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DEALING WITH MOVERS IN A LONGITUDINAL STUDY OF CHILDREN

J. M. Brick, Thanh Lê, and Jerry West[1]

ABSTRACT

The Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K) is a longitudinal survey of children sponsored by the U.S. Department of Education. Children were surveyed in kindergarten, first grade, and third grade and will be surveyed in fifth grade in 2004. Children who move from their original sample school to a different school are less likely to respond, more costly to interview, and a potential source of bias in the estimates. This paper describes the percentage of movers from year to year, and their characteristics are compared to children who do not move. The design and adjustment methods for handling movers are reviewed. The paper also discusses how subsampling movers and adjusting for mover nonresponse affect the survey goal of accurately characterizing the academic growth and experiences of children.

KEYWORDS: Mobility; Nonresponse Adjustment; Nonresponse Bias; Raking.

1. INTRODUCTION

A challenge facing longitudinal cohort studies is limiting sample attrition between and across waves of data collection. Attrition represents a potential source of bias in cross-sectional and longitudinal estimates produced from the survey data. While there are many factors that can contribute to sample attrition, a major contributor is the mobility of the sample. Over the life of the study, cases selected at baseline will move, and many may do so multiple times. Sampled cases that move between waves of data collection are more difficult to locate and contact, and cooperate at a lower rate than their counterparts who did not move (Laurie et al. 1999; Lepkowski and Couper 2002). The cost of fielding these cases is usually much higher than the cost of fielding a nonmover case. As a consequence, longitudinal researchers, survey managers, and survey statisticians consider design and statistical adjustment methods to lessen the adverse effect of movers on the quality and cost of the study.

This paper describes the patterns of mobility and examines the characteristics of movers compared to those who do not move in the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K), a U.S. longitudinal study of young children, their families, and early schooling. As discussed below, the magnitude of the number of movers in this longitudinal survey differs from that found in typical household longitudinal surveys. We describe the design and adjustment methods used to address the challenge presented by movers in the ECLS-K. The utility of these methods in offsetting the negative effect movers may have on the survey goal of accurately characterizing the academic growth and experiences of these children is also evaluated.

The ECLS-K is being conducted for the National Center for Education Statistics, Institute of Education Sciences of the U.S. Department of Education by Westat. The study is designed to provide detailed information about children's early education very broadly defined at specific points in time (e.g., at the beginning of their school careers) and their growth and development in critical cognitive and noncognitive domains. The ECLS-K selected a nationally representative sample of 22,782 children who were attending 1,277 publicly and privately funded kindergarten programs in the United States in the fall of 1998. Kindergarten is the first year of school for most children in the

[1] J. M. Brick and Thanh Lê, Westat, 1650 Research Boulevard, Rockville, MD, 20850 U.S.A., Jerry West, National Center for Education Statistics, Institute of Education Sciences, 1990 K Street NW, Washington, DC, 20006, U.S.A. The views expressed in this paper are part of ongoing research and analysis and do not necessarily reflect the position of the U.S. Department of Education.

United States and roughly 85 percent of children attend public kindergartens (West et al. 2000). A dual-frame, multi-stage sample design was used to select the children with counties and groups of counties constituting the first stage, school/kindergarten programs the second stage, and children the third and final stage.

The study design includes direct one-on-one assessments of children's achievement in critical academic subjects (e.g., reading and mathematics), telephone interviews with the children's parents about the home and family life, and self-administered questionnaires that ask teachers and school officials about the children's classroom and school experiences and environments. To date, five waves of data collection have been completed (fall and spring of kindergarten, fall and spring of first grade, and spring of third grade), and a sixth wave is scheduled for Spring 2004 when most of the children are expected to be in fifth grade.

1.1 Movers in the ECLS-K

The specific definition of movers is rather unique to this study because several types of children could be considered to be movers in the ECLS-K sample. Children may change residences as their parents move from one place to another either locally or long distance (residential mobility). Children may also change schools during a single school year or between school years (school mobility). While the two often occur concurrently, this is not always the case. Children's families may move from one residence to another but the move does not involve crossing school boundary lines; thus, the child has changed residences but not schools. Children may also change schools (e.g., a child may move from one private school to another) even though their family has not changed residences. Children may change residences and/or schools once or several times between data collection waves. In this paper, we define movers as children who change schools between one data collection point and another for operational and analytic reasons discussed later. No attempt is made to document or estimate the number of moves that occur between waves. Thus, a child who changes schools once is treated the same as a child who changes schools several times between adjacent waves of the study.

