been made available to the region. Interestingly, we find a negative and significant correlation with enrolment rates, though the sign is as expected for promotion and graduation rates. Finally, it is notable that child mortality only has a statistically significant effect on graduation (and continuation) rates.

Elasticities of selected determinants of timely completion of primary education

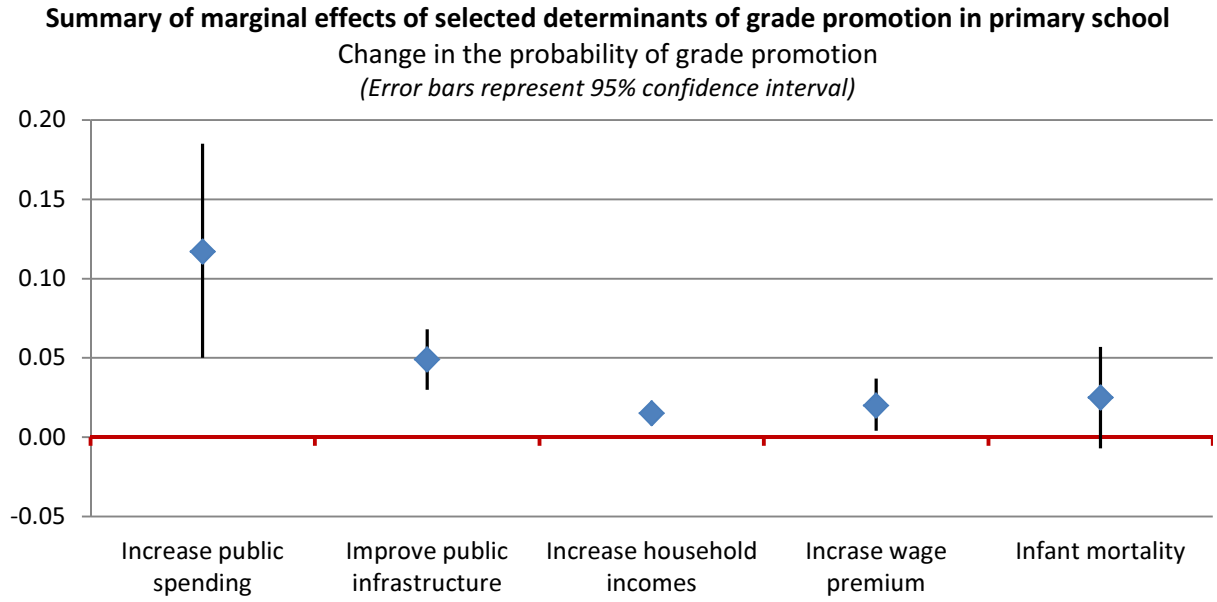
Variables	Enrolment	Promotion	Graduation
Public spending per capita	-0.145	0.117**	0.057
Infant mortality	0.008	0.025	-0.157*
Wage premium – primary school	0.020**	0.020*	0.010**
Household income per capita.	0.248**	0.015**	0.092
Household has access to electricity	-0.102**	0.049**	0.278**
N	1,696	10,149	1,413
LL	-802.168	-3,221.231	-659.436
LR chi2	300.904	257.004	173.051
Prob > chi2	0.000	0.000	0.000
Pseudo R2	0.158	0.038	0.116

