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Credit, Natural Disasters, Coffee, and Educational Attainment in Rural Honduras

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Summary. — This paper exploits a two-stage estimation approach to examine the impact on secondary school attainment in rural Honduras of four key variables affecting household choices: wealth, credit access, crop choice, and shocks. The first stage estimates the probability that a household is credit constrained, while the second estimates secondary school educational attainment of appropriately aged children. The second stage includes variables for crop selection and household wealth shocks from Hurricane Mitch in addition to other characteristics of the child, household, and community that can influence educational attainment. Credit-constrained households have lower educational attainment and are more likely to be adversely affected by negative shocks.

Key words — wealth, education, credit, natural disaster shocks, activity choice, Honduras

1. INTRODUCTION

International financial institutions, national governments, and non-governmental organizations are in the midst of a major push to improve the educational attainment of the poor throughout Latin America. The leading edge of that effort in Honduras is PRAF, The Family Allowance Program, which began as a joint undertaking of the World Bank, the Inter-American Development Bank, The International Food Policy Research Institute, and the Honduran national government (Glewwe & Olinto, 2004). [1] PRAF provides financial assistance to over 5,700 poor families in 70 of the poorest towns and villages in Honduras by conditioning cash transfer payments to these families on the school attendance of their children (PRAF, 2001). The rationale behind conditional cash transfer programs is to break the cycle of poverty by making school attendance attractive for poor families by increasing income levels and relaxing liquidity constraints. Major nationwide programs similar to PRAF have been developed in Mexico and Brazil, under the names Progresa and Bolsa Escola, respectively. Colombia, Chile, and Nicaragua also have similar programs in place (see Morley & Coady, 2003; Rawlings & Gloria, 2005 for recent reviews of these conditional cash-transfer programs).

This article examines the effect of four key factors on children's secondary school attainment in rural Honduras: wealth, credit constraints, crop choice, and a natural disaster (namely, Hurricane Mitch). It uses a panel dataset from households that spans 1994–2001 (Boucher, Barham, & Carter, 2005) [2] for a period that effectively precedes the implementation of PRAF. The main methodological contribution is an explicit treatment of the role of credit and its relationship to and interactions with these other key factors. In the first stage of the econometric model, credit constraints are examined, and in the second stage credit rationing outcomes are used as a treatment variable in the estimation of educational attainment. The paper's empirical contributions include highlighting the critical role of credit, the subtle effects of crop choice, and the contingent impact of shocks on secondary school attainment outcomes.

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Like most of Latin America, Honduras has recently achieved near universal enrollment in primary schooling (Bedi & Marshall, 2002), but not in secondary school where enrollment rates fall below 40% by high school (UNESCO, 1999). Similar trends elsewhere have increased policy attention on addressing enrollment in secondary school (Dubois, de Janvry, & Sadoulet, 2003). Our choice to focus on secondary school attainment is buttressed by the panel data that also show a precipitous decline in enrollment rates at the secondary level, which fall 25% points at both the middle and high school levels (see Appendix A1). The study focuses on a sample of 387 children who were between the ages of 13 and 18 in 2001, and includes 200 households with observations on the household's socio-economic situation in 1994 and 2001 including their wealth, credit constraints, and crop choices. The baseline data of 1994 are particularly propitious, because they reflect the wealth levels, crop choice, and credit conditions prior to the decision to invest in the secondary education of their children. The panel data from 2001 also provide information on wealth losses incurred during Hurricane Mitch, which occurred in 1998, and thus allows for an examination of the impact of a major household shock.

Basu (1999) provides a useful take-off point for understanding the roles of wealth, credit, and substitution of child labor for adult labor in shaping educational attainment outcomes. Wealth directly and indirectly shapes household investments in child education, because it influences the family's capacity to finance the associated costs either directly with income and assets or through access to loans or other forms of finance. The positive relationship between household wealth and child educational attainment in developing countries is well documented in works such as Filmer and Pritchett (1999), Patrinos and Psacharopoulos (1997), Sawada and Lokshin (2003), and Glewwe and Jacoby (2004). Similar results have been identified in Honduras (Bedi & Marshall, 2002; Cameron & Thorpe, 2000). Yet none of these studies examine explicitly the effect of credit constraints. While some explicitly subsume it into the wealth measure (because of the strong negative relationship between credit constraints and wealth), that approach overlooks both the potential for other sources of heterogeneity in credit constraints and the contingent role that credit can play in helping to overcome shocks. In that sense, our approach is novel to the educational attainment literature.