A goal of the ECLS-K is to describe children's early educational experiences and the factors that promote positive gains in student achievement and school progress or that hinder children's ability to benefit fully from their educational experiences. One such factor is student mobility. Mobile children are more likely to experience behavior and academic difficulties (Alexander and Entwisle 1999). Frequent movers are more likely to perform below grade level than their peers who never moved (GAO 1994) and to demonstrate lower reading and mathematics achievement (Heinlein and Shinn 2000). Children who move often are nearly twice as likely to repeat a grade than children who do not move (Simpson and Fowler 1994).

Given that mobility is an identified risk factor in children's early school performance, it is important to include as many movers in the study as possible for later analysis. However, including children who move increases the cost of the study. Thus, the desire to "protect" the sample of movers for the entire longitudinal study, and the negative effect they can have on survey operations, costs, and data quality can create a tension between the substantive goals of the study and the methodological and statistical goals.

In the next section we describe the sampling and data collection procedures used in the ECLS-K to deal with movers and give the response rates for movers and nonmovers. In the third section we present data on the number of movers and the characteristics of the movers. In the fourth section the weighting procedures are reviewed and the effectiveness of these procedures for reducing nonresponse bias is examined. The final section summarizes some key findings and discusses general plans for handling movers in the last wave of the survey.

2. SAMPLING AND FOLLOWING MOVERS

In most household longitudinal surveys, persons who move from their household are more expensive to interview because of the additional resources associated with locating the persons and interviewing them at their new location. Movers in the ECLS-K must also be located, and the cost of doing this is similar to that incurred in household surveys. However, the ECLS-K has special requirements that make completing interviews for children who do not attend the same school they were sampled at even more difficult and costly. We estimate the ratio of the cost of

collecting data for a mover in the ECLS-K is approximately three times the cost of collecting data for a nonmover. See White and Huang (1982) for costs of movers in a household longitudinal survey.

One of the key features in the ECLS-K that makes it relatively expensive for collecting data on movers is that data are acquired from a variety of sources, including the school administrator and the teacher of the child. The goal is to complete the child assessment in the sampled child's school and to obtain the information to contact the appropriate school officials (administrators and teachers of the sampled children). Since most movers attend schools with no other sampled children, all of the cost of obtaining permission from the school officials at the district or diocese and school levels to conduct the assessments and administer questionnaires is borne by that one mover if only one child is assessed in the school. For nonmovers, the cost was already expended to do this in the base year and then it was spread over other sampled children in the school. The schools that participated in previous waves are already expecting to participate again, so enlisting them for the next wave is relatively inexpensive. In cases in which the new schools do not agree to participate, the child assessment may be done in the child's home, but this is more expensive than doing the work in the school. Furthermore, the school and teacher data are missing if the schools do not participate. Even when new schools do participate in the survey, the cost of going to a school to collect data for one child is greater than the cost of collecting data for a number of sampled children in the same visit.

The optimal statistical design to account for the higher cost of movers is to subsample them, but the importance of movers as a domain of analytic interest requires a large enough sample to be able to produce reliable estimates of movers. In the ECLS-K we developed subsampling procedures that tried to accommodate both objectives. The subsampling of movers in the ECLS-K contrasts with the handling of movers in some household longitudinal surveys such as the Survey of Income and Program Participation (SIPP) that follows all movers who stay within 100 miles of the primary sampling unit (PSU) and drops those outside this range (Kalton, Winglee, and Jabine 1998).

In the base year, about six percent of children sampled moved between the first (fall) and second (spring) wave of data collection. All the children were included in the sample for the spring-kindergarten collection irrespective of whether they moved. In wave 4 (spring-first grade) all children in a random 50 percent subsample of base year schools were followed for data collection if they transferred from their base year school. This procedure was different from that used in wave 3 (fall-first grade), but since that wave only included a 30 percent subsample from the base year we do not discuss those procedures here. To maximize the amount of longitudinal data, care was taken during wave 4 to ensure that any mover subsampled in wave 3 was included.

