# Hurricane Mitch, Family Budgets and Schooling in Nicaragua

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August 2005
Revised April 2006

* This paper is prepared for the Inter American Development Bank conference to be held on February 10th, 2005 in Washington D.C. Contact information: Manuelita Ureta, Department of Economics, Texas A&M University, 4228 TAMU, College Station, TX 77843-4228, 979-847-9449 (Tel), 979-847-8757 (Fax), Manuelita.Ureta@tamu.edu (Email). **This is a preliminary and incomplete version—please do not cite without notifying the author.**

## 1. Introduction

Hurricane Mitch hit Nicaragua in November of 1998. I exploit the unique opportunity afforded by Mitch to measure the impact of a truly exogenous change in the family budget on children's and teenagers' advancement through the school system. Also, I examine the palliative role played by remittances in the wake of the hurricane. Mitch spared some areas of Nicaragua; families residing in those areas serve as control group in this "natural" experiment. I find that in rural areas, between the years 1998 and 2001, the estimated survival function for school enrollment for the "treated" children improves less than for the control group at every grade level from grades 1 through 6. While incomes of the treated families in the rural areas had recovered by 2001, the stagnation in income growth in the aftermath of the hurricane appears to have had a lasting effect on school retention for rural children. In urban areas, the survival functions decline about equally for the children in the treatment and the control families. The worsening in school retention of urban children occurred despite considerable growth in incomes by 2001.

The literature on schooling has emphasized the role of parental resources and innate ability in explaining differences in school attainment, yet the empirical literature has been unable to identify separately these two effects. Researchers use measures of parental schooling to proxy children's innate ability, but parental schooling may capture simultaneously innate ability, motivation and the capacity to generate income. Most studies find a strong correlation between parental schooling and children's education, but the correlation between household income (typically measured with error) and schooling has been found to be small. An empirical study that succeeds in isolating the separate effects of parental budgets and of parental schooling can shed light on the relative importance of these two variables on children's retention in school. This is important for policy purposes. There is little a government can do about the levels of parental education of today's children. But, if there is evidence that the demand for children's schooling responds to income or price changes, the scope and potential success of government policies aimed at increasing levels of school attainment are enhanced greatly.

Remittances are an increasingly important source of foreign exchange for Nicaragua. According to the Central Bank, remittances grew steadily in the 1990s, from 15 million US dollars in 1990 to 150 million in 1997. Family remittances financed an increasing fraction of total imports, reaching 11 percent in 1997. Many Nicaraguans working abroad send remittances to their families to complement household

income: in the year 2001 one in every four urban households and one in ten rural households received remittances from abroad. I find that, of the families affected by hurricane Mitch, on average only those residing in urban areas increased their reliance on remittances as a source of income relative to families in the control group.

The rest of the paper is organized as follows. Section 2 provides a brief review of the literature on parental resources and children's schooling. Section 3 presents Jacoby's model (1994) linking family income to children's schooling in the context of credit rationing. Section 4 describes the educational system in Nicaragua. Section 5 describes the data, and section 6 presents results and conclusions.

## 2. Literature Review

Most studies find a strong correlation between parental schooling and children's education, but the correlation between family income and schooling has been found to be small. Examples are the works of Behrman and Wolfe (1984), Parish and Willis (1993), and Lillard and Willis (1994). Haveman and Wolfe (1995) review a number of studies on the determinants of years of schooling based on US data and report that income elasticities have been estimated in a range from 0.02 to 0.2. They believe this result is likely explained by the measurement error in the family income variable. Yet, Hill and Duncan (1987) measure family income carefully and report an elasticity of 0.1.

Studies for developing countries suggest that credit constraints are crucial determinants of schooling. Jacoby (1994) uses data for Peru to estimate the effect of family income on the probability of withdrawing from school. He finds that "children from households with lower incomes, with less valuable durable good holdings, who have more closely spaced younger siblings, adjacent older male siblings, and greater childcare responsibilities begin withdrawing from school earlier." Edwards and Ureta (2003) estimate the effect of family income and of remittances on the hazard of dropping out of school using data for El Salvador, and find that the effect of remittances is significantly larger than that of income. They argue that, unlike family income, remittances are uncorrelated with parental schooling, and thus, are a better proxy for a pure income effect. Thomas *et. al.* (2004) examine the impact of the Indonesian financial crisis of 1998 on household spending on education and school enrollment of school-aged individuals. They find that spending on education declined, most dramatically among the

poorest households. Also, "poor households apparently sought to protect investments in the schooling of older children at the expense of the education of younger children."

## 3. Jacoby's Model

The literature on schooling has emphasized the role of family income and innate ability in explaining differences in school attainment. It is generally assumed that parents make schooling decisions on behalf of their children ages 18 or younger, and that children's schooling adds to the well being of parents. Becker and Tomes (1976), for example, assume that the "quality of children" is a normal good in parents' utility functions, and that, as income increases, the demand for children's quality goes up. This translates in a positive relation between parent's income and schooling that varies across children as a function of other specific factors such as innate ability.

An alternative avenue that links family income and children's schooling is to assume that parents altruistically value their children's consumption, and that maximization of the family's consumption requires optimum investment in children's human capital. Investment in schooling is optimally done at an early age—when the opportunity cost of the student's time is lowest—and continues until the rate of return to an additional year outweighs the cost (Ben-Porath (1967)). The cost of an additional year of schooling depends on the child's earning capacity, the ability to borrow and parental resources. If families face a higher opportunity cost of funds children drop out of the school system at an earlier age.

In Jacoby's model (1994) parents have perfect foresight and they value a unit of consumption equally whether the child or they consume it. Then, parents' utility $U$ is a concave function of total family consumption $C(t)$. The (only) child is eligible to enroll in school at time zero, when parents maximize discounted life-time utility by choosing $S(t)$, the fraction of time the child will spend in school each year, and $C(t)$. The human capital of the child, $H(t)$, is a homogenous stock of embodied knowledge; parents place no value on it after they die at time $T$.

The parents' maximization problem is given by equations (1) through (4). Equation (1) corresponds to discounted life-time utility, where $\delta$ is the rate of time preference. Equations (2) through (4) outline the constraints the parents face.

(1) $\max \int_0^T U(C(t))e^{-\delta t}dt$

subject to:

(2) $\dot{A}(t) = rA(t) + y + wH(t)[1 - S(t)] - C(t).$

$A(0) = A_0, A(T) = 0$

(3) $\dot{H}(t) = bH(t)S(t)$

$0 \le S(t) \le 1, H(0) = H_0$

(4) $A(t) \ge \underline{A}, \underline{A} \le 0$

Family income has two components, (constant) parental income, $y$, and child earnings, $wH(t)[1-S(t)]$, where $w$ is the market rental price of human capital, or, alternatively, the value of child human capital in home production. Then, the evolution of net financial assets, $A(t)$, is governed by equation (2) under the assumptions of a constant market interest rate $r$ and no school fees, so that $wH(t)S(t)$ is the only cost of attending school.

Equation (3) describes the evolution of the child's human capital. The model assumes a constant returns to scale production function where $H(t)S(t)$ is the only input and the parameter $b$ reflects either student ability or school quality or both. The condition $b > \max(r, \delta)$ insures the child will enroll in school. Finally, the borrowing constraint is given by equation (4), where $\underline{A}$ denotes the maximum net indebtedness available to the family.

The ability to borrow combined with constant returns to scale imply a simple schooling plan: the child attends full time ($S^*(t) = 1$) and then quits at a certain point. Part time schooling is never optimal and the timing of human capital investment is independent of parental income.

Jacoby's model was the first to introduce credit rationing while addressing the timing of schooling. Note that in this model credit rationing does not require that the direct costs of schooling be positive. In the model, when the credit rationing constraint is binding, i.e., $A(t) = \underline{A}$ and $A(t)$ is not optimal, the separation between consumption and human capital decisions breaks down. The optimal solution in this case calls for part time schooling, as the total years of school enrollment, $t_1^*$, remains unchanged.

Typically, part time schooling results in a higher probability of retention in grade. Thus, in the data the effect of the borrowing constraint does not show up as decreased enrollment but rather as a decreased probability of promotion to higher grade levels, conditional on enrollment.

As documented below, Hurricane Mitch decreased family income. This change, when fed to Jacoby's model, implies an earlier starting date for part time schooling for children in families that are credit-constrained. To look for evidence of this effect, I estimate survival functions for school enrollment. Note that, even if the decrease in family income has no effect on the optimal total number of years of school enrollment for a given child, an earlier onset of part-time schooling will have an effect on the survival function. This is because an earlier onset of part-time schooling increases the likelihood of retention in grade which, in turn, necessarily implies a lowered conditional probability of advancing to higher grade levels. Put differently, Jacoby's model is silent about enrollment rates per se, but has a direct implication about the behavior of the survival function.

## 4. The Nicaraguan Educational System

Nicaragua is the second poorest country in the Latin American and Caribbean region after Haiti, with a *per capita* GDP of US$750 in 2003. The country's population of about 5 million is approximately evenly divided between rural and urban areas.[2] Access to education had been limited, particularly in rural areas, until the 1980's when the Sandinista Revolution made education a political banner. During the early 1980's there was a significant expansion of coverage, coupled with major changes in curricular content aimed at spreading "revolutionary" ideas. Sadly, by the late 1980's the early gains in expansion of coverage were lost in the midst of severe budgetary cuts and the heavy toll of the war.[3]

The transition to democracy in the early 1990's began with an educational system extended beyond fiscal means, heavily politicized, and showing dismal indicators of performance. Table 1 reports the percentage of children eventually completing primary school. Remarkably, in 1990 only 19 percent of children completed the primary school cycle. During the decade of the 1990's significant progress was made: in Table 1 we see that by 2003 the Nicaraguan government estimates that 40 percent of children

[2] The 1995 Census estimated the rural population at 1.9 million, or 43% of total population in that year.
[3] After 40 years of political control by the Somoza family, a revolution in the 1970's brought to power the Sandinistas. The Sandinista government was confronted by the US sponsored contra guerrillas through much of the 1980's and was defeated in free elections in 1990, 1996, and again in 2001.

eventually complete the primary cycle. In the short span of a dozen years, the completion rate doubled. The figures in the table also show a gender gap in completion of primary schooling: girls had a 5 percentage-point advantage in 1992 that widened to 8 percentage points by 2003.

Children may attend private schools, traditional public, and autonomous public schools. After the fall of the Sandinista regime in 1990, the new government reformed the educational system to rid the curriculum of ideological content and to increase retention rates in the early primary grades. The initial reform was followed by a decentralization of the educational system. The key legal element used was the introduction of school autonomy. School autonomy was based on three elements: (i) a fiscal transfer to schools based on technical and equity criteria, (ii) parental control of the fiscal transfer at the school level, and (iii) full authority of the local school council over hiring and firing decisions.

A school must sign an agreement with the Ministry of Education (MED) to become autonomous. Then, the school receives a monthly transfer of funds based on a formula that takes into account the number of students, the location of the school, and the school's record on retention in grade and dropouts. The school has complete control over the use of the funds, as long as it complies with some technical requirements, such as the maximum number of students per class.

Autonomous schools have incentives to respond to changes in demand, because their funding is conditional on the number of students. The basic mechanism for financing autonomous schools is a fiscal transfer determined by a formula that I describe in some detail in the appendix. Parents enjoy a majority vote in the Local School Council. The Council controls the government's financial contribution and has the legal power to hire and fire school staff, including the school director. The Council also has the authority to require parental contributions and to reward high-performing teachers.

The relative importance of demand driven incentives in shaping the supply of schools has increased in Nicaragua in the 1990's. In 1993, 20 secondary schools became autonomous, and interest in school autonomy grew substantially in the following years. By late 1999, 1,612 primary schools (35 percent) and 169 secondary schools (61 percent) had become autonomous. As a result, of all children in the public school system, 52 percent of students in primary school and 83 percent of students in secondary

school were in autonomous schools in 1999.[4] By the end of 2001 almost 3,000 schools, 61 percent of primary and 53 percent of secondary, had become autonomous (King, Ozler, and Rawlings, 1999). According to official data, by 2003, one out of every three schools (public plus private) was an autonomous school.

Nicaraguan children start school behind schedule, make slow progress, and do not stay in school for long. Table 2 reports school enrollment rates by age and grade for 2003. The enrollment rate is 55 percent for 6 year-olds, increases to 100 percent for 10 year-olds, and collapses to 18 percent for 15 year-olds. Rates of retention in grade were high in the early 1990's, especially in the first grade where they approached 30 percent. Retention in grade declined until 1998, in part because of a policy of automatic promotion favored by then Minister of Education Mr. Belli. Once he left office, retention in grade climbed back up to reach the levels revealed in Table 2. Ignoring the (small) differences in birth-year cohort sizes, in every grade from the first through the sixth there are considerably more children who have been held back or started behind schedule than there are children who started on time and are making normal progress.

Part of the problem is incomplete coverage. By 1998, the coverage rate at the primary school level was 76 percent. An important expansion of net coverage at the secondary level during the 1990's brought the rate to about 34 percent in 1998. Unsurprisingly, coverage is considerably lower in rural than in urban areas.

Schooling indicators are much better in urban areas than in rural Nicaragua. In addition, there are important differences across the three regions of the country (Atlantic, Central, and Pacific). In particular, Table 3 shows that enrollment in the rural areas of the Pacific region is closer to urban levels than to the rest of the rural areas. Of the children in the rural Pacific areas who are not enrolled in school, only one percent is not enrolled for "school supply" reasons, compared to 20 percent of the children who are not enrolled and live in other rural areas.

[4] Source: World Bank Report No: 19560-NI, 1999.

