INSTITUTE FOR SOCIAL AND ECONOMIC RESEARCH AND POLICY
COLUMBIA UNIVERSITY
WORKING PAPERS

MEASURING ECONOMIC DISADVANTAGE DURING CHILDHOOD: A GROUP-BASED MODELING APPROACH

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June 2004

ISERP WORKING PAPER 04-03

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ABSTRACT

Recent research suggest that child well-being and subsequent status attainment are influenced not only by the overall magnitude of exposure to family economic disadvantage during childhood, but also by the age of exposure and significant changes in family economic circumstances. Unfortunately, traditional measures of children's economic deprivation – such as, permanent and transitory income, persistent or cumulative poverty, and the number and length of poverty spells – fail to differentiate between exposure to disadvantage at different stages in childhood and largely ignore how family economic circumstances are changing over time. In this paper we propose a new method for assessing economic disadvantage during childhood that captures both children's overall levels of exposure to economic disadvantage and their patterns of exposure. This new method, which takes advantage of recent advances in finite mixture modeling, uses a longitudinal latent class model to classify children into a limited number of groups with similar histories of exposure to family economic disadvantage. Using this new methodology, group membership can be related to both family background characteristics and achievement in childhood and early adulthood, making it possible both to assess how family characteristics affect patterns of exposure to disadvantage during childhood and directly test alternative theories about the effect of different patterns of exposure on achievement. In this paper the relationship between background factors – such as race, parental education, and family structure – and group membership is investigated, as is the association between group membership and achievement in early adulthood. The use of this technique is demonstrated using data from the Panel Study of Income Dynamics (PSID).

Key Words: poverty, latent class models, educational   attainment, unemployment, longitudinal data

Introduction

Few topics in the social sciences have generated more interest or research over the last half-century than questions about the influence of family economic background and disadvantage on child outcomes and early adulthood achievement (Brooks-Gunn and Duncan 1999; Blau and Duncan 1967; Haveman and Wolfe 1994; Mayer 1997; Sewell and Hauser 1975; Sewell, Hauser, and Featherman 1976). Research has shown that poor children tend to perform worse than children from more economically secure families on a wide variety of measures. Poor children have higher infant mortality rates (Klerman 1991; Gortmaker 1979), more asthma (Castro et al 2001), more physical and mental health problems (Korenman and Miller 1999; Lippman and Offord 1999; McLeod and Shanahan 1993; McLeod and Shanahan 1996; McLoyd and Wilson 1991), and are generally in worse health (McLoyd 1998). They are less well-adjusted (Conger, Conger and Elder 1999; Conger et. al. 1992) and report lower self-esteem (Axinn, Duncan, and Thornton 1999). They get worse grades in school (McLoyd 1998; Smith, Brooks-Gunn, and Klebanov 1999), are more often placed out of age-appropriate regular classrooms (Pagani, Boulerice, and Tremblay 1997 and 1999) and obtain fewer years of schooling than their more economically advantaged peers (Axinn, Duncan, and Thornton 1999; Haveman, Wolfe, and Wilson 1999; Mare 1980; McLoyd 1998; Pagani et al 1999). As adults, children from less affluent families are more likely to be unemployed or underemployed (Haveman and Wolfe 1994), earn lower wages when they do work (Kiker and Condon 1981) and be poor themselves (Garces 2000; Gottschalk and Danzinger 2001; Haveman and Wolfe 1994 and 1995; Rogers 1995).

Often, however, the estimated effect of family economic resources on child outcomes is quite modest (Behrman et. al. 1980; Blau 1999; Mayer 1997). When genetic endowments, parenting practices and other parental characteristics likely to influence children's outcomes are controlled, the estimated impact of family economic resources on child outcomes is typically even smaller (Behrman et. al. 1980; Mayer 1997; Olneck 1977). Consequently, some researchers have begun to question the role that family economic resources play in children's life chances (Mayer 1997).

One reason that the estimated impact of family income may be so small is that traditional measures of family economic deprivation fail to capture crucial aspects of the experience of disadvantage. An emerging body of research suggests that it is not merely, or perhaps even primarily, the overall level of economic deprivation that is important to child development and well-being and subsequent achievement (Andrews and Rosenblum 1994; Dearing, McCartney, and Taylor 2001; Duncan et al 1998; Galambos and Silberreisen 1987; Moore et al 2002; Yoshikawa 1999). Rather, the effect of economic deprivation seems to be contingent upon whether deprivation is experienced early or later in childhood and whether family economic circumstances are improving or deteriorating over time.

Yet, most measures of economic disadvantage do not take into account either when a child experiences economic deprivation or trends in family economic circumstances. Frequently, family economic background is simply conceptualized as the economic resources of the child's family at a single point in time, often indicated by the annual household income or poverty status of the family at the time of the interview. More dynamic conceptions of children's economic circumstances – such as, permanent and transitory income, cumulative and persistent poverty, and the number and length of poverty spells – also fail to capture these important aspects of a child's history of exposure to economic deprivation. Permanent income and permanent poverty measures, which typically average income or poverty status over a number of years, mask both when exposure to economic disadvantage occurs during childhood and whether family economic conditions are improving, deteriorating, or remaining the same. Cumulative or persistent poverty measures – which usually examine the proportion of childhood spent living in poverty – and poverty spell measures – which typically examine the number and duration of poverty spells children experience during their childhood – also fail to distinguish between families whose economic circumstances are improving and those whose economic circumstances are deteriorating or stable and do not usually differentiate between deprivation experienced early in childhood and later in childhood.

In this paper, we draw on recent methodological advances in the study of developmental trajectories (Jones, Nagin, and Roeder 2001; McLachlan and Peel 2000; Muthén 2000, 2001a, and

2001b; Muthén and Muthén 2000a; Nagin 1999; Nagin and Tremblay 1999; Nagin, Farrington, and Moffitt 1995; Nagin, and Land 1994; Verbeke and Lesaffre 1996), to propose an alternative means of assessing children's exposure to economic disadvantage. Rather than looking at permanent poverty, cumulative exposure to poverty, the duration of poverty spells, or some similar measure summarizing a child's exposure to economic deprivation during childhood, this new approach uses a finite mixture modeling strategy to classify children into a limited number of groups on the basis of similarities between their childhood experiences of economic deprivation.