Except for children who were repeating kindergarten, all base year children sampled in schools with a high grade of kindergarten are de-facto movers. Since many of these movers may move en masse to the same first grade school, special procedures were developed for these children. Using the information collected during spring-kindergarten, a list of destination schools was compiled for each terminal kindergarten school. The destination school having the most movers was designated as primary, provided the school had more than three movers. Children who moved en masse into a primary destination school in first grade were not considered movers. This procedure recognizes that the cost of collecting data for a child in destination schools is much closer to the cost in original schools than it is for those that move to schools without other sampled children.

Most of the same procedures were used to subsample movers between waves 4 and 5 (spring-third grade). The mover subsampling targeted the same 50 percent of children from the base year schools. In addition, children whose home language was not English and who moved between wave 4 and wave 5 were all retained rather than being subsampled at the 50 percent rate. Language minority children who were already subsampled out in wave 4 did not reenter the sample in wave 5. This modification was designed to increase the sample of children whose home language is not English for analytic purposes.

The following data collection strategies were used to decrease data collection costs for movers, while providing as much information as possible about the movers for analytic uses. The strategies included:

- Complete data collection was attempted for movers who moved into cooperating sampled schools or nonsampled schools in cooperating ECLS-K school districts or dioceses.
- Parent interviews were attempted regardless of children's mover status.
- Child assessments were attempted in the home for children who moved into schools that refused, districts that refused, schools in nonsampled districts or dioceses within primary sampling units (PSUs), or children

who were not in school but remained in sampled PSUs (e.g., home schooled children). School and teacher data were not collected for these children.

No child assessment, teacher or school data were collected for children who moved into schools in nonsampled districts or dioceses outside sampled PSUs, or children who were not in schools and were outside of sampled PSUs.

The data collection methods had different consequences for the weighted response rates for the different sources of data. In wave 5, child assessments were completed for 61 percent of movers and 95 percent of nonmovers; parent interviews were completed for 68 percent of movers and 85 percent of nonmovers; teacher data were collected for 36 percent of movers and 82 percent of nonmovers; and, school administrator questionnaires were completed for 37 percent of movers and 87 percent of nonmovers. These different response rates raise concerns about nonresponse bias. Before we examine nonresponse bias, we describe the magnitude of movers in the ECLS-K and the characteristics of the movers since these are other factors that affect the potential for nonresponse bias.

3. DESCRIPTION OF MOVERS

Table 1 shows that approximately 42 percent of the children who participated in the base year of the study moved at least once between the base year (kindergarten) and spring-third grade (wave 5). The estimates were developed using the weights (inverse probability selection) for the children in the base year after adjustment for base year nonresponse. No adjustments for later waves are included. While about six percent of the children moved between the fall and spring of the base year, about one-quarter (26%) changed schools between the base year and spring-first grade (wave 4) and roughly one-fifth (22%) changed schools between wave 4 and wave 5. The table also shows that just over half (52%) of the movers were subsampled and a fifth of those were identified as having moved outside their original PSU.

Table 1. Number of children in the ECLS-K who moved, by subsampling status and wave

	Sample size	Estimated percent*
Base year respondents	21,192	
Children who moved during K	1,259	6
Base year respondents eligible in 1st grade	21,136	
K-1st grade movers	5,441	26
Subsampled K-1st grade movers	2,591	46
Base year respondents eligible in 3rd grade	21,074	
1st-3rd grade movers	4,585	21
K-3rd grade movers**	8,859	42
Subsampled K-3rd grade movers	4,742	52
Unlocated subsampled K-3rd grade movers	614	13
Subsampled K-3rd grade movers who were out of sampled PSUs	868	20

* Percent was computed using base year weights that were adjusted only for base year nonresponse.

** Children with multiple moves between K and 3rd grade are only counted once.

Source: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 1998–99.

The percentage of children who moved in the ECLS-K is much larger than found in household longitudinal surveys. For example, Allen and Petroni (1994) estimated that about 20 percent of the SIPP persons were movers, while White and Huang (1982) estimated that about 23 percent moved in the Income Survey Development Program. Households with children would be a better comparison group, but we could not find published estimates for household longitudinal surveys that gave mover rates for this type of household. The large percentage of movers in the ECLS-K indicates that this is a source of potential bias that must be carefully considered.