## 5. The Data

*The surveys*

I use three surveys. Two of them are the 1998 and 2001 *Encuesta Nacional de Hogares sobre Medición de Nivel de Vida* also known as the Living Standards Measurement Surveys. These are nationally representative surveys collected by Nicaragua's National Institute of Statistics and Census (INEC) with the main purpose of evaluating the country's poverty alleviation strategies. The data were collected under the auspices of MECOVI (Programa para el Mejoramiento de las Encuestas y la Medición de las Condiciones de Vida en America Latina y el Caribe), which is funded by the Inter American Development Bank, the World Bank, and the United Nations Economic Commission for Latin America and the Caribbean.[5] The World Bank's Poverty and Human Resources Development Research Group makes the data available on its web site.[6] The 1998 and 2001 surveys use multistage stratified samples of housing units that are designed to be nationally representative. Unlike the current practice of data collection for the Current Population Survey (CPS) based primarily on computer-assisted telephone interviews, the surveys I analyze in this study rely primarily on face-to-face interviews and the responses are recorded by the interviewer on a paper copy of the survey instrument. Typically, a knowledgeable adult answers the questions for all members of the household. The basic or core module in the instrument follows closely that of the CPS, suitably modified to reflect idiosyncrasies specific to Nicaragua.

The two surveys may be combined to create a panel data set. The surveys have information on characteristics of the dwellings (such as access to water and electricity), and the demographic characteristics of each member of the household. In the specific case of schooling, there is information on whether an individual is enrolled in school and his or her grade level in 1998 and 2001. Individuals who are not enrolled report their highest grade completed. Regarding earnings, unearned income and consumption, these are measured in great detail in both survey years. The 1998 sample covers 4,209 families in 4,038 households, and 23,643 individuals; the 2001 sample covers 4,191 families in 4,001 households and 22,810 individuals.

[5] The MECOVI program has been instrumental in supporting data collection efforts in countries with a paucity of household survey data and in improving markedly the quality of the household survey data produced in most countries under its auspices.
[6] http://www.worldbank.org/lsms/lsmshome.html

In early November of 1998, shortly after completion of the data collection for the 1998 survey, hurricane Mitch hit the country with devastating storms. The INEC decided to re-interview households in the 1998 survey that were in areas affected by Mitch. The questionnaire used was an expanded version of the 1998 household questionnaire, including demographic characteristics of household members, economic activity, and income, with added questions to measure the effects of the hurricane on the household. This follow-up survey, collected in June of 1999, allows one to measure the wealth and income shock to households in terms of lost assets and lost jobs and businesses.

Based on information about the specific areas that were hit by Mitch, efforts were made to interview *every* household in the original 1998 survey's *segmento seleccionado* (chosen segment) deemed to have been hit by the storm. If upon arrival at the scene, it was determined that the hurricane did not go through a given area, the households were not interviewed. In affected areas, efforts were made to find household members that used to inhabit dwellings that were standing empty or had been destroyed. Efforts to locate those individuals were limited to the original municipality of residence. Because of the sampling strategy, the 1999 sample is neither nationally representative nor representative of the areas hit by Mitch.

By merging the 1998 and 1999 samples it is clear that the re-interview effort was very successful. One can count the number of households in a given segment in the 1998 survey and compare it with the number of households in the same segment in the 1999 sample. The overall re-interview rate is 94.7 percent, with a low of 88.6 percent in the Autonomous region of the South Atlantic and a high of 100 percent in the department of Rivas. The 1999 sample has 3,775 individuals in 595 families residing in 540 households. Of these, 3,262 individuals can be matched to individuals in the 1998 sample. The households in the 1999 sample are more likely to reside in rural areas, and are concentrated in the departments of Chinandega, Leon, Madriz, Esteli and Matagalpa. These departments are located north and northwest of Lake Managua.

Finally, I can examine changes in access to schools due to hurricane Mitch because the 1999 survey includes information provided by the survey respondents on damage to school facilities in their localities.

*Remittances, family income and family assets*

The survey instruments used in the 1998, 1999 and 2001 surveys are similar but not identical. In the 1998 and 1999 instruments there is a short section with questions on "other sources of family income in the past month." The section comes after the sections on work and earnings of employees and income and expenses of the self-employed. Respondents are asked whether any family member received income in the previous month from each of seven sources. For each source the survey records a yes/no answer and, if the answer is yes, it records the amount received. The listed sources of income are types of rental property, scholarships, various types of pensions and aid from relatives and friends. In the 2001 instrument, the section was modified. The item "aid from relatives and friends" was replaced with "cash aid" and a new section on remittances was added to the instrument. The new section asks about in-kind and cash gifts, from relatives residing abroad and in Nicaragua, and about the frequency of the gifts and how they are used. I keep track of both "cash aid" and remittances in the 2001 survey and report them separately.

The 2001 data set includes a variable for family income constructed by INEC, but there is no corresponding variable in the two earlier data sets. I constructed a measure of annual family income for the three surveys that is based on near identical questions to ensure consistency over time. As the 1999 instrument has the least detail, the measure of income is essentially based on the questions included in that survey. To construct the income measure I use the following information: (1) earnings from all jobs, in cash and in kind, (2) income from agricultural activities and the main non-agricultural family-owned business (fully- or partly-owned), (3) value of all goods and services from the agricultural activities and the main business that were consumed by the family, (4) agricultural and non-agricultural business expenses, (5) all other sources of income (remittances, rent, pensions, inheritances, etc.).

Questions pertaining to earnings of employees are designed to capture earnings in the previous month, questions pertaining to non-agricultural business income and expenses refer to the 2 weeks prior to the survey week, and questions pertaining to agricultural activities refer to the previous 12 months. The 1999 survey took place in June and hurricane Mitch struck in November of 1998, so annual income from agricultural activities in 1999 includes income from five months prior to the hurricane. Last, I deflate values for 1999 and 2001 so all values are expressed in 1998 *Córdobas*.

To establish whether families face credit rationing I examine the information on loans. An indirect approach is to examine net family assets as it is reasonable to assume that families with healthy net asset holdings do not face credit constraints. Unfortunately, in these surveys one can construct a good measure of family assets but there is no information on current indebtedness, so one cannot calculate net family assets. Nevertheless, I provide some evidence on family assets. To construct a measure of total assets I aggregate three categories: the value of the house and surrounding land plus the value of consumer durables owned by the family, business assets (inventory, equipment, vehicles, etc.), and agricultural assets (land, livestock, agricultural equipment and infrastructure).[7]

## 6. Results

*The treatment and control groups*

To the extent that hurricane Mitch was unanticipated and hit some but not all areas of the country, it provides an exceptional "natural experiment" for the study of individuals' responses to shocks. Unlike the United States' eastern seaboard where devastating hurricanes are routine, Nicaraguans had never before experienced a hurricane like Mitch. Just about everyone in the US carries insurance or gets assistance from the Federal Emergency Management Agency, whereas the vast majority of Nicaraguans had no insurance and foreign relief aid (beyond the most basic supplies like water and medicines) did not materialize until after the field work for the 1999 survey was done in June of that year.

Figure 1 portrays the path followed by the hurricane. Note that, unlike Honduras and El Salvador, only parts of Nicaragua were in the hurricane's path. This detail matters because it makes it more likely we have a natural control group. One need not be concerned by the fact that only the northern end of the country received the sustained downpour that Mitch brought. Swollen rivers and entire collapsed hillsides that became mudslides wreaked havoc in areas spread throughout the country. As Figure 2 and Table 4 document, not every department in the country suffered, and the affected areas are not

[7] In the 1998 survey respondents are asked the price at which they could sell their house and the rental value they would have to pay in order to rent their house. In subsequent years they are only asked the rental value, so I compute the average implied discount factor from the two answers given in 1998 and use it to compute the value of housing in 1999 and 2001. In all three years, the value of land used for home agricultural production (*produccion de patio*) gets double counted as it is also included in the valuation of the home; the double counting cannot be undone. Lastly, the value of livestock raised as a form of home agricultural production is not included as it is enumerated but not given a value in the 1999 survey.

geographically concentrated. The effect of Mitch can be separately identified from any possible regional effect.

Figure 2 is a map of Nicaragua showing departmental boundaries. Five departments are not represented in the 1999 survey because Mitch affected none of their residents who were in the 1998 sample. They are Managua, Carazo, Granada, Rio San Juan and Chontales. In the map they appear without shading. Departments that are shaded grey have rural households in the 1999 sample. Departments marked with black vertical lines have urban households in the 1999 sample. The map suggests that many more people in rural than urban areas were affected by the hurricane. The figures confirm this. Table 4 organizes the 1998 sample by region, department, and along the rural-urban divide, and reports the fraction of the 1998 sample included in the 1999 sample. It also reports the percentage of the 1998 sample families that were hit by Mitch. Overall, 21.2 percent of rural families and 6.8 percent of urban families in the 1998 sample were affected by the hurricane. There is great disparity in the effects of Mitch across departments. In Leon, Mitch affected 72 percent of rural families appearing in the 1998 sample. In Boaco, the figure is 39 percent of urban families.

I was able to match 566 of 595 families in the 1999 survey to families in the 1998 survey.[8] These families are the "treated" group. I limit the "control" group to families in the same departments where the treated families reside. Thus, the control group for rural families covers more departments than does the control group for urban families. The concern is that Managua, in particular, and perhaps all departments I omit from the control groups, may differ systematically from the rest of the country in unobserved ways that matter for family budget constraints during the 1998-2001 period.

Next, I examine the extent to which the treated group differs from the control group in 1998. Consumption levels, housing conditions, and schooling indicators vary significantly across urban and rural areas, so the analysis controls for region of residence. I report sample means for several variables of interest, compare means for the treatment and control groups, and use a two-sample t-test of the hypothesis that the corresponding variable has the same mean for the two groups, assuming unequal variances. To compare distributions, I use a chi-squared test. The comparisons appear in Table 5a. A

[8] While the 1999 survey has 540 households, one can match 566 families, since there are households with multiple families.

difference in means and a chi-squared statistic appear in bold typeface if the corresponding test results in rejection of the null hypothesis of equality of means or distributions.

There are 155 treated or "Mitch" families and 739 control families in urban areas. In rural areas there are 411 Mitch and 1,129 control families. The top panel of table 5a describes the structure of the families in the estimating sample. INEC reports a poverty line and identifies families living below the poverty line. About 36 percent of urban families are poor, 69 percent of rural families are poor, and there is no significant difference between the treatment and control groups in either region. The number of adults per family is about 2.6 for all four family types, but rural families on average have almost one more child than do urban families. In terms of the percentage of families with a female head and the percentage living in extended family arrangements, there are no significant differences between the treatment and control groups in either region.

The last three variables in the top panel of Table 5a provide information on the remoteness of the localities where the families reside. I report the percentage of families in each group living in dwellings without a source of water inside or outside the house. The percentage is around 15 percent in urban areas and 83 percent in rural areas. The difference (in absolute value) between the treatment and control groups is about 10 percentage points in urban areas and 4.3 percentage points in rural areas, and the difference is statistically significant for both areas. Access to electricity is much higher in urban areas but the treatment group is significantly less likely to have access. By all signs, families in the treatment group in urban areas are poorer than those in the control group, but this is not true in rural areas.

Urban families, on average, live about 9 minutes away from an elementary school. Rural families in the treatment group on average live 24 minutes walking distance from an elementary school whereas families in the control group live 34 minutes away. This difference is significant and, undoubtedly, stems from the over representation of the Pacific rural areas in the treatment group and the over representation of the Central and Atlantic regions in the control group. The latter are considerably more remote than the former. Also, the Pacific region has a better supply of schooling services.

The bottom panel of Table 5a presents characteristics of school-aged individuals in the treatment and control groups. There are no significant differences in the schooling of the mothers, or in the sex and age distributions of the school-aged population. Fathers in the urban control group have about one and a

half additional years of schooling than fathers in the treatment group. The percentage of kids who are enrolled in school and the distribution of enrollment across grades are significantly different for the treatment and control groups in the rural areas. Fifty-six percent of children in the Mitch families are enrolled in school versus 51 percent in the control group. Also, there are proportionately fewer Mitch kids enrolled in preschool and many more enrolled in grades 1 through 12 than is the case for the control group. This, again, reflects the over representation of the Pacific rural areas in the treatment group and the over representation of the Central and Atlantic regions in the control group.

The evidence reported in Table 5a reveals that there are statistically significant differences in the school enrollment rates of children and adolescents in 1998, prior to the arrival of hurricane Mitch. In Table 5b, I explore these differences further by reporting enrollment rates by single year of age for children aged 7 to 19. For urban children, overall enrollment rates are slightly higher for the treatment than the control groups. Only the difference in enrollment rates at age 9 is statistically significantly different from zero. Clearly, the small sample sizes play a role. When I test the null hypothesis that all the differences are jointly equal to zero, the F-statistic, with 12 and 1,047 degrees of freedom, is equal to 2.65 so I reject the null with a p-value equal to .0017.[9] Much the same is true for children of rural families. Only three differences, between the treatment and control groups, in enrollment rates by single year of age are significantly different from zero (ages 7, 9 and 18), but I reject the null hypothesis that all the differences are jointly equal to zero. The F-statistic for the test, with 12 and 1,161 degrees of freedom, is equal to 2.41, so I reject the null with a p-value equal to .0045.

For urban children, this is a case of statistical significance but small practical importance. The overall difference in enrollment rates between the treatment and control groups is 4 percentage points on a 77 percentage-point basis. For rural children, the overall difference is more substantial: 6 percentage points on a 52 percentage-point basis.