This new approach offers several benefits over alternative approaches. It allows us to identify rather assume distinctive groups of children who experience similar histories of exposure to economic disadvantage during their childhood and estimate the proportion of children who fall into each group. By relating the probability of group membership to individual and family circumstances, we can evaluate how different characteristics affect children's patterns of exposure to deprivation. By relating group membership to childhood and early adulthood outcomes, it is possible to directly evaluate alternative theories about the effects of different patterns of exposure to economic disadvantage during childhood on child development and subsequent achievement. We use data from the Panel Study of Income Dynamics (PSID) (Hofferth et. al. 2001) to assess the number of different groups in the population and to estimate the proportion of children that fall into each group. We also examine the relationship between group membership and family background factors and offspring's attainments in early adulthood.

Assessing Children's Exposure to Economic Disadvantage during Childhood

Researchers have operationalized children's family economic background and exposure to disadvantage during childhood in many different ways. The most common approach, which we refer to as the *static indicator approach*, has been to employ children's family's or household's income or poverty status at the time of the interview or assessment as an indicator of the family's overall economic circumstances (Behrman and Taubman 1985; Blau and Duncan 1967). More recently, researchers have begun to incorporate other static measures of family economic circumstances –

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such as, material hardship (Mayer and Jencks 1989), family consumption (Haskins 1999), and wealth and debts (Spilerman 2000; Conley 1999; Oliver and Shapiro 1995) – into their conceptions of children's family economic backgrounds. Even with these additional indicators of economic resources and material hardship, however, the static indicator approach often provides a misleading picture of children's "true" experience of deprivation during childhood. If a child's family's economic circumstances are systematically improving or deteriorating or are unstable, the picture that emerges from a single snapshot will depend on when the family's economic circumstances are measured. At different times, different groups of children will appear to be both absolutely and relatively more disadvantaged.

Dissatisfaction with the inherent limitations of a static, single indicator measure of family economic circumstances and deprivation has led to the development of a variety of more dynamic measures (Moore et al 2002; Blau 1999; Rodgers and Rodgers 1993; McLeod and Shanahan 1993; Guo 1998; Korenman, Miller, and Sjaastad 1995; Korenman and Miller 1999; Gottschalk and Danziger 2001; Duncan and Rodgers 1991; Bane and Ellwood 1983 and 1986). Many of these measures have aimed at providing a more stable assessment of a family's economic resources by averaging economic status over a number of years (Blau 1999; Korenman, Miller, and Sjaastad 1995; Gottschalk and Danziger 1999) or using statistical models to estimate the permanent component of family economic resources (Duncan and Rodgers 1991). Although these measures of *permanent income* or *permanent poverty* eliminate much of the random noise or transitory fluctuations found in static measures of income or poverty, they are often almost as misleading because they not only "average out" the transitory component of income or poverty status but tend to mask important systematic patterns of change, such economic improvement or decline.

An alternative approach to assessing children's economic circumstances and deprivation has focused on the amount of time that a child spends living in poverty during childhood. Often referred to as *persistent* or *cumulative poverty*, these measures typically assess the proportion or number of years that a child lived below the poverty line (McLeod and Shanahan 1993 and 1996; Guo 1998; Korenman, Miller, and Sjaastad 1995; Korenman and Miller 1999; Gailha and Doelalikar 1991;

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Duncan, Coe, and Hill 1984; Hill 1981; Rainwater 1981; Coe 1978; Levy 1977). A related approach has focused on the number and duration of poverty spells (Stevens 1999; Ruggles and Williams 1989; Bane and Ellwood 1983 and 1986). Persistent or cumulative poverty and poverty spell measures, like the other measures discussed above, conceal important aspects of children's family economic circumstances and exposure to disadvantage. These measures tend to obscure important systematic changes in family economic circumstances, such as whether economic conditions in the family are improving or deteriorating and whether deprivation occurs early or later in childhood.

This paper proposes a new approach to assessing children's economic disadvantage that focuses not only on the average or overall risk of exposure to economic disadvantage but also on how this risk of exposure is changing over the course of childhood. We use a group-based modeling strategy to classify children into groups on the basis of their risk profiles: that is, their initial risk of living in poverty and how this risk changes over time. In contrast to traditional approaches, such as poverty spell and permanent and cumulative poverty measures, which aim to create a simple summary measure that captures a child's exposure to economic deprivation during childhood, we aim to categorize children into a limited number of groups with similar patterns of exposure to economic deprivation during childhood. This approach has the benefit of retaining the simplicity of current measures of economic deprivation while more accurately describing children's patterns of exposure to economic disadvantage.

This approach assumes that the population of children is composed of a mixture of distinct groups defined by their histories of exposure to economic deprivation. Although this assumption is not likely to be literally true, it does closely approximate the theoretical distinction that many theories of poverty make between the long-term or persistent poor, the short-term or transitory poor, the near poor or working poor, and the non-poor (Wilson, 1987; Auletta 1982; Lewis 1959). An important purpose of these taxonomic theories of poverty is to highlight the causes and consequences of distinctive family economic trajectories for children and their families. The group-based modeling strategy proposed in this paper provides a methodological complement to this type of theory.

In contrast to approaches that assign children and families to different poverty status or income trajectory groups on the basis of some subjective categorization criteria (Moore et al. 2002), this approach makes it possible to explicitly test the basic elements of these theories: Are the different profiles predicted by these theories actually present in the population? Are the factors that are supposed to lead to different risk profiles related to the probability of group membership? Do child development and well-being and subsequent achievement differ for children with different patterns of exposure to economic deprivation during childhood? In the next section, we discuss why we expect family economic trajectories to have important consequences for children. And, in the following section, we discuss in greater detail the group-based modeling strategy that we will use to classify children into distinct groups on the basis of their risk of exposure to economic disadvantage over the course of their childhood.

Why Do Family Economic Trajectories Matter for Children?

As the availability of longitudinal data with detailed information on children's exposure to economic disadvantage during childhood have increased in recent years, an emerging body of research evidence suggests that the timing and duration of economic disadvantage as well as the direction of changes in family economic circumstances can have important effects on child development and subsequent achievement. Duncan, Brooks-Gunn, and Klebanov (1994) find that long-term poverty is more strongly associated with negative child outcomes than short-term poverty. Duncan et. al. (1998) find that the harmful effects of poverty on child outcomes depends on when children are exposed to economic disadvantage, with more acute effects in children exposed to poverty in early childhood.