+ $p<0.1$; * $p<0.05$; ** $p<0.01$

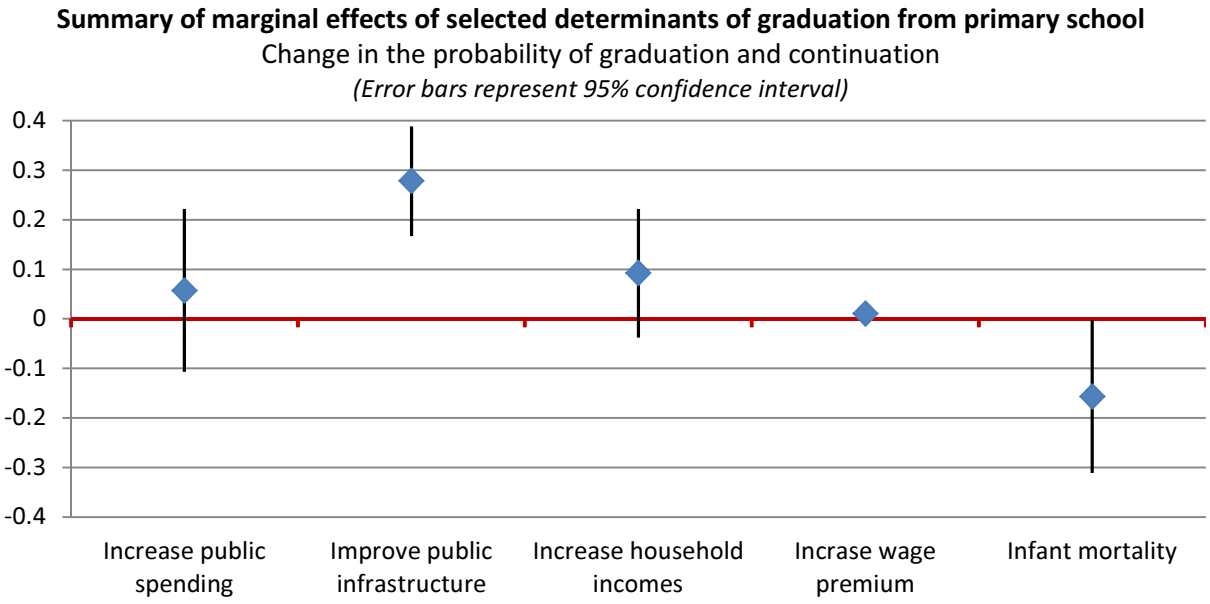
We see that the effect of income on enrolment clearly reflects the demand for education services by families. However, there are some puzzling results that will require new sources of data and additional analysis to understand. As seen in the chart below, public spending has a weak negative relationship with school enrolment. Though this is in line with the work of Vos and Ponce (2004), which finds that lowering the number of teachers hired while improving their quality, among other policies, has a large impact on enrollment. The mechanism through which this effect is operating depends on the marginal productivity of additional educators, and this is likely what we are seeing in the case of Honduras. It is also possible that spending is being increased in response to poor outcomes in a virtuous counter-cyclical mechanism, though we consider this a smaller effect given the long lead timeframes for approving budget allocations to the sector. Another possible explanation is poor management in the affected schools, whereby poor operational management leads to poor results, and the same management limitations lead to poor administrative and budgetary implementation. Of course, it could simply be that families do not consider small variations in education spending in their decision of whether or not to enroll their child in primary school at the proper age. This does not explain why a greater availability of public infrastructure is linked to decreases in the probability of enrolment. It is likely that a region-specific characteristic is interacting with this term, something we could not test for with the available data.



The probability of grade promotion in primary school is closely associated with supply-side variables as well as demand side variables. Interestingly (or perhaps obvious) additional resources spent on schools have a much larger impact on promotion rates than the effect of greater household incomes. Clearly income determines entry into school, but has only a small effect on in-school results. The quality of the school, measured by its budget, determines how well students do in each grade level.



The results for graduation from primary school and enrolment in secondary school (continuation of studies) are puzzling and likely reflect a mix of the effects seen above (enrolment incentives and education performance.) All variables have the expected relationship, however only the availability of infrastructure is statistically significant.



4 Conclusion and Implications for policymaking

Our decision to focus on the timely completion of primary education instead of simply primary school enrolment or attendance is grounded on the purpose of the educational system. Enrolled students who are unable to complete their education on time represent wasted resources and wasted economic opportunities for the individual and for the national wellbeing.

The results show that improvements in the socio-economic situation of Honduran households have a significant effect on achieving educational outcomes. Public interventions can also have a direct effect in some cases, but even where they are relatively ineffective, policies that result in income growth, greater wage premium for educational achievements and better infrastructure can have the added benefit of improving rates of enrolment, promotion, and graduation in Honduras. A combination of policies, both direct and indirect, can significantly improve timely completion of primary education goals. There are also opportunities to increase the impact of policy interventions by increasing the effectiveness of spending (increasing the elasticity).

Household income per capita, as a measure of the purchasing power for education services, has its largest effect on timely enrollment of students. Additional public expenditures on education have a limited effect on enrollment rates, but are a significant determinant of grade promotion. The expected wage premium for having a complete primary education impacts all aspects of timely completion. This can provide an example for labor sector policies that can influence an important development objective for Honduras.

Government policies that stimulate growth and increase in household income per capita will have a large effect on timely primary school enrolment. Honduras already has a very high enrolment rate in primary (over 90% as of 2011) but still requires a push to reach the goal of having all children complete primary education on time. However, additional interventions are subject to diminishing returns and fiscal conditions remain challenging. These results show that efforts to enroll all children on time should focus first on increasing household incomes. Honduras already provides transfers tied to education, and this can perhaps be increased or additional programs can be created. In addition,

income growth that is targeted to the population with the lowest enrollment rates can be very effective. At the same time, the government can invest in infrastructure improvements such as roads and electricity networks that have a positive effect on the accessibility of schools, as well as child health. Reducing infant mortality itself and access to health services, which can be improved by investing in a better transportation network, can reduce the impact of infant mortality on education.

