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Determinants of Education Duration in Jamaica

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Abstract

In this paper we have applied discrete time survival analysis techniques to analyze education duration in Jamaica. Based on the Jamaica Survey of Living Conditions 2002, we are able to estimate the effects of household, individual, and other related covariates on the risks of students dropping out. We compare the discrete time Cox model and discrete time logit model and determined that the two estimations are consistent. The estimation results measure the effects of the covariates and can be used to predict the dropout risks of particular students in each grade, which could provide useful implications for the formation of policy to improve education in Jamaica.

Keywords: education; dropout; time; survival analysis; poverty

JEL classification: I2; J24; N36

Introduction

Jamaica is a small island country with a population of 2.7 million and a GDP per capita in 2005 of http://en.wikipedia.org/wiki/Jamaica4,482 US dollars (PPP). In spite of its low rank in GDP per capita (111th among world countries in 2005), Jamaica stands out in the developing world as a country with a strong commitment to education: public spending on education grew to 7.6% of GDP in 1997-1998. This was complemented by an estimated household spending of about 6% of GDP. With significant public and private investment in education as well as successful governmental education policies, the country has made impressive progress in providing primary and secondary education.

In the 1990s, the Jamaica Ministry of Education and Culture (MOE&E) embarked on a 15-year "Reform of Secondary Education Program" (ROSE). The first phase focusing on lower secondary schools has been completed. The second phase focuses on improving upper secondary schools and on improving education quality at all levels.[1] Although the education system in Jamaica is complex and includes different types of schools that are constantly evolving[2], the system can be summarized and described as follows: Primary education is from Grade 1 to Grade 6, lower secondary education is from Grade 7 to 9, and upper secondary education is from Grade 10 to 11 (or 13[3]). In 1997-1998, the gross enrollment rates were more than 100 percent in primary education,

[1] Sources: Jamaica Secondary Education, Volume I, World Bank Report No 19069-JM, 1999.
[2] Note: "Time" is one of the most important key words in our study. However, in our paper "time" in different contexts represents different things: It represents grade when we are talking about a time period in the survival analysis, such as in the "discrete time survival analysis."; It represents real time, such as year or age when we are talking about the time/age effect on the dropout risks of students. Readers should be aware and refer to the right meaning based on context.
[3] Grades 12-13 are not required for attending tertiary education institutions in Jamaica.

97 percent in lower secondary education, and 66 percent in upper secondary education. The net enrollment rates were 93 percent in primary education, 82 percent in lower secondary education, and 49 percent in upper secondary education.[4]

According to the World Bank's World Development Indicators (2005), in 2002-03 the gross enrollment rates in primary and secondary education in Jamaica were 101% and 84%, respectively, and the net enrollment rates were 95% and 75%. In comparison, the gross enrollment rates in 2002-03 for primary and secondary education in middle income countries averaged 112% and 74%, respectively. The gross enrollment rate in secondary education in Jamaica in 2002-03 was 10% higher than the average for middle income countries.

Although these are significant and impressive achievements, we also find that the net enrollment rates decreased more than 10% from primary education to lower secondary education, and furthermore, decreased more than 30% from lower secondary education to upper secondary education. We might be eager to know “Where, What and How”: Where (or in which grade) the students tend to drop out of school, what factors affect dropout behavior, and how to increase education duration in Jamaica. We believe that research on these questions will be informative and helpful to continued improvement of education in Jamaica. In this paper, we will apply discrete time survival analysis to analyze education duration in Jamaica: First we will analyze the data from JSLC 2002, investigate the pattern of educational attainment in Jamaica, and summarize

[4] Sources: MOE&C Statistics; PIOJ, 1999, p. 37-45.

some related variables; then the discrete time Cox model and the logit model will be applied to estimate the effects of the related covariates; in the end, we want to discuss the policy implications of our research to the continued improvement of education in Jamaica.

The paper is structured as follows: In Section 1, we will briefly review the literature for education studies and the application of survival analysis. In Section 2, we will introduce the data and the survival techniques (the discrete time Cox model and the discrete time logit model). In Section 3, we will apply these survival techniques to exploration of education duration in Jamaica. In Section 4, we will discuss the policy implications of our findings. And in Section 5, we will discuss the conclusions drawn from our research and its limitations.

1 Literature Review

1.1 Education Literature

Since 1940s, the concept of “dropout” has been used to represent a category of people who do not complete secondary education. For more than 50 years, this subject has attracted enormous interest from economists, and substantial research has been done on the determinants of dropping out. The dropout problem attracts much attention from economists for various reasons. These reasons fall into three categories that can be summarized as follows: (1) Dropping out undermines the individual’s future welfare: Dropouts tend to have lower income and higher unemployment; Dropouts are also more likely to have health problems, and as an economy upgrades, dropouts will have an even

harder time surviving economically. (2) Dropouts generate large social costs. They tend to receive more public assistance and also tend to engage in criminal activities (Catterall, 1987; Rumberger, 1987 and 2001; Murnane and Levy, 1996). (3) Dropouts decrease human capital accumulation in a country and thus in the long run damage the country's economic growth. For developing countries, education is the principal way to escape poverty and ignite sustainable economic growth.[5] However, dropouts may lead to a vicious cycle in developing countries: poor education>poverty>poor education. The dropout rate is used to measure the probability of dropping out of school. Reducing the dropout rate can break the cycle of poverty and is a crucial part of poverty reduction in developing countries. For all of these reasons and more, this issue has drawn the attention of economists and spurred their research into why students drop out and how they can be retained in school. The importance of this issue has attracted much attention from economists who have explored the reasons for dropping out and the ways to deal with this problem.

In the human capital framework, children's human capital derives from two sources: First, the inheritance of genetic and cultural endowments from parents, and second, the investments in children by parents. Inheritance depends on the parents'

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5 Fulci (1999) said, 'Education is the key to development. Quality basic education, as well as secondary and higher education, vocational training, and skill acquisition throughout life are indispensable tools to eradicate poverty.' (Reported by Singh, 1999)

abilities, education, and cultural background. The investments by the parents depend on parental preferences, income, and other factors. The human capital theory emphasizes the effect of family factors on children's educational attainment. Other social disciplines such as sociology and psychology contribute many other theories to the literature. These theories include peer/role models, a life span development approach, a stress theory, the "working mother perspective," and the "economic deprivation perspective," (Haveman and Wolfe, 1995).

Drawing on these various theories, Rumberger (2001) presents two conceptual frameworks: one is from an individual perspective, and the other one is from an institutional perspective. The individual framework focuses on the attributes of students, such as their values, attitudes, and behaviors, and how these attributes contribute to their decisions about their education. The institutional framework focuses on the settings and environment in which children live, such as families, schools, and communities.

Haveman and Wolfe (1995) summarized three primary categories that will affect the educational attainment of children: the choices made by the society/government that determine the opportunities available to both children and their parents (i.e. the social investment in children); the choices made by parents regarding the quantity and quality of family resources devoted to children (the parental investment in children); and the choices that children make given the investments in and opportunities available to them. The children's educational attainment is the outcome of these choices. These three categories are consistent with Remberger's two frameworks. Haveman and Wolfe (1995)

also provided a useful review of the literature on dropout research, and we will summarize their main finding as follows.

In one of earliest studies, Blau and Duncan (1967) used a system of recursive regression equations to estimate the relationships among time-ordered, life cycle family background characteristics and children's educational attainment. In 1970s, the researchers of the Wisconsin Longitudinal Study estimated the determinants of educational attainment based on a life cycle framework that included the number of family members, school, and aspiration variables. (Haveman and Wolfe, 1995)

The factors affecting children's educational attainment in recent research can be summarized as including social, family, choice, and background characteristics. Social factors include background and quality of students in the school, race structure in the school, school location (such as urban/rural and South/North), neighborhood, state and local education expenditures, unemployment rates, etc. Family factors include characteristics of the head of family (sex, education, and so on), family structure (parents, siblings, and so on), parents' occupation, family income, family birth plan, distance to schools, etc. Factors related to students' own choices include scores at school, expectations/self-esteem, pregnancy, religious activities, etc. The background characteristics include race, gender, time, age, opportunity wages, etc. The measurements of children's educational attainment include a high school graduation dummy variable, years of schooling, dropout risk, etc. Although Ordinary Least Square (OLS) and logit/probit models are widely used, survival analysis techniques have become more and

more popular in the most recent literature (Haveman and Wolfe, 1995).

1.2 Survival Analysis

(1) Survival Analysis and Its Application to Education

Survival analysis is a statistical technique for studying the occurrence and timing of events. It's also known as event history analysis, reliability analysis, failure time analysis, duration analysis, and transition analysis (Allison, 1995). Willet and Singer (1991, 1995) and Singer and Willet (1992, 1993) introduced survival analysis (especially discrete time survival analysis) to education issues (such as students' education paths and teachers' career paths). Since then, it has become more and more popular in the analysis of education issues.

Some of the key concepts of survival analysis include time, event, survival function, hazard, and the hazard function. Time is recorded when an event happens and can be continuous or discrete. An event can be death, dropping out of school/some programs, or any event that is of research interest. Survival and the hazard function will be introduced in detail later.

(2) Advantages of Survival Analysis Compared with Traditional Methods

Enrollment rates are widely used to measure education status in a country. Enrollment rates are typically available for primary, secondary, and college levels. Gross enrollment rates are calculated as the number of enrolled students divided by the total population within the specific age range eligible for enrollment in school. Net enrollment

rates adjust the gross enrollment numerator for students within the designated age range.[6] We can see the limitations of enrollment rates: (1) it makes little sense to calculate an enrollment rate for each grade, because students of the same age are not necessary to enroll in the same grade. Enrollment rates by school level cannot accurately reflect education in each grade; (2) enrollment rates are inappropriate as a reflection of the educational attainment of people beyond school age (16); (3) it is difficult to measure the enrollment rates at different school levels for the same cohort of people; thus, we do not have a way to "follow" a group of people and see when they drop out of school; (4) and enrollment rates can be manipulated easily. Researchers can get a higher or lower enrollment rate simply by changing the research group. For example, including (excluding) a group of students (mostly in the lower grades) with higher enrollment will increase (decrease) the enrollment rates.

Some empirical studies have applied logit models to estimate graduation rates in primary schools, secondary schools and colleges. In this line of research, the authors usually ask if a student has graduated from school. These studies are helpful as a way to explore if the students have made it through school. Their two limitations are that (1) they cannot handle those students who are still in schools, and (2) they have little information on when (in which grade) students tend to drop out. (Willett and Singer, 1991)

[6] Here is an example of the calculation of an enrollment rate: n1 is the number of students in the primary schools (Grades 1-6); n2 is the number of people within a certain age range who are eligible for enrollment in the primary schools; n3 is the number of students in the primary schools who are also within a certain age range who are eligible for enrollment in the primary schools. We have n3<=n1. The gross enrollment rate will equal n1/n2 and the net enrollment rate will equal to n3/n2. We can see that the gross enrollment rate is not less than the net one, and it can be more than 100%.