One of the primary concerns of the now vast child labor literature (Basu, 1999) is that children's capacity to substitute for adult labor (on or off the farm) can reduce their educational attainment by decreasing or eliminating the time and energy they have for participating in school. In rural areas, this substitution effect is shaped by household livelihood strategy, especially crop choice as well as by location (or distance from school). Examination of the relationship between crop or technology choice and child labor has generally shown that decreasing labor intensiveness corresponds to decreases in child labor and *ceteris paribus* increases in educational attainment (Galbi, 1997; Levy, 1985; Salazar-Carrillo, 1998). In our sample of rural Honduran households, nearly all grow food stuffs (maize and beans), while nearly 70% also cultivate coffee. Coffee cultivation could create an important substitution effect because of its strong potential for child labor use in trimming, weeding, and harvesting. Cameron and Thorpe (2000) found that households in Honduras that farmed coffee had higher educational attainment rates, but in their study coffee farming was also effectively a proxy for wealth, thus confounding livelihood strategies and wealth measures. There is another source of potential confound in the possibility that coffee cultivation and credit access are intertwined; institutions such as the Banco de Café in Honduras offer credit—not surprisingly—to farmers investing in coffee. This provides another rationale for explicit treatment of credit along with wealth and child labor substitution effects.

The fourth key factor in this study—shocks—has recently become an important theme in the literature on conditional transfer programs and education in developing countries (Bourguignon, 2000; De Janvry *et al.*, 2004; Duryea & Arends-Kuenning, 2003). The latter two articles suggest that programs such as PRAF were designed to help the chronically poor but not specifically to dampen the impact of temporary shocks. Yet, as Basu (1999) points out, the typical reason that children at least initially drop out of school to enter the labor market is not a long term problem, but rather short term crises that require money. Hurricane Mitch, which occurred in October of 1998, was essentially a temporary shock that affected 43% of the households in the study sample. Thomas (2004) and Rucci (2004) found that negative macro economic shocks decreased schooling in Indonesia and Argentina. However, Thomas (2004) found that households tended to maintain their investment in older children and Rucci (2004) found that the negative relationship was only seen in poorer households. This latter finding coincides with our specific interest in examining the interaction of shocks and credit in shaping education attainment outcomes.

Intuitively, Mitch's destruction might be expected to decrease educational attainment because of the wealth shocks experienced by some households. However, it is unclear what role such a large macro shock would have on educational attainment rates, because the economic destruction may also have decreased child labor opportunities. For example, Duryea and Arends-Kuenning (2003) and Binder (1999) in their respective studies of Brazil and Mexico found results suggesting that economic downturns actually increase school attendance rates. These papers conclude that the impact of own wage substitution caused from decreased job opportunities for children outweighs household income effects from the shock. Moreover, Hurricane Mitch was also followed by substantial but uneven flows of external aid that could have helped to sustain educational investment for many families. Having a better idea of the extent to which poor households' educational attainment are vulnerable to shocks would allow programs such as PRAF to modify their design to respond more effectively to crises or shocks. Moreover, identifying how credit constraints or the lack thereof affect the capacity of the household to pursue educational attainment following shocks is particularly important to the design of these programs.

The rest of the paper is organized as follows. Section 2 presents the two-stage treatment model of credit access and educational attainment. Section 3 provides a description of the data, specification of the model, and attention to endogeneity concerns. Section 4 gives the results of the estimation, while Section 5 concludes.

2. ECONOMETRIC APPROACH

(a) *SAGE measure of educational attainment*

Educational attainment is typically measured by current participation status in school or the number of years of school completed (Morley & Coady, 2003). The first measure has the advantage of identifying the current status of school age children, while the second portrays how many years of schooling children have obtained. Obviously, both are of interest in the examination of secondary school attainment outcomes. For those students who have not had a spell out of school, the SAGE measure adopted here from Patrinos and Psacharopoulos (1997) subsumes both features of those measures. It is calculated as follows:

$$\text{SAGE} = [S/(A - E)] * 100,$$

where S is the total number of years of school completed, A is the age of the child, and E is the age that children start school, which for Honduras is 6 years old.

A score of 100 means that a child is keeping up with the grade level expected for his or her age, and scores less than 100 mean that either the student has missed some school previously or is currently not participating.

For our analysis SAGE scores are useful measures because they highlight the long term educational attainment for older children who may still be in school. SAGE scores also reveal if a child has had a spell out of school, which current enrollment status does not. At the same time they correct for age, to allow easier comparisons of children who may have the same number of grades completed but are of different ages and are likely to have different educational attainments when they reach maturity. That said, SAGE scores are highly correlated with years of school completed. In our sample, the correlation between SAGE scores and years completed was over .91. [3] (For an actual comparison of the three measures of educational attainment in the sample, see the table in Appendix A1.) A careful look at those measures reveals that the SAGE score is non-monotonic in its evolution across age, with a notable dip for 9 and 10 year old children, which given their currently high enrollment rates may reflect the effects of Hurricane Mitch on their initial schooling attainment. Because of the non-monotonic nature of SAGE scores, age is controlled for in the econometric model directly.

(b) *A treatment model of credit constraints and educational attainment*

Our econometric model of educational attainment incorporates credit constraints using a two-stage model. Recent empirical work on educational attainment has begun to highlight the links between credit access and educational attainment; however, these works have not untangled the connection between credit and wealth effects (Beegle, Dehejia, & Gatti, 2003; Brown & Park, 2002; Jacoby & Skoufias, 1997). Specifically, they examine the effect on education of wealth and credit in frameworks that do not control for the potential endogeneity between credit and wealth. This paper attempts to confront the endogeneity directly through a two-stage estimation approach. Jacoby and Skoufias (1997) find that having access to credit helps Indian households maintain their child's school attendance in the face of weather shocks to crops. Brown and Park (2002) and Beegle *et al*. (2003) using samples of Chinese and Tanzanian households, respectively, focus only on credit access and education, but also find that credit access has a stronger impact on education than wealth.