Observed differences in the outcome of interest between the treatment and control groups prior to the "treatment" are not necessarily problematic. If the groups differ in the outcome due to some observed or unobserved factor that remains invariant throughout the "experiment," the difference-in-differences approach is perfectly adequate. In this application it is clear that rural families in the control group are

[9] The degrees of freedom of the F-statistic reflect the clustering on family id in the computation of standard errors.

concentrated in the relatively remote Central and Atlantic areas, farther from schools than rural families in the treatment group. This remoteness was little changed in the three years from 1998 to 2001. As for the urban sample, I have no ready explanation for the difference in enrollment rates. Perhaps the considerably smaller sample size for the treatment group is part of the explanation.

In table 6 I examine total income, its sources, and income per adult equivalent for the treatment and control groups, all measured in 1998 *Córdobas*.[10] In accordance with the findings in table 5a, families in the treatment group in urban areas are significantly poorer than families in the control group. Average total annual income is almost 22 thousand *Córdobas* for the Mitch families compared to about 34 thousand for the control group. Rural families enjoy much lower incomes than do urban families. The average total annual family income in rural areas is about 15 thousand *Córdobas* for the treatment group and 18 thousand for the control group. The bulk of income comes from adults earnings, both in urban and in rural areas. The second most important income source is business revenue in urban areas, and revenue from agricultural activities in rural areas.

Lastly, it appears that urban families, especially those in the control group, rely more heavily on transfers from relatives to supplement their incomes than do rural families. Annual average "aid from relatives" is close to C$ 600 for families in rural areas, regardless of their treatment status. In urban areas, annual "aid from relatives" averages C$ 1,001 for Mitch families, compared to C$2,027 for the control families. At first blush, this is not what one would expect. The amount migrants remit is probably primarily determined by local labor market conditions and cost of living in the locality where the migrants reside. So we do not expect to see systematic differences in the amount of remittances received by, say, urban and rural families. Yet, the average remittance amount received by urban

[10] I top- and bottom-code the figures for each of the six income sources listed in table 6 at the 98-th and 2nd percentiles by region of residence.

Income per adult equivalent is defined as

$$INCAE = \frac{TOTINC}{(A + 0.75K)^{0.75}} \ . \qquad (1)$$

The numerator in (1) is income from earnings and all other sources summed over all individuals in the sample members' families except live-in domestic help. Because scale economies and age-specific needs affect the amount of income allocated to each family member, I convert the measure of total family income into adult equivalent units. A standard way to define adult equivalents is $(A+\alpha K)^{\beta}$, where A is the number of adults in the family, K is the number of children, and $\alpha$ and $\beta$ are the weights placed on children's consumption (relative to adults') and total family size, respectively. I define adults as individuals age 18 and over and, following evidence reported in Citro and Michael (1995) and Deaton and Paxson (1998), use $\alpha=\beta=0.75$ as weights.

families in the control group, C$ 2,027, is much larger than the average for the other 3 groups of families. I suspect this result is driven by data errors that the top- and bottom-coding of the underlying figures does not eliminate because of the small sample sizes involved. There are 11 families who report unusually large remittance amounts in 1998. Nine of them also appear in the 2001 sample. The average remittance amount for these nine families was C$ 75,400 in 1998 compared to C$ 13,420 in 2001, an 82 percent decline. Indeed, only one of the nine families reports remittances of a comparable magnitude in 2001 and in 1998. Perhaps during the 1998 interview the respondents gave an annual figure despite the fact that they were queried about *monthly* income. The more detailed questioning in 2001 may have lowered the probability this error would occur again.

In sum, the treatment families in urban areas appear to be considerably poorer than are families in the control group. The main differences in income stem from adult earnings, business revenue and aid from relatives. The income gap between rural families in the treatment and control groups is much smaller, though it is also statistically significant. In their case, the difference does not arise from a gap in adult earnings; it arises from the gap in revenues from agricultural and business activities. Again, the difference in incomes does not necessarily pose a problem for the analysis if it stems from forces that remain invariant during the time period under examination.

*Constraints in access to credit*

The model outlined in section 3 links the family budget constraint to children's schooling by relying on the existence of constraints in the family's access to credit markets. In the case of Nicaragua, there is ample evidence that families have very limited access to credit. At the top of the list of reasons for this is the deterioration of the financial system. Recent years have seen bankruptcies of institutions that traditionally gave credit to farmers. By all accounts, nowadays it is almost impossible for small and even medium sized producers to gain access to credit. I document this in Table 7a by reporting several measures of families' access to credit in the 12 months prior to the 1998 survey week.

Given that a majority of families in Nicaragua own a business, agricultural or otherwise, it is remarkable that 84 percent of urban families and 89 percent of rural families obtained no loans in the year prior to the survey. The modal reason for not having obtained credit is that the families do not have property to use as collateral. When families are asked about the main problem they face in the operation of their

business, “lack of own capital” plus “lack financing” tie “high input prices” as the most frequent answers.

For those who obtained loans, the picture that emerges is no less grim. Three-quarters of all loans had to be repaid in less than one year. For fixed-length loans with a duration quoted in months (the modal type of loan), the average loan duration was 6 months. For those respondents who quoted a monthly rate of interest on the loan (again, the modal response), the average rate of interest was 6.4 percent per month for urban residents and 5.7 percent per month for rural residents. By international standards, these are very high rates of interest. Given the terms for loans reported in the data, it is difficult to see how producers manage to earn enough to repay the loans and have anything left over.

In table 7b I report family assets in 1998 to gauge whether the bulk of Nicaraguan families own enough assets to cast doubt on the notion that the families face credit constraints. As I mentioned earlier, one cannot calculate net assets for there is no information in the survey on current debt, so these figures *overestimate* net assets of families. The picture that emerges is consistent with the evidence in table 7a. The value of owner-occupied housing represents about 87 percent of the assets of urban families, and total assets amount to about 1.37 times average annual income. Rural families’ assets are considerably lower despite the double counting of the land on which the home sits. For rural families agricultural assets account for the majority share of total assets, and total assets amount to about 1.7 times average annual income. This does not imply that rural families are less credit constrained than their urban counterparts. To the extent that agricultural infrastructure (wells, fences, etc.) cannot be sold separately from the land on which it sits, it makes for a worse collateral than, say, livestock or equipment.

Lastly, note the very large standard deviations of all the averages that appear in table 7b. They reflect the highly skewed nature of the distribution of assets across families. The majority of families have very little by way of assets that can be used as collateral. The median is about half of the average of total assets and well below average annual income for all four types of families.

*The supply of schooling*

A pre-condition for finding an empirical effect of changes in the family budget constraint on the demand for children’s schooling is that the supply of schooling will rise to meet the growth in demand. Else,

increases in demand will simply go unmet. In the specific case of Nicaragua before and after hurricane Mitch, it must be the case that the supply of schooling services was not widely disrupted due to the hurricane, precluding any analysis of changes in demand for schooling due to the shock to family income. I examine several measures of school supply. The bulk of the evidence suggests that disruptions in the supply of schooling services were few and brief.

One place to look for signs of disruption is reported damage to roads. In 1999, the families were asked whether access to their house changed after Mitch. Surprisingly, 22 percent respond that the access has improved, 12 percent respond that it has worsened, 61 percent respond there has been no change, and 5 percent respond they were not living there when Mitch hit. On the whole, then, if anything, the responses suggest that access improved as a result of works carried out because of Mitch.

In the 1999 sample of families hit by Mitch, no school-aged kid is "not enrolled" because the school was destroyed by the hurricane. This is not say that no schools were destroyed: recall that the 1999 survey is not representative of all areas hit by Mitch. The World Bank documentation for the 1999 sample claims that over 300 schools were destroyed. But, apparently, none of the schools in the vicinity of the families in the 1999 sample was destroyed. The reported average distance and travel time to primary school also did not change as a result of Mitch. For the treated groups, average distance is 1,104 meters in 1998, 1,112 meters in 1999 and 483 meters in 2001, compared with 1,134 meters in 1998 and 397 in 2001 for the control group. The push by the government to expand the supply of primary schools in remote areas is evidenced by the large decline in average distance from 1998 to 2001. Note, though, that there is no increase in average distance for the treated households between 1998 and 1999. I find essentially the same results for average walking time to the nearest primary school.

Table 8 summarizes the reported reasons why children and adolescents aged 7 to 18 are not enrolled in school, by year, region of residence and treatment status. Sadly, almost 1 in 5 report that they are "too old" or uninterested in attending school. It is a fair assumption that a child is too old when he or she has been retained in grade once or perhaps more often and now faces the prospect of having younger classmates. An examination of Table 2 reveals that an important fraction of students are behind grade at every possible schooling level. Focusing on Table 8, between 50 and 70 percent of all children and adolescents who are not enrolled in school cite work (housework, fieldwork, or caring for children) or money problems as the main reason for not attending school. Surprisingly, there is no difference in this

dimension between the rural and the urban sectors, but there is a pronounced trend over time. The fraction reporting "work" as the reason for not attending school grows steadily while the fraction reporting "money problems" drops in both regions and for the treated and control groups. The only category where there is a difference is problems with the supply of schooling services. In urban areas hardly anyone fails to enroll in school for lack of schooling services, compared to anywhere from 8.8 to 23.1 percent for rural children.[11] For this analysis, whether there are problems with the supply of school services is not an issue. Rather, what matters is whether there was an important disruption due to Mitch. The treated households in rural areas report a slight increase in the fraction of schooled-aged kids not enrolled for supply reasons, from 8.8 in 1998 to 12.7 in 1999. The fraction then drops to 10.5 in 2001. Fur urban residents, the fraction of schooled-aged kids not enrolled for supply reasons is 4.6 in 1998, and zero in 1999 and 2001.

In all, then, the evidence presented in Tables 2 and 8 taken together with the discussion in section 3 suggests that the supply of schooling services is set to meet increases in demand for schooling in all but the most remote areas of rural Nicaragua, and any disruptions in the supply due to Mitch were short-lived and not widespread. Yet another detail bolsters this conclusion. In Nicaragua, the school year runs from January through December, with a summer break. In November 1998, in areas where the hurricane did the most damage to infrastructure, the academic year was brought to a close and children were or were not promoted based on their grades up to that point. The school year started a bit late in 1999 in areas with widespread damage, providing an opportunity to repair the schools.

*The immediate impact of hurricane Mitch on schooling and work*

Table 9 presents enrollment rates by single year of age for children in the treatment group, for 1998 and 1999—the aftermath of the hurricane. As was the case in earlier tables, sample sizes are an issue. At first blush, hurricane Mitch had had little effect on enrollment rates by June 1999. In urban areas we see a small decline in enrollment rates, but none of the changes at each individual age is statistically

[11] The low rate of school attendance in rural areas has not gone unnoticed. There is a program underway tailored after the highly rated *PROGRESA* program in rural areas of Mexico. The program in place in some rural areas in Nicaragua is funded from abroad. The (self) evaluation of the program suggests that the current practice of giving the mother about 450 Córdobas per month conditional on her children attending school has been a resounding success. Unfortunately, it appears that the evaluation is silent on the serious side effects the program has generated. There are reports that on days when the moneys are distributed the incidence of drunkenness among adult men and domestic violence toward women is well above usual levels.

significantly different from zero. Nevertheless, a test of the null hypothesis that the changes are jointly equal to zero rejects the null. The F-statistic has 12 and 107 degrees of freedom and is equal to 2.32, with a p-value equal to .011.

In rural areas there is scant change. The overall enrollment rate changes from 63.9 percent to 63.4 percent. No change at the level of single years of age is significant and I cannot reject the null hypothesis that the differences are jointly equal to zero.

If Mitch had any effect on school enrollment rates it had to affect the underlying trends because Table 9 shows very small effects, if any, on the levels. Note that the calculations presented in Table 9 are based on a sample of children who are present in both years of the sample. The motivation for the sample selection rule is to abstract from the possibly confounding effect of changes in the composition of the sample through migration. Of course, the effect of Mitch on the incentives to migrate may well have been quite large, and perhaps it was through this channel, migration, that Mitch had an effect on enrollment rates.

The model reviewed in section 3 predicts that a shock to income would likely result in a change in the intensity of schooling for at least some children. In Table 10, I report the fraction of school-aged children who work, before and after the hurricane. Also, I report the average number of hours worked per week among those who work. For urban children there is an increase in the proportion of children aged 7 to 9 who work, from zero to 8.5 percent, and a corresponding decline for those aged 16 to 18, from 44 to 36 percent. The increase in the fraction working for the youngest aged is statistically significantly different from zero, but I would not put too much weight on this result since the urban sample size for the treatment group is so small. Mean hours worked by those working drops from 40.4 in 1998 to 31.5 in 1999. So while the proportion working remains constant at 18 percent, the number of hours worked drops considerably. Perhaps the opportunities for employment in urban areas affected by Mitch worsened for these very young workers.

The picture that emerges from the rural sector is quite different. There is a small, insignificant decline in the proportion of children aged 7 to 12 who work. There is a large, significant increase in the proportion of adolescents aged 13 to 18 who work. The increase is equal to ten percentage points for those aged 13 to 15 and equal to 12 percentage points for those aged 16 to 18. The average number of

hours worked declines by 4.4 hours, from 40.2 to 35.8 hours per week. Interestingly, average hours worked per week decline for all age groups, not just for the older ones who saw an influx of new workers. While average hours worked per week were equal for the urban and rural areas in 1998 (40 hours), by 1999 the rural kids work 4.3 more hours per week than do their urban counterparts.

In sum, six months after hurricane Mitch hit parts of Nicaragua, we observe a modest decline in school enrollment rates in urban areas accompanied by no change in the proportion of children who work and a large decline in average hours worked by those who work. In rural areas, there was essentially no change in enrollment rates accompanied by an important increase in the proportion of children who work, together with a small decrease in average hours worked by those who work.