Recent studies have also revealed the importance of changes in family economic circumstances. Dearing, McCartney, and Taylor (2001) find that such changes are particularly consequential for poor children, with declining economic fortunes associated with worse outcomes for children and rising fortunes associated with improved outcomes. Declining family economic circumstances have also been linked to adolescents' expectations for job success (Galambos and

Silbereisen 1987). Moore and her colleagues (2002) find that children who experience stable, but disadvantaged economic circumstances do not have worse outcomes than children who were never poor, but that children whose family economic circumstances decline or fluctuate are at greater risk of behavioral problems and score lower on cognitive tests. The suggestive research by Rosenblum and colleagues (Andrews and Rosenblum 1991; Andrews and Rosenblum 1994; Rosenblum and Paully 1984) on primates indicates that infant primates raised in environments with greater food instability show more sustained clinging to mother, lower levels of social play and exploration, higher levels of affective disturbance, and higher levels of depression than infants raised in environments with fewer resources but greater stability. As Yoshikawa (1999) notes, economic transitions in family life have important implications for child development and outcomes.

Research indicates that family economic trajectories and transitions matter because changes in a family's economic circumstances can have profound effects on parental stress, parenting practices, and family interpersonal dynamics. Changes in a family's economic circumstances, particularly income losses or income instability, can increase parental stress, making parents more irritable, hostile, tense, and explosive (Liker and Elder 1983; Conger et al. 1993). Alcohol abuse rises in families that have experienced a job loss or substantial loss of income (Catalano et al. 1993; Pierce et al. 1994), as does depression (Grunberg, Moore and Greenberg 2001; Vinokur, Price and Caplan 1996; Mallinckrodt and Bennett 1992), feelings of a loss of control (Ross and Mirowsky 1992), and pessimism (Galambos and Silbereisen 1987). Moreover, family economic decline not only affects the stress level of the parent directly experiencing the income loss, it is also frequently transmitted to their spouse, reducing their emotional and physical health as well (Rook, Dooley, and Catalano 1991; Elder and Liker 1982).

Changes in a family's economic fortunes not only increase parental stress they also strain and disrupt relationships within the family. Income and job loss increase marital discord, lower marital quality (in terms of happiness and satisfaction), and reduce marital stability (Conger et al. 1990; Atkinson, Liem, and Liem 1986). Economic losses also strain relationships between parents and children. Elder, Nguyen, and Caspi (1985) find that income losses increase the rejecting behavior of

fathers. Whitbeck et al. (1991) find that income loss reduces parental support and involvement. The suggestive research on primates by Rosenblum and colleagues (Andrews and Rosenblum 1991; Andrews and Rosenblum 1994; Rosenblum and Paully 1984) indicates that mothers assigned to environments with food instability exhibit weaker attachment to their infants than mothers in environments with less food but greater stability.

An expanding body of research indicates that the age at which children experience economic deprivation and overall trends in family economic circumstances may be as important to child well-being and development and subsequent achievement as the overall magnitude and duration of deprivation. The most widely-used summary measures of economic deprivation, such as poverty spells and permanent, cumulative, and persistent poverty, however, fail to capture these important dimensions of disadvantage. Though more sophisticated summary measures might be developed to address these newly recognized dimensions of childhood deprivation, the complexity of such a measure would be certain to limit its usefulness and popularity. We, therefore, propose pursuing an alternative path, which retains much of the simplicity of traditional measures of economic deprivation while more accurately characterizing patterns of economic deprivation during childhood. Rather than developing more sophisticated measures of economic disadvantage, we seek to identify groups of children will similar patterns of exposure to economic deprivation during childhood.

Identifying Children with Similar Childhood Experiences of Economic Disadvantage

We identify groups of children with similar childhood experiences of economic disadvantage using finite mixture models. In recent years these techniques have become increasingly popular with researchers seeking to identify groups of subjects with distinctive patterns of behavior. The range of issues examined is wide. For example, mixture models have been used to identify distinctive criminal careers and patterns of delinquency (Jones, Nagin, and Roeder 2001; Nagin 1999; D'Unger et al. 1998) as well as patterns of anti-social behavior Schaeffer et al. (2003). Oxford et al. (2003) and Muthén and Muthén (2000a and 2000b) documented distinct patterns of substance abuse using these models while Croudace et al. (2003) identified distinctive patterns of bed-wetting in children.

Muthén et al. (2000) and Dunn et al. (2003) have used finite mixture modeling to identify non-compliant subjects in clinical experimental trials. To our knowledge, we are the first to use these techniques to categorize children with distinctive histories of economic disadvantage. More information on the estimation of these models may be found in Nagin (1999), Jones, Nagin, and Roeder (2001), McLachlan and Peel (2000), and Muthén (2001a).

The finite mixture model assumes that the sample is composed of a mixture of population groups with distinctive patterns of behavior. Membership in a group, however, is unobserved; only the mixture of groups is observed. Consequently, it is not possible to directly estimate each group's size and pattern of exposure to economic disadvantage over time. Group membership can, however, be inferred from the data. In the mixture model, this heterogeneity is captured by an unobserved (latent) categorical variable, with the observed outcomes at each time point – in this case, poverty status in each year – serving as indicators of the latent class variable (Muthén 2001a). Since group membership is unobserved, the proportion of cases in each class is unknown and must be estimated by the model, as must the conditional item probabilities for each class.

This paper uses these longitudinal latent class models to classify children on the basis of their family's movements in and out of poverty. This discussion draws on the mixture modeling framework developed by Muthén (2001a). Let $\mathbf{u}$ denote a time-ordered series of dichotomous variables indicating whether a child's family's income is at or below the official poverty line in a given year, where u_{ik} equals 1 if child i is living in poverty and 0 otherwise. Let $\mathbf{x}$ denote categorical or continuous covariates, such as race, parental education, and family structure. Let $\mathbf{z}$ denote one or more continuous outcome variables, such as educational achievement in early adulthood. Let $\mathbf{c}$ denote a latent categorical variable with K classes, $c_i = (c_{i1}, c_{i2}, c_{i3}, \ldots, c_{ik})$, where c_{ik} equals 1 if child i belongs to class k and 0 otherwise. The model has three parts: $\mathbf{c}$ is related to $\mathbf{x}$, $\mathbf{u}$ is related to $\mathbf{c}$, and $\mathbf{z}$ is related to $\mathbf{c}$. Figure 1 depicts these relationships.