Table 2. Characteristics of children who moved and did not move in ECLS-K

Characteristic	Base year respondents		Percent difference from base year respondents					
			KG to first grade		First grade to third grade		KG to third grade	
	Sample size	Percent*	Nonmovers	Movers	Nonmovers	Movers	Nonmovers	Movers
Sex								
Male	10,830	51.5	-0.1	0.2	-0.5	1.9	-0.5	0.7
Female	10,349	48.5	0.1	-0.2	0.5	-1.9	0.5	-0.7
Race/ethnicity								
White, non-Hispanic	11,723	57.6	2.1	-5.5	2.4	-8.3	4.3	-5.6
Black, non-Hispanic	3,204	16.1	-1.2	3.5	-1.6	5.9	-2.9	4.1
Hispanic	3,732	18.9	-0.8	2.1	-0.6	1.8	-1.2	1.4
Asian/Pacific	1,575	3.5	0.1	-0.3	-0.1	0.2	0.0	0.0
Other	888	3.9	-0.1	0.3	-0.1	0.5	-0.2	0.2
SES Quintile								
First (lowest)	3,754	20.1	-1.4	3.8	-1.0	3.7	-2.2	3.0
Second	3,893	20.3	0.1	-0.3	-0.4	1.5	-0.5	0.7
Third	3,968	20.1	0.2	-0.4	0.0	0.0	0.3	-0.4
Fourth	4,130	19.8	0.6	-1.6	0.4	-1.4	0.8	-1.1
Fifth (highest)	4,346	19.8	0.5	-1.5	1.0	-3.8	1.5	-2.2
Language Minority Family								
Yes	2,759	12.2	0.0	-0.3	-0.2	-0.1	0.0	-0.4
No	17,198	87.8	0.0	0.3	0.2	0.1	0.0	0.4
Location								
Urban (central city)	8,737	37.1	-2.0	5.3	-2.1	7.3	-4.5	5.9
Suburban	8,174	41.6	0.6	-1.5	0.3	-0.9	0.8	-0.9
Rural	4,281	21.3	1.4	-3.8	1.8	-6.4	3.8	-5.0
Minority Enrollment								
Less than 25%	10,030	48.0	2.7	-7.3	3.1	-11.1	6.0	-8.0
25-49%	3,364	17.5	-1.0	2.9	-0.6	2.3	-1.6	2.1
50-74%	2,283	12.3	-0.7	2.0	-0.5	2.0	-1.6	2.2
75% or more	4,985	22.3	-0.9	2.4	-1.9	6.8	-2.8	3.7

*Percent was computed using base year weights that were adjusted only for base year nonresponse.

Source: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 1998–99.

Table 2 gives some characteristics of the movers and compares these characteristics to those of nonmovers. Compared to base-year participants as a whole and to nonmovers specifically2, movers were more likely to be Black or Hispanic, and less likely to be White. Movers were more likely to be from families in the bottom 20 percent and less likely to be from families in the top 20 percent of the socioeconomic (SES) distribution.3 Children who moved were more likely to have attended base-year schools located in central cities compared to base-year participants and nonmovers. Children who moved were less likely to have attended base-year schools in rural areas. Movers were also less likely to have attended schools with low concentrations of minority children (less than 25% minority enrollment) and more likely to have attended schools with high concentrations of minority children enrolled (75% or more minority enrollment).

[2] All the differences noted are statistically significant at the 95 percent confidence level.

[3] Socioeconomic status is a composite variable derived from the following variables: mother/female guardian's education, father/male guardian's education, mother/female guardian's occupation, father/male guardian's occupation, and household income (see NCES 2001, Chapter.7).

These patterns existed for both children who moved between kindergarten and first grade, and those who moved between first and third grades. However, some of the differences were larger for first to third grade movers than for kindergarten to first grade movers. For example, the difference in the percent of movers versus nonmovers who are Black increased from 4.7 percent (kindergarten to first grade) to 7.5 percent (first to third grade). The difference in the percent of movers versus nonmovers who attended high poverty schools (schools with 75% or more minority children enrolled) increased from 3.3 percent to 8.7 percent. We expected these differences might be more pronounced in the latter wave because the kindergarten to first grade movers often have different reasons for changing schools that are not as related to residential mobility or problems adjusting to the school. For example, if an individual child (as opposed to all the children in a program) attended kindergarten in a school that did not have a first grade, they would be a mover but this is not related to residential mobility.

In household longitudinal surveys, the same general patterns as noted above are often found. For example, Kalton, Winglee, and Jabine (1998) found lower SES persons were more likely to move, and Hendrick (1996) proposed nonresponse weighting cell adjustments based on mover status to reduce nonresponse bias due to moving.