*Differences in differences: school enrollment survival functions and family income*

To exploit the "natural experiment" nature of the phenomenon under study here, I estimate survival functions for school enrollment of children and youth aged 7 to 18, separately for urban and rural residents and the treated and control groups. The observations in the 1998 survey provide the pre-treatment data, while the observations in the 2001 survey provide the post-treatment data. I report Kaplan-Meier estimates of the survival functions in Tables 11a and 11b, and in Figures 3 and 4. The estimates do not control for any covariates nor is the sample stratified in any way. If hurricane Mitch had an impact on the intensity of schooling, one would expect it to show up in the raw data.

Two distinct patterns are evident in the estimated survival functions. First, in the three years between 1998 and 2001, the survival functions move up significantly in rural areas for the treated and the control groups. The opposite holds for urban residents. The improvement in retention rates in rural areas is to be expected given all the efforts that have gone into alleviating the dismal past record of school attainment in the rural sector. The worsening condition in urban areas presents a puzzle. At this point I cannot offer a definitive explanation for it. Perhaps, migration flows between the rural and urban regions are the root cause: the rural youth may have left home to look for work in the cities. Second, the *changes* in the survival functions differ between the treated and the control group and between regions, in very interesting ways.

For residents of urban areas, the difference in the changes in the survival functions for the treated and the control groups are striking. From the first through the sixth grade, the deterioration in retention rates is *lower* for residents in areas that were hit Mitch than for the control group, especially at the fifth grade. This suggests that the "treated" children were considerably more likely than the control group to advance past the first cycle of primary schooling. (See the figures in the column labeled "Diff. in Diff." in Table 11a.) The relative gains of the treatment group go away in the seventh and eighth grades, only to reappear in grades nine and higher. There are so few observations left in the treated group at grades nine and higher that one can't make much of the estimates for those grades.

For rural residents, the survival function for the treated improves less than for the control group at every grade level from grades 1 through 6. For grades 7 and higher, there is no pattern to the changes in the survival functions. (See the figures in the column labeled "Diff. in Diff" in Table 11b.) So, if Mitch had an effect on school survival functions in rural areas, it was to limit the improvements in advancement and retention in primary school.

A child who has not been retained in grade will be about 14 years old in the $7^{th}$ grade. So it appears that the relative worsening in survival rates for the treated group in urban areas corresponds with the grade levels where work becomes a viable alternative to school enrollment. Recall that in Table 10 we see that, in urban areas, kids aged 13 to 15 are more than twice as likely to work as are kids aged 10 to 12. In sum, then, in urban areas the treated group appears to have made relative gains in advancement and retention in primary school, but the gains disappear in grades where children can opt for work.

Naturally, it is important to examine the time path of the changes for the treated groups. The estimated survival functions for the years 1998, 1999 and 2001 for the treated groups (rural and urban) are presented in Figure 5. It is clear that a good portion of the 1998-2001 change occurred between 1998 and 1999. Also, the functions for 1999 are essentially bounded by the functions for 1998 and 2001, suggesting that nothing too dramatic happened during 1999.

A few comments are in order. The estimates are based on samples that include all individuals residing in departments that were affected by Mitch in 1998 and 2001. I do not limit the sample to matched individuals because of the potential bias that would arise from sample attrition. In the case of the treated group attrition is especially problematic: if a teenager leaves school and moves away from his or her

parents' home to find work, the sample of matched individuals will bias the estimates in the direction of improved survival rates even if rates did not change. So I include everyone living in a household in 2001 and classify them as "treated" or "control" based on whether the household appears in the 1999 survey. In the 2001 survey I match about 63 percent of the individuals and 75 percent of the households to the 1998 sample. Again, leaving out the households that were added in 2001 to maintain sample sizes, and the individuals who joined matched households, would bias the results in the direction of the behavior of households and individuals who are less mobile than average. It is particularly problematic that the 2001 sample does not "add" treated households. Though there is a way to ameliorate this problem. One can reclassify some of the new-to-2001 households as "treated" if they reside in the narrowly defined *segmento* where the original treated households were found. All in all, then, I suspect that the estimates reported above are somewhat biased in favor of finding improved survival rates for the treated group.

As a robustness check, I estimate the survival functions using the entire sample instead of only the residents in department where "Mitch" families reside. The results appear in Appendix Tables A1 and A2. Essentially, identical patterns emerge, except they are more pronounced and some of the differences-in-differences estimates are significantly different from zero, no doubt because of the larger numbers of observations.

If hurricane Mitch had an effect on children's schooling, one expects the effect originated in the exogenous shock to the families' assets and to the families' income-generating capabilities. Tables 12a and 12b report means of annual total family income and by source of income, and income per adult equivalent, separately for urban and rural families. The figures for 1999 and 2001 are expressed in 1998 *Córdobas*. I also present differences in means between 2001 and 1998, separately for rural and urban residents and the treated and control groups, and differences in differences.

Urban residents in the affected areas saw a very modest decline in average total family income from C$22,024 in 1998 to C$21,745 in 1999. A substantial decline in net revenue from business, about C$1,800, was countered by modest increases in adult earnings and in net revenue from agricultural activities (about C$600 each), and in unearned income (about C$500). It would be premature to conclude that hurricane Mitch had a nil effect on family finances in urban areas. Real GDP growth had averaged about 5 percent per year in the four years prior to 1999. Against this background, even a

modest drop in real income is quite a deviation from trend and perhaps from expectations about income growth.

Between 1999 and 2001, families in the treatment group in urban areas enjoy a large increase in annual income, driven primarily by increases in adults' earnings, net revenue from business and cash aid and remittances from relatives. From this expansion, income per adult equivalent grows by 35 percent between 1998 and 2001.

Urban residents in the control group have an average annual income of C$34,144 in 1998 and C$ 42,621 in 2001, which represents an increase of C$8,477, or 25 percent. The increase in total income for the control families falls short of the increase enjoyed by the treatment families (C$9,551), both in absolute terms and in percentages. Yet, income per adult equivalent increased by a lot more, C$1,166, for the control than the treated families. This suggests that a non-negligible change in family composition occurred between 1998 and 2001, with treated families acquiring comparatively many more new members than did the control families.

The pattern of income changes in rural areas is quite different from what we see for the urban residents. Rural families in the treatment group essentially see no change in total income after the hurricane, but there are important changes in the underlying components of income. While average total family income barely increases from C$15,355 to C$15,579, adult earnings drop by C$1,200, unearned income increases by about C$650, aid from relatives increases by about C$600 and a C$900 drop in business revenue is made up for by a C$1,200 increase in agricultural revenue.

In the two years between 1999 and 2001, income rebounds by enough that in 2001, in real terms, family income has risen by almost 38 percent to C$21,197. The one striking difference between urban and rural families in Mitch areas is that aid from relatives increased immediately (by 1999) for rural families and then leveled off. For urban families, instead, there was no increase in aid from relatives after the hurricane, but it more than doubled by 2001.

For rural families in the control group, average family income is equal to C$18,597 in 1998 and increases to C$22,377 by 2001, a far more modest rebound than the increase enjoyed by Mitch families.

In terms of statistical significance, the *increases* in total family income and income per adult equivalent between 1998 and 2001 are significantly different from zero. This also holds for some of the changes in the components of income: remittances and net revenue from business and agricultural activities. I cannot correct for the attrition of households that left the sample because their dwellings were completely destroyed and relocated elsewhere. These households likely are the ones that were most hurt by Mitch. If the destruction of dwellings was more prevalent in rural areas (worse construction standards, perhaps) this would help explain the apparent larger growth in incomes for the rural than the urban treated families. It would also explain the larger income growth seen for the treated families compared to the control families.

In sum, the changes in survival rates line up reasonably well with the observed changes in family income: in urban areas incomes declined after the hurricane and school survival rates fell alongside. As for the differences-in-differences, the estimates also line up reasonably well. Overall, the families in the treatment group saw *larger* increases in income than did the control group and survival rates worsened *less* for their children than for the children in the treatment group. A key issue is the reason behind the overall worsening in survival rates in the urban region. One can speculate on various scenarios, like migration of rural youth to the cities in search of work. But this is beyond the scope of this analysis.

In rural areas, the changes in school survival rates also line up reasonably well with the observed changes in family income. Incomes stagnated in 1999 and more than recovered by 2001, and survival rates improved over the same period. As for the differences-in-differences, the estimates do not line up well. Incomes increased more for the families in the treatment group and the improvement in survival rates for their children fell behind the one for children in the control group.

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**Table 1. Percent of Children Completing Primary School, by Year and Sex**

| Year | Total | Girls | Boys |
|---|---|---|---|
| 1990 | 19 | - | - |
| 1991 | 18 | - | - |
| 1992 | 22 | 25 | 20 |
| 1993 | 23 | 25 | 20 |
| 1994 | 26 | 29 | 23 |
| 1995 | 26 | 29 | 23 |
| 1996 | 26 | 31 | 24 |
| 1997 | 27 | 29 | 24 |
| 1998 | 31 | 34.4 | 27.2 |
| 1999 | 32.2 | 35.7 | 28.9 |
| 2000 | 35.4 | 39.2 | 31.9 |
| 2001 | 36.3 | 40.5 | 32.4 |
| 2002 | 38.5 | 42.8 | 34.6 |
| 2003 | 40.8 | 44.4 | 36.0 |

Source: MECD (Office of Planning and Policies)

**Table 2. School Enrollment Rates in 2003, by Age and Grade**

| | Percent of the Population of Children of a Given Age Enrolled in Grades 1 through 6 | | | | | | Percent |
|---|---|---|---|---|---|---|---|
| Age | 1st Grade | 2nd Grade | 3rd Grade | 4th Grade | 5th Grade | 6th Grade | Enrolled in Grades 1-6 |
| 6 | 50.1 | 5.2 | 0.1 | 0 | 0 | 0 | 55.5 |
| 7 | 44.4 | 32.2 | 7.4 | 0.3 | 0 | 0 | 84.3 |
| 8 | 26.5 | 28.9 | 28.5 | 8.2 | 0.4 | 0 | 92.6 |
| 9 | 15.8 | 20.7 | 23.9 | 24.7 | 8.2 | 0.6 | 94.0 |
| 10 | 10.9 | 15.7 | 19.4 | 22.1 | 23.6 | 8.7 | 100.0 |
| 11 | 6.0 | 9.4 | 13.1 | 16.4 | 18.2 | 21.4 | 84.6 |
| 12 | 4.2 | 7.3 | 10.0 | 13.6 | 15.3 | 18.5 | 68.9 |
| 13 | 2.0 | 3.7 | 5.7 | 8.3 | 9.8 | 13.4 | 42.9 |
| 14 | 1.0 | 1.8 | 2.8 | 4.6 | 5.8 | 8.6 | 24.7 |
| 15 | 0.8 | 1.2 | 1.9 | 3.0 | 4.1 | 7.2 | 18.0 |

Author's calculations based on data from MECD (Ministerio de Educación, Cultura y Deportes).

**Table 3. Percent of the Population Aged 6 to 18 Enrolled in School in 1998, by Region**

| Region | Percent Enrolled |
|---|---|
| Managua | 85.6 |
| Pacific Urban | 81.2 |
| Central Urban | 77.6 |
| Atlantic Urban | 75.7 |
| Pacific Rural | 70.2 |
| Central Rural | 49.1 |
| Atlantic Rural | 39.6 |
| All | 67.5 |

**Table 4. Geographic Distribution of the Full 1998 Sample and the "Treatment" Group**

| | | Number of Families in the 1998 Sample | | | Percent of 1998 Sample Families Hit by Mitch | |
|---|---|---|---|---|---|---|
| Region | Department | Urban | Rural | Total | Urban | Rural |
| Managua | | | | | | |
| | Managua | 479 | 65 | 544 | 0.0 | 0.0 |
| Pacific | | | | | | |
| | Chinandega | 182 | 119 | 301 | 22.5 | 46.2 |
| | Leon | 183 | 125 | 308 | 24.6 | 72.0 |
| | Masaya | 180 | 125 | 305 | 0.0 | 24.0 |
| | Carazo | 124 | 83 | 207 | 0.0 | 0.0 |
| | Granada | 121 | 71 | 192 | 0.0 | 0.0 |
| | Rivas | 74 | 109 | 183 | 0.0 | 9.2 |
| Central | | | | | | |
| | Nueva Segovia | 110 | 89 | 199 | 0.0 | 10.1 |
| | Madriz | 55 | 111 | 166 | 23.6 | 16.2 |
| | Esteli | 132 | 81 | 213 | 25.0 | 53.1 |
| | Jinotega | 53 | 176 | 229 | 0.0 | 9.1 |
| | Matagalpa | 103 | 196 | 299 | 0.0 | 30.6 |
| | Boaco | 59 | 125 | 184 | 39.0 | 19.2 |
| | Chontales | 100 | 86 | 186 | 0.0 | 0.0 |
| Atlantic | | | | | | |
| | North Atlantic Autonomus | 108 | 137 | 245 | 0.0 | 18.3 |
| | South Atlantic Autonomus | 157 | 147 | 304 | 0.0 | 21.1 |
| | Rio San Juan | 50 | 94 | 144 | 0.0 | 0.0 |
| All | | 2270 | 1939 | 4209 | 6.8 | 21.2 |