<Figure 1>

$\mathbf{c}$ is related to $\mathbf{x}$ by a multinomial logistic regression. The probability that individual i falls into class k of the latent variable c is:

$$P(c_{ik}=k|x_i) = \frac{e^{a_{ck} + \gamma_{ck}\mathbf{x}_i}}{\Sigma^K_{k=1} \, e^{a_{ck} + \gamma_{ck}\mathbf{x}_i}}$$

where α_k is a $K-1$ parameter vector of logit intercepts and γ_k is a $(K-1)$ x q parameter matrix of logit slopes. The last class is the reference class with coefficients standardized to zero, $\alpha_k = 0$ and $\gamma_k = 0$. By directly linking group membership to individual and family background characteristics, it is possible to examine how these characteristics may have dissimilar affects on children's patterns of exposure to economic disadvantage. For example, by distinguishing between those characteristics that affect a child's exposure to many different patterns of economic deprivation and those that primarily affect a child's exposure to a specific pattern of disadvantage.

For **u**, conditional independence is assumed given $\mathbf{c}_i$ and $\mathbf{x}_i$,

$$P(u_1, u_2, u_3,\ldots,u_r | c_i,x_i) = P(u_1 | c_i,x_i)P(u_2 | c_i,x_i)\ldots P(u_r | c_i,x_i)$$

Thus, the marginal probability for item $u_j = 1$ is:

$$P(u_j = 1) = \Sigma^K_{k=1}(c = k)P(u_j = 1 | c = k)$$

and the joint probability of all u's equal to 1 is:

$$P(u_1, u_2, u_3,\ldots,u_r = 1) = \Sigma^K_{k=1}P(c = k)P(u_1 = 1 | c = k)P(u_2 = 1 | c = k)\ldots P(u_r = 1 | c = k).$$

Consequently, the estimated probability that individual i falls into class k is:

$$P(c = k | u_1, u_2,u_3,\ldots,u_r) = \frac{P(c = k)P(u_1 = 1 | c = k)P(u_2 = 1 | c = k)\ldots P(u_r = 1 | c = k)}{P(u_1, u_2, u_3,\ldots,u_r)}$$

Each individual, therefore, is allowed fractional class membership (i.e. may have nonzero values for more than one class), reflecting uncertainty in the classification of individuals.

Distal outcomes $\mathbf{z}$ is related to $\mathbf{c}$ by a linear regression model:

$$z_i = \alpha_k$$

where α_k indicates the mean levels of achievement in early adulthood in class k. Since child development and well-being and subsequent achievement are directly related to group membership in this model we can explicitly evaluate alternative hypotheses about the effects of different patterns of exposure to economic deprivation on mean outcomes.

Models were estimated in M-Plus by maximum-likelihood estimation via the EM algorithm. Due to panel attrition in the PSID data, missingness increases over time (Fitzgerald, Gottschalk, and Moffitt 1998). A maximum-likelihood missing data routine was implemented to use data from all observations in the data set in the estimation of the parameters of the model. This estimation assumes that data are missing at random (MAR). Chi-square tests for the unrestricted latent class model indicated that the more restrictive assumption of missing completely at random (MCAR) was met. This method makes maximum use of information on children with one or more years of missing data and increases our statistical power for detecting and differentiating between developmental trajectories. Results from the maximum-likelihood missing data estimation routine were similar to results generated using listwise deletion, suggesting that our results are robust across different missing data specifications. A weighted likelihood approach that accounted for unequal selection probabilities and differential non-response was used to estimate all models.

One challenge of the mixture-modeling framework is determining the optimal number of groups to include in the model. At present, no consensus exists on the best measure of model fit to use when comparing models with different numbers of groups. A number of researchers have suggested using information criteria – such as Akaike's Information Criterion (AIC), Consistent AIC (CAIC), Bayesian Information Criterion (BIC), and sample-size adjusted BIC – which reward more

parsimonious models (fewer latent classes) that more accurately reproduce the data (D'Unger et al. 1998; Nagin 1999; Bozdogan 1987; McLachlan and Peel 2000; Muthén and Muthén 2000a; Yang 1998). Other researchers have suggested using statistics – such as Entropy, Normalized Entropy Criterion (NEC) and the Classification Likelihood Criterion (CLC) -- that reward models that produce well-separated clusters, i.e. those where the estimated probabilities approach zero or one (Wedel and Kamakura 1998). Recently, Lo et al (2001) have recommended using an adjusted likelihood ratio test, the Lo-Mendell-Rubin (LMR LRT) test, which adjusts the conventional likelihood ratio test for k versus k +1 classes for violation of regularity conditions, to evaluate the proper number of classes (Muthén 2003). In this study, we use all three types of statistics to determine the appropriate number of latent classes.

Data

This analysis is based on data drawn from the Panel Study of Income Dynamics (PSID), a nationally representative panel study conducted annually since 1968 by the Survey Research Center at the University of Michigan (Hofferth et. al. 2001). Individuals from original sample households are reinterviewed every year, whether or not they are living in the same dwelling or with the same people. Adults are followed as they grow older, and children are observed as they advance through childhood and into adulthood, forming family units of their own. This procedure produces an unbiased sample of families each year as well as a continuously representative sample of children born into families each year (Fitzgerald et al. 1998a; Levy and Duncan 2000). As of 2001, the PSID data included longitudinal information on 63,453 individuals who were either members of one of the original sample families, the offspring of one of those individuals, or their co-residents. Our sample includes the 2,386 children who were between the ages of birth and five years old on January 1, 1968. Children's histories of economic disadvantage are analyzed over the twelve-year period from 1968 (when children were 0-5 years old) to 1979 (when they were 11 to 16).

We classify children into groups on the basis of their family's poverty status between 1968 and 1979.[1] In any given year, a child is considered to be living in poverty if the family's total annual income falls below the official poverty threshold defined by the U.S. Bureau of the Census for a family unit of its size and with its number of related children under eighteen years of age. Because the PSID consistently finds higher reported incomes than does the Census Bureau, the official poverty threshold is inflated by 25%, as is commonly done by researchers using the PSID (Bane and Ellwood 1983; Stevens 1999).