Some other studies have applied OLS model to estimate the duration of education and to determine at what point students tend to dropout. (Duration at school is most often the dependent variable.) However, OLS model still cannot overcome these problems: (1) Some students are out of school because they are transferring to other schools or because of illness, death, etc., but they are not dropouts and cannot be counted as such; consequently their observed duration at school will be shorter than the actual duration; (2) for those students still in school, the observed duration of education will be also shorter than the actual duration; (3) and the estimation duration from OLS could be longer than the possibly longest duration. Because of these limitations, the OLS estimate will tend to be biased.

Survival analysis can overcome all of these shortcomings. By estimating the dropout risk for each grade, it provides detailed information on the dropout risks for students in each grade. On the other hand, by treating as "censored observations" those students who do not drop out during the period of research, it can account for those students who are still in school but have transferred to other schools, or temporarily left school because of illness or other reasons but are not dropouts. Moreover, survival analysis has one more advantage: the ability to incorporate time varying data. While it is difficult for traditional models like OLS and logit models to incorporate time varying data, some survival models can do so easily and naturally.

Because of the above advantages (ability to identify the timing of the problem, ability to handle censored data, and ability to incorporate time varying variables)

compared with traditional methods, survival analysis has become more and more popular in social science and natural science. The development of survival statistical techniques, its availability in standard statistical software (such as SAS and STATA) and the improvement in data quality has enabled researchers to apply survival analysis to education duration research.

2 Data and Empirical Methods

2.1 Data: Introduction and Summary

The data is from the Jamaica Survey of Living Conditions 2002, which was undertaken to establish baseline measurements of household welfare and subsequently to monitor the impact of Jamaica's Human Resources Development Program on health, education and nutrition (The World Bank, 2002). The survey covers 6,976 households randomly selected from the Labour Force Survey (LFS)[7]. All household members older than 3 in 2002 were included in the survey. After matching education data, household consumption data, and household demographic data, etc., we were able to develop a data set that includes the variables that might affect individual educational attainment. Understanding education and related demographic variables can provide basic information for our survival modeling; thus we summarize these variables as follows.

(1) School Enrollment

Table 1 shows Jamaican school enrollment in 2002, when 65.03% of the

[7] LFS used a two-stage stratified sampling strategy, and the sample is self-weighted. That is, each household in Jamaica is equally likely to be included in the survey sample. For details, please see Jamaica Survey of Living Conditions 1988-2000: Basic Information, the World Bank (2002).

population was not enrolled in any type of school (including institutes, colleges and universities). However, 7.11% of the people were enrolled in the Basic/Infant/Nursery/Kindergarten schools, and 15.79% of the people were enrolled in Grades 1-6, which included primary schools, all-age schools, and primary/junior high schools. The primary schools have better reputation than the all-age and primary/junior high schools.)

About 10.69% of people were enrolled in the secondary schools of all types. About 8.67% were in secondary high schools (7.61%), technical schools (0.76%), and vocational/agricultural schools (0.30%) (Grades 7-11 or 13); 2.02% were in all-age schools, primary/junior high schools, and junior high schools (Grades 7-9), which have inferior educational quality.

Universities or other tertiary schools accounted for 0.93% of the population, and 0.3% of the people were enrolled in adult and special schools.

Table 1 also shows the difference in school enrollment between males and females. Females were a relatively larger proportion of the enrollment in secondary high schools, technical schools, vocational/agricultural schools, universities/post-secondary schools, and adult education/night schools. The gap between female-male enrollments in favor of females grew larger in upper level education.

(Insert Table 1: Enrollment in Jamaica 2002 (by school type))

(2) Educational Attainment

The JSLC 2002 also provided information on the educational attainment of people

not in schools in 2002. Table 2 resembles Table 1, but the two tables have totally different meanings: Table 1 reflects the current education enrollment in schools in 2002, and Table 2 reflects the educational attainment by school type for persons not in school in 2002. Thus, the two tables have very different distributions.

Table 2 shows that 19.98% of the people not enrolled in school in 2002 had a primary school education (including primary, all-age, and primary/junior high schools). 71.52% had a secondary school education. 27.58% of these people had been in all-age schools (Grades 7-9). 42.72% had been in new secondary (12.83%), comprehensive (5.27%), secondary high (20.04%), technical (2.63%), and vocational/agricultural schools (1.95%).

Here again we also see a gender difference in educational attainment. After secondary school, more females than males are present at each level, and this gender gap grows larger as the level of education increases. For secondary schools, males had a relatively larger presence in the lower and lesser quality secondary schools, and females had a relatively larger proportion of enrollment in the upper and better quality secondary schools. (Note: The percentages of males and females not in schools in 2002 were 49% and 51%, respectively. The numbers are shown in the last row in Table 2.)

(Insert Table 2: Educational attainment in Jamaica 20028 (by school type))

(3) Household Demographics

The JSLC 2002 recorded every household member's relation to the head of

[8] The numbers here are for those who were not in school in 2002.

household, which provides useful information on household demographics. Table 3 shows the survey comprised 6,795 households. However, only 2,911 heads of household had spouses or partners. Furthermore, only 121 of 8,154 children of the heads had spouses. However, there were 2,616 grandchildren of the heads in the households.) The exploration of household demographic structure will help our modeling because family characteristics are expected to greatly affect educational attainment.

(Insert Table 3: Household Demographic Constituents in Jamaica 2002)

(4) Student Distribution by Grade

In Table 1, we saw the school enrollment of Jamaica in 2002. Now we will continue to explore student distribution by grade. Table 4 lists the number of students and percentages for Grades 1-13 in 2002. The progression in grade levels is marked by a visible trend of diminishing enrollment. This enrollment decline accelerates after Grade 9: from Grade 9 to Grade 10, the decrease is about 1.82%; from Grade 10 to 11, the decrease is about 1.99%; and from Grade 11 to 12, the decrease jumps to about 4.75%. The table shows that after lower secondary school, the number of students declined sharply. The huge decrease from Grade 11 to Grade 12 is not especially surprising because only a few upper secondary schools have Grades 12 and 13.

(Insert Table 4: Student Distribution in Jamaica 2002 (Grades 1-13))

(Insert Figure 1: Student Distribution in Jamaica 2002 (Grades 1-13))

(5) Educational Attainment-by Grade Reported

Now we turn to analyzing the educational attainment (by grade and age group) of

those people not currently in school in 2002. Table 5 and Figure 2 show that the younger generations generally have higher educational attainment than their elders. For people older than 60, the educational peaks are at Grade 6 (around 45%) and Grade 9 (around 25%); for people between ages 41 and 60, the peaks are at Grade 6 (around 21%), Grade 9 (around 40%), and Grade 11 (around 18%); for people between 21 and 40, the peaks are at Grade 9 (28%) and Grade 11 (53%); and for people between 3 and 20, the peaks are at Grade 9 (22%) and Grade 11 (58%)[9]. The increase in educational attainment over time is obvious.

(Insert Table 5: Educational attainment in Jamaica 2002: Grade Reported (by age group))

(Insert Figure 2: Educational attainment in Jamaica 2002 (by age group))

(6) Other Demographics

The marital and union statuses were also reported in the survey. They are summarized in Table 6-1 and 6-2.

(Insert Table 6-1: Marital Status Reported: (age >=15))

(Insert Table 6-2: Union Status Reported: (age >=15))

(7) Summary

In this section, we have briefly described the educational attainment and demographic variables in Jamaica. We also have explored the basics of gender and time/age effects on educational attainment. From the tables, especially Tables 4 and 5, we

[9] A large proportion of people between ages 3 and 20 are still in school, which will be treated as censored observations in the following survival analysis.

can get useful information on educational attainment in 2002 by grade for both students and nonstudents. As we discussed in Section 1.2, integration of the information in these two tables is difficult with traditional methods. However, survival analysis easily handles this integration issue through its “censored data” analytical strategy.

As already observed, survival analysis has other superior attributes for this type of analysis. The next section will introduce the survival techniques used in this paper and then apply them to explore dropout risk by grade and estimate the effects of covariates such as household income (household total expenditure), gender, head of household, household demographic variables, time, and government policy, etc.

2.2 Empirical Methods: Introduction to Survival Analysis

(1) Basic Concepts

Survival Function

Survival function (or survivor function, survivorship function) gives the probability of surviving after a specific time. In survival analysis, surviving not only refers to the status of being alive but also to a status of not having experienced or engaged in or performed a specific event or action, such as divorce or dropping out of a program or, to use a business example, a company’s bankruptcy, and so on. In this paper, surviving refers to the specific status of not having dropped out of school. The survival function can be written as $S(t)$ = Pr(T>t), where t is time, and T is the time of the occurrence of an event.

Hazard Function

The hazard function is crucial in survival analysis. The hazard at a specific time corresponds directly to the risk of the occurrence of an event. In this paper, hazard is the dropout risk/rate of students. The hazard function can be defined as:

$$h(t) = \lim_{dt \to 0} \frac{S(t) - S(t+dt)}{dt} \frac{S(t)}{}$$

$$= \frac{f(t)}{S(t)}$$

where dt is a time period, $f(t)$ is the density distribution function of an event occurrence.

The relationship between the survival function and the hazard function can be written as

$$S(t) = \exp\left(-\int_0^t h(t)\, dt\right)$$

For discrete time, the hazard is defined as the conditional probability of the occurrence of an event, given that no previous event has occurred (Singer and Willet, 1993). It can be referred to as discrete time hazard function:

$$h(t) = \Pr[T = t | T \geq t]$$

$$= \frac{S(t-1) - S(t)}{S(t-1)}$$

where T is the time of event occurrence.

The relationship between the discrete time hazard function and the survival function can be written as:

$$S(t) = \prod_{t=1}^{t} (1 - h(t))$$

In this paper, school grade level is used as the measurement of educational attainment, and the discrete time survival analysis is applied.

(2) Semi-parametric Analysis: Cox Regression

Cox (1972) proposes a semi-parametric regression, which has become one of the most popular methods in survival analysis. Compared with other regression methods, Cox regression does not need to choose some particular probability distribution to represent survival times. Such probability distributions, when they have been used, have been typically arbitrary assumptions. Without them, the results of Cox regression will be more robust. The Cox method can handle continuous and discrete data. However, we will only introduce the discrete time method, which is the method applied in our paper.