**Table 5a. Sample Means, Differences, and Tests of Equality of Demographic Characteristics, for Families Affected by Mitch (Mitch) and Families Spared by Mitch (Control) in 1998**

| | Urban | | | | Rural | | | |
|---|---|---|---|---|---|---|---|---|
| | Mitch | Control | Diff. | P-value | Mitch | Control | Diff. | P-value |
| **Families** | | | | | | | | |
| % of Families in Poverty | 37.7 | 30.2 | 7.6 | .080 | 69.3 | 69.0 | 0.3 | .911 |
| No. of Adults | 2.59 | 2.62 | -.03 | .811 | 2.63 | 2.56 | .07 | .375 |
| No. of Children | 2.39 | 2.66 | -.27 | .086 | 3.53 | 3.45 | .08 | .595 |
| % Female-Headed Families | 30.3 | 35.3 | -5.0 | .225 | 15.3 | 18.7 | -3.4 | .115 |
| % of Households with Two or More Families | 5.5 | 6.0 | -0.5 | .824 | 3.5 | 2.1 | 1.5 | .157 |
| % of Families without Water on the Premises | 23.2 | 12.7 | **10.5** | .004 | 86.1 | 81.8 | **4.38** | .034 |
| % of Families without Electric Power | 18.1 | 8.5 | **9.5** | .004 | 71.0 | 71.0 | 0.0 | .997 |
| Distance to School (minutes) | 9.2 | 8.0 | 1.1 | .141 | 24.4 | 34.5 | **-10.14** | .000 |
| Number of Observations | 155 | 739 | | | 411 | 1,129 | | |
| **Individuals Aged 6 to 18** | | | | | | | | |
| Father's Schooling | 4.09 | 5.55 | **-1.46** | .002 | 2.82 | 2.30 | .51 | .059 |
| Mother's Schooling | 5.33 | 5.10 | .24 | .713 | 2.58 | 2.05 | .54 | .052 |
| % Female | 55.3 | 52.2 | 3.04 | .369 | 48.2 | 47.9 | 3.10 | .870 |
| % Enrolled in School | 79.8 | 79.4 | 0.33 | .904 | 56.2 | 50.7 | **5.54** | .003 |
| Age Distribution: | | | | | | | | |
| % Aged 6 to 8 | 23.4 | 24.8 | Pearson's | | 25.3 | 27.8 | Pearson's | |
| % Aged 9 to 11 | 20.6 | 20.7 | Chi-squared: | | 22.3 | 23.1 | Chi-squared: | |
| % Aged 12 to 15 | 34.6 | 30.6 | 1.83 | | 29.8 | 29.1 | 4.19 | |
| % Aged 16 to 18 | 21.4 | 23.8 | p-value: | .604 | 22.7 | 20.1 | p-value: | .241 |
| Distribution of Enrollment: | | | | | | | | |
| Preschool | 21.8 | 21.5 | Pearson's | | 44.8 | 51.5 | Pearson's | |
| Primary, Grades 1 to 3 | 31.1 | 29.3 | Chi-squared: | | 34.5 | 31.0 | Chi-squared: | |
| Primary, Grades 4 to 6 | 21.8 | 22.3 | 0.728 | | 13.8 | 11.8 | **14.771** | |
| Secondary | 25.3 | 26.9 | p-value: | .948 | 6.9 | 5.7 | p-value: | .005 |
| Number of Observations | 257 | 1,381 | | | 971 | 2,533 | | |

**Table 5b. School Enrollment Rates in 1998, by Age, Region of Residence and Treatment Status**
**(Standard errors in parentheses)**

| | URBAN | | | RURAL | | |
|---|---|---|---|---|---|---|
| Age | Mitch | Control | Diff. | Mitch | Control | Diff. |
| 7 | .905 | .870 | .035 | .833 | .625 | **.208** |
| | | | (.072) | | | (.052) |
| 8 | .952 | .914 | .038 | .827 | .729 | .099 |
| | | | (.056) | | | (.052) |
| 9 | 1.000 | .924 | **.076** | .859 | .679 | **.181** |
| | | | (.026) | | | (.054) |
| 10 | .929 | .948 | -.019 | .794 | .678 | .115 |
| | | | (.073) | | | (.061) |
| 11 | .944 | .893 | .052 | .782 | .685 | .097 |
| | | | (.064) | | | (.059) |
| 12 | .962 | .892 | .070 | .736 | .711 | .026 |
| | | | (.049) | | | (.063) |
| 13 | .833 | .875 | -.042 | .561 | .575 | -.014 |
| | | | (.084) | | | (.071) |
| 14 | .905 | .802 | .103 | .462 | .458 | .003 |
| | | | (.077) | | | (.075) |
| 15 | .625 | .769 | -.144 | .363 | .320 | .043 |
| | | | (.133) | | | (.065) |
| 16 | .600 | .717 | -.117 | .227 | .253 | -.025 |
| | | | (.135) | | | (.062) |
| 17 | .625 | .487 | .139 | .208 | .187 | .021 |
| | | | (.132) | | | (.058) |
| 18 | .364 | .506 | -.142 | .185 | .078 | **.106** |
| | | | (.117) | | | (.054) |
| All ages | .812 | .800 | | .579 | .519 | |
| No. of Obs. | 234 | 1,248 | | 863 | 2,251 | |

**Table 6. Sample Means, Differences, and Tests of Equality of Sources of Income, for Families Affected by Mitch (Mitch) and Families Spared by Mitch (Control) in 1998**

| | Urban | | | | Rural | | | |
|---|---|---|---|---|---|---|---|---|
| | Mitch | Control | Diff. | P-value | Mitch | Control | Diff. | P-value |
| Sources of Income: | | | | | | | | |
| Adult Earnings | 18,122 | 24,848 | **-6,725** | .003 | 10,271 | 11,176 | -905 | .211 |
| Kids Earnings | 681 | 794 | -113 | .590 | 878 | 764 | 114 | .356 |
| Unearned Income | 155 | 386 | **-232** | .035 | 68 | 135 | **-67** | .018 |
| Aid from Relatives | 1,001 | 2,027 | **-1,025** | .017 | 545 | 680 | -135 | .232 |
| Business Net Revenue | 1,793 | 5,669 | **-3,876** | .003 | 952 | 1,723 | **-771** | .001 |
| Agricultural Net Revenue | 174 | 398 | -223 | .102 | 2,655 | 4,061 | **-1,405** | .002 |
| Total Income | 21,926 | 34,121 | **-12,195** | .000 | 15,370 | 18,538 | **-3,168** | .002 |
| Income per Adult Equivalent | 7,685 | 11,250 | **-3,565** | .000 | 4,985 | 5,907 | **-922** | .005 |
| Number of Observations | 155 | 739 | | | 411 | 1,129 | | |

**Table 7a. Measures of Families' Access to Credit by Region of Residence, Full 1998 Sample**
**(All questions refer to the previous 12 months)**

| | Urban | Rural |
|---|---|---|
| Percent reporting that the family members obtained a given number of loans, by number of loans received: | | |
| 0 loans | 83.9 | 89.3 |
| 1 loan | 14.0 | 10.1 |
| 2 loans | 1.1 | 0.5 |
| 3 loans | 0.8 | 0.1 |
| 4 loans | 0.2 | 0.1 |
| Percent reporting a given reason for no family member having asked for a loan, by reason: | | |
| Do not have property for use as collateral | 20.5 | 25.4 |
| Fear of losing the collateral | 11.2 | 8.8 |
| Too risky due to low income | 10.1 | 10.4 |
| Interest rates are too high | 9.3 | 8.4 |
| No lender in the community | 6.1 | 12.8 |
| Prefers to work with own resources | 8.9 | 11.7 |
| Other reasons | 19.2 | 17.4 |
| No need for a loan | 14.7 | 5.1 |
| Percent reporting a given problem as the main problem in the family's productive business, by problem: | | |
| High price of inputs | 32.3 | 29.5 |
| Lack of own capital | 15.3 | 15.6 |
| Lack financing | 13.2 | 10.6 |
| Has no problems | 27.0 | 35.3 |
| Percent reporting a given problem as the second most serious problem in the family's productive business, by problem: | | |
| High price of inputs | 8.9 | 10.7 |
| Lack of own capital | 33.3 | 39.1 |
| Lack financing | 31.1 | 33.0 |
| Percent reporting that their main loan had to be repaid in less than one year | 74.9 | 73.4 |
| Average loan duration, for fixed-length loans with duration quoted in months | 6.0 | 6.4 |
| Average loan duration, for fixed-length loans with duration quoted in years | 2.1 | 1.9 |
| Average loan duration, for flexible-length loans with duration quoted in months | 3.7 | 4.7 |
| Average monthly rate of interest, for those reporting a monthly rate | 6.4 | 5.7 |

**Table 7b. Average Family Assets in 1998, by Region of Residence and Treatment Status**
**(1998 Córdobas, Standard Deviations in Square Brackets)**

| | Urban | | Rural | |
|---|---|---|---|---|
| | Mitch | Control | Mitch | Control |
| Asset Category: | | | | |
| Home and Consumer Durables | 26,876 | 40,878 | 11,416 | 14,334 |
| | [36,900] | [65,160] | [15,246] | [16,514] |
| Business | 2,477 | 3,980 | 260 | 322 |
| | [8,496] | [11,822] | [1,065] | [1,182] |
| Land, Livestock, and Agricultural | 786 | 2,276 | 12,707 | 18,541 |
| Equipment and Infrastructure | [5,480] | [12,165] | [37,028] | [46,891] |
| Total Assets | 30,140 | 47,135 | 24,383 | 33,197 |
| | [42,151] | [72,701] | [43,348] | [52,579] |
| Total Income (from Table 5b) | 21,926 | 34,121 | 15,370 | 18,538 |
| Number of observations | 153 | 739 | 413 | 1,129 |

**Table 8. Reason for Not Enrolling in School for Individuals Aged 7 to 18, by Year, Region of Residence and Treatment Status**
**(Percentages)**

| | Urban | | Rural | |
|---|---|---|---|---|
| Reason | Mitch | Control | Mitch | Control |
| **1998** | | | | |
| Age reasons, uninterested | 29.6 | 16.0 | 11.0 | 11.6 |
| Housework, fieldwork, caring for children | 15.9 | 24.8 | 26.2 | 26.0 |
| School supply reasons: no space for child, grade level is not offered, school is too far, there are no teachers | 4.6 | 0.8 | 8.8 | 23.1 |
| Lack of money | 40.9 | 46.4 | 41.1 | 32.5 |
| Other reasons: lack of safety on road to school, pregnancy, family problems, illness or disability, other | 9.1 | 12.0 | 13.0 | 6.9 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |
| Number of observations | 44 | 250 | 363 | 1078 |
| **1999** | | | | |
| Age reasons, uninterested | 16.0 | | 13.9 | |
| Housework, fieldwork, caring for children | 28.0 | | 28.0 | |
| School supply reasons: no space for child, grade level is not offered, school is too far, there are no teachers | 0.0 | | 12.7 | |
| Lack of money | 42.0 | | 35.8 | |
| Other reasons: lack of safety on road to school, pregnancy, family problems, illness or disability, other | 14.0 | | 9.6 | |
| Total | 100.0 | | 100.0 | |
| Number of observations | 50 | | 332 | |
| **2001** | | | | |
| Age reasons, uninterested | 35.7 | 25.0 | 24.4 | 18.2 |
| Housework, fieldwork, caring for children | 32.1 | 27.4 | 37.3 | 33.1 |
| School supply reasons: no space for child, grade level is not offered, school is too far, there are no teachers | 0.0 | 2.4 | 10.5 | 15.5 |
| Lack of money | 21.4 | 31.1 | 21.9 | 26.4 |
| Other reasons: lack of safety on road to school, pregnancy, family problems, illness or disability, other | 10.7 | 14.2 | 6.0 | 6.8 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 |
| Number of observations | 28 | 212 | 201 | 632 |

**Table 9. School Enrollment Rates by Year, Age and Region of Residence, for Individuals Residing in Mitch Households, Who Are Present in Both Years**
**(Standard errors in parentheses)**

| | URBAN | | | RURAL | | |
|---|---|---|---|---|---|---|
| Age | 1998 | 1999 | '99-'98 Diff. | 1998 | 1999 | '99-'98 Diff. |
| 7 | .950 | 1.000 | .050 | .840 | .797 | -.043 |
| | | | (.050) | | | (.063) |
| 8 | .952 | 1.000 | .048 | .829 | .871 | .042 |
| | | | (.048) | | | (.058) |
| 9 | 1.000 | .913 | -.087 | .859 | .876 | .017 |
| | | | (.061) | | | (.045) |
| 10 | .923 | .947 | .024 | .783 | .836 | .052 |
| | | | (.093) | | | (.064) |
| 11 | .941 | 1.000 | .059 | .776 | .855 | .078 |
| | | | (.059) | | | (.057) |
| 12 | 1.000 | .944 | -.056 | .739 | .770 | .031 |
| | | | (.056) | | | (.067) |
| 13 | .833 | .920 | .087 | .557 | .667 | .109 |
| | | | (.084) | | | (.080) |
| 14 | .905 | .750 | -.155 | .509 | .556 | .046 |
| | | | (.121) | | | (.091) |
| 15 | .667 | .790 | .123 | .418 | .383 | -.035 |
| | | | (.157) | | | (.085) |
| 16 | .636 | .778 | .141 | .255 | .290 | .036 |
| | | | (.179) | | | (.083) |
| 17 | .615 | .546 | -.070 | .236 | .273 | .036 |
| | | | (.189) | | | (.080) |
| 18 | 0 | .412 | .412 | .286 | .206 | -.079 |
| | | | (.123) | | | (.078) |
| All ages | .866 | .844 | | .639 | .634 | |
| No. of obs. | 201 | 224 | | 733 | 797 | |