A quick perusal of empirical research on the factors influencing educational attainment (Binder, 1998; Filmer & Pritchett, 1999; Ray, 2000) reveals that it identifies many of the same determining factors as does research on the determinants of credit access within a household, particularly household wealth and the education level(s) of the head(s) of household (Boucher *et al*., 2005; Sundaram-Stukel, 2005). Hence, one challenge in modeling the links between credit constraints and educational attainment stems from the prospect that in addition to these observed factors that influence both outcomes, there are also likely to be unobserved characteristics, which may influence both credit access and education investments. Unless controlled for, these unobserved characteristics lead to problems with standard two-stage methods of examining linked phenomena because of the potential correlation between error terms in the two estimations. The treatment effects model is a common way to control for correlation between error terms in a two-stage regression with an endogenous dummy variable, which is used in the estimation of another continuous fully observed variable (see Greene, 2000; Maddala, 1983). In our model, the endogenous dummy variable is a supply-side credit rationing measure, which is then used as a key regressor in the estimation of the child's SAGE score.

The formal model specification is as follows:

In the first stage, the probability of being credit rationed is estimated using a standard probit model, which is shown in the equation below [4]

$$\Pr(z_j = 1 \mid w_j) = w_j\gamma + \omega_i. \tag{1}$$

In (1), z_j is a dummy variable that takes the value of 1 if a household is credit rationed and 0 if it is not. This outcome is predicted by exo- genous variables w_j with coefficients γ and a random component ω_i, which comprises the error term of (1).

In the second stage, the child's educational attainment, $y_{j,i}$—their SAGE score—is estimated using a standard two-tailed tobit as shown below [5]

$$y_{j,i} = x_j\beta + z_j\delta + \varepsilon_i. \tag{2}$$

The dependent variable, $y_{j,i}$ is estimated using the value of z_j along with x_j which is a $K \times 1$ matrix of explanatory variables, with $\beta(K \times 1)$ unknown coefficients. We assume as hypothesized above that the error terms from the two stages are correlated with each other. Maddala (1983) shows that the bias which stems from the correlation between the error terms in the first and second stage can be controlled for by adding an inverse mills ratio (λ_j) that is constructed from the first-stage probit estimation. These inverse mills ratios are

$$\lambda_j = \phi(w_j\gamma)/\Phi(w_j\gamma), \quad \text{if } z_j = 1 \tag{4}$$

for credit rationed households.

$$\lambda_j = -\phi(w_j\gamma)/(1 - \Phi(w_j\gamma)), \quad \text{if } z_j = 0 \tag{5}$$

for non-credit rationed households.

where ϕ is the standard normal density function and Φ is the cumulative distribution function of the standard normal distribution. Thus, our empirical analysis of SAGE scores is based on the final second stage equation, which is specified as follows:

$$y_{j,i} = x_j\beta + z_j\delta + \rho\sigma\lambda_j + \mu_j. \tag{6}$$

McDonald and Moffitt (1980) have shown that β is not a measure of the marginal effects of x on y, because β does not take into account the probability that the expected value of y is within the specified range of the tobit. We therefore follow their specification of calculating the marginal effects in Eqn. (6) [6] for each of the direct effects measured in the variables denoted in x_j, by taking their coefficients (β) and multiplying them by the probability that the dependent variable is uncensored. The marginal effects on education of variables in the first stage are calculated in a similar way except that δ is used instead of β and is multiplied by the marginal effect of w_j on the probability of being credit rationed. For independent variables in both stages of the equation, the total marginal effects are calculated by summing the effects of the variable on education directly from the second stage and its impact on education through credit in the first stage at the variable means.

3. DATA, SPECIFICATION OF THE REGRESSION, AND ENDOGENEITY CONCERNS

(a) *Data description, basic specification*

The panel data set used is based on waves gathered in 2001 and 1994. [7] The sample was drawn from four departments in the Northwestern region of Honduras (Comayagua, Ocotopeque, Santa Barbara, and Yoro). From an overall panel of 362 households that were interviewed in both waves, 200 households are used in the analysis below. The reduced sample size results from including only households with children who are of secondary school age. The 200 households had 387 children between the ages of 13 and 18, and their mean SAGE score was 56.8 with a standard deviation of 28.2. In the sample, 21% of children had SAGE scores of at least 80, while 15% had scores less than or equal to 20.

Because the SAGE score data reflect the education attained during the 1994–2001 period, this study exploits initial values of key variables as exogenous measures. To be more precise, the children in the sample were secondary school age, 13–18 years old in the year 2001, which means they were of primary school age 6–11 years old in 1994. Because, the decision to leave school is generally made toward the end of primary school years, it is likely that the households would be making decisions on how much to invest in the secondary education of their children based on wealth, credit access and crop selection holdings in 1994.