A final note

A key lesson of this study is that it provides a rigorous example of how to analyze the effect of policy on outcomes, requiring detailed data and proper statistical technique in support of better informing policy decisions. The estimated elasticities present a challenge to the researcher in part because of the complex nature of the interaction between the variables, but also due to the sensitivity of the results to definitions and model specification. This is compounded by the micro nature of this analysis and the difficulty in collecting the data needed, particularly in lower income countries. On top of this, these elasticities are often used in further estimations (in this case a CGE model for Honduras) with significant repercussions if not done carefully.

We recognize that these results have some statistical limitations due to data availability. It serves us to remember that this analysis was done first and foremost to provide coefficients needed in the MAMS CGE model for Honduras and that the MAMS structure imposes some limitations on the specific form of the estimated model.[4] The minimum specification includes public spending, public infrastructure, infant mortality, the wage premium, and household income. We are also constrained by the available data in the same way as all other similar studies.

The researcher can apply increasingly sophisticated statistical methods to isolate interactions, but there is little to be done in the face of a limited dataset. The lesson here is that governments can benefit significantly from this type of analysis in designing policies and improving their effectiveness. However, this requires an investment in funds and institutional commitment to create the capacities and data required. The recent proliferation of household surveys has increased the availability of data, but has done little to provide information on policy implementation such as investment and budget execution with enough detail to be of analytical use. One glaring example in Honduras is the lack of sufficiently detailed spending data on policies destined to lower infant and child mortality rates. Having only aggregated results at the level of "child health" is inadequate to understand the relationship with outcomes. The analysis could also benefit from more detailed information on public infrastructure spending (roads, water and sanitation, and others), of effective access to health and education facilities (distance and cost), and an open policy to encourage researchers to dig into the datasets. This is important because case studies with sufficient detail to be of value are also very specific and cannot be generalized to the national context.

As countries make progress towards their human development goals, the impact of policy interventions is reduced. At the same time, the fiscal space to dedicate significant amounts of spending for development is smaller. It is evident that governments must look for increased efficiencies in their spending and other interventions. Identifying the most effective approaches to reach human development goals requires detailed data and analytical capacities. The analysis presented here shows that, for Honduras, public spending in education alone is not an efficient strategy to improve educational outcomes. However it also shows that there are opportunities to

[4] More information on the MAMS model and its use in Honduras is available in the UN DESA/DPAD webpage http://www.un.org/en/development/desa/policy/capacity/projects_mdgs.shtml.

leverage spending with policies to increase household incomes, improve infrastructure, and strengthen the labor markets.

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Annex I

In a logistic model (in our case a logit model), the coefficients have a different interpretation than in the commonly used linear OLS model. This can readily be seen from its form, where β is the coefficient:

$$\text{Prob}(Y = 1|X) = \frac{e^{\beta_0+\beta_1 X_1+\cdots+\beta_n X_n}}{1 + e^{\beta_0+\beta_1 X_1+\cdots+\beta_n X_n}}$$

In a linear model, the coefficient directly represents the marginal effect of changing the independent variable on the dependant variable. In a non-linear model, the coefficients are in an exponent and in both the numerator and the denominator, making it hard to directly infer their impact on the probability that the dependent variable will be true. In order to have a measure of this marginal effect, we must evaluate the function with different values of the independent variable of interest. The resulting change in the probability of the dependent variable is our single estimate for the marginal effect of the change:

$$Marginal\ effect = \frac{x_i}{f} * \frac{df}{dx_i}$$

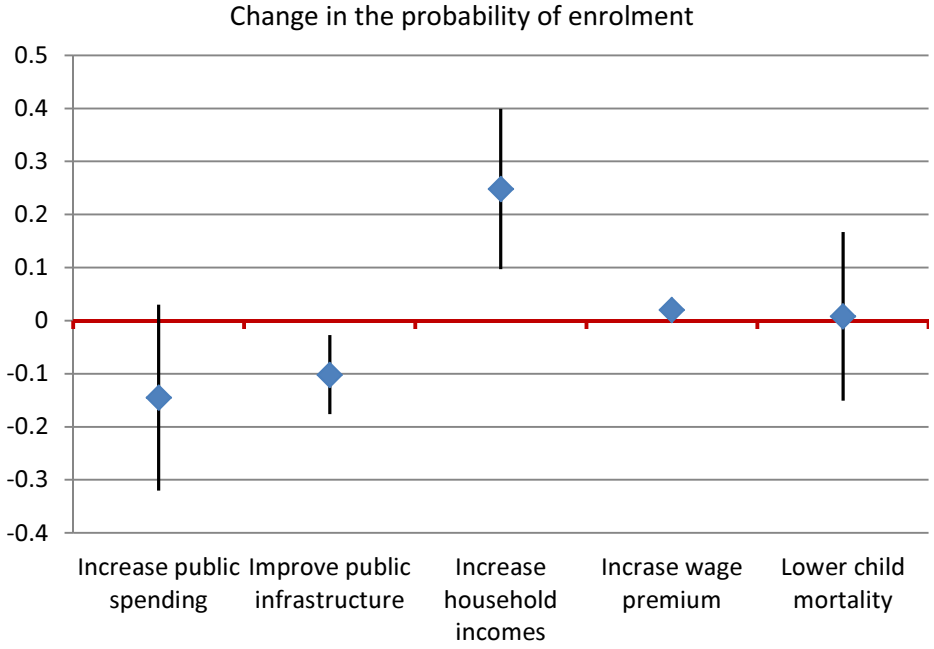
Where f = the estimated function; x_i = each independent variable i. In the case of categorical variables, the change is discrete as that variable switches from one state to another.

The reader will note that evaluating the effect of changes in one independent variable requires holding other variables constant, often at their mean values. This method of computing the marginal effect at means, or MEM, gives us the instantaneous rate of change of a variable on the probability of the outcome. In the case of a continuous variable, this instantaneous change is likely to be different than a larger unit or percentage change and the reporting a single marginal effect may not be useful. In addition to this, using the MEM approach may make little sense since it holds all other variables at their means and this may not represent any possible reality. In the example of a categorical variable, what does it mean to be 0.455 orphan? This should be considered when interpreting the results and evaluating the marginal effect at various levels would provide a more complete picture of the relationship.

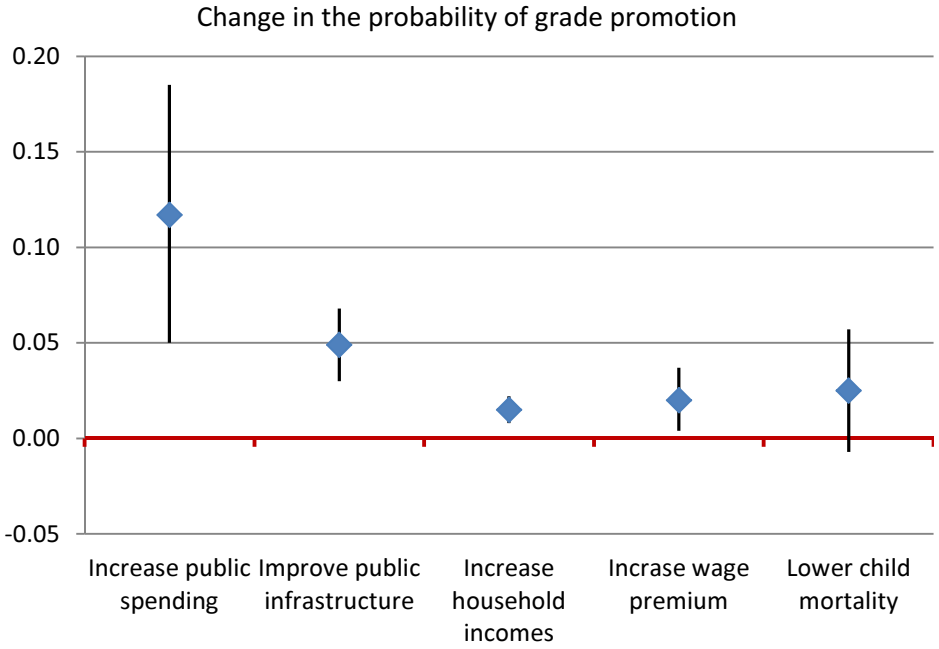
In many cases, such as in this present work, we require a single estimate of the elasticity. In order to have a better representation of the relationship and avoid the problems noted above, we compute the average of marginal effects, or AME. This involves estimating the marginal effects for all possible values of the other variables and then aggregating the results.