**Table 10. Working Behavior of Children and Teenagers in Mitch Families**
**(Standard Errors in Parentheses)**

| | Fraction Working | | | Among Those Working: Average # of Hours per Week | | |
|---|---|---|---|---|---|---|
| Age | 1998 | 1999 | Diff. | 1998 | 1999 | Diff. |
| **Urban Residents** | | | | | | |
| 7 – 9 | .000 | .085 | **.085** (.039) | - | 14.5 | 14.5 (1.9) |
| 10 – 12 | .085 | .094 | .009 (.049) | 38 | 17.7 | -20.3 (10.6) |
| 13 – 15 | .206 | .191 | -.016 (.059) | 33.1 | 24.4 | -8.9 (7.2) |
| 16 – 18 | .436 | .361 | -.076 (.076) | 44.8 | 45.0 | 0.2 (7.2) |
| All ages | .176 | .179 | | 40.4 | 31.5 | |
| No. of obs. | 239 | 280 | | 42 | 50 | |
| **Rural Residents** | | | | | | |
| 7 – 9 | .062 | .055 | -.008 (.020) | 29.7 | 23.4 | -6.2 (4.6) |
| 10 – 12 | .174 | .151 | -.023 (.033) | 30.2 | 24.2 | -6.0 (3.2) |
| 13 – 15 | .312 | .416 | **.104** (.041) | 43.1 | 35.3 | **-7.8** (2.9) |
| 16 – 18 | .455 | .576 | **.121** (.043) | 43.7 | 40.7 | -3.0 (2.1) |
| All ages | .246 | .292 | | 40.2 | 35.8 | |
| No. of obs. | 894 | 936 | | 220 | 273 | |

**Table 11a. Estimated Survival Functions for Urban Residents, by Year**
**(Standard Errors in Parentheses, Normal-Based 95% Confidence Intervals in Brackets)**

| | Children and Teenagers in Mitch Families | | | Children and Teenagers in Control Families | | | |
|---|---|---|---|---|---|---|---|
| Grade Level | 1998 | 2001 | Diff. | 1998 | 2001 | Diff. | Diff. in Diff. |
| 0 | .9579 | .9265 | -.0313 | .9430 | .9024 | **-.0406** | .0093 |
| | (.0124) | (.0147) | (.0258) | (.0062) | (.0065) | (.0113) | (.0280) |
| | | | [-.082, .019] | | | [-.063, -.019] | [-.046, .064] |
| 1 | .9536 | .9232 | -.0304 | .9354 | .8952 | **-.0401** | .0098 |
| | (.0131) | (.0151) | (.0267) | (.0066) | (.0068) | (.0120) | (.0293) |
| | | | [-.083, .022] | | | [-.064, -.017] | [-.048, .067] |
| 2 | .9299 | .8984 | -.0315 | .9173 | .8772 | **-.0401** | .0086 |
| | (.0165) | (.0173) | (.0319) | (.0076) | (.0073) | (.0139) | (.0348) |
| | | | [-.094, .031] | | | [-.067, -.013] | [-.060, .077] |
| 3 | .8978 | .8558 | -.0420 | .8913 | .8346 | **-.0567** | .0147 |
| | (.0205) | (.0207) | (.0389) | (.0089) | (.0086) | (.0160) | (.0419) |
| | | | [-.118, .034] | | | [-.881, -.025] | [-.068, .097] |
| 4 | .8734 | .8344 | -.0390 | .8540 | .7906 | **-.0634** | .0244 |
| | (.0233) | (.0223) | (.0436) | (.0106) | (.0097) | (.0184) | (.0468) |
| | | | [-.124, .046] | | | [-.099, -.027] | [-.067, .116] |
| 5 | .8324 | .7920 | -.0405 | .8251 | .7439 | **-.0811** | .0407 |
| | (.0275) | (.0253) | (.0494) | (.0118) | (.0109) | (.0209) | (.0538) |
| | | | [-.137, .056] | | | [-.122, -.040] | [-.065, .146] |
| 6 | .7112 | .6455 | -.0657 | .7486 | .6526 | **-.0960** | .0303 |
| | (.0373) | (.0327) | (.0657) | (.0147) | (.0126) | (.0252) | (.0698) |
| | | | [-.194, .063] | | | [-.145, -.047] | [-.107, .167] |
| 7 | .6893 | .6122 | -.0771 | .6904 | .5986 | **-.0918** | .0147 |
| | (.0392) | (.0343) | (.0698) | (.0169) | (.0136) | (.0281) | (.0743) |
| | | | [-.214, .060] | | | [-.147, -.037] | [-.131, .160] |
| 8 | .6160 | .5192 | -.0968 | .6485 | .5605 | **-.0880** | -.0088 |
| | (.0468) | (.0382) | (.0799) | (.0187) | (.0143) | (.0299) | (.0845) |
| | | | [-.253, .060] | | | [-.147, -.029] | [-.174, .157] |
| 9 | .5582 | .5007 | -.0576 | .6147 | .5220 | **-.0927** | .0352 |
| | (.0530) | (.0390) | (.0883) | (.0205) | (.0151) | (.0324) | (.0934) |
| | | | [-.231, .116] | | | [-.156, -.029] | [-.148, .218] |
| 10 | .5350 | .5007 | -.0343 | .5845 | .4998 | **-.0847** | .0504 |
| | (.0556) | (.0390) | (.0910) | (.0229) | (.0157) | (.0354) | (.0960) |
| | | | [-.213, .144] | | | [-.154, -.015] | [-.138, .239] |
| 11 | .3344 | .3894 | .0551 | .4804 | .3645 | **-.1159** | .1710 |
| | (.0735) | (.0502) | (.1273) | (.0323) | (.0189) | (.0476) | (.1371) |
| | | | [-.195, .305] | | | [-.209, -.023] | [-.098, .440] |

Note: Standard errors and confidence intervals for the differences in estimated survivor functions, and for the differences in differences, were bootstrapped using 1013 bootstrap samples.

**Table 11b. Estimated Survival Functions for Rural Residents, by Year**
**(Standard Errors in Parentheses, Normal-Based 95% Confidence Intervals in Brackets)**

| | Children and Teenagers in Mitch Families | | | Children and Teenagers in Control Families | | | |
|---|---|---|---|---|---|---|---|
| Grade Level | 1998 | 2001 | . Diff | 1998 | 2001 | Diff. | Diff. in Diff. |
| 0 | .8260 | .8648 | .0388 | .7434 | .8322 | **.0887** | -.0499 |
| | (.0124) | (.0124) | (.0223) | (.0088) | (.0087) | (.0161) | (.0287) |
| | | | [-.005, .083] | | | [.057, .120] | [-.106, .006] |
| 1 | .8044 | .8575 | **.0531** | .7191 | .8193 | **.1003** | -.0472 |
| | (.0132) | (.0127) | (.0232) | (.0091) | (.0090) | (.0168) | (.0302) |
| | | | [.008, .099] | | | [.067, .133] | [-.106, .012] |
| 2 | .7453 | .8292 | **.0839** | .6448 | .7732 | **.1284** | -.0445 |
| | (.0152) | (.0140) | (.0269) | (.0103) | (.0101) | (.0188) | (.0340) |
| | | | [.031, .137] | | | [.092, .165] | [-.111, .022] |
| 3 | .6508 | .7589 | **.1081** | .5394 | .6921 | **.1526** | -.0445 |
| | (.0181) | (.0171) | (.0335) | (.0116) | (.0120) | (.0218) | (.0415) |
| | | | [.042, .174] | | | [.110, .195] | [-.126, .037] |
| 4 | .5642 | .6878 | **.1237** | .4614 | .6204 | **.1590** | -.0353 |
| | (.0201) | (.0197) | (.0368) | (.0124) | (.0134) | (.0237) | (.0443) |
| | | | [.052, .196] | | | [.113, .205] | [-.122, .051] |
| 5 | .4962 | .6274 | **.1312** | .3995 | .5673 | **.1678** | -.0366 |
| | (.0215) | (.0220) | (.0415) | (.0130) | (.0145) | (.0257) | (.0495) |
| | | | [.050, .212] | | | [.118, .218] | [-.134, .061] |
| 6 | .2983 | .4309 | **.1326** | .2692 | .4097 | **.1405** | -.0079 |
| | (.0233) | (.0263) | (.0461) | (.0136) | (.0166) | (.0276) | (.0544) |
| | | | [.042, .223] | | | [.086, .195] | [-.114, .099] |
| 7 | .2508 | .3913 | **.1405** | .2291 | .3659 | **.1368** | .0037 |
| | (.0236) | (.0274) | (.0470) | (.0138) | (.0173) | (.0287) | (.0567) |
| | | | [.048, .233] | | | [.081, .193] | [-.108, .115] |
| 8 | .2299 | .3449 | **.1150** | .1823 | .3166 | **.1343** | -.0193 |
| | (.0245) | (.0292) | (.0494) | (.0144) | (.0183) | (.0305) | (.0596) |
| | | | [.018, .212] | | | [.075, .194] | [-.136, .098] |
| 9 | .1694 | .3038 | **.1344** | .1557 | .2615 | **.1058** | .0286 |
| | (.0294) | (.0310) | (.0534) | (.0154) | (.0196) | (.0333) | (.0638) |
| | | | [.030, .239] | | | [.041, .171] | [-.096, .154] |
| 10 | .1506 | .2878 | **.1373** | .1427 | .2452 | **.1024** | .0348 |
| | (.0316) | (.0332) | (.0588) | (.0166) | (.0205) | (.0361) | (.0701) |
| | | | [.022, .253] | | | [.032, .173] | [-.103, .172] |
| 11 | .0753 | .1439 | .0686 | .0999 | .1740 | .0741 | -.0055 |
| | (.0555) | (.0447) | (.0793) | (.0237) | (.0247) | (.0481) | (.0922) |
| | | | [-.087, .224] | | | [-.020, .168] | [-.186, .175] |

*Note*: Standard errors and confidence intervals for the differences in estimated survivor functions, and for the differences in differences, were bootstrapped using 1005 bootstrap samples.

**Table 12a. Means and Differences in Means in Annual Family Income, Its Sources, and Income per Adult Equivalent, Urban Residents**
**(1998 Córdobas, Standard Deviations in Square Brackets and Standard Errors in Parentheses)**

| | Mitch Families | | | | Control Families | | | |
|---|---|---|---|---|---|---|---|---|
| | 1998 | 1999 | 2001 | '01-'98 Diff. | 1998 | 2001 | '01-'98 Diff. | Diff. in Diff. |
| Total Family Income | 22,024 | 21,745 | 31,575 | **9,551** | 34,144 | 42,621 | **8,477** | 1,074 |
| | [23,486] | [18,293] | [35,130] | (3,555) | [34,772] | [45,821] | (2,133) | (5,021) |
| Sources of Income: | | | | | | | | |
| Adult Earnings | 18,189 | 18,788 | 22,004 | 3,815 | 24,869 | 27,827 | **2,958** | 857 |
| | [20,444] | [17,793] | [27,902] | [2,904] | [26,769] | [30,136] | (1,484) | (3,556) |
| Kids Earnings | 684 | 493 | 554 | -130 | 798 | 833 | 35 | -165 |
| | [2,135] | [1,628] | [1,665] | (224) | [2,427] | [2,611] | (131) | (309) |
| Unearned Income | 155 | 623 | 725 | **570** | 387 | 861 | **474** | 96 |
| | [858] | [1,508] | [2,397] | (216) | [1,310] | [2,639] | (111) | (266) |
| Aid from Relatives + Remittances | 1,006 | 985 | 2,363 | **1,357** | 2,026 | 2,426 | 400 | 957 |
| | [3,261] | [2,346] | [5,520] | (516) | [5,118] | [6,495] | (297) | (702) |
| Business Net Revenue | 1,815 | 81 | 5,162 | **3,347** | 5,665 | 10,218 | **4,553** | -1,206 |
| | [12,348] | [305] | [13,019] | (1,497) | [15,335] | [22,730] | (1,022) | (2,379) |
| Agricultural Net Revenue | 175 | 775 | 767 | **592** | 400 | 456 | 56 | **536** |
| | [592] | [2,676] | [2,008] | (178) | [1,685] | [1,849] | (92) | (220) |
| Income per Adult Equivalent | 7,719 | 7,522 | 10,446 | **2,727** | 11,257 | 15,150 | **3,893** | -1,166 |
| | [8,516] | [6,397] | [11,707] | (1,215) | [11,449] | [18,943] | (828) | (1,929) |
| Aid from Relatives | 1,006 | 985 | 1,347 | - | 2,026 | 998 | - | - |
| | [3,261] | [2,346] | [3,413] | | [5,118] | [3,111] | | |
| Remittances | - | - | 1,016 | - | - | 1,429 | - | - |
| | | | [2,246] | | | [3,535] | | |
| No. of Observations | 155 | 166 | 134 | | 739 | 769 | | |