Using the 1994 measures eliminates endogeneity problems associated with using contemporaneous wealth measures to predict education outcomes, and thus allows for the prospect that households may have used assets held at the outset of the educational choice period to finance or leverage investments in education. Likewise, credit access in 1994 could have allowed households either to finance child education through loans or as as Basu (1999) and Jacoby and Skoufias (1997) point out, having the ability to borrow may also have allowed families to send their children to school instead of using them as a buffer against shocks, particularly for the case of families near subsistence levels of wealth.

Definitions and descriptive statistics for the variables used in the empirical analysis are provided in Table 1. Some of the key variables used to predict educational attainment outcomes (SAGE scores) include credit rationing (*Credit94*), land and non-land wealth measures from 1994 (*CoffeeLand*, *OtherLand*, and *Wealth94*), and measures of the impact of Hurricane Mitch (*Mitch*) and aid received (*Aid*).

Additional control variables are added to the SAGE regressions for

1. Child characteristics: *Female*, *Age*, *Birthorder*, *ChildHead* which denote, respectively, gender, age, birth order and whether the head of the household is a parent of the child.
2. Household characteristics: *FemaleHead*, *EducHead*, *EducSpouse* which denote, respectively, the gender of the household head, the education level of the head of the household and their spouse.
3. *Travelschool* denotes the travel time in minutes to the nearest school, a commonly used measure of one of the direct costs of sending a child to school.

Table 1 also includes the definitions and descriptive statistics on variables used in the first stage model of credit rationing (*Credit94*). One inherent problem in measuring the impacts of both credit rationing and wealth on education is that wealthier households generally are less likely to be rationed. This necessitates including in the first stage credit rationing model wealth measures (*CoffeeLand*, *OtherLand*, *and Wealth94*) as well as other household characteristics that are likely to impact both education and credit access (*FemaleHead*, *EducHead*, *EducSpouse*). Without an instrument in the first stage regression to identify credit rationing outcomes that is unrelated to education outcomes, it would not be possible to disentangle the effects of wealth and credit in the second stage estimation. Here, an instrument for the distance to bank is used (*Travelhealth*).

Distance to bank is a good candidate for an instrument, because it is likely to be associated with rationing outcomes, but not schooling (as long as distance to school and bank is not strongly correlated). A proxy for distance to bank, travel time to health care facility, is used as an instrument in the first stage to predict credit rationing outcomes. The data collected in 1994 did not include distance to bank, but

Table 1. *Variables definitions and means*

Variable	Description	Year collected	Stage used	Mean	Stdv.
SAGE	100 * (years of school completed/(child's age − 6))	2001	Dependent second	56.79	28.22
WEALTH94	Per capita wealth not including land, in 1994 1,000s of lempiras	1994	Both	4.37	12.11
Mitch	Losses from Mitch divided by 2001 wealth	2001	2	9%	0.32
Mitch * Credit01	Shock credit interaction: equals MITCH if credit rationed in 2001, or else 0	Both	2	0.04	0.27
Aid	Aid received from Mitch divided by 2001 wealth	2001	2	1%	0.03
CoffeeLand	Manzanas of coffee land owned	1994	Both	3.28	5.10
OtherLand	Manzanas of non-coffee land owned	1994	Both	14.00	30.50
Adults	Number of adults in household	1994	Both	3.41	1.91
Coffee	1 if household farms coffee, or else 0	1994	Both	76%	0.42
Credit94	1 if credit rationed, or else 0	1994	2 and dependent first	0.39	0.49
Female	1 if female child, 0 if male	2001	2	51%	0.5
Birthorder	Child's birth order (0 if child's parent is not the household head)	2001	2	1.4	1.26
Children94	Number of children	1994	Both	4.36	2.5
Age	Age of child in years	2001	2	15.67	1.7
FemaleHead	1 if female head of household, 0 if male	2001	Both	8%	0.28
EducHead	Education of household head in years of school	2001	Both	2.54	3.07
EducSpouse	Education of household spouse in years of school	2001	Both	2.42	2.75
AgeHead	Age of household head	2001	Both	56.4	13.1
ChildHead	1 if child of head, 0 if not	2001	2	0.73	0.44
TravelSchool	Travel time to nearest secondary school in minutes	2001	2	24.87	31.1
TravelHealth	Travel time to nearest health clinic in minutes, a proxy for distance to bank divided by 10	1994	1	8.54	8.49
COMOY	Departmental dummy variable	2001	1	0.49	0.50
OCOT	Departmental dummy variable	2001	1	0.13	0.35
YORO	Departmental dummy variable	2001	1	0.12	0.32

Bold indicates variables that are dichotomous dummy variables.

that information was collected in the 2001 survey. The 2001 data show a strong correlation (.68) between household distance to the nearest healthcare facility and distance to the bank, but a much weaker correlation between distance to the healthcare facility and the school (.15). Thus, we use travel time to healthcare facility (*TravelHealth*) as a proxy for bank distance in 1994 in the first stage estimation of credit rationing to help with identification.