The basic idea of the Cox regression for discrete time data is to estimate a binary model to predict whether an event does or does not occur in each time period. Cox regression then relates the conditional probability of event occurrence ($P(t)$)[10] to the covariates by a logit equation:

$$\log\left(\frac{P(t)}{1 - P(t)}\right) = \alpha(t) + \beta x$$

In the equation, $\alpha(t)$ is a set of constants for each time period and controls the time variance of the regression model. x is the covariate array that can include time unvarying variables as well as time varying variables. In this model, the odds ratio

[10] The conditional probability of event occurrence is also known as a discrete time hazard in the Cox regression, which is the same as in Singer and Willet (1993).

between any two individuals does not depend on time, thus the model can be described as a proportional odds model. The semi-parametric method will make use of this characteristic and will not estimate $\alpha(t)$.[11] That is to say, the estimation ignores the baseline hazard function and focuses only on the estimation of the effects of the covariates. However, after estimating the coefficients of the covariates, the nonparametric maximum likelihood method can still be used to estimate the survival function, $S(t)$.

(3) Parametric Analysis: Logit Model

In the Cox regression, the semi-parametric estimation discards the information of $\alpha(t)$. However, the traditional logit model can be used to estimate the model. With the logit model, we can directly estimate the effect of time, $\alpha(t)$. Meanwhile, the maximum likelihood method to estimate the logit model is more computationally efficient than the semi-parametric method used in the Cox regression.

Allison (1995) argues that uncontrolled heterogeneity confounds the hazard function and, thus research on the shape of the hazard function might yield incorrect information. He suggests that researchers should be cautious when using alternatives to the Cox regression to study the time dependence of the hazard function.

3 Empirical Analyses

In this section, survival analysis is applied as follows: First, we will apply semi-parametric survival analysis using Cox regression's discrete time survival model. Cox

[11] For details of the estimation algorithm, please see Cox (1972).

regression makes no assumption of the baseline hazard function of time and therefore the estimation of covariates' coefficients will be robust. Second, we will apply parametric survival analysis, i.e., the logit model for the survival analysis, to estimate the effects of covariates as well as the baseline hazard function of time. A comparison of the estimation result to the result obtained by the Cox regression could test the accuracy of the model.

However, the use of current variables to explain the occurrence of a past event is a problem common to other studies and also occurs here. This problem is resolved by narrowing the research field from the entire population to the youngest group, i.e., people ages 3 to 20. The variables in the survey should be applicable for modeling of this group. For example, Figure 3, shows that almost all people in this group (ages 3-20) are unmarried. Because marriage is a crucial event that will affect household formation and thus variables at the household level, this fact thus supports our assumption to some extent.

On the other hand, although information on older generations will be lost by narrowing the research focus, we believe that such loss is justifiable because the refined study will provide more up-to-date and useful information for policy makers. Thus, people aged 3-20 will be the focus of our survival modeling.

(Insert Figure 3: Number of People by Marriage and Age, JSLC 2002)

3.1 Semi-parametric Survival Analysis: Cox Regression

(1) Covariates in the Survey

Based on previous analysis and on the literature, the model could include income,

gender, age, educational attainment, and gender of heads of households, number of siblings, geography, and distance to schools, etc. We will expect the following effects on educational attainment:

Income: A positive effect; educational attainment should increase when household income increases. The survey does not report total household income, so household total expenditure is used as a proxy for household income.

Gender: Females will have positive effect because females have better educational attainment in general. In the model, females have a value of 1, and males have a value of 0.

Age (or Time): A negative effect; younger generations should have higher educational attainment because of the improvement of education quality by government policy, etc.

Educational attainment of the head of household: A positive effect because a household head with more education should lead to higher educational attainment of children.

Gender of head of household: Some literature suggests that a female head of household might have a negative effect. In the model, females have a value of 1, and males have a value of 0.

Number of siblings: A negative effect; more siblings will lead to lower educational attainment of children.

Geographic area: Jamaica can be divided into three geographic areas: Kingston Metropolitan Area (KMA), Other Towns, and Rural Areas. People living in KMA and Other Towns areas should have higher educational attainment.

Distance to schools: A negative effect; the farther the distance to schools, the higher the education cost will be, which will lead to lower educational attainment. Because not all people report the distance to schools, we used the average distance (in miles) to schools for people within the same district. Thus, we obtained the distance to the nearest primary school and the distance to the nearest secondary school.

Meanwhile, we also suspect that the effect of age (time) may vary in primary, lower, and upper secondary education. Consequently, we created interaction variables between age and these school types. As a result of these considerations, we have individual variables (gender, age), family variables (household income, gender, and education of heads of households, number of siblings), and school variables (distance to

schools). An age variable can also be used to control the time effect.

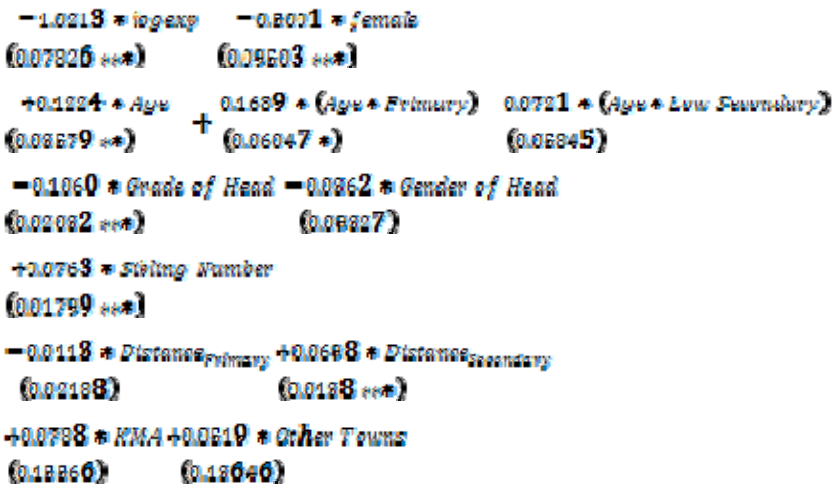
(2) Estimation

After getting the variables available from JSLC 2002, we can estimate a discrete time Cox model. The result is shown in Table 7. We can see that 6,982 individuals are included in the model and 92.17% of them are censored. This should not be a surprise, because the research subjects are ages 3-20 and most of them were at school at that time. As noted earlier, the capability to handle censored data is one of the biggest advantages of survival analysis, and that advantage is also one of the main reasons we chose to use survival analysis in the study.

The table shows that all three global null hypothesis tests (likelihood ratio test, score test and Wald test) are significant ($p<.0001$). Household income, gender, age, grade level attained by the head of household, number of siblings, and distance to the nearest secondary school are all significant, but the gender of the head of household, distance to nearest primary school, and the geographic dummy variables (KMA, Other Towns?, and Rural Areas) are not statistically significant. The interaction between age and the dummy variable for primary school is significant, but the interaction between age and the lower secondary school dummy variable is not significant. The full expression of the model can be written as:[12]

$$\log\left\{\frac{P(G)}{1-P(G)}\right\} = \alpha(G)$$

[12] Standard errors for the coefficients are reported inside the parenthesis below the coefficients. Please note that Cox regression doesn't estimate time effect, i.e. $\alpha(G)$ in the model. [12]
***:.0001 significant level; **: .001 significant level; *.01 significant level



As noted earlier, we also can estimate a logit model for the discrete time survival model if we want to know the effects of time. For convenience, we will continue to estimate a logit model and then compare it with the result from this model. After that, we can discuss these comparative findings.

(Insert Table 7: Estimation of Discrete Time Cox Model)

3.2 Parametric Survival Analysis: Logit Model

In this section we will apply a traditional logit model to survival analysis and estimate the time effect. The logit model has become popular for discrete time survival analysis because it is easier to understand and use. Before the logit model can be used, however, the cross-sectional data must be transformed into a new data set categorized by time and individual. That is to say, each individual will have several observations that correspond to his or her "current" grade level. Moreover, each observation must include new time/grade dummy variables. Singer and Willett (1993) demonstrate in detail how to transform the relevant data. The estimation of the logit model is shown in Table 8. In comparing Table 8 to Table 7, the close similarity of the estimation of the coefficients of

the covariates is obvious because the Cox model applied a semi-parametric method to the estimation of a logit model that does not include the time effect. Table 8 also includes the time/grade effect. Because the estimation results are very similar, we can focus on the estimation result from the logit model and discuss its findings.

(1) Income Effect

Household income has a positive and significant effect on educational attainment. The coefficient of the log form of household total expenditure is -1.0222, and the odds ratio is 0.360. The result shows that the increase in household income will decrease the risk of dropping out of school and thus increase individual educational attainment. An increase in log income by 1 will reduce the odds ratio by 64%. This finding is consistent with the previous study.

(2) Gender Effect

The gender effect is very significant. The coefficient is -0.5005, and the odds ratio 0.606. The result reflects that females are at lower risk of dropping out and achieve higher educational attainment. Females have an odds ratio that is 60.6% of males.

(3) Time-Age Effect

We estimate age and its interaction variables with primary and lower secondary school types. The upper secondary school dummy variable is left out of the model. The coefficient of age variable, 0.1125, is significant. The coefficient of the interaction between age and the primary school dummy variable is 0.169, which is also significant. However, the interaction between age and the lower secondary school dummy variable is

-0.0721 and not significant with a 20% confidence level. The result shows that in general the dropout risk increases as age increases, i.e., younger people are associated with lower dropout risks. This finding tells that educational attainment improves over time. The improvement is much greater for those in primary school education than for those in secondary schools. Lower secondary school education does not perform better than upper secondary school education. In fact, the performance for lower secondary schools is slightly worse but not significant. Nevertheless, this result for the lower secondary schools surprises us because our research subjects (aged 3-20) were in the secondary schools during the ROSE I project (implemented after 1994), which tried to reform lower secondary school education.

If we look at the odds ratio, for every year that students age, the odds ratio will increase by 13% in general and by 31.4% in primary school. In other words, the odds ratio decreases by 13% annually in general and by 31.4% annually in primary school. This improvement can be attributed to the Jamaican government's educational policies and to the nation's determination and efforts to improve its education.

(4) Effects of Head of Household

The literature shows that head of household might have two effects on educational attainment: The educational attainments of the household's children might be positively correlated to the attainments of the head of household or the gender of head of the household might affect the educational attainments of the children[13]. Our estimation

[13] For example, Buchmann and Hannum (2001) performed a review of the literature that shows that in some African

shows that the educational attainment of the head of the household has a significant effect, -0.1061, and the associated odds ratio is 0.964. That is to say that for every additional grade of educational attainment by the head of a household, the odds ratio related to the risk of a child in the household dropping out will be reduced by 3.6%. As for the impact of the gender of the head of household, however, the coefficient is negative but not statistically significant.