Recent research has revealed that an unconditional model without covariates is not suitable identifying the appropriate number of classes (Muthén 2003). Proper model specification and accurate estimation of the class proportions and class membership requires that antecedents (predictors) of class membership be included in the set of covariates. Consequently, only conditional models, which include the antecedents of class membership, are presented here. The predictors of group membership examined in this study include: race of the head, sex of the head, number of children in the family, head's education, and head's employment status in 1968. The early adulthood outcomes examined in this study are years of schooling completed and employment status at the age of 25 years old.[2] Table 1 presents weighted descriptive statistics for the sample.

<Table 1>

The percentage of families living in poverty fluctuated from year to year, ranging from 12.9% in 1973 to 18.5% in 1975. Fifteen and a half percent of families were headed by African Americans and 10.8% were headed by women. The average family in the sample had 3.2 children. Approximately 4 out of 10 family heads were high school dropouts and 11.2% were not working at the beginning of the study. The average child in the sample had attained 13.1 years of education by the age of 25 and 81.4% were employed.

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[1] Models using age as the time variable instead of survey year were also estimated. Results for these models closely paralleled the results presented here, however, because of sparseness in the data matrix these models encountered significant estimation difficulties and required less plausible missing data assumptions. Consequently, they are not presented here.

[2] We also investigated using earned income and occupational status at age 25 years old as distal outcomes. However, high levels of missingness on these outcome measures precluded their use in this set of models.

Results

Number of Groups

Table 2 summarizes results for conditional models with between two and five latent classes. Models with more latent classes did not achieve convergence. Sequential model comparisons between models with k and $k + 1$ classes recommend a model with four latent classes. The Lo-Mendell-Rubin adjusted likelihood ratio test comparing models with four and five latent classes indicates that the addition of a fifth class does not significantly improve model fit (LMR LRT = 203.260, p = 0.447). The LMR LRT comparing models with three and four latent classes does indicate that the addition of a fourth class substantially improves model fit (LMR LRT = 514.966, p = <0.001). On the other hand, information criterion statistics recommend a model with at least five classes. The addition of a fifth class reduces AIC by 168.715, BIC by 64.988, and the sample-size adjusted BIC by 122.178. Entropy values for all models are quite high (0.894 or greater), indicating strong separation of classes. Because the sequential model comparisons strongly indicate that a fifth latent class is unnecessary and the improvements in the information criterion statistics with the addition of a fifth class are relatively small, we present results for the four-class model.

<Table 2>

Figure 2 depicts the estimated probability of living in poverty by year for each of the four classes. The largest group, the non-poor, which accounts for 71.7% of children, has little exposure to economic disadvantage throughout childhood. In any given year, children in non-poor families have less than a 3% chance of living in poverty. The long-term poor trajectory group, which constitutes a much smaller percentage of the population of children (7.3%), by contrast, has very high levels of exposure to economic disadvantage throughout childhood. In the early years of childhood, children in long-term poor families have more than a 90% chance of living in poverty in any given year. Over time the likelihood of children in long-term poor families living in poverty slowly declines, though their overall risk of exposure to poverty remains high even as these children enter adolescence. By the time these children are between the ages of 12 and 16, the risk of

exposure has fallen to 75%. The two other groups, the moving out and the moving into poverty groups, which account for 10.6% and 10.3% of children, respectively, represent trajectories of change. Children in the moving out of poverty group, who might also be described as the transient poor, begin life with relatively high risks of exposure to poverty (over 55%). As these children age, however, their risk of exposure to economic disadvantage drops precipitously, until adolescence when they generally have less than a 10% chance of living in poverty in any given year. Children in the moving into poverty group follow the opposite path. They begin life with modest chances of living in poverty, but they become increasingly likely to live in poverty over the course of their childhood. In the early years of their childhood, children in these families have around a 30% chance of living in poverty in any given year. As these children age, however, their risk of exposure to poverty increases sharply, hitting between 70% and 80% in any given year as they enter adolescence.

<Figure 2>

Determinants of Group Membership

Group membership can be related to antecedents (predictors) by a multinomial logistic regression predicting latent class membership. Table 3 displays coefficients for a multinomial model relating group membership to the race of the head, the sex of the head, the number of children in the family, the head's education, and the head's employment status in 1968. The largest class, the non-poor trajectory class, serves as the reference group in this model. The coefficients in the table represent logged odds ratios. The numbers in parentheses are standard errors.

<Table 3>

As expected, children in families headed by African-Americans are much more likely than children in other families to be classified in one of the three trajectory groups with substantial exposure to economic deprivation during childhood. Children in families headed by an African American are nearly 20 times more likely than children in other families to be classified in the long-term poor group, 6 times more likely to be classified in the moving into poverty group, and 3 times

more likely to be classified in the moving out of poverty group. In contrast to traditional measures of economic deprivation, however, the group-based approach sheds additional light on the specific nature of African-American economic deprivation. Black children are not only more likely to be poor than other children, they are also more likely to be reared in families with extensive exposure to poverty (i.e., the long-term poor group) and in families whose risk of exposure to poverty increases over time (i.e., moving into poverty group). By contrast, non-black children are much more likely be reared in families that are either not poor or are moving out of poverty.

By focusing on patterns of exposure to economic disadvantage during childhood, the group-based methodology also provides a more comprehensive picture of how other background factors affect children's experiences of economic deprivation. For example, children in female-headed families are significantly more likely than children in other types of families to be raised in families in which the child's exposure to poverty rises over time. Children in these families are not, however, more likely than other children to be reared in families that are persistently poor or moving out of poverty. Not surprisingly, children in larger families are also significantly more likely than children in smaller families to be exposed to economic disadvantage. However, in contrast with children in female-headed families, they are much more likely to be raised in families that are persistently poor, and, to a somewhat lesser extent, moving out of poverty.

Living in a family headed by a high school dropout or an unemployed person has a more generalized effect on children's exposure to economic deprivation. Children in these families are significantly more likely than other children to be exposed to poverty during their childhood. However, they do not, with the exception of the modest tendency of children in families initially headed by an unemployed person to be persistently poor (i.e., long-term poor), tend to follow one of the poverty patterns more than the others. By contrast with race, female headship, and family size, which appear to have very specific effects on children's patterns of exposure to economic disadvantage, education and employment status seem to have more wide-ranging effects, increasing children's risk of exposure to different patterns of economic deprivation by similar amounts.