(b) *Descriptive statistics for key variables*

A quick look at descriptive statistics for the key variables is illustrative of the factors influencing educational attainment. For example, the effect of wealth on education is apparent from the descriptive statistics provided in Table 2. To measure a household's non-land wealth in 1994 (*Wealth94*), we aggregated the value of livestock, farm equipment, and business assets. Households with per capita non-land wealth of over 1000 lempiras per capita had SAGE scores 8.9 points higher than the average of the sample, or about 15% higher than the average score. [8]

A pronounced difference in SAGE scores is also evident in the credit rationing variable. To measure credit rationing, we utilize the same measure as Boucher *et al.* (2005), where a household is defined as rationed and given a value of one if they did not obtain a formal loan and reported that they could not have received one if they had applied. Otherwise, the household is given a value of zero. In the sample, 61% of the households reported that they were not rationed in 1994. For households that were credit rationed, their children's SAGE average scores are 11 points below children in households that were not credit rationed. [9] Table 3 shows that being credit rationed in 1994 had a greater impact on school enrollment in 2001 than being credit rationed in 2001.

To capture the relative wealth loss (*Mitch*) for an individual household from Hurricane Mitch, we divide the total loss of permanent

Table 2. *SAGE means by key variables*

	Count of children	Mean SAGE (2000)	Stdv. SAGE (2000)
Non-land wealth percapita (1994)			
Under 100 lempiras	143	53.9	29.2
100–1000 lempiras	99	49.7	27.0
Over 1000 lempiras	144	64.2	26.3
Household choice (1994)			
Does not farm coffee	91	62.7	28.1
Farms coffee	296	54.9	28.0
Coffee land holdings			
.01–1.5 manzanas	92	44.6	29.0
1.5–4 manzanas	107	60.5	24.0
Over 4 manzanas	97	58.6	28.8
Credit access (1994)			
Not credit rationed	238	61.0	28.4
Credit rationed	151	50.2	26.0
Mitch effect			
No loss	221	54.4	28.0
0–10% of wealth lost	114	62.2	26.5
Over 10% of wealth lost	54	55.2	31.1

Table 3. *Comparison of household credit rationing in 1994 and 2001 by child*

		Rationed in 1994			
		No		Yes	
		Percent	Average SAGE	Percent	Average SAGE
Rationed in 2001	No	51%	62.3	24%	51.9
	Yes	10%	54.5	14%	47.3

assets associated with Mitch by the household's wealth from 2001. [10] These losses were the sum of lost livestock, business capital, farm equipment, land, housing, as well as wages, medical bills, and funeral costs for those who were injured or died as a result of the Hurricane. The average relative wealth loss (*Mitch*) was .09 or 9% of household wealth, with a standard deviation of .31. In the sample, 57% of households had no losses, and 29% had a loss of between 0% and 10% of wealth, and 14% had losses greater than 10% of wealth. The comparison in Table 2 of SAGE scores with losses from Hurricane Mitch does not provide as clear of a picture as with the other two key variables. In the econometric analysis, we also include an interaction term between shocks and credit and a variable (*Aid*) which is the total aid received divided by the household's wealth.

The final core variable of interest is livelihood strategy. For most of these rural households, the choices include off-farm wage labor or small enterprises, farming coffee, or farming other crops. In order to test for the substitution effect in the education attainment stage, we include a dummy variable (*Coffee*) that takes a value of one if the household farmed coffee in 1994 and zero if they did not. About 76% of the households in our sample grew coffee in 1994, and contrary to Cameron and Thorpe (2000) we find that children who live in households that farmed coffee have SAGE scores that are lower by about seven points (see Table 2). However, children in households that have at least 1.5 manzanas of coffee land per adult have SAGE scores about as high as those that do not farm coffee. The wealth effect of coffee and other lands is controlled for both directly and indirectly in the regressions by including them in both stages, using separate (manzana) measures of coffee land holdings (*CoffeeLand*) and other agricultural land holdings (*OtherLand*).

(c) *Other possible endogeneity issues*

We also consider here two other possible endogeneity concerns related to the shock variable, Mitch, and the crop selection variable, *Coffee*. For *Mitch*, we regressed it against credit, wealth, and coffee cultivation, and none of the estimated coefficients were statistically significant (see Appendix A2). These regression results also show that relative economic isolation as measured by travel time to the nearest school had no significant effect on the shock measure. One variable that did have a significant and positive effect was the number of adults in the household in 1994. More adults were associated with a higher relative shock measure, probably because the losses also included lost wages and potential wages, so households with more labor had more to lose in labor opportunities. Yet these households with more adults would also have more labor available to smooth education consumption after a shock.

An examination of the panel data shows that over 90% of the households that farmed coffee in 1994 continued to farm coffee in 2001. Furthermore, since coffee plants take several years to generate yields, any investment in coffee was likely made before the child's birth. Therefore, it is unlikely that crop selection in 1994 was endogenous to schooling decisions from 1994 to 2001 and we treat crop selection as an exogenous variable. An attempt was made to create instruments for the decision to cultivate coffee based on the household's endowment at the time of formation; however, these instruments were weak and did not change the results substantially.