(5) Effect of the Number of Siblings

The coefficient for the variable concerning the number of siblings is significant, 0.0764, and the odds ratio is 1.079. In other words, for every additional sibling in a family, the odds ratio for a child's risk of dropping increases by 7.9%. This is also consistent with the literature. More siblings mean fewer family resources to put into education for each child, which might cause lower educational attainment. In explaining the effect of siblings, Buchmann and Hannum (2001) emphasize the importance of understanding the social and economic contexts in which families make educational decisions for their children.

(6) School Effect

The literature shows that the distance from home to school will affect educational attainment. In our estimation, the distance to primary school has no significant effect. However, the distance to secondary school has a significant effect, 0.0764, and the odds

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contexts female headship appears to be associated with greater educational opportunities for children in South Africa (Fuller and Liang, 1999) and in sub-African countries (Lloyd and Blanc, 1996).

ratio is 1.072. That is to say, an increase in distance by 1 mile will increase the odds ratio by 7.2%.

(7) Geographic Effect

Jamaica is divided into three geographic areas: KMA, Other Towns, and Rural Areas. The literature highlights the difference in education quality between rural and urban areas. However, after we control other variables, we cannot find a significant difference between them. This suggests that geography does not directly influence educational attainment; instead it is the characteristics of geographic areas that have direct effects.

(8) Time-Grade Effect

The logit model includes an estimate of a time effect. In this study, our research time span is from Grade 1 to 11: i.e., students who have completed Grade 11 are treated as survivors. Each time/grade is associated with a baseline hazard, which is derived by assuming that all other variables are 0.

Our estimation has 10 dummy variables, one each for Grades 1 to 10. These produce a clear pattern of coefficients in which the coefficients increase as the grade levels increase and all of these coefficients are negative except for Grade 10. The coefficients for Grades 7-9 are negative but not significant. These results tell us two things. First, in general the baseline hazards increase as grade levels increase but Grade 10 is an exception and has a higher baseline hazard than Grade 11. Second, the coefficients of Grades 7-9 are not significant, which shows that grades in the secondary

schools differ little in baseline hazard except for Grade 10, which has a much higher baseline hazard. This result for Grade 10 might reflect a space shortage in the upper secondary schools that prevents students from achieving higher educational attainment.

(Insert Table 8: Estimation of Discrete Time Survival Model-Logit Model)

(9) Summary

After getting the estimates, we can write the estimated logit model as follows: [14]

$$\log\left(\frac{P(G)}{1-P(G)}\right) = 8.4172 \quad (1.1714^{***})$$

$$(-19.3456 * Grade1)\,\mathbb{I}((210.2)) \quad (-7.0268 * Grade2)\,\mathbb{I}((1.1868^{***})) \quad (-6.8801 * Grade3)\,\mathbb{I}((1.1456^{***})) \quad (-6.4051 * G$$

$$(-4.9914 * Grade6)\,\mathbb{I}((1.0964^{***})) \quad (-0.895 * Grade7)\,\mathbb{I}((1.0252)) \quad (-0.9229 * Grade8)\,\mathbb{I}((1.0424)) \quad (-0.34$$

$$\underset{(0.0783^{***})}{1.0222 * Ivyway} \quad \underset{(0.0961^{***})}{0.2005 * Female}$$

$$\underset{(0.0868^{***})}{+0.1225 * Age} + \underset{(0.0605^{**})}{0.169 * (Age * Primary)} \quad \underset{(0.0385)}{0.0721 * (Age * Lower\ Secondary)}$$

$$\underset{(0.0208^{***})}{-0.1061 * Grade\ of\ Head} \quad \underset{(0.0988)}{-0.0862 * Gender\ of\ Head}$$

$$\underset{(0.0180^{***})}{+0.0764 * Sibling\ Number}$$

$$\underset{(0.0219)}{-0.0118 * Distance_{Primary}} \quad \underset{(0.0188^{***})}{+0.0689 * Distance_{Secondary}}$$

$$\underset{(0.1887)}{+0.079 * KMA} \quad \underset{(0.1865)}{+0.0619 * Other\ Towns}$$

As a demonstration, we can use our estimation to draw hazard and survival curves for a typical individual with median values of those variables as follows: household income is J$283,322[15]; age is 18; the head of household has completed Grade 10; there are five siblings; and the distance to a secondary school is 3.03 miles. We also will have

[14] ***:.0001 significant level; **: .001 significant level
[15] In 2002, 1 US dollar=48.416 JM dollars.

hazard and survival curves by gender as in Figure 4. As we can see, the hazards at Grade 10 are almost two times as many as those at Grade 11. This is mostly caused by the shortage of space for students in the upper level secondary schools.

To demonstrate the application of our estimation, we will use as an example our analysis of the effect of the ROSE II project in its effort to provide enough space in the upper secondary schools. Based on our estimation and on an assumption that after completion of the ROSE II project the peak at Grade 10 will decline to the same level as that at Grade 11, we can estimate that the probability that these typical individuals will complete Grade 11 will increase by about 5%, to 86% from 81%. [16]

(Insert Figure 4-1: Estimated Hazard Curves for Typical Individuals)

(Insert Figure 4-2: Estimated Survival Curves for Typical Individuals)

4 Policy Implications

In the previous sections, we examined the JSLC 2002 data and applied survival analysis techniques to explore education duration in Jamaica. To some extent, the findings should be able to answer the questions of "Where, What and How": where (or in which grade) the students tend to drop out of school, what factors affect dropout behavior, and how to increase education duration.

4.1 Where Is the Problem?

From Table 8 in Section 3.3, we can see the coefficients of the dummy variables

[16] Specifically, the increases are 4.7% (from 85% to 89.7%) for females and 6.7% (from 77% to 83.7%) for males. The calculation process is omitted. Readers should be able to calculate the numbers based on Table 8 and the formulas in Section 2.2.

of Grades 1-10. This table tells us the distribution of dropout risk is as follows:

(1) Primary Schools

In general, dropout risks were quite low in primary schools. Nevertheless, there was a trend of increasing risks from Grade 1 to Grade 6. Grade 6 especially had a huge increase in dropout risk compared with Grade 5. In Table 8, the coefficient of Grade 6 is 1.1876 higher than that of Grade 5, which means an odds ratio increase of about 2.28 times. Figure 4 shows that the estimated hazard for typical individuals in Grade 6 is significantly higher than for those in Grades 1-5, and Grade 6 has the same hazard level as in the lower secondary schools. (It is even slightly higher than the estimated hazards in Grade 7 and Grade 8.) This finding is very interesting and also confusing: Why did the dropout risk "suddenly" increase in the last year of primary schools when students were so near a graduation certification? Another thing worthy of note is that the curves for females and males diverge after Grade 6 as the effect of gender becomes increasingly obvious with the increase in the risk of dropping out.

(2) Lower Secondary Schools

The dropout risks in lower secondary schools were similar in Grade 7 and in Grade 8. However, Figure 4 shows that the dropout risk almost doubled in Grade 9. Table 8 shows that the coefficient increased from -0.9229 in Grade 8 to -0.3469 in Grade 9, which means an odds ratio increase of about 0.779 times. Again we are confronted by the same question of why the dropout risk "suddenly" increased in the last year of primary schools when a graduation certification was within reach.

The second problem in the lower secondary schools is that the improvement over time is slower than in primary schools (and even slower than in secondary schools, although not significant.). The lag in improvement in the lower secondary schools deserves attention because the ROSE I project that targeted lower secondary schools was completed in this period.

(3) Upper Secondary Schools

The upper secondary schools carried the highest dropout risks. This is obvious in Figure 4. Table 8 shows (1) that Grade 10 has a positive coefficient compared with Grade 11, and (2) Grades 1-9 have negative coefficients compared with Grade 11. As discussed earlier, one of main reasons for the high dropout risk in Grade 10 is because of space shortages in the upper secondary schools. However, even after we eliminate this effect by assuming that Grade 10 has the same dropout risk as Grade 11, thus controlling for the effect of a space shortage, the dropout risks in upper secondary high schools remain quite high. In Figure 4, the numbers are 6% and 4%, respectively, for males and females. Using the same assumption, we can estimate that 8% and 5%, respectively, of males and females could not go to upper secondary schools because of the space shortage. The unanswered question is why the dropout risks were so high despite the students' successfully entry into the upper secondary schools?

4.2 What Factors Matter?

The analysis thus far has revealed the factors that could affect dropout risk. As a summary, we know that (1) household income, age, and the grade level achievement of

the head of household have positive effects on educational attainment, and females typically surpass males in educational attainment; (2) the number of siblings and the distance to secondary schools have negative effects; and (3) the gender of the head of household head and the geographic area have no effect.

4.3 How: Some Policy Suggestions

Based on the foregoing analysis, some policy suggestions for continued improvement of education are:

(1) Target the Right Place

In general, secondary schools (especially upper secondary schools) have higher dropout risks. While this generalization is noteworthy, the most effective way to lessen dropout risks would be to focus on several "problematic" grades: Grade 6, Grade 9, and Grade 10. There is a need especially to determine why dropout risks increased so dramatically in the last year of primary school and lower secondary school. Were the students intimidated by the prospect of a difficult last year? The high dropout risk observed in Grade 10 was caused by two factors: admission limitation (a space shortage in upper secondary school) and voluntary dropouts. As we have estimated, providing enough space in upper secondary school might increase the percentage of graduation from secondary schools by 5%, to 86% from 81%.

(2) Gender Difference

In our estimation in Figure 4, we can see an 8% difference in survival rates between females and males. This is a significant percentage. If survivorship for males

could be raised to the same level of females, it would mean about a 4% increase in the percentage of graduation from secondary schools. However, we do not know the reasons for the gender gap in education. Although much literature has been developed, little of it relates directly to Jamaica. (And in many developing countries, the gender gap favors males because females receive less education because of social discrimination.) A study of this issue should be able to provide useful policy guidance for solving the problem of inferior educational performance by males in Jamaica.

(3) How to Break the Cycle of Poverty?