4. STATISTICAL ADJUSTMENT METHODS AND EVALUATION

In this section we describe the weighting procedures used in the ECLS-K and examine the effectiveness of these procedures in compensating for attrition nonresponse. We begin with a brief summary of the procedures used to produce the cross-sectional weights for the fifth wave (third grade) of the ECLS-K. The longitudinal weighting followed similar methods. The initial weights used for developing weights for the wave 5 respondents were the final weights of the base year respondents because all eligible children are retained across waves if they responded in the base year. The base year weights were the inverse probability selection weights adjusted for nonresponse at the school and child level. No control totals of sufficient quality were available for poststratification. The initial weights were adjusted to account for the subsampling of children who moved between the base year and wave 5. The next step in weighting was a nonresponse adjustment that included separate classes for movers and nonmovers.

The final weighting step for wave 5 was raking the weights to sample-based control totals computed using the initial child weights. The dimensions used in the raking were: 1) gender by age, 2) region by locale, 3) race/ethnicity by SES quintile, 4) school type, 5) language minority status, and 6) mover status in spring-first grade. These dimensions were selected because they were important analytic variables, especially for domain estimates, and were correlated with response rates. The variables used as controls in raking were examined for each wave of the follow-up and modified if deemed necessary, but for consistency new dimensions were not added unless they were very important. The one dimension added in wave 5 was wave 4 mover status.

The methods used above are not novel, but we have not found published literature on the effectiveness of the sample-based raking in this context. Rizzo, Kalton, and Brick (1996) explicitly consider sample-based raking for the SIPP, but that survey has several features that are different from the ECLS-K. In particular, the SIPP weights are poststratified to known population totals in the base year and that may mitigate the nonresponse adjustment effects. The ECLS-K weights are not poststratified. Furthermore, Rizzo et al. (1996) do not fully consider the variance implications of the nonresponse adjustment method because of the effect of the poststratification.

4.1 Evaluating the Mean Square Error Estimates

We examine the effect of nonresponse due to attrition in the ECLS-K by comparing estimates from the base year respondents to estimates computed using only respondents in wave 5 with their appropriate weights. This method is related to the methods used in the base year of ECLS-K by Brick and Bose (2001) and in the first grade by Bose and West (2002). The idea is to assess attrition bias by isolating the effect of attrition from the other sources of differences in the estimates. To do this, the same base year data are used, and the only differences are in the survey weights and the smaller number of respondents available in wave 5. This method gives a direct and easily interpreted measure of nonresponse bias due to the additional nonresponse arising from the loss in the sample size since the base year.

The base year weight is used to estimate characteristics for the base year respondents. The form of the estimate is $\hat{y}_{by} = \sum w_i y_i$, where w_i is the base year weight adjusted only for base year nonresponse for respondent *i* and y_i is the value reported in the base year for respondent *i*. The number of respondents for the base year estimate is 21,192 children. The wave 5 estimate is computed using only the respondents in wave 5, and is written as $\hat{y}_{3rd} = \sum w_i^* y_i$, where w_i^* is the wave 5 weight, y_i is the value reported in the base year for respondent *i* as defined above, and the sum is over all wave 5 respondents.

Attrition bias is estimated by the difference between the wave 5 estimate and the base year estimate, namely $b_{3rd} = \hat{y}_{3rd} - \hat{y}_{by}$. This is a direct estimate of the attrition bias in the third grade estimate since it uses the same responses, the observed third grade respondent set, and the weights used to produce third grade estimates. The most serious limitation of b_{3rd} as an estimate of bias is that the true bias should be based on third grade responses rather than base year responses. Of course, such a statistic is not available, but b_{3rd} is a very useful alternative. Since the ECLS-K collects data from different sources and produces weights to support analyses of the data from these sources, the third grade estimates were produced using the three different cross-sectional weights developed for wave 5. These are a child assessment (14,349 respondents), a parent interview (13,392 respondents), and a child-parent-teacher (CPT) weight (10,332 respondents). The CPT weight requires the child assessment, the parent interview, and the teacher interview all be completed for the case to be considered a respondent. Since this weight compensates for the greatest amount of nonresponse, we focus most of our attention on the estimates produced using the CPT weight.