4. RESULTS

The coefficient estimates of the two-stage estimation are reported in Table 4; Table 5 presents the marginal effects of the coefficients. Two variations of the model are shown in Table 4. The first is the basic model without shock-credit interactions. The second includes *Mitch* ∗ *Credit01*, an interaction term between the magnitude of the shock and the credit constraint measure. Because the shock occurred closer to the second observation of the panel, we used an exogenous switching measure for credit rationing status from the 2001 sample for this interaction term. [11]

Our results across the two model variants show a strong relationship between credit rationing, wealth, and educational attainment. As predicted wealth is a key factor in determining credit rationing as both non-land wealth (*Wealth94*) and coffee land holdings (*CoffeeLand*) are negatively correlated with being credit rationed. However, none of the wealth measures were significant in the second stage prediction of SAGE scores. It is noteworthy, and perhaps not surprising, that in a single stage regression on educational attainment that omits the credit constraint term and uses wealth

Table 4. *Results of two stage regression on SAGE scores*

Variable	Model 1		Model 2	
	Estimate	(SE)	Estimate	(SE)
Wealth94	0.20	0.16	0.22	0.16
MITCH	**−12.76**	**4.16**	4.50	10.71
MITCH * CREDIT00			**−25.54**	**12.29**
AID	−7.82	35.57	−4.59	34.46
CoffeeLand	0.20	0.49	0.08	0.50
OtherLand	−0.03	0.05	−0.02	0.05
Coffee	**−8.59**	**4.43**	**−7.82**	**4.53**
Adults	0.19	0.96	0.46	0.99
Credit94	**−8.80**	**3.65**	**−8.46**	**3.61**
Female	**7.77**	**2.66**	**7.49**	**2.63**
BirthOrder	2.36	1.47	2.33	1.48
Children94	−0.44	0.66	−0.30	0.68
Age	**−4.41**	**0.76**	**−4.31**	**0.74**
FemaleHead	−0.80	5.92	−0.04	5.72
EducHead	**1.96**	**0.69**	**1.98**	**0.69**
EducSpouse	**2.10**	**0.63**	**2.07**	**0.63**
AgeHead	**3.60**	**1.55**	**3.57**	**1.52**
ChildHead	−0.86	4.28	0.27	4.25
TravelSchool	**−0.23**	**0.05**	**−0.23**	**0.05**
Constant	**101.68**	**17.15**	**97.45**	**16.80**
SIGMA	**24.52**	**0.96**	**24.17**	**0.94**
RHO	**0.81**	**0.15**	**0.75**	**0.16**
First stage				
Wealth94	**−0.07**	**0.03**	**−0.07**	**0.03**
CoffeeLand	**−0.26**	**0.05**	**−0.26**	**0.05**
OtherLand	**−0.02**	**0.01**	**−0.02**	**0.01**
Coffee	−0.10	0.25	−0.10	0.25
Adults	0.04	0.05	0.04	0.05
EducHead	**−0.15**	**0.04**	**−0.15**	**0.04**
FemaleHead	**0.56**	**0.27**	**0.56**	**0.27**
COMOY	0.15	0.19	0.15	0.19
OCOT	0.22	0.27	0.22	0.27
YORO	**0.63**	**0.27**	**0.63**	**0.27**
AgeHead	0.11	0.07	0.11	0.07
EducSpouse	0.00	0.00	0.00	0.00
TimeHealth	**−0.01**	**0.00**	**−0.01**	**0.00**
Constant	**0.17**	**0.55**	**0.17**	**0.55**

Bold indicates significance at 5% level, bold and italics indicates significance at 10% level.
$N = 387$.

measures that the wealth coefficient estimates are all significant. An examination of Table 5 shows that the net marginal effects of wealth on educational attainment are positive and significant, but overall the results suggest that these impacts are coming through their impact effect on credit access. The identification of the credit rationing estimation is buttressed by the finding that the proxy for bank distance (*TravelHealth*) is statistically significant in the expected direction; that is, those farther from banks are more likely to be credit rationed.

In Table 4, the credit-rationing variable (*Credit94*) is significant at the 5% level in predicting SAGE scores. The marginal effects estimate in Table 5 predicts that not being credit rationed is associated with an increase in SAGE scores of about 14 points. In addition, the use of the two-stage model is supported by the significant and positive estimate on Rho, the measurement of the correlation of error terms in the two stages. The positive coefficient estimate of Rho suggests that household's unobservable factors, which lead to credit rationing, may also