Our estimation shows that household income and educational achievement, as measured by the grade level achievement of the head of household, had significant effects on educational attainment. Household income directly affects the resources available for children's education. The effect of the grade level achievement of the head of household might come from two sources: inheritance, and awareness of education's importance. Human capital theories show that higher educational attainment is associated with higher income. And the absence of such attainment is associated with a cycle of poverty represented by: poverty (Generation I)>low educational attainment (Generation II) > low income (Generation II) + low educational attainment (Generation II) > low educational attainment (Generation III)…

This depiction of the poverty cycle shows that it can be broken by any one of three ways: (1) increased family income; (2) increased parental education; (3) increased educational attainment of children. Several projects have been undertaken in Jamaica to

help the poor, such as the Jamaica National Poverty Eradication Programme, School Feeding Programme, Rural Electrification Programme (REP), and so on. Such programs have increased family income and thus have the potential to increase the educational attainment of poor people. Increasing parental education is more difficult, although there are adult schools. The more feasible way might be for the government to adopt a policy to increase the awareness among parents of the importance of education. To increase the educational attainment of children, we should focus on school quality and increased effort by students. Unfortunately, our research does not yield much information directly related to the quality of schools. The only factor related to schools is the variable of distance to secondary schools, which had a significant negative effect on educational attainment. Thus, we suggest that increased space in the upper secondary schools should be achieved by building new schools instead of enlarging the current ones. (If new schools can only be created by much higher expenditures, this goal should still be pursued by emphasizing cost effective policies.) Another study focusing on school quality and the effect on students should be able to provide useful policy guidance.

(4) Uncontrollable Effects

The effects of age (time), gender of the head of household, number of siblings and geographic factors are uncontrollable. As we have seen in Figure 5, education in Jamaica is improving continuously and significantly over time. However, the time effect chronicled here relates mainly to the past efforts in education of the Jamaican people and government and may not have the same effect in the future. Gender of the head of

household is uncontrollable, and in any case, the effect was insignificant. The number of siblings had a negative effect on educational attainment. It is common sense in terms of economics that more children mean fewer resources for each child. However, as a social phenomenon, the number of children in a family is hard to control by governmental policy. Geographic factors are also uncontrollable. However, after controlling for other covariates in our model, geographic effects became insignificant. A governmental policy that directly targets a geographic area might not be necessary.

5 Conclusions

In our study we have applied survival techniques to analyze education duration in Jamaica based on JSLC 2002 data. Because of the limitation of the data, we do not have time varying covariates. Thus we focused on the youngest cohort, who had an age range of 3-20, and we assumed that the values of the covariates would change little for them. Although this focus loses information on the older generations, such a study still could provide useful information for policy makers who deal with current issues in education.

The estimation results of the Cox regression and the logit model are very similar, and the logit model gives us an extra estimation of the time (grade) effect. The estimated model can be used to estimate an individual's hazard function as we have shown in Figure 4. The analysis in this section provides information about where the problem was and what caused the problem. The results could be used by policy makers to target the right persons and right time to reduce dropout rates. They also could estimate the effects

of education policies, their economic background, and their demographic characteristics.

In Section 4, we provide some policy implications based on our research.

However, our study does have several obvious limitations. First, we did not have time varying variables from the survey data, a lack that might cause inaccurate estimation of the effects of the covariates. Longitudinal data based on several continuous surveys for the same cohort would improve our estimation. Second, we did not have enough variables. The Jamaica Survey of Living Conditions 2002 has a section on education, but the variables we can use from it are very limited. Our covariates can be grouped into approximately four categories: individual characteristics (gender, age), family characteristics (household income, gender and educational attainment of the head of household, and number of siblings), school characteristics (distances to primary and secondary schools), geographic characteristics (KMA, Other Towns and Rural Areas), and a time/grade variable. The variables are very limited, and we cannot estimate the effects of many other important factors, such as school quality, exam scores, etc. Third, we measured educational attainment based on education duration of individuals (i.e. their grades completed or attending). However, education duration does not distinguish the difference in quality between types of schools. For example, a graduate from the all-age schools generally has lower educational attainment than a graduate from the primary schools because all-age schools, generally, are inferior to the primary schools. Further studies in these fields will allow better estimations.

Appendix:

Tables:

Table 1: Enrollment in Jamaica 2002 (by school type)

School Type	MALE	FEMALE	Grand Total	Percentage
BASIC/INFANT/NURSERY /KINDERGARTEN	838	792	1,630	7.11%
Primary	1,080	1,037	2,118	9.24%
ALL AGE (GRADES 1-6)	579	515	1,094	4.77%
ALL AGE (GRADES 7-9)	138	105	243	1.06%
Primary/JUNIOR HIGH (GRADES 1-6)	206	203	409	1.78%
Primary/JUNIOR HIGH (GRADES 7-9)	91	60	151	0.66%
JUNIOR HIGH (GRADES 7-9)	36	33	69	0.30%
SECONDARY HIGH	812	932	1,744	7.61%
TECHNICAL	77	97	174	0.76%
VOCAT/AGRIC	27	41	68	0.30%
UNIVERSITY	29	44	73	0.32%
OTHER TERTIARY (PUBLIC)	28	63	91	0.40%
OTHER TERTIARY (PRIVATE)	16	32	48	0.21%
ADULT LITERACY CLASSES	4	3	7	0.03%
ADULT EDUCATION/NIGHT	14	32	46	0.20%
SPECIAL SCHOOL	10	7	17	0.07%
NONE	7,313	7,591	14,904	65.03%
TOTAL	11,315	11,603	22,920	100.00%

Table 2: Educational Attainment in Jamaica 2002[17] (by school type)

School Type	MALE	FEMALE	Grand Total	Percentage
BASIC/INFANT/NURSERY /KINDERGARTEN	32	41	73	0.50%
Primary	1,025	1,066	2,091	14.36%
ALL AGE (GRADES 1-6)	390	389	779	5.35%
ALL AGE (GRADES 7-9)	2,176	1,841	4,017	27.58%
Primary/JUNIOR HIGH (GRADES 1-6)	18	21	39	0.27%
Primary/JUNIOR HIGH (GRADES 7-9)	50	37	87	0.60%
JUNIOR HIGH (GRADES 7-9)	58	33	91	0.62%
NEW SECONDARY[1]	920	949	1,869	12.83%
COMPREHENSIVE[2]	362	406	768	5.27%
SECONDARY HIGH	1,353	1,565	2,918	20.04%
TECHNICAL	199	184	383	2.63%
VOCAT/AGRIC	91	193	284	1.95%
UNIVERSITY	117	133	250	1.72%
OTHER TERTIARY (PUBLIC)	148	290	438	3.01%
OTHER TERTIARY (PRIVATE)	60	112	172	1.18%
ADULT LITERACY CLASSES	10	15	25	0.17%
ADULT EDUCATION/NIGHT	14	43	57	0.39%
SPECIAL SCHOOL	33	25	58	0.40%
NONE	88	76	164	1.13%
TOTAL	7,144	7,419	14,563	100.00%

Note: 1. New secondary schools converted to comprehensive high in the 1998/1999 academic year.
2. Comprehensive high schools converted to secondary high in 2000/2001 academic y ear.

[17] The numbers here are for those who were not in school in 2002.

Table 3: Household Demographic Constituents in Jamaica 2002

Relation to head of household	Number	Percentage
Head	6,975	30.43%
Spouse/Partner	2,911	12.70%
Child of Head/Spouse	8,154	35.58%
Spouse of Child	121	0.53%
Grandchild	2,616	11.41%
Parent of Head/Spouse	237	1.03%
Other Relative	1,537	6.71%
Helper/Domestic	31	0.14%
Other Not Relative	335	1.46%
Total	22,917	1.00%

Table 4: Student Distribution in Jamaica 2002 (Grades 1-13)

Grade	Number	Percentage	Grade	Number	Percentage
1	661	11.09%	8	515	8.64%
2	623	10.45%	9	532	8.93%
3	621	10.42%	10	424	7.11%
4	589	9.88%	11	305	5.12%
5	568	9.53%	12	22	0.37%
6	559	9.38%	13	9	0.15%
7	532	8.93%	Total	5,960	100.00%

Table 5: Educational Attainment in Jamaica 2002: Grade Reported[18] (by age group)

Grade	Age 3-20	Age 21-40	Age 41-60	Age> 60	Total	Percentage
1	6	13	18	20	57	0.44%
2	6	20	32	60	118	0.91%
3	11	55	68	115	249	1.93%
4	13	46	86	168	313	2.43%
5	39	155	137	133	464	3.60%
6	34	147	741	1,149	2,072	16.06%
7	28	90	82	65	265	2.05%
8	47	166	134	101	448	3.47%
9	308	1,627	1,335	602	3,872	30.01%
10	92	374	72	7	545	4.22%
11	813	3,018	607	39	4,477	34.69%
12	5	11	7	1	24	0.19%
Total	1,402	5,722	3,319	2,460	12,904	100.00%

Table 6-1: Marital Status Reported: (age >=15)

Marital Status	Number	Percentage
MARRIED	4,046	24.96%
NEVER MARRIED	10,795	66.60%
DIVORCED	123	0.76%
SEPARATED	185	1.14%
WIDOWED	905	5.58%
UNKNOWN	154	0.95%

[18] Note: Only for those people who have left schools with educational attainment between Grade 1 and Grade 13.

Table 6-2: Union Status Reported: (age >=15)

Union Status	Number	Percentage
MARRIED	3,903	24.09%
COMMON LAW	2,606	16.08%
VISITING	2,028	12.52%
SINGLE	5,633	34.77%
NONE	1,754	10.83%

Table 7: Estimation of Discrete Time Cox Model

Total Obs	Event	Censored	Censored
6,982	547	6,435	92.17%

Covariates	**Coefficient**	**Chi-Square**	**Pr>ChiSq**
Household Income (log form)	-1.0213	170.2995	<.0001
Gender	-0.5001	27.6982	<.0001
Age	0.1224	11.693	0.0006
Age*Primary	0.1689	7.8053	0.0052
Age*Lower Secondary	-0.0721	1.5199	0.2176
Grade of Head	-0.1060	27.2024	<.0001
Gender of Head	-0.0362	0.1504	0.6981
Sibling Number	0.0763	18.0029	<.0001
Distance-Primary	-0.0113	0.2661	0.6059
Distance-Secondary	0.0698	25.6078	<.0001
KMA Area	0.0788	0.2563	0.6127
Other Towns	0.0519	0.1444	0.704

Testing Global Null Hypothesis			
Test	**Chi-Square**	**DF**	**Chi-Square**
Likelihood Ratio	396.5562	12	<.0001
Score	394.1473	12	<.0001
Wald	370.7448	12	<.0001

Table 8: Estimation of Discrete Time Survival Model-Logit Model

Covariates	Coefficient	Chi-Square	Pr>ChiSq
Intercept	8.4172	51.3959	<.0001
grade1	-19.3456	0.0085	0.9267
grade2	-7.0268	36.915	<.0001
grade3	-6.8301	35.5478	<.0001
grade4	-6.4051	32.4019	<.0001
grade5	-6.179	30.4034	<.0001
grade6	-4.9914	20.7265	<.0001
grade7	-0.995	0.9419	0.3318
grade8	-0.9229	0.7838	0.376
grade9	-0.3469	0.1088	0.7415
grade10	0.859	42.7507	<.0001
Household Income (log form)	-1.0222	170.3635	<.0001
Gender	-0.5005	27.7172	<.0001
Age	0.1225	11.701	0.0006
Age*Primary	0.169	7.8084	0.0052
Age*Lower Secondary	-0.0721	1.5211	0.2175
Grade of Head	-0.1061	27.223	<.0001
Gender of Head	-0.0362	0.1507	0.6979
Sibling Number	0.0764	18.0159	<.0001
Distance-Primary	-0.0113	0.2662	0.6059
Distance-Secondary	0.0699	25.6257	<.0001
KMA Area	0.079	0.2571	0.6121
Other Towns	0.0519	0.1445	0.7039

Testing Global Null Hypothesis			
Test	**Chi-Square**	**DF**	**Chi-Square**
Likelihood Ratio	2060.0773	22	<.0001
Score	4180.3474	22	<.0001
Wald	1210.4211	22	<.0001

Table 9: The Education System in Jamaica, 1997/98

Level	Total Enrollment in Public Institutions	Gross Enrollment Ratio (%)	Net Enrollment Ratio (%)	Girls' Enrollment as % of Total
Early Children (3-5)	132,060	87	84	50
Primary	302,090	>100	93	49
Secondary	227,222			
Grade 7-9	152,982	97	82	51
Grade 10-11	69,316	66	49	54
Grade 12-13	5,014	1.5		63
Special Education	2,058	N/A	N/A	N/A
Tertiary	28,144	6.1		66

Sources: MOE&C Statistics; PIOJ, 1999, p. 37-45; Jamaica Secondary Education, Volume I, World Bank Report No. 19069-JM, 1999.