For the evaluation we selected 50 characteristics of the children (percentages and means) and 13 assessment scores from the base year data. For each statistic we then computed the wave 5 estimate, its variance $\left(\text{var}\left(\hat{y}_{3rd}\right)\right)$, bias $\left(b_{3rd}\right)$, relative bias $\left(rb_{3rd} = 100 \times b_{3rd} / \hat{y}_{by}\right)$, and estimated root mean square error $\left(rmse_{3rd} = \left(\text{var}\left(\hat{y}_{3rd}\right) + \max\left[0, b_{3rd}^2 - \text{var}\left\{b_{3rd}\right\}\right]\right)^{-2}\right)$. To evaluate sources of error, we computed the same statistics for different sets of respondents. To isolate the effect of subsampling we computed statistics called $\hat{y}_{sub}$ that excluded movers who were not subsampled (17,028 respondents). To isolate the effect of mover subsampling with mover nonresponse, we computed $\hat{y}_{mov}$ (15,762 respondents) that excluded movers not subsampled and nonresponding movers. Finally, we examined the effect of the sample-based raking by computing $\hat{y}_{-rak}$, which used the final wave 5 weight prior to the sample-based raking adjustment.

A summary of the evaluation statistics is given in Table 3. The first row gives the mean and median sampling error for the base year estimate. Since we only examine attrition bias from the base year, the attrition bias for this estimate is zero by definition. The next two rows give the mean and median evaluation statistics that address mover subsampling and mover nonresponse. Theoretically, $\hat{y}_{sub}$ should have no attrition bias because the weights are adjusted for the subsampling. Table 3 shows that both the mean and median biases for $\hat{y}_{sub}$ are smaller than the sampling error of the bias. However, subsampling greatly reduces the sample size and increases the variability in the weights. As a result, the sampling error and rmse for this estimate are greater than those for the base year estimates.

Table 3. Summary statistics for evaluation statistics of all estimates

CPT Estimate*	Mean				Median			
	b	*rb*	$se(\hat{y})$	*rmse*	*b*	*rb*	$se(\hat{y})$	*rmse*
$\hat{y}_{by}$			0.737				0.628	
$\hat{y}_{sub}$	-0.002	0.07%	0.788	0.804	-0.001	0.00%	0.700	0.759
$\hat{y}_{mov}$	0.031	-0.30	0.778	0.874	0.018	0.13	0.697	0.833
$\hat{y}_{-rak}$	0.208	-0.57	0.894	1.368	0.157	0.58	0.852	1.330
$\hat{y}_{3rd}$	0.245	0.38	0.851	0.911	0.033	0.52	0.834	0.846

*The column headings do not give the subscript. For example, $b_{3rd} = 0.245$.

Source: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 1998–99.

The median of the bias and relative bias for the $\hat{y}_{mov}$ estimates are not negligible, but these average biases are still small. On the other hand, the estimated rmse for these estimates are higher than for the estimates that only include mover subsampling.

The last two rows are for the estimates of third grade respondents—the penultimate row using weights without the sample-based raking and the last row using the final third grade weights that include the raking. First, we discuss the final third grade weights that include raking. The median relative bias is small (0.5%) for the CPT estimates. On the other hand, the sampling error and rmse of the estimates are substantially greater than the estimates that only exclude the subsampled cases $(\hat{y}_{sub})$ due to the loss in sample size from nonresponse. However, the rmse of the raked estimates $(\hat{y}_{3rd})$ is very similar to the rmse for the estimates for $\hat{y}_{mov}$, despite the fact that the sample size is much smaller (the sample size for $\hat{y}_{mov}$ is 15,762 and the sample size for $\hat{y}_{3rd}$ and the CPT weights is 10,332). We also examined the biases for the child assessment and parent interview weights that had larger numbers of respondents (not shown in table). As might be expected, the median biases and relative biases increase as the number of respondents decreases. Nevertheless, the relationships for all three sets of weights hold rather uniformly.

To examine the effect of the sample-based raking we compare the estimates in the last two rows of Table 3. The differences in the estimates suggest there is some improvement due to the raking (the median bias, relative bias, and rmse are all smaller for the raked estimates as compared to the unraked estimates), but the level of improvement is not obvious and may be confounded in the aggregation.