Table 5. *Marginal effects*

Variable	Model 1		Model 2	
	Estimate	(SE)	Estimate	(SE)
Variables in second stage				
Mitch	**−12.14**	**3.77**	5.23	6.47
Mitch * CREDIT01			**−24.99**	**7.60**
AID	−7.80	37.20	−4.57	36.70
Credit94	**−14.84**	**5.98**	**−14.30**	**5.89**
Female	**8.13**	**2.33**	**7.78**	**2.30**
BirthOrder	***2.43***	***1.30***	***2.38***	***1.28***
Children94	−0.49	0.53	−0.39	0.53
Age	**−4.11**	**0.69**	**−4.05**	**0.68**
ChildHead	−0.43	3.90	0.67	3.86
TravelSchool	**−0.22**	**0.04**	**−0.21**	**0.04**
Constant	**102.08**	**14.94**	**97.83**	**14.79**
Sum of effects for both stages				
Wealth94	**0.46**	**0.12**	**0.47**	**0.12**
CoffeeLand	**0.92**	**0.37**	**0.77**	**0.36**
OtherLand	0.04	0.05	0.04	0.05
Adults	0.49	0.71	0.75	0.70
Coffee	**−6.83**	**3.66**	**−6.07**	**3.61**
FemaleHead	−3.22	4.94	−2.37	4.87
EducHead	**2.20**	**0.55**	**2.26**	**0.54**
EducSpouse	**2.14**	**0.57**	**2.09**	**0.56**
AgeHead	**3.35**	**1.27**	**3.37**	**1.25**

Bold indicates significance at 5% level, bold and italics indicates significance at 10% level.
$N = 387$.

be associated positively with investments in children's education. One possible explanation for this outcome is that a household orientation toward pursuing non-agricultural activities in these rural areas might be associated with lower credit availability (where formal loans are primarily for agriculture) and thus with higher investment in children's education (less substitution effect).

The importance of credit constraints is further underscored by the significant estimate for the interaction term between credit access and shocks. In model 1, which does not include the interaction term, households with larger shocks from Mitch had lower SAGE scores. In the second model when the interaction term *Mitch * Credit01* is added, this interaction term is significant and negative (i.e., credit constrained households with larger losses have lower education attainment outcomes). Moreover, in this second model, the shock term, *Mitch*, is not significant, suggesting that it is the combination of the shock and credit rationing status that matters most in shaping educational attainment outcomes. Combined, these results demonstrate that credit rationing and wealth effects though closely related may also be confounded in papers that do not attempt to distinguish between the two effects.

The coefficient estimate of the coffee dummy variable (*Coffee*) in the second stage is consistent with the results in the descriptive statistics for the first two models in the second stage, which shows a negative relationship between coffee farming and education. However, adopting coffee also increases access to credit; therefore, when the total marginal effects are summed the results suggest that households with smaller coffee farms (less than about 2 manzanas) may have lower education, but those with larger coffee land holdings do not have lower SAGE scores compared to households without coffee.

Finally, we consider the effects of child, household, and community characteristics on SAGE scores. In the second stage of the regression, child characteristics such as gender and age are positive and significant at 5%. As suggested elsewhere, girls of secondary school age in Honduras have higher educational attainment than boys, about eight SAGE points. These findings are also consistent with the substitution effect, as it is likely that males and older children would have a higher potential earning power in rural areas, and thus be less likely to opt out of school and into the labor market. These results may differ in urban areas, or more industrialized rural areas, where girls are more likely than boys to be hired to work in factories and thus girls would have a higher opportunity cost of education. Of the household characteristics, only education of the household head and spouse was significant and positive in their effects on educational attainment. The total marginal effects suggest that each additional year of school for a household head or spouse is associated with an increase of about two SAGE points. The community characteristic, *Travelschool*, was significant and negative in its effect on educational attainment. The marginal effect of a decrease in a child's travel time to school by one standard deviation (31.1 min) would lead to an expected increase of over six SAGE points.

5. CONCLUSION

In the conceptual and econometric framework, we hypothesized that credit rationing and wealth played a vital role in the ability of a household to educate their children. The results show that both are important, but that wealth impacts education mainly through decreasing the likelihood of a household being credit rationed. We also hypothesized that there may be unobserved characteristics of a household that affect credit and education outcomes, and motivated a two-stage econometric approach, which controlled for these unobservables in order to better examine the link between credit access and education. The results from our econometric model support the use of a two-stage approach as the error terms of the two stages are indeed significantly correlated, though perhaps not in the anticipated direction.

This study also examined the effects of shocks, specifically that of Hurricane Mitch. In our first model, this shock independent of credit access showed a significant influence. However, once we include an interaction term between credit access and the shock from the Hurricane, then the influence of the shock was only significant for those rationed in credit markets. This result along with the strong direct link between credit access and educational attainment would imply that improving liquidity either via direct transfers or the existing micro credit program loans for households that have just faced a temporary shock could be useful policy tools to augment the work of conditional transfer programs that aim to support educational investments by poor families. In other words these programs could have positive effects on education whether or not households face shocks. When they actually do, our results show directly that credit rationed households hit by a shock were likely to remove their children from school, which supports the potential for an *ex post* credit program to have positive impacts. In addition, as Basu (1999) suggests knowledge of the potential credit access may also allow poor households to send their children to school without losing the buffer children's income provides against negative economic shocks. While we have not shown that counterfactual effect directly, the positive effect of credit access on education is quite consistent with that conclusion.