Figures:

Figure 1: Student Distribution in Jamaica 2002 (Grade 1-13)

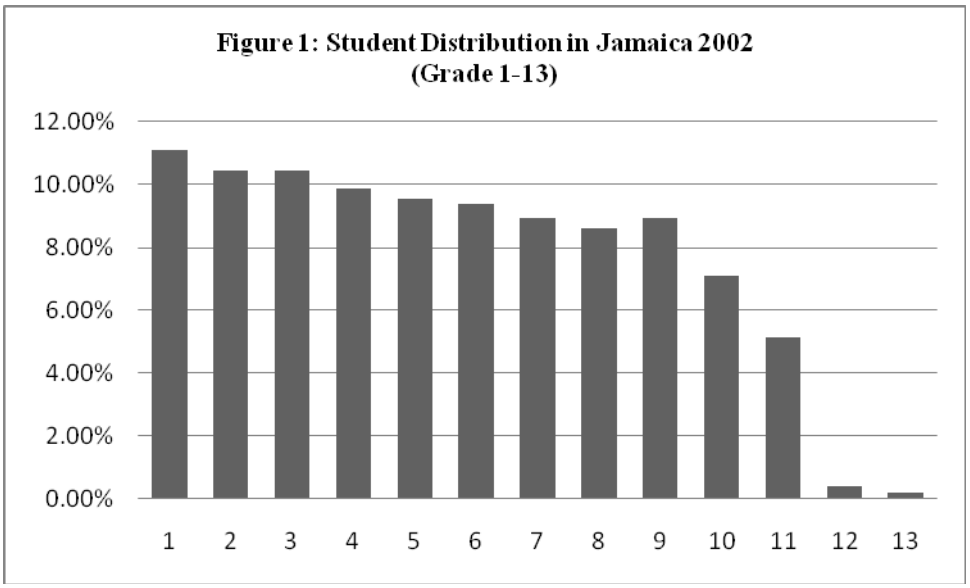


Figure 2: Educational attainment in Jamaica 2002 (by age group)