**Table 12b. Means and Differences in Means in Annual Family Income, Its Sources, and Income per Adult Equivalent, Rural Residents**
**(1998 Córdobas, Standard Deviations in Square Brackets and Standard Errors in Parentheses)**

| | Mitch Families | | | | Control Families | | | |
|---|---|---|---|---|---|---|---|---|
| | 1998 | 1999 | 2001 | '01-'98 Diff. | 1998 | 2001 | '01-'98 Diff. | Diff. in Diff. |
| Total Family Income | 15,355 | 15,579 | 21,197 | **5,841** | 18,597 | 22,377 | **3,780** | 2,061 |
| | [15,440] | [14,202] | [16,564] | (1,188) | [19,941] | [22,805] | (896) | (1,584) |
| Sources of Income: | | | | | | | | |
| Adult Earnings | 10,263 | 9,035 | 11,381 | 1,118 | 11,202 | 12,140 | 938 | 181 |
| | [10,898] | [9,545] | [11,088] | (818) | [14,431] | [13,629] | (586) | (1,047) |
| Kids Earnings | 876 | 775 | 790 | -86 | 768 | 550 | -218 | 132 |
| | [2,333] | [1,766] | [2,095] | (166) | [2,271] | [1,757] | (85) | (166) |
| Unearned Income | 68 | 729 | 212 | **144** | 135 | 130 | -6 | **149** |
| | [416] | [1,767] | [787] | (45) | [566] | [670] | (26) | (49) |
| Aid from Relatives + Remittances | 544 | 1,131 | 1,147 | **604** | 683 | 1043 | **360** | 243 |
| | [2,088] | [3,280] | [2,401] | (169) | [2,087] | [2,458] | (97) | (183) |
| Business Net Revenue | 952 | 16 | 2,327 | **1,375** | 1,731 | 2,048 | 317 | **1,059** |
| | [3,379] | [96] | [5,855] | (345) | [4,935] | [6,046] | (231) | (419) |
| Agricultural Net Revenue | 2,653 | 3,893 | 5,338 | **2,686** | 4,078 | 6,466 | **2,388** | 297 |
| | [6,426] | [7,386] | [8,471] | (551) | [8,930] | [11,036] | (420) | (741) |
| Income per Adult Equivalent | 4,980 | 4,887 | 7,056 | **2,076** | 5,925 | 7,400 | **1,475** | 601 |
| | [5,009] | [4,633] | [7,002] | (445) | [6,427] | [8,630] | (319) | (569) |
| Aid from Relatives | 544 | 1,131 | 544 | - | 683 | 443 | - | - |
| | [2,088] | [3,280] | [1,462] | | [2,087] | [1,374] | | |
| Remittances | - | - | 604 | - | - | 601 | - | - |
| | | | [1,342] | | | [1,419] | | |
| No. of Observations | 411 | 429 | 320 | | 1,129 | 1,165 | | |

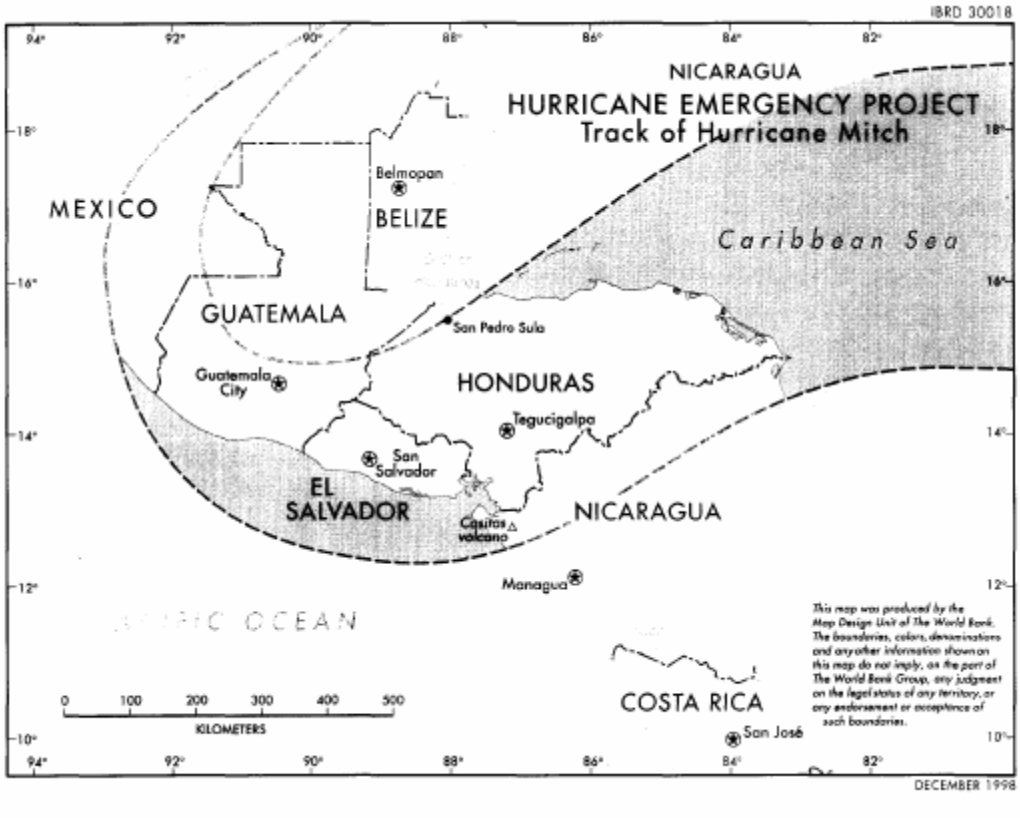


**Figure 1. Track of Hurricane Mitch**
Source: The World Bank: Report No. T-7279-NI (1998)

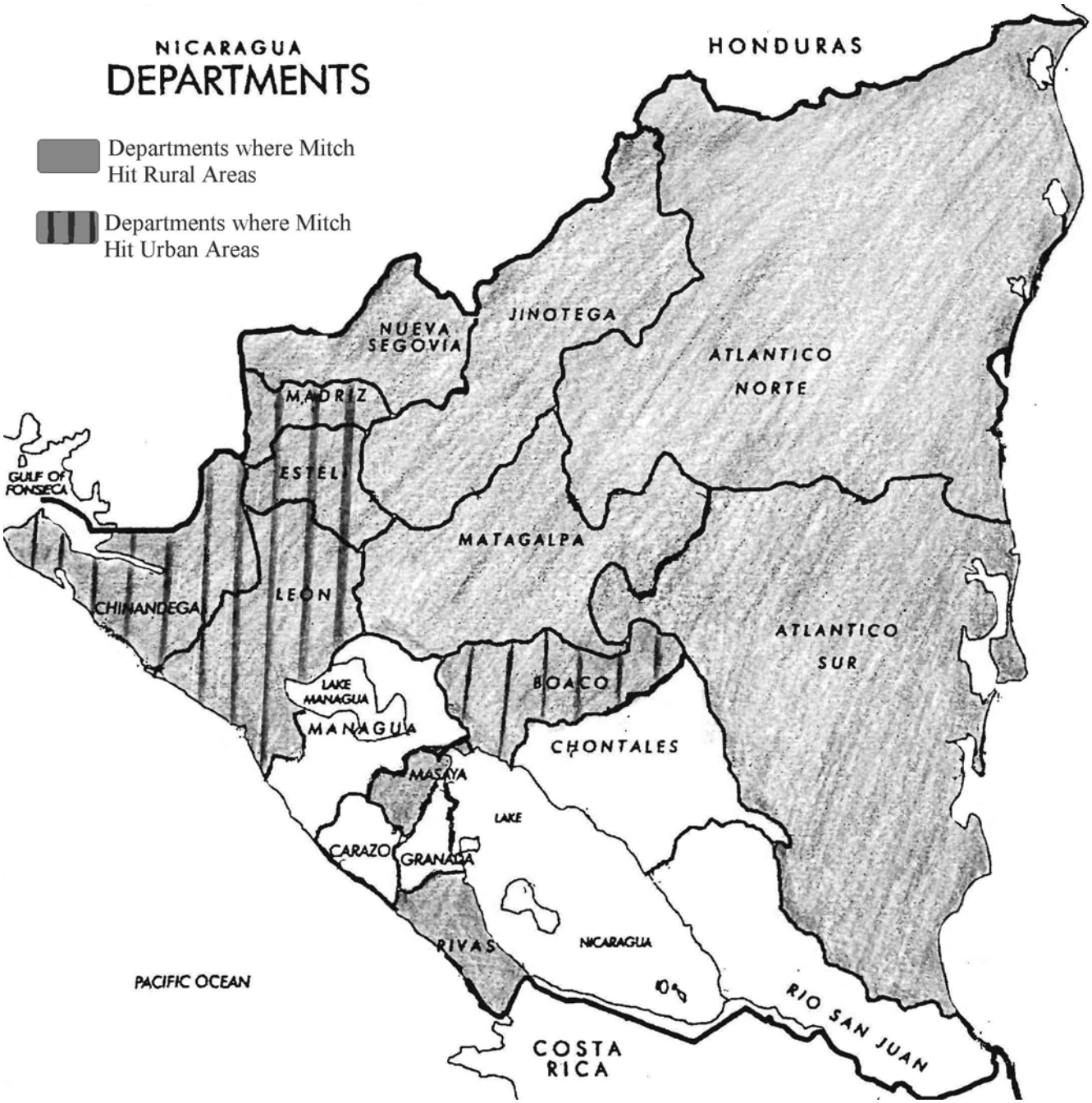


**Figure 2. Map of Nicaragua Showing Departments Where Hurricane Mitch Affected Urban and/or Rural Residents**

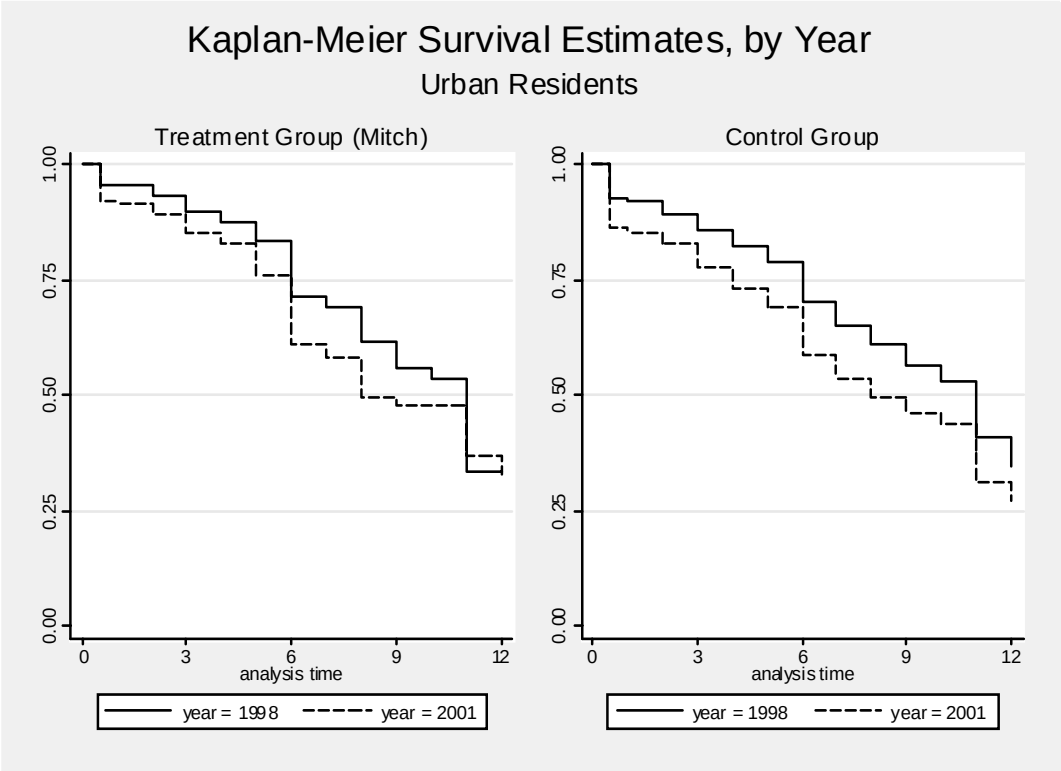


**Figure 3. Kaplan-Meier Estimates of the Probability of Remaining in School Up to a Given Grade Level (Analysis Time) or Beyond, Urban Residents**

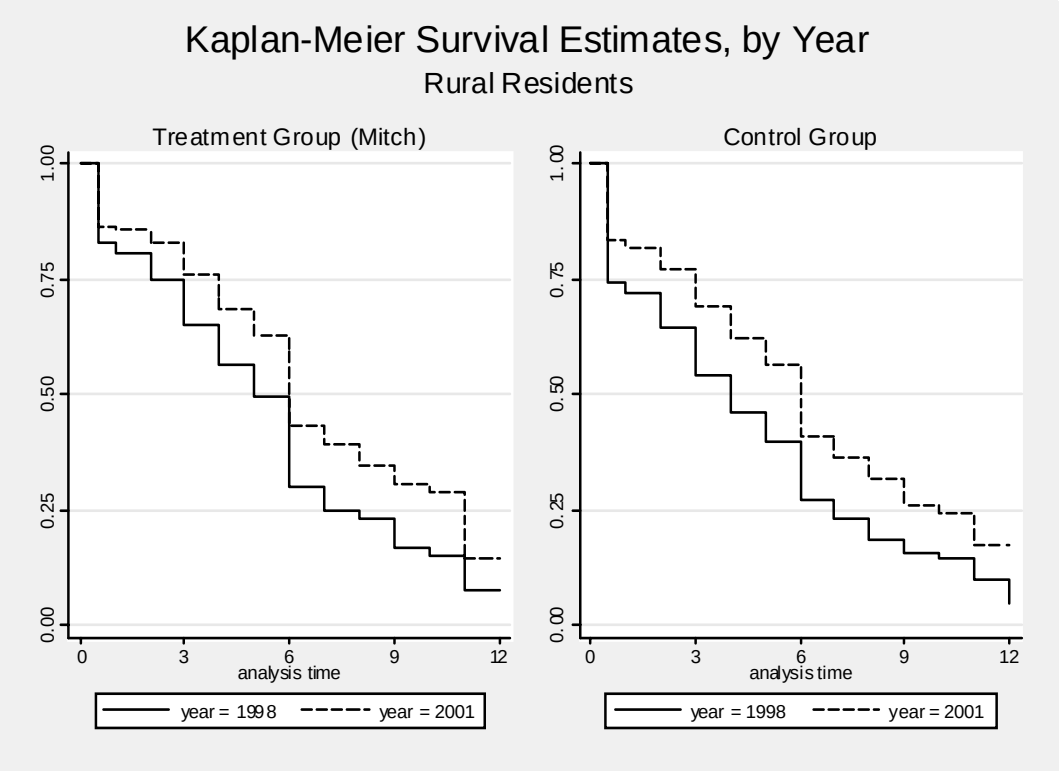


**Figure 4. Kaplan-Meier Estimates of the Probability of Remaining in School Up to a Given Grade Level (Analysis Time) or Beyond, Rural Residents**