To assess the effect of the sample-based raking further, we computed the difference of the absolute values of the relative bias $(reldiff = |rb_{-rak}| - |rb_{3rd}|)$, and the ratio of the rmse's $(ratio = rmse_{-rak} / rmse_{3rd})$. If the reldiff is greater than zero for a particular estimate, then raking reduces the bias. Similarly, if ratio is greater than unity, then raking reduces the root mean square error of the estimate. Since some demographic data were used as controls in the raking, we present the reldiff and the ratios only for the assessment score estimates in the graphs below. Figure 1 shows the distribution of reldiff for the assessment score estimates; Figure 2 shows the distribution of ratio for the same estimates.

In Figure 1, 10 of the 13 absolute values of the relative biases of the score estimates are greater than zero, and the three negative values are all less than 0.5 percent. This figure shows the raking was effective at reducing the bias due to attrition. The ratios in Figure 2 indicate the raking was also effective in decreasing the root mean square errors of the score estimates, with 11 of the 13 estimates having ratios greater than unity.

Figure 1. Difference between absolute value of relative bias of unraked and raked estimates for estimates of scores using CPT respondents

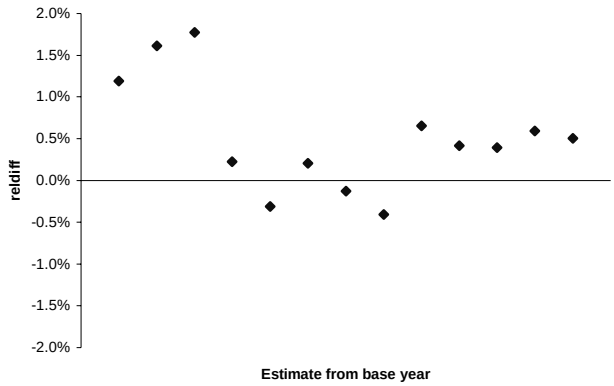
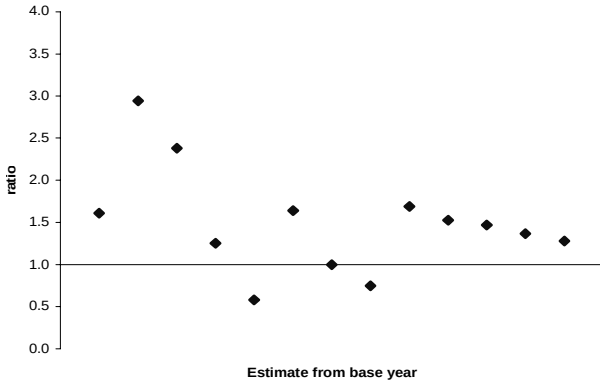


Figure 2. Ratio of root mean square error of unraked and raked estimates for estimates of scores using CPT respondents



Source: U.S. Department of Education, National Center for Education Statistics, Early Childhood Longitudinal Study, Kindergarten Class of 1998–99.

Generally speaking, the analysis revealed that despite the large losses in sample size due to movers and the potential for nonresponse bias, the biases due to attrition nonresponse in the estimates from the ECLS-K third grade sample were small. Subsampling movers did not introduce bias, but the lower response rate for the movers could have resulted in large biases. We found that the relative bias and rmse generally increased as the percentage of the base year children who responded decreased—the estimates using the child and parent respondents had very small biases, while the estimates using the CPT weights are larger. The evaluation also showed that sample-based raking the wave 5 estimates to the base year estimates generally decreased the bias of the estimates and reduces the rmse. Thus, the sample-based raking achieved the goal of reducing attrition bias and controlled the increase in the variance associated with the sample size losses from nonresponse.

5. SUMMARY

In this paper, we have reviewed the design and adjustment methods used in the ECLS-K to deal with the large percentage of children who moved during the course of this longitudinal study. Because the cost of following movers and collecting all the child assessment, parent interview, school and teacher data for movers is high, movers were subsampled. Subsampling greatly reduced the data collection costs and still provided enough data on movers to meet analytic requirements for this domain.

A very large percentage of the children in the ECLS-K were movers and the response rates for movers were much lower than the response rates for nonmovers. When these factors are combined with the differences in the characteristics of the movers and nonmovers, the potential for nonresponse bias is high. Despite this, we found that the nonresponse bias of the estimates from the third grade (wave 5) was relatively small. The use of a mover status category in the nonresponse adjustment weighting helped reduce the bias, and the sample-based raking to the characteristic of the base year children further reduced the nonresponse bias and variance of the estimates. Even when the percentage of cases that were considered respondents was small (using the CPT weights that required data from three different sources), the bias and root mean square error were small.