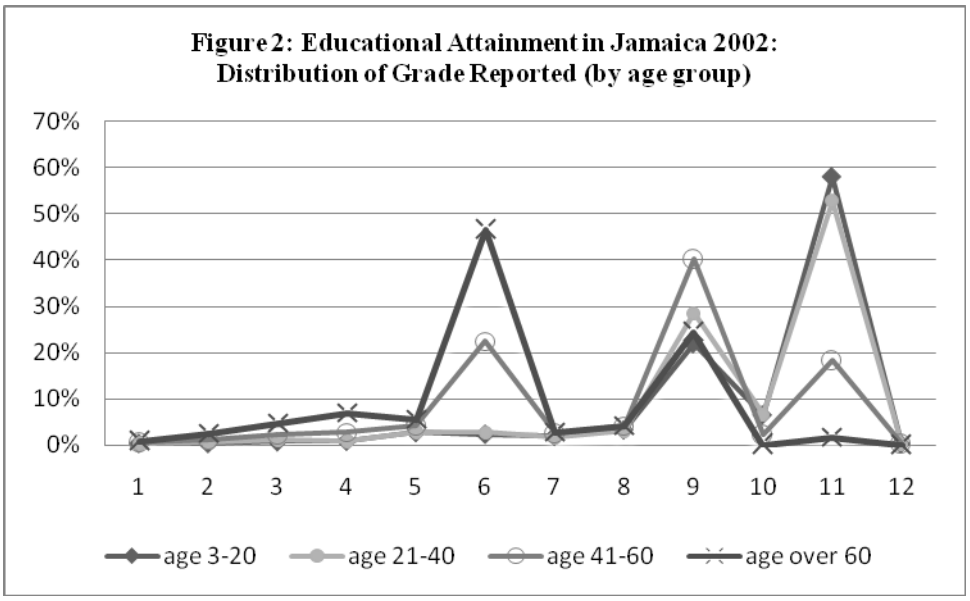


Figure 3: Number of People by Marriage and Age

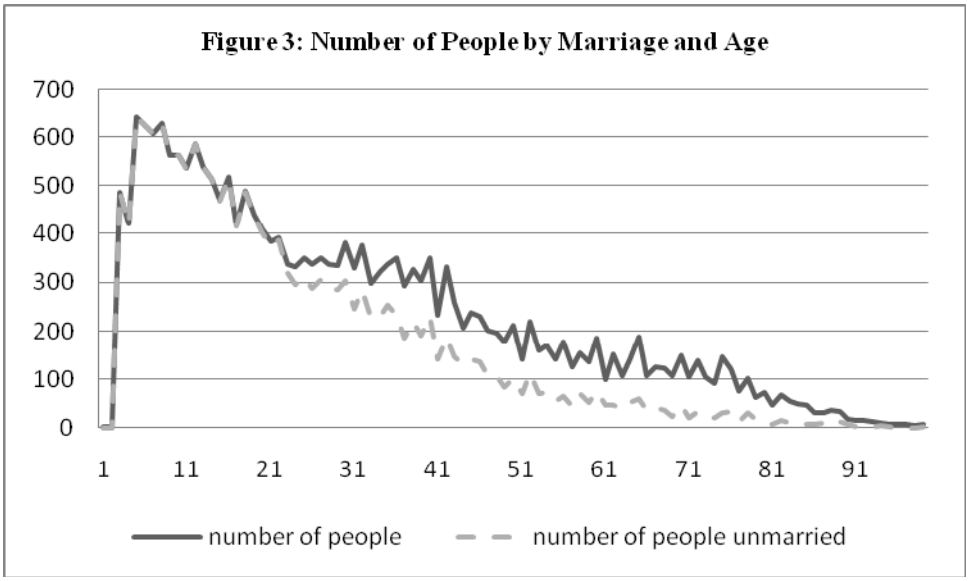


Figure 4-1: Estimated Hazard Curves for Typical Individuals

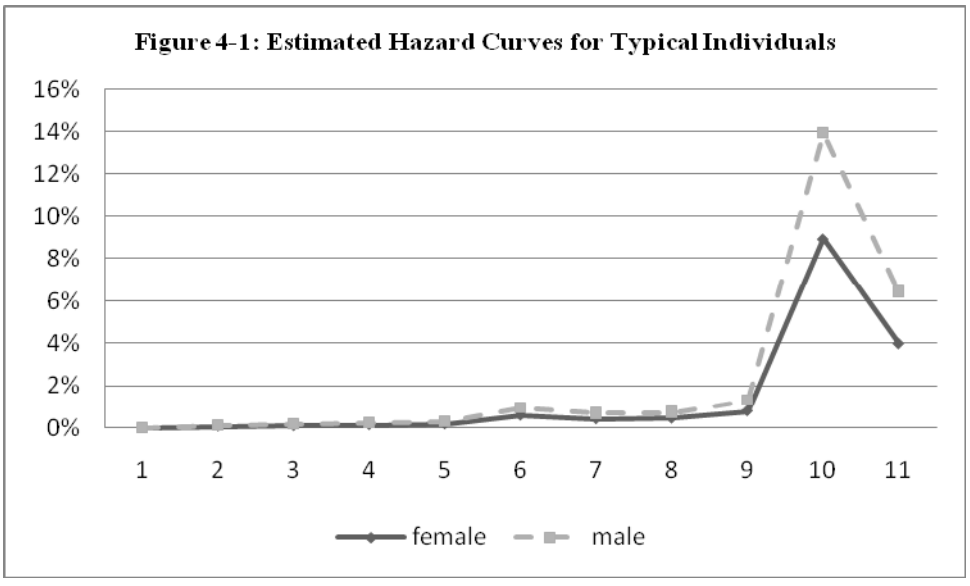


Figure 4-2: Estimated Survival Curves for Typical Individuals

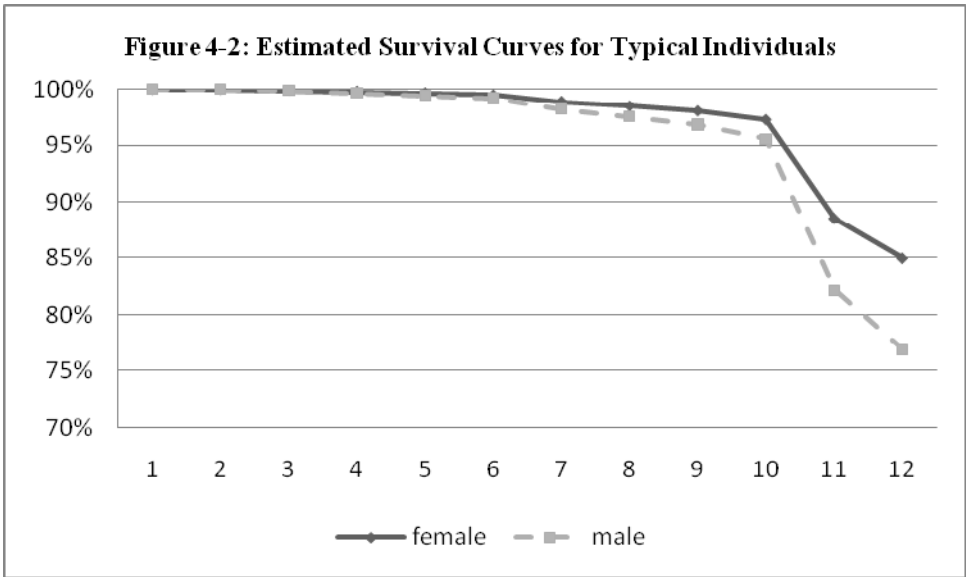


Figure 5-1: Life Table Analysis-Survival Curve, by age group and gender

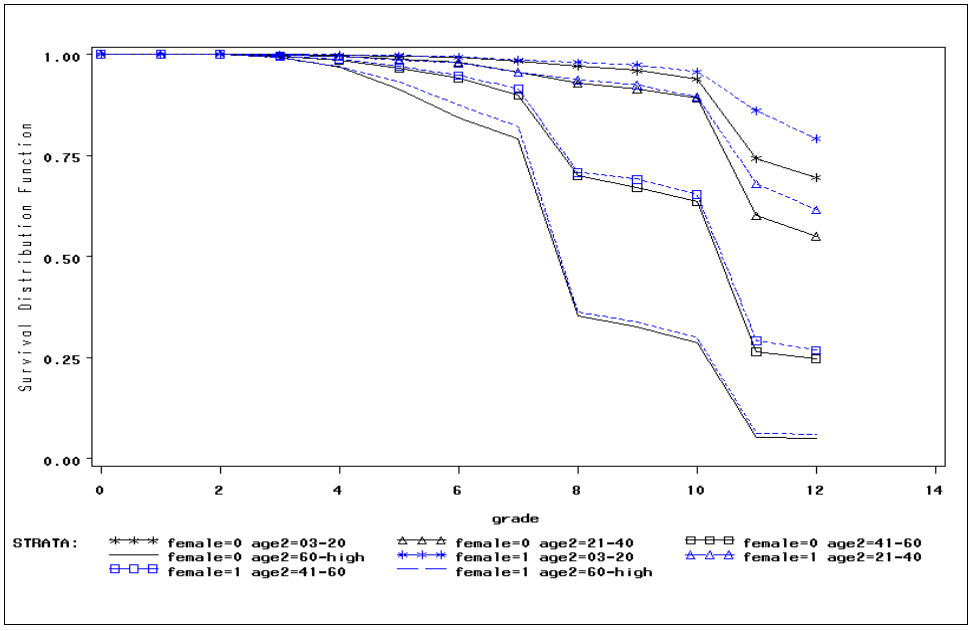
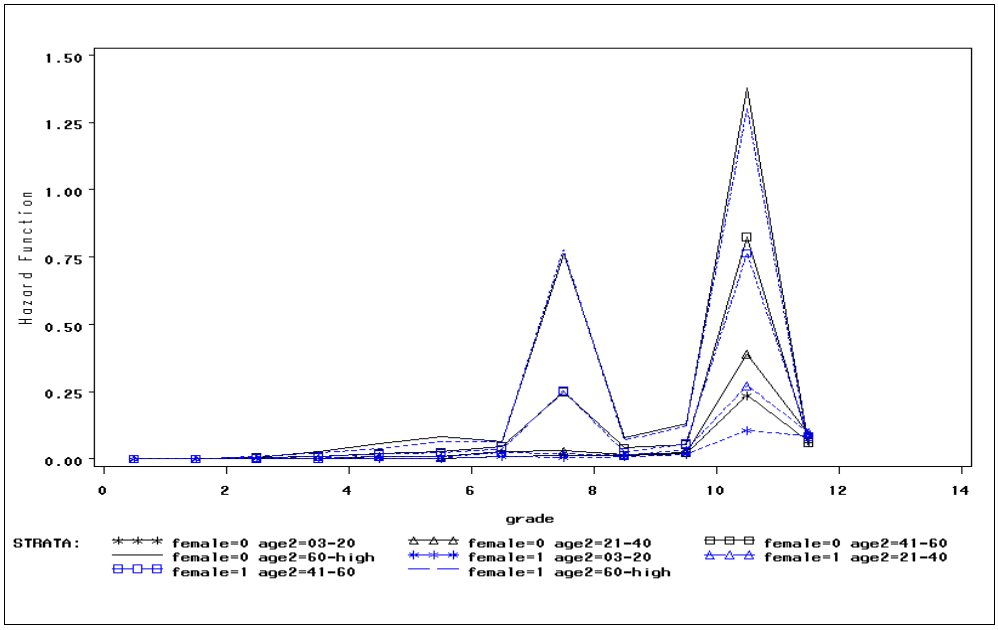


Figure 5-2: Life Table Analysis-Dropout Hazard Curve, by age group and gender



References

Aalen, O. O., & Gjessing, H. K. (2001). Understanding the Shape of the Hazard Rate: A Process Point of View. *Statistical Science, 16*(1), 1-14.

Ainsworth, J. W. (2002). Why Does It Take a Village? The Mediation of Neighborhood Effects on Educational Achievement. *Social Forces, 81*(1), 117-152.

Alexander, K. L., Entwisle, D. R., & Kabbani, N. (2001). The Dropout Process in Life Course Perspective: Early Risk Factors at Home and School. *Teachers College Record, 103*(5), 760-822.

Allison, P. D. (1982). Discrete-Time Methods for the Analysis of Event Histories. *Sociological Methodology, 13*, 61-98.

Arjas, E. (1988). A Graphical Method for Assessing Goodness of Fit in Cox's Proportional Hazards Model. *Journal of the American Statistical Association, 83*(401), 204-212.

Astone, N. M., & McLanahan, S. S. (1991). Family Structure, Parental Practices and High School Completion. *American Sociological Review, 56*(3), 309-320.

Bailey, B. (2004). Gender and Education in Jamaica: Who is Achieving and by Whose Standard? *Prospects, 34*(1), 53-69.

Baker, J. L. (1997). Poverty Reduction and Human Development in the Caribbean: A Cross-Country Study. *World Bank Discussion Paper NO 366*.

Balfanz, R., & Legters, N. (2004). Locating the Dropout Crisis. Which High Schools Produce the Nation's Dropouts? Where Are They Located? Who Attends Them? Report 70 (pp. 49): Center for Research on the Education of Students Placed At Risk, Publications Department, CRESPAR/Johns Hopkins University, 3003 N. Charles St., Suite 200, Baltimore, MD 21218. Web site: http://www.csos.jhu.edu.

Bank, T. W. (1993). Caribbean Region: Access, Quality, and Efficiency in Education.

Bank, T. W. (1999). *Jamaica Secondary Education: Improving Quality and Extending Access Volume I&II*: The World Bank, Latin America and the Caribbean Region.

Barber, J. S., Murphy, S. A., Axinn, W. G., & Maples, J. (2000). Discrete-Time Multilevel Hazard Analysis. *Sociological Methodology, 30*, 201-235.

Barro, R. J., & Lee, J.-W. (1993). International comparisons of educational attainment. *Journal of Monetary Economics, 32*(3), 363-394.

Barro, R. J., & Lee, J.-W. (2000). *International Data on Educational Attainment Updates and Implications*: SSRN.

Beck, N., Katz, J. N., & Tucker, R. (1998). Taking Time Seriously: Time-Series-Cross-Section Analysis with a Binary Dependent Variable. *American Journal of Political Science, 42*(4), 1260-1288.

Becker, G. S. (1962). Investment in Human Capital: A Theoretical Analysis. *The Journal of Political Economy, 70*(5), 9-49.

Becker, G. S. (1972). Schooling and Inequality from Generation to Generation: Comment. *The Journal of Political Economy, 80*(3), S252-S255.

Becker, G. S., & Chiswick, B. R. (1966). Education and the Distribution of Earnings. *The American Economic Review, 56*(1/2), 358-369.

Becker, G. S., & Tomes, N. (1986). Human Capital and the Rise and Fall of Families. *Journal of Labor Economics, 4*(3), S1-S39.

Behrman, J. R., Duryea, S., & Szekely, M. (1999). *Schooling Investments and Aggregate Conditions: A Household-Survey-Based Approach for Latin America and the Caribbean*: SSRN.

Bishop, J. H., & Mane, F. (2004). The Impacts of Career-Technical Education on High School Labor Market Success. *Economics of Education Review, 23*(4), 381-402.

Box-Steffensmeier, J. M., & Jones, B. S. (1997). Time is of the Essence: Event History Models in Political Science. *American Journal of Political Science, 41*(4), 1414-1461.

Buchmann, C., & Hannum, E. (2001). EDUCATION AND STRATIF ICATION IN DEVELOPING COUNTRIES: A Review of Theories and Research. *Annual Review of Sociology, 27*(1), 77-102.

Burkam, D. T., Lee, V. E., & Smerdon, B. A. (1997). Gender and Science Learning Early in High School: Subject Matter and Laboratory Experiences. *American Educational Research Journal, 34*(2), 297-331.

Campbell, G. V. (1966). A Review of the Drop out Problem. *Peabody Journal of Education, 44*(2), 102-109.

Card, D. (2001). Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems. *Econometrica, 69*(5), 1127-1160.

Chiswick, B. R. (1988). Differences in Education and Earnings Across Racial and Ethnic Groups: Tastes, Discrimination, and Investments in Child Quality. *The Quarterly Journal of Economics, 103*(3), 571-597.

Crane, J. (1991). The Epidemic Theory of Ghettos and Neighborhood Effects on Dropping Out and Teenage Childbearing. *The American Journal of Sociology, 96*(5), 1226-1259.

Crowder, K., & South, S. J. (2003). Neighborhood distress and school dropout: the variable significance of community context. *Social Science Research, 32*, 659-698.

Dagenais, M., Montmarquette, C., & Viennot-Briot, N. (2002). Dropout, School Performance and Working while in School: An Econometric Model with Heterogeneous Groups.

Davis, R. (2004). *Task Force on Educational Reform Final Report*.

Day, J. C., & Newburger, E. C. (2002). The Big Payoff: Educational Attainment and Synthetic Estimates of Work-Life Earnings. Special Studies. Current Population Reports (pp. 14): For full text: http://www.census.gov/prod/2002pubs/p23-210.pdf.

Doris, R. E., Karl, L. A., & Linda Steffel, O. (2005). First Grade and Educational Attainment by Age 22: A New Story1. *The American Journal of Sociology, 110*(5), 1458.

Dorn, S. (1993). Origins of the "Dropout Problem." *History of Education Quarterly, 33*(3), 353-373.

Eckstein, Z., & Wolpin, K. I. (1999). Why Youths Drop Out of High School: The Impact of Preferences, Opportunities, and Abilities. *Econometrica, 67*(6), 1295-1339.