By focusing on patterns of exposure to economic deprivation, it is possible, therefore, to develop a more comprehensive understanding of children's exposure to economic deprivation. We can identify general patterns of exposure to economic disadvantage and estimate the proportion of children who experience each pattern. By relating group membership to antecedent factors we can distinguish between background characteristics that have very general effects on children exposure to economic disadvantage, such as low education, which raise children's risk of falling into any of the disadvantaged trajectory groups, and those which have more specific effects, such a female headship and race, which increase children's risk of falling into specific patterns of exposure to economic disadvantage. By extending this model to include distal outcomes, we can also evaluate the effect that different patterns of exposure to economic deprivation have on child development and well-being and subsequent achievement.

Group Differences in Early Adulthood Achievement

Distal outcomes can also be related to group membership by a regression model. Two measures of achievement in early adulthood are examined in this study: years of education completed and employment status at age 25 years old. Table 4 displays the estimated coefficients and standard errors from the regression models relating early adulthood achievement to group membership.

<Table 4>

If, as some research suggest (Duncan, Brooks-Gunn, and Klebanov 1994), it is cumulative exposure to economic deprivation during childhood that harms children most, then we would expect that children from the long-term poverty group would achieve the least in early adulthood. If, however, as other research suggest (Duncan et. al. 1998), it is exposure to economic disadvantage in early childhood that is most damaging, we would expect children from both the long-term poverty group and the moving out of poverty group to suffer low achievement. If, on the other hand, as still other research suggest (Dearing, McCartney, and Taylor 2001; Galambos and Silbereisen 1987; Moore et. al. 2002), it is declining family economic circumstances that are most

detrimental to children, we would expect children from the moving into poverty group to achieve the least in early adulthood.

As expected, young adults from more advantaged families, on average, achieve more than young adults from less privileged families. Young adults from families with the least exposure to economic deprivation (i.e., the non-poor group) achieve more education and work more at age 25. These children are estimated to complete, on average, 13.5 years of education. Nearly 85% of these young adults employed at age 25. Children in the other groups, by contrast, on average attain 12 years of schooling or less and have employment rates between 60% and 75%.

The negative effects of extended exposure to economic deprivation during childhood on subsequent achievement are evident from the estimated coefficients in Table 4. Young adults from the long-term poverty group attain the least education and have the highest unemployment rate. On average, this group of young adults completes only 11.7 years education by the time they are 25 years old and just over 60% of them are employed at age 25.

Early adulthood achievement in the two other groups – the moving out of poverty and moving into poverty groups – falls between these extremes. Though overall achievement levels in these two groups are quite similar, young adults in the moving into poverty group, on average, appear to achieve slightly more in early adulthood than young adults from the moving out of poverty group, suggesting that poverty in early childhood more be more important to subsequent achievement than overall trends in family economic conditions. The typical young adult from the moving out poverty group completes 11.9 years of education by age 25, while the typical young adult from the moving into poverty group attains 12.2 years of schooling. Similarly, while only 72.1% of young adults in the moving out of poverty group are employed at age 25, 76.2% of young adults in the moving into poverty group are.

Discussion

Recent research suggests that family economic trajectories have important implications for child development and achievement. Children who are exposed to economic disadvantage for an

extended period of time have worse outcomes than children who are only exposed to economic deprivation for only a short time period (Duncan, Brooks-Gunn, and Klebanov 1994). It is, moreover, not only the duration and magnitude of exposure to disadvantage that affects child well-being and development, it is also the timing and sequencing of disadvantage in a child's life. Economic deprivation in early childhood appears to have worse effects than disadvantage later in childhood (Brooks-Gunn and Duncan 1999). Children in families whose economic circumstances are deteriorating seem to fare worse than children in families whose economic circumstances are stable or improving (Dearing, McCartney, and Taylor 2001; Galambos and Silbereisen 1987; Moore et al. 2002).

Traditional measures of economic deprivation – such as, permanent and transitory income and poverty, persistent or cumulative poverty, and the number and length of poverty spells – fail to capture these important dimensions of economic disadvantage. Measures of permanent income or poverty, which average income or poverty status over a number of years, "average out" any systematic changes in income. Measures of cumulative or persistent poverty, which examine cumulative exposure to poverty, ignore whether families are moving into, out of, or into and out of poverty. Poverty spell measures, too, tend to neglect how family economic circumstances are changing over time. None of these measures distinguishes economic deprivation early in childhood from deprivation later in childhood or adolescence.

In this paper we propose a new approach to assessing children's exposure to economic disadvantage that focuses on their risk and changes in their risk of exposure to economic deprivation over the course of their childhood. This new method, which is based on recent advances in mixture modeling, classifies children into a limited number of groups with similar risk profiles. This approach offers several advantages over alternatives. First, it allows us to identify rather assume distinctive groups of children with similar histories of exposure to economic deprivation. Second, the technique makes it possible to estimate the proportion of children who experience each of the identified patterns. Thirdly, it allows us to relate the probability of group membership to individual and family characteristics, allowing us to investigate how different

characteristics have different effects on children's patterns of economic deprivation. And, finally, it allows us to examine the association between group membership and childhood or early adult outcomes, facilitating direct testing of alternative theories about the effects of different patterns of exposure on achievement and well-being.

We demonstrated the use of these techniques using data from the Panel Study of Income Dynamics. Our analysis identified four groups of children with distinctive histories of exposure to economic deprivation. Children in the first group, which we have labeled the *non-poor*, have very little risk of ever living in poverty. Children in the second group, which we have labeled the *long-term poor*, have a very high risk living in poverty in any given year. Children in the two other groups have variable risks of living in poverty over the course of their childhood. Children in the third group, which we have referred to as the *moving out of poverty* group, begin life with high risks of exposure to economic disadvantage; however, as these children age their risks of exposure to deprivation precipitously drops. Children in the fourth group, which we have referred to as the *moving into poverty* group, follow the opposite trajectory: they start life with modest risks of living in poverty, but over the course of their childhood their risk of exposure sharply rises. Seven of every ten children are estimated to experience the non-poor trajectory. Less than 8% of children are expected to experience the long-term poverty trajectory. Roughly 10% of children experience each of the trajectories of change.