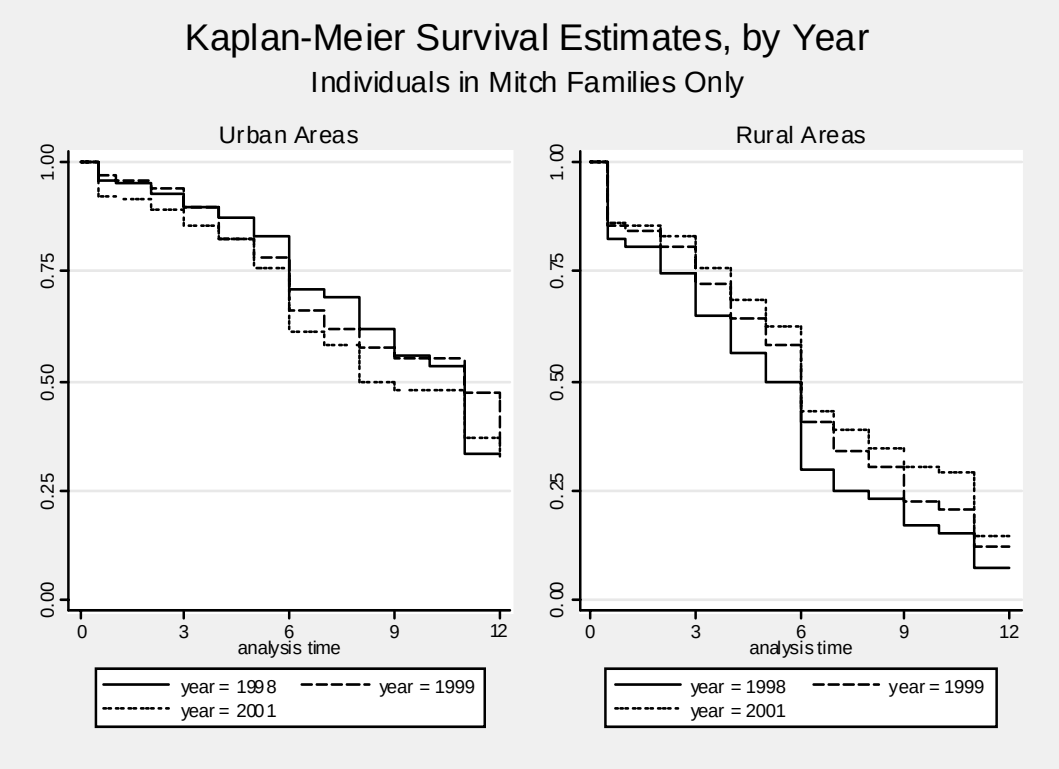


**Figure 5. Kaplan-Meier Estimates of the Probability of Remaining in School Up to a Given Grade Level (Analysis Time) or Beyond, Individuals in Mitch Families Only**

APPENDIX A: Tables A1 and A2

**Table A1. Estimated Survival Functions for Urban Residents, by Year**
**(Standard Errors in Parentheses, Normal-Based 95% Confidence Intervals in Brackets)**

| Grade Level | Areas Hit by Mitch | | | Areas Spared by Mitch | | | Diff. in diff. |
|---|---|---|---|---|---|---|---|
| | 1998 | 2001 | Diff. | 1998 | 2001 | Diff. | |
| 0 | .9579 | .9196 | -.0382 | .9377 | .8931 | **-.0446** | .0064 |
| | (.0124) | (.0148) | (.0419) | (.0038) | (.0040) | (.0097) | (.0453) |
| | | | [-.120, .044] | | | [-.064, -.025] | [-.082, .095] |
| 1 | .9536 | .9166 | -.0370 | .9308 | .8842 | **-.0466** | .0096 |
| | (.0131) | (.0148) | (.0391) | (.0040) | (.0041) | (.0105) | (.0446) |
| | | | [-.114, .040] | | | [-.067, -.026] | [-.078, .097] |
| 2 | .9299 | .8935 | -.0364 | .9107 | .8633 | **-.0474** | .0111 |
| | (.0165) | (.0168) | (.0622) | (.0046) | (.0045) | (.0110) | (.0702) |
| | | | [-.158, .086] | | | [-.069, -.026] | [-.126, .149] |
| 3 | .8978 | .8537 | -.0441 | .8833 | .8233 | **-.0600** | .0160 |
| | (.0205) | (.0188) | (.0683) | (.0054) | (.0052) | (.0082) | (.0746) |
| | | | [-.178, .090] | | | [-.076, -.044] | [-.130, .162] |
| 4 | .8734 | .8259 | -.0475 | .8518 | .7855 | **-.0663** | .0189 |
| | (.0233) | (.0220) | (.0690) | (.0062) | (.0058) | (.0096) | (.0732) |
| | | | [-.183, .088] | | | [-.085, -.047] | [-.125, .162] |
| 5 | .8324 | .7604 | -.0721 | .8190 | .7478 | **-.0712** | -.0009 |
| | (.0275) | (.0259) | (.1030) | (.0071) | (.0063) | (.0083) | (.1075) |
| | | | [-.274, .130] | | | [-.087, -.055] | [-.212, .210] |
| 6 | .7112 | .6124 | -.0998 | .7365 | .6503 | **-.0862** | -.0126 |
| | (.0373) | (.0325) | (.0782) | (.0089) | (.0075) | (.0093) | (.0835) |
| | | | [-.252, .055] | | | [-.104, -.068] | [-.176, .151] |
| 7 | .6893 | .5811 | -.1082 | .6838 | .5957 | **-.0882** | -.0200 |
| | (.0392) | (.0338) | (.1002) | (.0100) | (.0081) | (.0161) | (.1150) |
| | | | [-.305, .088] | | | [-.120, -.057] | [-.245, .205] |
| 8 | .6160 | .4940 | -.1220 | .6364 | .5440 | **-.0924** | -.0300 |
| | (.0468) | (.0363) | (.1217) | (.0112) | (.0087) | (.0216) | (.1424) |
| | | | [-.361, .117] | | | [-.135, -.050] | [-.309, .249] |
| 9 | .5582 | .4766 | -.0816 | .5927 | .5046 | **-.0881** | .0065 |
| | (.0530) | (.0369) | (.1075) | (.0125) | (.0092) | (.0111) | (.1138) |
| | | | [-.292, .129] | | | [-.110, -.066] | [-.217, .230] |
| 10 | .5350 | .4766 | -.0583 | .5633 | .4786 | **-.0848** | .0264 |
| | (.0556) | (.0369) | (.1075) | (.0138) | (.0096) | (.0115) | (.1166) |
| | | | [-.269, .152] | | | [-.107, -.062] | [-.202, .255] |
| 11 | .3344 | .3707 | .0364 | .4314 | .3505 | **-.0809** | .1173 |
| | (.0735) | (.0468) | (.1511) | (.0197) | (.0115) | (.0222) | (.1400) |
| | | | [-.260, .332] | | | [-.124, -.037] | [-.157, .392] |

Note: Standard errors and confidence intervals for the differences in estimated survivor functions, and for the differences in differences, were bootstrapped using 1033 bootstrap samples.

**Table A2. Estimated Survival Functions for Rural Residents, by Year**
**(Standard Errors in Parentheses, Normal-Based 95% Confidence Intervals in Brackets)**

| | Areas Hit by Mitch | | | Areas Spared by Mitch | | | |
|---|---|---|---|---|---|---|---|
| Grade Level | 1998 | 2001 | Diff. | 1998 | 2001 | Diff. | Diff. in diff. |
| 0 | .8260 | .8648 | **.0388** | .7593 | .8406 | **.0814** | **-.0425** |
| | (.0124) | (.0124) | (.0068) | (.0075) | (.0074) | (.0058) | (.0011) |
| | | | [.025, .052] | | | [.070, .093] | [-.045, -.040] |
| 1 | .8044 | .8575 | **.0531** | .7351 | .8284 | **.0933** | **-.0402** |
| | (.0132) | (.0127) | (.0144) | (.0078) | (.0076) | (.0113) | (.0031) |
| | | | [.025, .081] | | | [.071, .115] | [-.046, -.034] |
| 2 | .7453 | .8292 | **.0839** | .6681 | .7839 | **.1159** | **-.0320** |
| | (.0152) | (.0140) | (.0049) | (.0088) | (.0086) | (.0148) | (.0099) |
| | | | [.074, .094] | | | [.087, .145] | [-.051, -.013] |
| 3 | .6508 | .7589 | **.1081** | .5720 | .7106 | **.1386** | -.0305 |
| | (.0181) | (.0171) | (.0006) | (.0099) | (.0101) | (.0186) | (.0180) |
| | | | [.107, .109] | | | [.102, .175] | [-.066, .005] |
| 4 | .5642 | .6878 | **.1236** | .4932 | .6380 | **.1448** | -.0211 |
| | (.0201) | (.0197) | (.0131) | (.0108) | (.0114) | (.0371) | (.0240) |
| | | | [.098, .149] | | | [.072, .218] | [-.068, .026] |
| 5 | .4962 | .6274 | **.1312** | .4301 | .5852 | **.1551** | -.0239 |
| | (.0215) | (.0220) | (.0052) | (.0114) | (.0123) | (.0294) | (.0258) |
| | | | [.023, .239] | | | [.097, .213] | [-.074, .027] |
| 6 | .2983 | .4309 | **.1326** | .2946 | .4336 | **.1390** | -.0064 |
| | (.0233) | (.0263) | (.0216) | (.0120) | (.0142) | (.0532) | (.0748) |
| | | | [.090, .175] | | | [.035, .243] | [-.153, .140] |
| 7 | .2508 | .3913 | **.1405** | .2451 | .3808 | **.1357** | .0048 |
| | (.0236) | (.0274) | (.0545) | (.0123) | (.0149) | (.0569) | (.1114) |
| | | | [.034, .247] | | | [.024, .247] | [-.214, .223] |
| 8 | .2299 | .3449 | **.1150** | .1991 | .3292 | **.1300** | -.0150 |
| | (.0245) | (.0292) | (.0233) | (.0128) | (.0156) | (.0298) | (.0530) |
| | | | [.069, .161] | | | [.072, .188] | [-.119, .089] |
| 9 | .1694 | .3038 | **.1344** | .1756 | .2815 | **.1059** | .0285 |
| | (.0294) | (.0310) | (.0099) | (.0135) | (.0166) | (.0366) | (.0465) |
| | | | [.115, .154] | | | [.034, .178] | [-.063, .120] |
| 10 | .1506 | .2878 | **.1372** | .1624 | .2702 | **.1078** | **.0294** |
| | (.0316) | (.0332) | (.0190) | (.0144) | (.0172) | (.0238) | (.0048) |
| | | | [.100, .175] | | | [.061, .154] | [.020, .039] |
| 11 | .0753 | .1439 | **.0686** | .1083 | .1854 | .0772 | -.0085 |
| | (.0555) | (.0447) | (.0286) | (.0193) | (.0211) | (.0895) | (.0609) |
| | | | [.013, .125] | | | [-.098, .253] | [-.128, .111] |

Note: Standard errors and confidence intervals for the differences in estimated survivor functions, and for the differences in differences, were bootstrapped using 1005 bootstrap samples.

## APPENDIX B: Funding Formula for Autonomous Schools in Nicaragua

The educational system in Nicaragua is organized in four levels: (1) preschool (up to 6 years of age), (2) six years of primary education (ages 7 to 12), and (3) five years of secondary education (ages 13 to 17) split into two cycles—3 years of "basic" cycle and 2 years of "diversified" cycle. The secondary education system leads to a Baccalaureate in Humanities or Science, which is one of the prerequisites for access to higher education. Alternatively, students go into technical secondary education where they are awarded the title of *Técnico Medio* after three years of "diversified cycle" in technical training. The fourth level is post-secondary education, which can be general or technical.

The monthly transfer to autonomous schools is calculated as follows:
Step 1: Enrollment = (Initial Enrollment x (1- Adjusted Dropout Rate))
The dropout rate is given a leeway of 5% points: if the dropout rate is 8.5%**,** enrollment is reduced by 3.5%.
Step 2: Assignment of Teaching and Administrative Load. The enrollment figure from step 1 is used to establish the *expected* number of teachers and administrators that the MED will pay to employ in each school.
Step 3: Fiscal Transfer = (Expected No. of Teachers x Average Teacher Salary) + (Expected No. of Administrators x Salary Scale20) + Pro-rated Fringe Benefits + 5.94% of total salaries for school materials.

To compensate schools located in poor areas, the MED uses the salary scale for rural areas, plus the number of students per class, as compensatory mechanisms. Rural salaries are higher than urban ones, and rural areas tend to have low student/teacher ratios, especially in multi-grade elementary schools. In cases where rural schools are grouped around a magnet school (in an arrangement called *Nucleos Educativos Rurales Autónomos),* the group classifies as a large school, which is also favored by the transfer formula. The formula establishes that maintenance, and the financing of additional school materials, is a local responsibility. Most capital investments, such as the rehabilitation of elementary schools, are now under the responsibility of the Investment Fund for Social Emergency (FISE). The fund has also been used to pay for school maintenance in rural areas in collaboration with local governments. As a result, funds raised by local schools go to increase teacher salaries and for additional improvements to the schools.