Ensminger, M. E., Lamkin, R. P., & Jacobson, N. (1996). School Leaving: A Longitudinal Perspective Including Neighborhood Effects. *Child Development, 67*(5), 2400-2416.

Ensminger, M. E., & Slusarcick, A. L. (1992). Paths to High School Graduation or Dropout: A Longitudinal Study of a First-Grade Cohort. *Sociology of Education, 65*(2), 95-113.

Evans, H. (1999). Gender Differences in Education in Jamaica. In L. Quamina-Aiyejina (Ed.), *Education For All In The Caribbean: Assessment 2000 Monograph Series*.

Farmer, T. W., Estell, D. B., Leung, M.-C., Trott, H., Bishop, J., & Cairns, B. D. (2003). Individual Characteristics, Early Adolescent Peer Affiliations, and School Dropout: An Examination of Aggressive and Popular Group Types. *Journal of School Psychology, 41*(3), 217-232.

Ferguson, I. L. (1947). Education in Jamaica, British West Indies. *The Journal of Negro Education, 16*(4), 600-603.

Fernandez, R. M. (1989). Dropping out among Hispanic youth. *Social Science Research, 18*(1), 21.

Gonzales, N., Cauce, A., Friedman, R., & Mason, C. (1996). Family, peer, and neighborhood influences on academic achievement among African-American adolescents: One-year prospective effects. *American Journal of Community Psychology, 24*(3), 365-387.

Griliches, Z. (1977). Estimating the Returns to Schooling: Some Econometric Problems. *Econometrica, 45*(1), 1-22.

Grosh, M. E. (1991). The Household Survey as A Tool for Policy Change: Lessons from The Jamaican Survey of Living Conditions: LSMS Working Paper NO 80.

Haddad, W. D. (1981). The World Bank's Education Sector Policy Paper: A Summary. *Comparative Education, 17*(2), 127-139.

Hammond, S. A. (1946). Education in the British West Indies. *The Journal of Negro Education, 15*(3), 427-449.

Han, T., & Ganges, T. W. (1995). *A Discrete-Time Survival Analysis of the Education Path of Specially Admitted Students.* Paper presented at the American Educational Research Association Annual Meeting, San Francisco, California.

Haveman, R., & Wolfe, B. (1995). The Determinants of Children's Attainments: A Review of Methods and Findings. *Journal of Economic Literature, 33*(4), 1829-1878.

Hendrickson, L. (1982). Current Trends in Educational Research and Evaluation. *Contemporary Sociology, 11*(4), 407-409.

Hill, C. R. (1979). Capacities, Opportunities and Educational Investments: The Case of the High School Dropout. *The Review of Economics and Statistics, 61*(1), 9-20.

Holmes, B. (1964). Higher Education in Britain: A Review Essay. *The Journal of Higher Education, 35*(7), 397-399.

Honig, B. (1996). Education and Self-Employment in Jamaica. *Comparative Education Review, 40*(2), 177-193.

Jackson, G. A., & Weathersby, G. B. (1975). Individual Demand for Higher Education: A Review and Analysis of Recent Empirical Studies. *The Journal of Higher Education, 46*(6), 623-652.

Jacobs, J. A., & King, R. B. (2002). Age and College Completion: A Life-History Analysis of Women Aged 15-44. *Sociology of Education, 75*(3), 211-230.

Jimerson, S., Egeland, B., Sroufe, L. A., & Carlson, B. (2000). A Prospective Longitudinal Study of High School Dropouts: Examining Multiple Predictors across Development. *Journal of School Psychology, 38*(6), 525-549.

Johnson, I. Y. (2006). Analysis of Stopout Behavior at a Public Research University: The Multi-Spell Discrete-Time Approach. *Research in Higher Education, 47*(8), 905-934.

Kiefer, N. M. (1988). Economic Duration Data and Hazard Functions. *Journal of Economic Literature, 26*(2), 646-679.

Kooperberg, C., Stone, C. J., & Truong, Y. K. (1995). Hazard Regression. *Journal of the American Statistical Association, 90*(429), 78-94.

Krueger, A. B., & Lindahl, M. (2001). Education for Growth: Why and For Whom? *Journal of Economic Literature, 39*(4), 1101-1136.

Laird, J., Lew, S., DeBell, M., & Chapman, C. (2006). Dropout Rates in the United States: 2002 and 2003. E.D. TAB. NCES 2006-062 (pp. 79): ED Pubs, P.O. Box 1398, Jessup, MD 20794-1398. Tel: 877-433-7827 (Toll Free); Web site: http://www.edpubs.org.

Le, n, L. F., & Tsai, C.-L. (2004). Functional Form Diagnostics for Cox's Proportional Hazards Model. *Biometrics, 60*, 75-84.

Lee, V. E., & Burkam, D. T. (2001). *Dropping out of High School: The Role of School Organization and Structure.* Paper presented at the Dropouts in America: How Severe is the Problem? What Do We Know about Intervention and Prevention?, Harvard Graduate School of Education, Cambridge, MA.

Levin, B. (1992). Dealing with Dropouts in Canadian Education. *Curriculum Inquiry, 22*(3), 257-270.

Lucas, S. R. (2001). Effectively Maintained Inequality: Education Transitions, Track Mobility, and Social Background Effects. *The American Journal of Sociology, 106*(6), 1642-1690.

McMahon, W. W. (1975). Economic and Demographic Effects on Investment in Higher Education. *Southern Economic Journal, 41*(3), 506-514.

Miao, J., & Haney, W. (2004). High School Graduation Rates: Alternative Methods and Implications: Boston College.

Mingat, A., & Tan, J.-P. (1985). On Equity in Education Again: An International Comparison. *The Journal of Human Resources, 20*(2), 298-308.

Mingat, A., & Tan, J.-P. (1986). Financing Public Higher Education in Developing Countries. The Potential Role of Loan Schemes. *Higher Education, 15*(3), 283-297.

Parzen, M., & Lipsitz, S. R. (1999). A Global Goodness-of-Fit Statistic for Cox Regression Models. *Biometrics, 55*(2), 580-584.

Perie, M., Sherman, J., Phillips, G., & Riggan, M. (2000). *Elementary and Secondary Education: An International Perspective.*

Prevatt, F., & Kelly, F. D. (2003). Dropping Out of School: A Review of Intervention Programs. *Journal of School Psychology, 41*(5), 377-395.

Psacharopoulos, G., & Yang, H. (1991). Educational attainment among Venezuelan youth: an analysis of its determinants. *International Journal of Educational Development, 11*(4), 289-294.

Rosenthal, B. S. (1998). Non-School Correlates of Dropout: An Integrative Review of the Literature. *Children and Youth Services Review, 20*, 413-433.

Rumbaut, R. n. G. (2005). Turning points in the transition to adulthood: Determinants of educational attainment, incarceration, and early childbearing among children of immigrants. *Ethnic & Racial Studies, 28*(6), 1041-1086.

Rumberger, R. W. (1987). High School Dropouts: A Review of Issues and Evidence. *Review of Educational Research, 57*(2), 101-121.

Rumberger, R. W. (1995). Dropping out of Middle School: A Multilevel Analysis of Students and Schools. *American Educational Research Journal, 32*(3), 583-625.

Rumberger, R. W. (2001). *Why Students Drop Out of School and What Can Be Done.* Paper presented at the Dropouts in America: How Severe is the Problem? What Do We Know about Intervention and Prevention?, Harvard Graduate School of Education, Cambridge, MA.

Rumberger, R. W., & Lamb, S. P. (2003). The early employment and further education experiences of high school dropouts: a comparative study of the United States and Australia. *Economics of Education Review, 22*(4), 353-366.

Sandefur, G. D., McLanahan, S., & Wojtkiewicz, R. A. (1992). The Effects of Parental Marital Status during Adolescence on High School Graduation. *Social Forces, 71*(1), 103-121.

Schemper, M. (1992). Cox Analysis of Survival Data with Non-Proportional Hazard Functions. *The Statistician, 41*(4), 455-465.

Singer, J. D., & Willett, J. B. (1993). It's about Time: Using Discrete-Time Survival Analysis to Study Duration and the Timing of Events. *Journal of Educational Statistics, 18*(2), 155-195.

Singh, S. (1999). UN: Ten priorities for poverty eradication. *The South-North Development Monitor (SUNS)*

Statistics, N. C. f. E. (1993). *International Comparisons of Educational Attainment*.

Stearns, E., & Glennie, E. J. (2006). When and Why Dropouts Leave High School. *Youth Society, 38*(1), 29-57.

Stinebrickner, T. R. (1999). Estimation of a Duration Model in the Presence of Missing Data. *The Review of Economics and Statistics, 81*(3), 529-542.

Swanson, C. B., & Chaplin, D. (Writer) (2003). Counting High School Graduates when Graduates Count: Measuring Graduation Rates under the High Stakes of NCLB: Urban Institute, 2100 M Street, N.W., Washington, DC 20037. Tel: 202-833-7200; Fax: 202-429-0687; e-mail: paffairs@ui.urban.org; Web site: http://www.urban.org.

Taulbee, J. D. (1979). A General Model for the Hazard Rate with Covariables. *Biometrics, 35*(2), 439-450.

The Ministry of Education, Youth and Culture (2004). *The Development of Education: National Report of Jamaica*.

Tilak, J. B. G. (2007). Post-Elementary Education, Poverty and Development in India. *International Journal of Educational Development, 27*(4), 435-445.

Tinto, V. (1975). Dropout from Higher Education: A Theoretical Synthesis of Recent Research. *Review of Educational Research, 45*(1), 89-125.

Ulubasoglu, M. A., & Cardak, B. (2006). International Comparisons of Rural-Urban Educational Attainment: Data and Determinants, *SSRN Working Paper Series*: http://ssrn.com/abstract=649883.

Walker, S. P., Grantham-McGregor, S. M., Himes, J. H., Williams, S., & Duff, E. M. (1998). School performance in adolescent Jamaican girls: associations with health, social and behavioural characteristics, and risk factors for dropout. *Journal of Adolescence, 21*, 109-122.

Willett, J. B., & Singer, J. D. (1991). From Whether to When: New Methods for Studying Student Dropout and Teacher Attrition. *Review of Educational Research, 61*(4), 407-450.

Wu, L. L., & Tuma, N. B. (1990). Local Hazard Models. *Sociological Methodology, 20*, 141-180.

Xu, R., & O'Quigley, J. (2000). Proportional Hazards Estimate of the Conditional Survival Function. *Journal of the Royal Statistical Society. Series B (Statistical Methodology), 62*(4), 667-680.

Zvi, E., & Kenneth, I. W. (1999). Why youths drop out of high school: The impact of preferences, opportunities, and abilities. *Econometrica, 67*(6), 1295.