Results from our examination of the correlates of group membership both parallel findings from previous studies on the determinants of childhood poverty and shed new light on how family characteristics affect patterns of exposure to economic deprivation. Consistent with previous studies we find that children in larger families and in families headed by an African American, a female, a high school dropout, or an unemployed person are more likely to be poor. We, however, also find that different family characteristics have different effects on children's patterns of exposure, shedding new light on nature of childhood disadvantage. For example, we find that children in families headed by African Americans are much more likely to be exposed to significant, extended, and rising levels of economic deprivation during their childhood and that children in

families headed by women are more likely to experience deteriorating economic circumstances. By contrast, we find that children in families headed by high school dropouts and unemployed persons are more likely to experience a more generalized increase in economic deprivation, with heightened risk of falling into any of the disadvantaged trajectory groups.

Our examination of the relationship between group membership and early adulthood achievement reveals the negative impact that extended exposure to economic disadvantage and –to a lesser extent – deprivation in early childhood has on achievement. Children with long-term exposure to economic disadvantage during childhood attain considerably less education and are much less likely to be employed at age 25 years old than children from more advantaged circumstances. Somewhat unexpectedly, children raised in families with deteriorating economic circumstances (i.e., moving into poverty group) appear to have slightly higher achievement than do children raised in families with improving economic circumstances (moving out of poverty group), potentially reflecting the deleterious effects of economic deprivation in early childhood (Brooks-Gunn and Duncan 1999). This finding warrants further investigation and replication.

This research has demonstrated the use of a new method of assessing children's exposure to economic deprivation. This method has enabled us to empirically identify a limited number of groups of children with very different histories of exposure to economic deprivation. The groups identified by the model were intuitively, theoretically, and substantively meaningful. This new approach to assessing children's exposure to economic disadvantage has shed new light on the nature of childhood disadvantage, revealing how some of the traditional determinants of childhood poverty are associated with very different patterns of exposure to economic deprivation during childhood. It has also enabled us to evaluate the effect that different patterns of economic deprivation have on achievement in early adulthood.

In addition to replicating these preliminary findings with other data, future researchers using these techniques will want explore the effects of time-varying factors, such as changes in family structure or occupational mobility, on the group membership. Another fruitful avenue for future

research using these techniques will be to examine how important life events, such as divorce, illness, or job loss, affect group membership.

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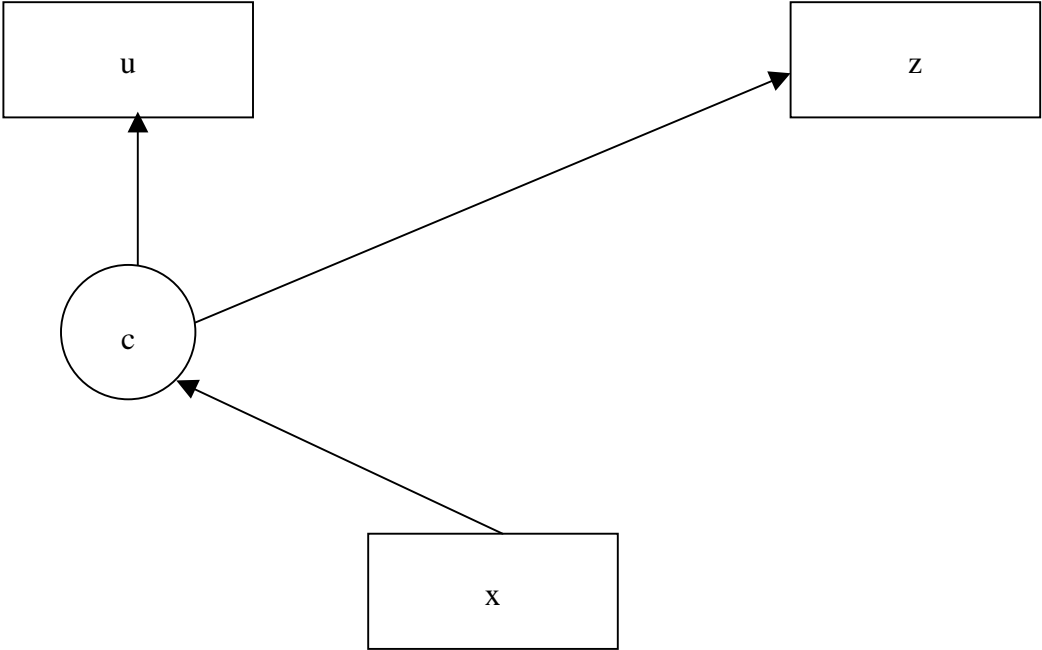
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Figure 1: General Modeling Framework

Table 1: Means (Weighted) and Standard Errors for Variables Used in the Analysis

Variable	N	Mean	S.E.
Poverty Status			
1968	2,386	0.176	0.008
1969	2,310	0.164	0.008
1970	2,263	0.172	0.008
1971	2,218	0.171	0.008
1972	2,163	0.158	0.008
1973	2,120	0.129	0.007
1974	2,080	0.177	0.008
1975	2,025	0.185	0.009
1976	1,975	0.165	0.008
1977	1,942	0.155	0.008
1978	1,910	0.153	0.008
1979	1,861	0.131	0.008
Family Characteristics			
Family head African American (in 1968)	2,376	0.155	0.007
Female-headed family (in 1968)	2,386	0.108	0.006
Number of children in family (in 1968)	2,386	3.227	0.039
Head high school dropout (in 1968)	2,361	0.408	0.010
Head unemployed (in 1968)	2,386	0.112	0.006
Early Adulthood Achievement			
Years of education (age 25)	1,176	13.111	0.059
Employment status (age 25)	1,189	0.814	0.011

Table 2: Results for Conditional[a] Longitudinal Latent Class Models with Different Numbers of Latent Classes