The ECLS-K was the first survey of this population and it was difficult to accurately estimate the percentage of children who would be classified as movers. This made it difficult to estimate data collection costs and the effects of

moving on the sample sizes. The operational data from this survey could be used in future surveys of this type to optimize the subsampling procedures. The ability to subsample differentially by the characteristics of the movers also provides the opportunity to achieve key substantive goals of the survey while controlling the overall cost.

As noted in the introduction, the sixth wave of data collection wave is scheduled for spring 2004 when most of the children will be in fifth grade. The specific procedures used for sampling movers in this wave will differ somewhat from those described in this paper for operational and substantive reasons. One issue that was re-evaluated for this wave is the cost and analytic value of continuing to attempt to interview base year respondents who have not responded in recent waves of data collection. As a result, this wave will exclude children who have neither first-grade nor third-grade data. In addition, children will be subsampled at different rates depending on the longitudinal data available from previous rounds. Children whose home language is not English will continue to be subsampled at higher rates. Once the full longitudinal study is completed, the new procedures can be evaluated.

One of the limitations of the current study is that the evaluation focused on estimates of all children and did not examine domain estimates. As noted earlier, some domains such as children who move, are of great interest. We plan to continue this research by examining the bias and mean square error associated with domains.

REFERENCES

Allen, T. and Petroni, R. (1994), "Mover Nonresponse Adjustment Research for the Survey of Income and Program Participation", *Proceedings of the Survey Research Methods Section, American Statistical Association,* pp. 662-667.

Alexander, K.L. and Entwisle, D.R. (1999), "Children in Motion: School Transfers and Elementary School Performance", *The Journal of Educational Research*, 90 (1), pp.3-12.

Brick, J.M., and Bose, J. (2001), "Analysis of Potential Nonresponse Bias", *Proceedings of the American Statistical Association, Survey Research Methods Section* [CD-ROM].

Bose, J. and West, J. (2002). "Examining Additional Nonresponse Bias Introduced Through Attrition", *Proceedings of the Survey Research Methods Section, American Statistical Association,* pp. 278-283.

General Accounting Office (1994), *Elementary School Children: Many Change Schools Frequently, Harming Their Education*, Washington, DC: US Printing Office.

Heinlein, L.M. and Shinn, M. (2000), "School Mobility and Student Achievement in an Urban Setting", *Psychology in the Schools*, 37 (4), pp. 349-357.

Hendrick, M. (1996), "The Creation and Evaluation of Longitudinal Nonresponse Cells for the 1996 Survey of Income and Program Participation", *Proceedings of the Survey Research Methods Section, American Statistical Association,* pp. 575-578.

Kalton, G., Winglee, M., and Jabine, T. (1998), *SIPP Quality Profile, 3rd Edition*, SIPP Working Paper Number 230, U.S. Department of Commerce, Bureau of the Census.

Laurie, H., Smith, R., and Scott, L. (1999), "Strategies for Reducing Nonresponse in a Longitudinal Panel Survey", *Journal of Official Statistics*, 15 (2), pp.269-282.

Lepkowski J. M. and Couper, M. P. (2002), "Nonresponse in the Second Wave of Longitudinal Household Surveys, in Groves, R. Dillman, D., Eltinge, J. and Little, R. (eds.) *Survey Nonresponse,* New York, NY: Wiley.

National Center for Education Statistics (NCES) (2001), *Early Childhood Longitudinal Study, Kindergarten Class of 1998-99: Base Year Public-Use Data Files User's Manual (NCES 2001-029, revised)*, Washington, DC: U.S. Government Printing Office.

Rizzo, L., Kalton, G., and Brick, J.M. (1996), "A Comparison of Some Weighting Adjustment Methods for Panel Nonresponse", *Survey Methodology*, 22, pp. 43-53.

Simpson, G.A. and Fowler, M.G. (1994), "Geographic Mobility and Children's Emotional/Behavioral Adjustment and School Functioning", *Pediatrics*, 93 (2), pp. 303-309.

West, J., Denton, K., and Germino, Hausken E. (2000), *America's Kindergartners*, NCES 2000-070, Washington, DC: National Center for Education Statistics.

White, G. and Huang, H. (1982), "Mover Follow-up Costs for the Income Survey Development Program", *Proceedings of the Survey Research Methods Section, American Statistical Association*, pp.376-381.