Annex II

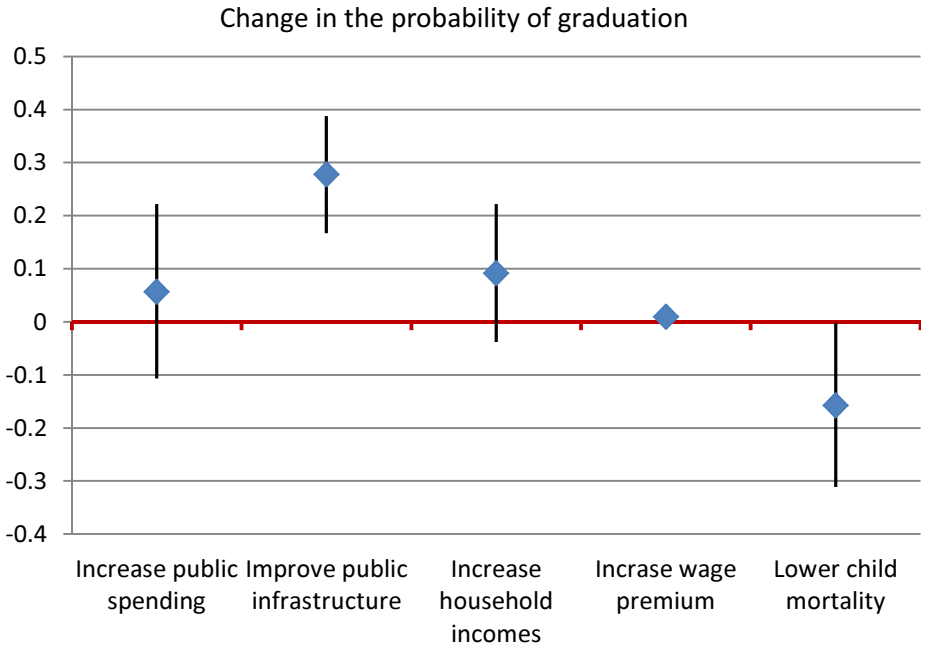
Summary of marginal effects of selected determinants of primary school enrolment



Summary of marginal effects of selected determinants of grade promotion in primary school



Summary of marginal effects of selected determinants of graduation from primary school



Annex III

Determinants for the probability that an individual receives a wage income

Variables	Coefficient
Completed Primary	-0.144**
Completed Secondary	-0.078
Completed Tertiary	0.322**
Age 18-24	-0.087
Age 25-34	-0.091
Age 35-44	0.203**
Experience	-0.003
Sex	-0.509***
Works in the public sector	1.358***
Works in the private sector	1.594***
Regional aggregates (depdom)	0.001
Log of wage income	-0.021
Constant	1.196***
N	10,872

* $p<0.1$; ** $p<0.05$; *** $p<0.01$

Annex IV

Additional returns to completing educational cycles

Department	Domain	Primary	Secondary	Tertiary
Atlántida	Urban	0.35	0.52	0.58
	Rural	0.29	0.22	0.06
Colon	Urban	0.27	0.28	0.67
	Rural	0.29	0.41	1.09
Comayagua	Urban	0.21	0.72	0.88
	Rural	0.34	0.68	1.07
Copan	Urban	0.52	0.62	0.52
	Rural	0.41	1.32	1.10
Cortes	San Pedro Sula	0.17	0.45	0.68
	Urban	0.24	0.40	0.55
	Rural	0.31	0.52	0.68
Choluteca	Urban	0.11	0.52	0.78
	Rural	0.23	0.61	1.10
El paraíso	Urban	0.40	0.41	0.53
	Rural	-0.18	0.39	1.19
Francisco Morazán	Central District	0.37	0.49	0.67
	Urban	0.06	0.35	0.31
	Rural	0.30	0.63	0.93
Intibuca	Urban	0.41	1.01	0.42
	Rural	-1.08	-0.27	1.93
La paz	Urban	-0.08	0.78	-0.04
	Rural	0.36	1.18	0.72
Lempira	Urban	0.07	1.10	0.38
	Rural	-1.31	0.14	3.35
Ocotepeque	Urban	0.09	0.71	0.40
	Rural	0.03	1.25	0.00
Olancho	Urban	0.38	0.65	0.44
	Rural	0.11	0.42	0.78
Santa Barbara	Urban	0.59	0.65	0.66
	Rural	0.11	1.18	0.16
Valle	Urban	0.53	0.11	0.82
	Rural	0.01	0.67	0.41
Yoro	Urban	0.43	0.33	0.67
	Rural	0.33	0.78	0.94
National average	**Urban**	**0.28**	**0.56**	**0.55**
	Rural	**0.03**	**0.63**	**0.97**
	Total	**0.17**	**0.59**	**0.75**