	Two classes	Three Classes	Four Classes	Five Classes
Sequential Model Comparisons (k classes vs. $k + 1$ classes)	2 vs. 1	3 vs. 2	4 vs. 3	5 vs. 4
Vuong-Lo-Mendell-Rubin log-likelihood value for model with $k + 1$ classes	-7,114.319	-6,654.443	-6,396.960	-6,294.602
Vuong-Lo-Mendell-Rubin log-likelihood value for model with k classes	-11,146.926	-7,114.319	-6,654.443	-6,396.960
-2 difference in log-likelihood	8,065.214	919.753	514.966	204.715
Difference in number of parameters (k classes vs. $k + 1$ classes)	18	18	18	18
Vuong-Lo-Mendell-Rubin log-likelihood p value (k classes vs. $k + 1$ classes)	<0.001	<0.001	<0.001	0.445
Lo-Mendell-Rubin adjusted likelihood ratio test value	8,007.903	913.217	511.306	203.260
Lo-Mendell-Rubin adjusted likelihood ratio p value	<0.001	<0.001	<0.001	0.447
Information Criterion				
Akaike's Information Criterion	14,288.638	13,404.885	12,925.920	12,757.205
Bayesian Information Criterion	14,461.516	13,681.490	13,306.251	13,241.263
Sample-size adjusted Bayesian Information Criterion	14,366.200	13,528.984	13,096.556	12,974.378
Entropy	0.936	0.918	0.909	0.894

[a] Class antecedents include race of the head, sex of the head, number of children in the family, head's education, and head's employment status in 1968.

Figure 2: Estimated Probability of Living in Poverty for Four-Class Longitudinal Latent Class Model of Poverty Exposure, By Class and Year
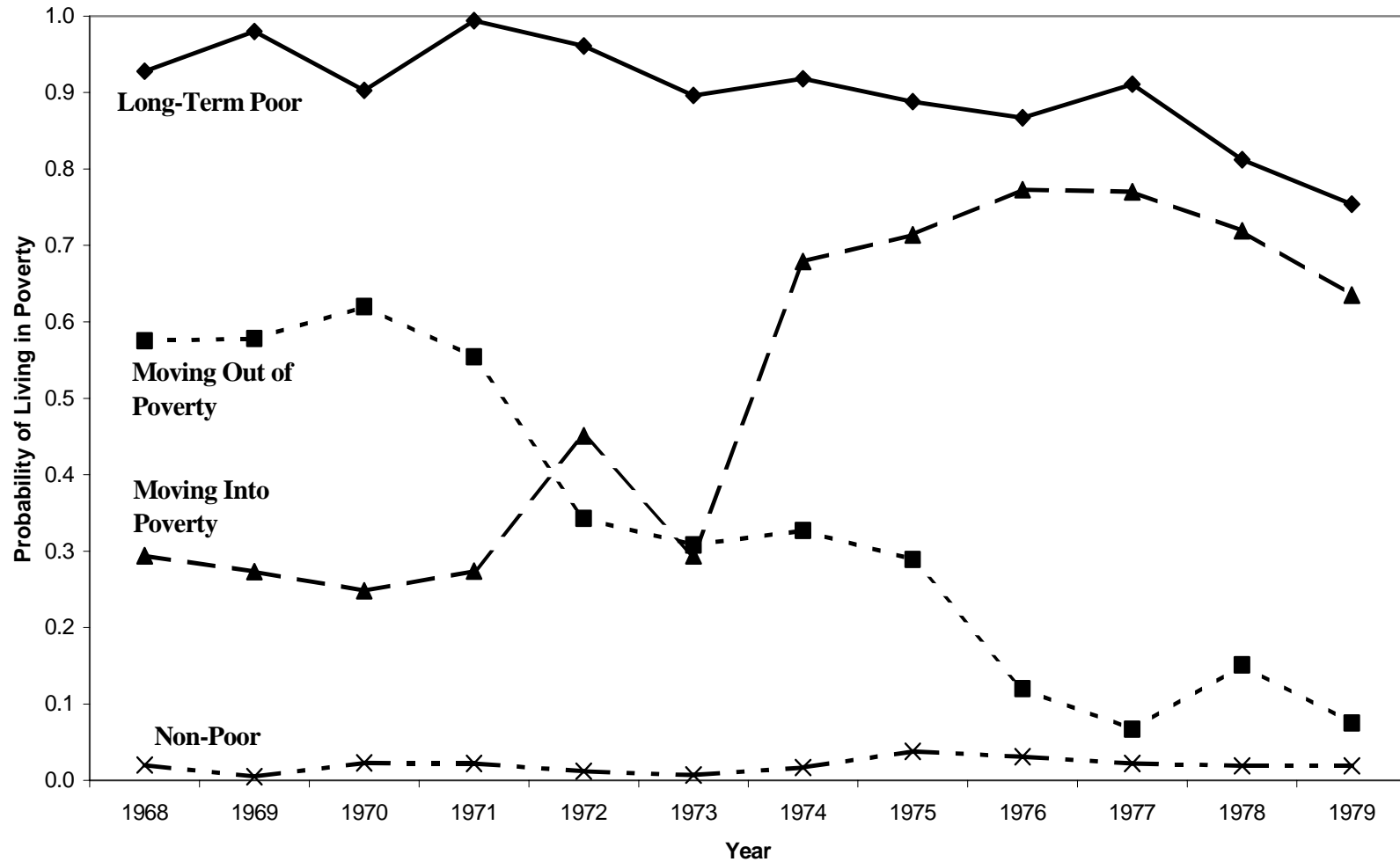
Table 3: Multinomial Logistic Regression Coefficients for Model Predicting Latent Class Membership

Variable	Long-Term Poor	Moving Out of Poverty	Moving Into Poverty
Intercept	-8.528***	-4.454***	-3.513***
	(0.466)	(0.396)	(0.309)
Race			
African-American Head	2.946***	1.110***	1.746***
	(0.277)	(0.266)	(0.223)
Family Structure			
Female Head	0.571	0.597	1.011***
	(0.389)	(0.396)	(0.275)
Number of Children	0.853***	0.426***	0.094*
	(0.061)	(0.051)	(0.041)
Education			
Head High School Dropout	1.649***	1.452***	1.448***
	(0.293)	(0.218)	(0.239)
Employment Status			
Head Unemployed	3.431***	1.693***	1.500***
	(0.353)	(0.373)	(0.291)

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 4: Model Estimated Mean Education and Employment Levels at Age 25 Years Old, By Latent Class

Class	Education		Employment Status	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Long-Term Poor	11.733	0.163	0.616	0.055
Moving Out of Poverty	11.890	0.136	0.721	0.050
Moving Into Poverty	12.154	0.156	0.762	0.050
Non-Poor	13.488	0.067	0.849	0.012

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