Our findings give ambiguous results in terms of the effect of crop selection on educational attainment. We found in the second stage that households that farm coffee have lower SAGE scores, which counters a previous study by Cameron and Thorpe (2000). However, the effect in the second stage is overcome by the positive impact of coffee adoption on credit access which thus indirectly increases education. The combination of the direct effects in the second stage and indirect effects in the first stage shows that overall coffee has a positive significant net impact on educational attainment for household with larger coffee land holdings, but a negative impact for those with smaller land holdings. These results give further evidence to credit's crucial role in educational attainment, because without the increased credit access our results suggest that households farming coffee would have lower educational attainment.

Our results also confirm several influences that are common to the educational attainment literature. We found that children who live closer to a secondary school had higher educational attainment. This result implies that lower attainment is also affected by a lack of supply of affordable educational opportunities. We also found that similar to other studies children who lived in a household headed by a more educated person had higher SAGE scores. This suggests that increasing the educational outcome of the current generation will likely increase the educational attainment of future generations. Overall, the results of this analysis are hopeful, especially for the potential of conditional transfer programs to help break the vicious cycle of low educational outcomes in rural Honduras and elsewhere in Latin America both directly through the income and liquidity support they provide to poor households and potentially in combination with measures that further shore up the capacity of those households to withstand negative shocks.

NOTES

1. A change in government in 2002 led also to a change in the contracting non-governmental organizations and the overall organization of PRAF. Details on the new program organization are under investigation.

2. The dataset was gathered as part of an ongoing study of land and credit market reforms in rural Honduras, and so includes a wide range of relevant variables on household wealth, credit access, crop choice, demographics, education investment, and the like.

3. The final results and conclusions of the empirical analysis do not differ dramatically if SAGE scores or years of school completed are used.

4. The first stage is estimated at the household level, since credit access is estimated on the household level. Inverse mills ratios are then calculated for the second stage and the regression is run with all 387 children.

5. A two-tailed tobit is used, since SAGE scores range from 0 to 115; however, treating SAGE scores as a continuous variable does not substantially change the results.

6. In Eqn. (6), μ is the unobserved error term. As specified in Greene (2000) and Maddala (1983), we assume that ε and u_j are bivariate normal with mean zero. The covariance of the error terms is represented by ρ, while the variance of ε, standardized by the variance of u, is represented by σ.

7. The European Community, US AID, and the World Bank sponsored the 2001 data gathering effort. The former was surveyed by Ramón Lopez and the World Bank in 1994.

8. One manzana is equivalent to 1.68 acres. One US dollar was equivalent to between 14.2 and 15 Honduran Lempiras in the year 2000.

9. This difference is significant at the 5% level using a standard t-test.

10. Ideally we would have used a measure of wealth before Hurricane Mitch, however, of the two samples the one taken after Hurricane Mitch is closer. One possible problem with this measure could be that the household with credit access could recover faster and might have higher wealth levels in 2000 than those without credit access. However, the data do not provide evidence to support this problem as the size of MITCH appears to be unrelated to credit access in 1994. In the sample correlation between Credit94 and MITCH is .07, and the difference in the means of MITCH for those rationed and those with credit access is not different from zero using a simple t-test.

11. Although the criteria for being credit constrained were the same in both the 1994 and 2000 observations, the correlation between the rationed variables in 1994 and 2000 was only .22.

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APPENDIX A1. SAMPLE MEANS BY AGE OF THREE DIFFERENT EDUCATION MEASURES

Level	Age	Count of children	Percent enrolled	Average years of school completed	Expected years of school completed	Average of SAGE
Primary school	7	31	90%	0.42	1	41.94
	8	30	100%	1.53	2	76.67
	9	42	95%	1.67	3	55.56
	10	36	83%	1.85	4	46.32
	11	48	83%	3.33	5	66.67
	12	41	90%	4.25	6	70.83
Middle school	13	55	64%	4.76	7	67.99
	14	71	58%	5.36	8	66.98
High school	15	56	39%	5.73	9	63.69
	16	55	35%	5.71	10	57.09
	17	64	27%	5.61	11	51.00
	18	85	27%	6.19	12	51.58
Total		614	59%	4.38		59.63

APPENDIX A2. ENDOGENEITY OF THE SHOCK MEASURE ***MITCH***

Mitch, our measure of the relative hurricane losses within the household, is treated in the analysis as exogenous to other key variables, namely credit, wealth, and coffee adoption. To support this assumption, we ran an OLS regression using *Mitch* as the dependent variable on the 200 households within the sample, and found that none of the key variables had statistically significant coefficients (see Table 6).

Table 6. *OLS on Mitch with other key variables*

	Estimate	(SE)
Wealth94	−0.0001	0.0002
Adults	**0.0296**	**0.0124**
Credit94	−0.0465	0.0462
Coffee	0.0535	0.0500
TravelSchool	−0.0004	0.0007
Constant	−0.0130	0.0709

Bold indicates significance at 5% level. Number of observations: 200 households. *R*-square: .05.